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Executive Summary

Executive Summary

Ports from all over the globe are committed to the protection of environment and are taking steps and endeavors to become clean, green and environment-friendly. They have the responsibility to adopt greener practices in regard to prevention of air, water and soil/sediment pollution. With these objectives in mind, Ministry of Shipping, Government of India desires that all Major ports should prepare their Environmental Management and Monitoring Plan (EMMP), which should comprehensively cover various aspects of environmental measures, Green Port measures as well as sustainability measures.

Marine ports are major hubs of economic activity and also one of the major sources of pollution. In particular, the following activities result in highly significant environmental, ecosystem and human health impacts :

- Number of ships with engines continuously running on pollution discharging fuels
- Thousands of diesel trucks per day
- Diesel locomotives hauling cargo and other polluting equipments

Major ports mainly handle containerized cargo, dry bulk like food grain, timber, coal, iron ore, china clay, cement, fertilizer, liquid cargo including POL (Petroleum, oil and lubricants). The cargo is stored at the port for transitory period and then evacuated to the destinations through rail road or pipelines.

The impacts of these port related activities mainly manifest in terms of deterioration of air, water and sediment/soil quality. They also increase the noise levels. Subsequently, they affect ecosystem as well as human health and thus can increase risk of illness, respiratory diseases or cancer etc.

Ports always undergo expansions so as to accommodate ever-increasing cargo volumes due to the continuous growth of international trade. Moreover, Marine ports

are one of the most poorly regulated sources of pollution releasing largely unchecked quantities of health-endangering air and water pollution, noise and light pollution. Ultimately, all these adversely affect the nearby communities, and harm even the marine habitats.

EMMP (Environment Management Monitoring Plan) is an effective tool to work on micro-level to identify and address various effects of port operations on the environment. Moreover, EMMP also helps in assisting and ensuring the effectiveness of the EIA process and implementation of the commitments made. EMMP is mainly aimed at minimizing various adverse impacts on environment. It is important that port authorities ensure that the cargo handling operations and other allied activities do not violate regulatory environmental standards and norms. At the same time, they should also adopt the necessary mitigation measures. Ultimately, EMMP acts as a comprehensive manual for environmental protection, reduction in carbon (GHG) emission and finally it helps in converting major ports into "Green Ports".

This report, inter alia, discusses solutions to port pollution problems and provides requisite information on the health and environmental impacts of port operations; an overview of policies governing marine ports; and detailed analysis for developing a green plan for ports' environmental management and monitoring. It focuses on the following main operations at the ports :

- Cargo handling at berths
- Stacking and handling of cargo at yards
- Evacuation of cargo

This report has been prepared on the basis of various international reports available on these ports and the data and information contained in those. Essentially, the report looks into (a) identification of sources of pollution and relevant monitoring plans in accordance with CPCB (Central Pollution Control Board)-standards, norms and guidelines; (b) corrective and preventive measures; (c) CRZ-notification and land use planning; (d) various developmental aspects; (e) national, international laws and treaties; (f) associated and relevant carbon and ecological footprints and various

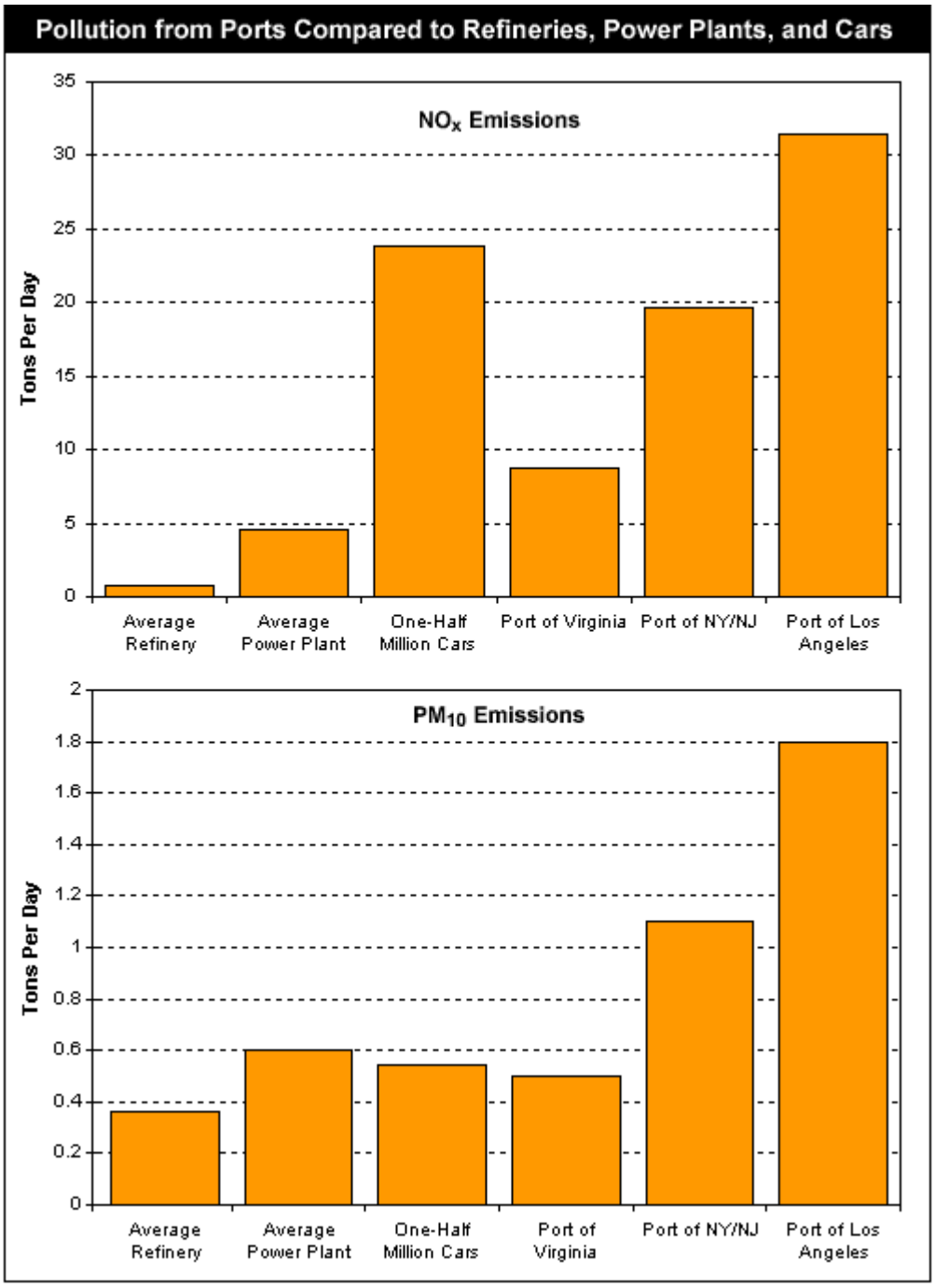
interrelated socio-economic (health, education, environmental awareness, costs and benefits etc.).

E.1 Air Pollution and Health Impacts from Port Operations

The diesel engines at ports power ships, trucks, trains, and cargo-handling equipments. However, at the same time they emit vast amounts of air pollution, which ultimately affects ecosystem-health as well as human health including that of workers and people living in nearby communities. By now several epidemiological studies have established that diesel exhaust increases cancer risks substantially. Many studies have linked diesel exhaust with asthma also. Major air pollutants from diesel engines at ports include particulate matter (PM), volatile organic compounds (VOCs), nitrogen oxides (NOx), and sulfur oxides (SOx).

As far as major health impacts of pollution from ports are concerned, they include asthma, various other respiratory diseases, cardiovascular disease, lung cancer, and premature death. In children, these may lead to increases in school absenteeism and emergency-hospitalization etc. There are numerous studies showing that children living near busy diesel trucking routes are more likely to suffer from decreased lung function, wheezing, bronchitis, and allergies. Many major ports are very close to residential neighborhoods, schools, and playgrounds. Therefore, due to close proximity to ports, nearby communities face much higher health risks from associated air pollution.

When compared with other air polluting sources (cars, power plants and refineries etc.), ports are expected to contribute significantly higher amounts of air pollutants as has been depicted in the following figure. This data is about USA. Nonetheless, it throws light on relative order of magnitude of emissions from various types of sources. And would therefore, help in developing appropriate environmental management plan. The significantly larger contribution of port-related sources to air pollution can mainly be attributed to the fact that pollution from cars, power plants, and refineries is somewhat controlled, whereas port pollution has almost no regulatory control.



Source : http://www.nrdc.org/air/pollution/ports/execsum.asp

E.2 Water Pollution from Port Operations

Waste water and leaking of toxic substances from ships, storm water runoff, and dredging happen to be the major water quality concerns at ports. This would

subsequently damage marine life and associated ecosystems, as well as human health through bacterial and viral contamination of commercial fish and shellfish, depletion of oxygen in water, and bioaccumulation of certain toxins in fish.

E.3 Land Use Problems at Ports

Ports have many land-use issues. Their location with respect to residential area finally decides the magnitude and direction of various impacts. So a site-specific and appropriate land-use-planning is not only essential, but also crucial from environmental management point (EMP) of view. Ports are often in close proximity to residential areas, creating nuisance and hazards for nearby communities.

E.4 Noise and Light Pollution

Ports can be loud, ugly, and brightly lit all through the night. The impacts can range from simple annoyances to serious negative health effects. Noise pollution has been linked to hearing impairment, hypertension (high blood pressure), sleep deprivation, reduced performance, and even aggressive behavior. Bright and flashing lights at night can disrupt biological rhythms and cause stress and irritation. Ports can also be bad neighbors by ignoring residents of the communities living next door, or making little or no effort to solicit community input into operational decisions that will directly affect the life of the community and its residents. They may ignore residents of nearby communities, and may not share critical information about possible effects of port operations.

E.5 Some Significant Indicators

Following parameters can form an indicator-group for estimating the overall environmental impact of ports :

- Over loading with trucks in the freeways and neighborhood streets
- No. of surrounding homes coated with soot
- Asthma rates in the neighborhood
- Containers stacking

- Amount of dredged sludge forming toxic islands
- Impact on important marine animal habitats

E.6 Recommendations for Ports

In order to protect local population and environment, the ports must commit to implement appropriate management plans (EMP), not only during expansions but also during regular operations. By following appropriate measures, the ports worldwide would be able to successfully decrease impacts on local communities and ecosystems. Moreover, local activists should be made aware of these options so that they can advocate their implementation. Ports should also consider the use of cleaner fuels and equipment as most effective mitigation options.

E.6.1 Marine Vessels

- The Mumbai Port Trust should expedite implementation of stricter emission standards for all marine vessels within two years and should also ensure that more polluting ships pay higher fees upon entering a port.
- There should be financial incentives for the cleanup and replacement of older marine vessels.
- Ships should use low-sulfur diesel
- Regional authorities should monitor and enforce ship speed limits.
- Engine repower and retrofit programs for cleaning up harbor craft, such as tugboats
- By providing electric power at docks and "plugging-in" ships and tugboats to shore side power while at berth, one can limit idling of ocean-going vessels and tugboats
- Using the cleanest grade of diesel fuel possible, with low sulfur content for ships and ocean-going vessels.
- Emission controls on ocean-going vessels

E.6.2 Cargo-handling Equipment

- Replace obsolete equipment (i.e. more than 10 years old) with the cleanest available equipment and fuel choices, preferably alternative fuels.
- Retrofit [with diesel particulate filters (DPFs) with lean NOx catalysts (LNCs) or with diesel oxidation catalysts (DOCs)] other (relatively younger) equipment i.e. less than ten years old to run on the best available control technology,
- Switch to cleaner diesel fuels, such as low-sulfur fuel

E.6.3 On-road Trucks and Locomotives

- Replacement of older (high emitting) trucks with newer (low emitting trucks) by incentivizing the scheme
- Offer incentives for installing appropriate pollution control measures, viz., DPFs with LNCs or DOCs.
- Make cleaner fuels, such as diesel emulsions or low-sulfur diesel, available to off-site trucks.
- Minimize truck idling by enforcing idling limits or by installing idle shut-off controls.
- Replace all locomotives that do not meet environmental standards with electric-hybrid or alternative-fuel engines
- Install and use engine emission-controls wherever possible
- Provision for automatic engine shutoff controls to minimize unnecessary idling
- Use of cleaner fuels

E.6.4 Storm-Water Management

- There should be a proper storm-water management plan for preventing spread of pollution
- Regular oversight and inspections of individual terminals

- Education and training of terminal staff
- Regular water quality monitoring, and adoption of best management practices for prevention, control, and treatment of storm water runoff.
- Traffic management for pollution mitigation through appropriate land-use; light-management, noise abatement; and improved aesthetics
- The effluent guidelines require a general baseline level of pollutant reduction
- Authorities should give special attention to the development of total maximum daily pollution-loads (TMDLs)

E.6.5 On-road and Off-road Vehicles

- The Mumbai Port Trust should follow the full implementation of emissions standards for on-road, heavy-duty trucks and the related lower sulfur diesel requirements. There should be a cleanup schedule for existing polluting diesel engines.
- There should be incentive programs to reduce pollution from heavy-duty diesel engines, regional authorities should sponsor such programs.
- Regional authorities should adopt fleet rules to clean up and require new, cleaner purchases of all heavy-duty engines

E.6.6 Inland Cargo Transport and Locomotives

- Fees should be charged from each container entering a port to provide funding for mitigation of the environmental impacts of moving those containers.
- There should be a sustainable transportation system program, facilitating the shift of cargo transport from more polluting modes (such as trucking) to cleaner locomotive and barge transport.
- There should be financial incentives for the cleanup and replacement of older locomotives.

E.6.7 Land Use and Community Participation

- Port authorities should work together with local communities and marine terminals to improve efficiency and land use and to minimize impacts of terminals on local communities.
- Neighboring states should work together in coastal alliances to protect their marine natural resources and to share information on programs and technologies.

E.6.8 Oil Spills, Ballast Water and Waste Discharge

- Port authorities should require ports to take steps to ensure that oil pollution does not become part of runoff and that port-wide oil-recycling programs are in place.
- Authorities should adopt ballast water regulations.
- There should be more stringent requirements on the dumping of wastes containing oxygen-depleting nitrogen and phosphorous, as well as persistent toxic compounds that continue to threaten marine life.

E.7 Green Port Plan

The Green Port Program is an umbrella program designed to achieve the Port's environmental sustainability goals in six key areas : water, energy, air, waste management, sustainable development and sustainable business practices. The ultimate goal of a Green Port Plan program is to achieve long-term environmental, societal and economic benefits through resource conservation, waste reduction and pollution prevention. Many ports like the Port of San Diego have their Green Port Policy already in place since 2008. The Green Port Program unifies the Port's environmental sustainability goals (in many key areas) by way of setting measurable goals and evaluating progress in each area on an annual basis (https : // www.portofsandiego.org/environment/green-port.html ? tmpl = component & print = 1 & page=). The program encourages continuation of the Port's existing environmental efforts and expands these efforts through new programs and initiatives in the following key areas:

E.7.1 Energy

The goal under this area is to c*onserve energy and maximize energy efficiency of various Port operations. This can be achieved in the following manner :*

- Reduce the Port's operational energy use
- Conduct a pilot project to assess various applied and applicable energy efficiency technologies
- Investigate opportunities to participate in renewable energy projects
- Conduct a solar assessment to determine optimal locations for applying future photovoltaic systems
- Install photovoltaic systems on the Administration and General Services Buildings and pursue funding for other solar projects

E.7.2 Waste Management

The goal under this area is to *reduce waste from Port operations through material reuse, recycling and composting, which can be achieved in the following manner :*

- Explore ways to enhance the composting program
- Expand collection opportunities for electronic waste
- Investigate opportunities to expand the Port's current recycling program

E.7.3 Sustainable Development

The goal under this area is to e*nhance the environmental performance of Port buildings while maximizing long-term economic benefits. This can be achieved in the following ways :*

- Acquire LEED certification for the Administration Building.
- Acquire LEED certification for the General Services Building.
- Continue work on LEED certification for Broadway.
- Educate key Port employees on sustainable building principles.

E.7.4 Water

The goal under this area is to *improve water quality and reduce the Port's water usage to preserve water supply, which can be achieved in the following manner :*

- Conduct a sustainable landscaping project
- Develop and implement a water conservation strategy
- Replace plumbing fixtures in Port buildings with water efficient fixtures
- Explore opportunities to expand the Smart and Efficient water-use System on tidelands

E.7.5 Air

The goal under this area is to *reduce greenhouse gas contributions and other air emissions from Port operations. This can be achieved in the following manner :*

- Define and publicly register the carbon and ecological footprints of Port operations, and establish goals to maintain or reduce this footprint.
- Explore ways to assist tenants in measuring and reducing their carbon footprint
- Monitor the Vessel Speed Regulation Program so as to control the speed-dependent air-emissions
- Monitor and manage shore power installation.

E.7.6 Sustainable Business Practices

The ultimate goal under this area is to g*ive equal weight to environmental, economic and social concerns in the decision-making process by way of doing the following :*

- Increase opportunities for employees and the public to participate in the Green Port Program to learn about ways to be more sustainable
- Establish the Port as a drop-off location for a Community Supported Agriculture Program
- Increase outreach efforts as part of the Green Port Education Program.

- Continue the Commuter Assistance Program
- Expand the use of environmentally-friendly products used in Port operations.

E.8 Conclusion

Globally, not enough is being done to alleviate the severe impacts of the highly polluting shipping industry despite real and significant environmental and health impacts associated with marine port operations. Ports should take internal measures to reduce pollution caused by port activities. Likewise, regulatory agencies at the national, state, and local level must provide long overdue safeguards. Further, if port expansions are to continue, all projects must be mitigated to the maximum extent possible, efficiency must be improved, and current operations should be cleaned up. The present report delineates the environmental management, monitoring and green plan for Mumbai Port Trust.

For monitoring and overseeing the Green Port Program, there should be a committee called "The Green Port Program Steering Committee". This committee should include representatives from a variety of departments throughout the Port and should be responsible for overseeing decisions related to the Green Port Program. The Steering Committee should be chaired by an environmental expert who can manage and coordinate the Green Port Program. This Committee should also provide overall guidance to the Green Port Program by identifying priorities and projects, measuring and assessing projects, and communicating the Port's progress to staff and the public. Projects selected for the Green Port Program must satisfy the criterion of benefitting the environment and must fall into at least one of the six areas of focus (water, energy, air, waste management, sustainable business practices, and sustainable development), and be above and beyond compliance. Once, these minimum requirements are met, projects should then be evaluated by an additional set of criteria, including environmental, economic and societal benefits of the project, cost, educational value, and measurability.

Chapter 1

Introduction & Background Information

Chapter 1

Introduction & Background Information

1.1 Preamble

Nearly 25% of Indian population lives in the coastal zone. Mainly in view of this and the likely impact coastal zone's activities can have on this population, the Indian Ministry of Environment and Forests (MoEF) on January 07, 2011 released Coastal Regulation Zone (CRZ) Notification 2011 to replace CRZ Notification of 1991. Also an Island Protection Zone (IPZ) Notification, 2011 was released to cover Andaman & Nicobar Islands, Lakshadweep.

The Coastal Regulation Zone (CRZ) Notification of 1991 was issued under the Environment (Protection) Act, 1986, with the aim to provide comprehensive measures for the protection and conservation of Indian coastal environment. However over the last two decades, many pertinent issues requiring further modifications in the notification emerged.

- The 1991 Notification stipulated uniform regulations for the entire Indian coastline which includes 5500 Km coastline of the mainland and 2000 Km of coastline of the islands of Andaman & Nicobar and Lakshadweep. However, it failed to take into account the diversity of Indian coastline in terms of biodiversity, hydrodynamics, demography, geomorphologic and geological features.

- In the 1991 Notification, no clear procedure for obtaining CRZ clearance was laid down and no time lines stipulated. Furthermore, there was no format given for the submission of clearance applications.

- It may be noted that the 1991 Notification, also did not provide a post clearance monitoring mechanism or a clear cut enforcement mechanism to check violations.

- The 1991 Notification sought to regulate all developmental activities in the inter-tidal area and within 500 meters on the landward side. No concrete steps were indicated, however, with regard to the pollution emanating from land based activities.

- Moreover, the restrictive nature of the 1991 Notification caused hardships to the persons /communities living in certain ecologically sensitive coastal stretches. These included slum dwellers and other persons living in dilapidated and unsafe buildings in Mumbai, communities living in islands in the backwaters of Kerala, local communities living along the coast of Goa and other traditional coastal inhabitants.

- It was in view of the above-mentioned facts that the 1991 Notification has been amended almost 25 times in consideration of requests made by various State Governments, Central Ministries, NGOs etc. In addition, there are also several office orders issued by Ministry of Environment and Forests clarifying certain provisions. The frequent changes to the 1991 Notification have been consolidated in the 2011 Notification.

1.2. Objectives of the Coastal Regulation Zone Notification, 2011

The main objectives of the Coastal Regulation Zone Notification, 2011 are :

- To ensure livelihood security to the fishing communities and other local communities living in the coastal areas;
- To conserve and protect coastal stretches and;
- To promote development in a sustainable manner based on scientific principles, taking into account the dangers of natural hazards in the coastal areas and sea level rise due to global warming etc.

1. 3. Identification and Classification of CRZ Areas under the 2011 Notification

In the 1991 Notification the CRZ area was classified as CRZ-I (ecologically sensitive), CRZ-II (built-up area), CRZ-III (Rural area) and CRZ-IV (water area). In the 2011 Notification, the above classification is retained. The only change is in the CRZ-IV, which includes the water areas up to the territorial waters and the tidally influenced water bodies.

For the very first time, a separate draft Island Protection Zone Notification has been issued for protection of the islands of Andaman & Nicobar and Lakshadweep under Environment (Protection) Act, 1986.

1.3.1 The CRZ-I Area

The CRZ Notification, 2011 clearly lists out the areas that fall within the category of CRZ-I. It includes :

(i) Ecologically sensitive areas and the geomorphologic features that play a primary role in maintaining the integrity of the coast.

- Mangroves
- Corals and coral reefs and associated biodiversity
- Sand Dunes
- Mudflats which are biologically active
- National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986); including Biosphere Reserves encompassing;
    - Salt Marshes
    - Turtle nesting grounds
    - Horse shoe crabs habitats
    - Sea grass beds
    - Nesting grounds of birds
    - Areas or structures of archaeological importance and heritage sites

(ii) The area between Low Tide Line and High Tide Line.

1.3.1a Activities Permissible in CRZ-I

The activities permitted in CRZ-I under the 2011 Notification are :

(i) No new construction shall be permitted in CRZ-I except;

- Projects relating to the Department of Atomic Energy;
- Pipelines, conveying systems including transmission lines;
- Facilities that are essential for activities permissible under CRZ-I;
- Installation of weather radar for monitoring of cyclones movement and prediction by the Indian Meteorological Department;
- Construction of trans-harbour sea link and roads on stilts or pillars without affecting the tidal flow of water, between LTL and HTL.
- Development of green field airport already permitted at only Navi Mumbai;

(ii) Between Low Tide Line and High Tide Line in areas which are not ecologically sensitive, the following may be permitted;

- Exploration and extraction of natural gas;
- Construction of dispensaries, schools, public rain shelter, community toilets, bridges, roads, jetties, water supply, drainage, sewerage which are required to meet the needs of traditional inhabitants living within the biosphere reserves after obtaining approval from concerned CZMA.
- Salt harvesting by solar evaporation of seawater;
- Desalination plants;
- Storage of non-hazardous cargo such as edible oil, fertilizers and food grain within notified ports;
- Construction of trans-harbour sea links, roads on stilts or pillars without affecting the tidal flow of water.

1.3.2 CRZ-II and the Permitted Activities

The Notification defines CRZ-II as the areas which are developed up to or close to the shoreline and fall within municipal limits. Buildings are permissible on the landward side of the existing road, authorized structure or hazardous line where there are no authorized structures. Other activities such as desalination plants and storage of non-hazardous cargo are also permissible.

1.3.3 CRZ-III and the Permitted Activities

CRZ-III areas are those areas that are relatively undisturbed and do not fall under either in Category I or II and also include rural and urban areas that are not substantially developed. All permissible activities for CRZ-III as listed in the CRZ Notification, 1991 are retained in the Notification. Between 0-200 meters from HTL is a No Development Zone where no construction shall be permitted. Only certain activities relating to agriculture, horticulture, gardens, pasture, parks, play field, forestry, projects of Department of Atomic Energy, mining of rare minerals, salt manufacture from seawater, facilities for receipt, storage, re-gasification of petroleum products and liquefied natural gas, facilities for generating power by non-conventional energy sources and certain public facilities may be permitted in this zone.

Between 200-500 meters of HTL, construction and repair of houses of local communities, tourism projects including green field airport at Navi Mumbai, facilities for receipt, storage, degasification of petroleum products and liquefied natural gas, storage of non-hazardous cargo, desalination plants, facilities for generating power by non-conventional energy sources are permissible.

1.3.4 CRZ-IV and the Permitted Activities

The aquatic area from low tide line upto territorial limits is classified as CRZ-IV including the area of the tidally influenced water body. In CRZ-IV areas, there is no restriction on the traditional fishing and allied activities undertaken by local communities. However, no untreated sewage, effluents or solid waste shall be let off or dumped in these areas. A comprehensive plan for treatment of sewage generating from the city must be formulated and be in place for regular updating.

1.4. Special Provisions for the Fisher-folk Communities

Since the fishing communities traditionally live in the coastal areas, they have been given primary importance when drafting the CRZ Notification 2011. One of the stated objectives of the Notification is *"to ensure livelihood security to the fisher communities and other local communities, living in the coastal areas… and to*

promote development through sustainable manner based on scientific principles taking into account the dangers of natural hazards in the coastal areas, sea level rise due to global warming."

The following are the provisions in the 2011 Notification that address the issues relating to fishermen community :

(i) Water area up to 12 nautical miles and the tidally influenced water bodies have been included under the Coastal Regulation Zone in order to:

- control the discharge of untreated sewage, effluents and the disposal of solid wastes - as such activities endanger the fish and their ecosystem;
- Conserve and protect habitats in the marine area such as corals and coral reefs and associated biodiversity, marine sanctuaries and biosphere reserves, sea grass beds etc. which act as spawning, nursery and rearing grounds for fish and fisheries;
- Regulate activities in the marine and coastal waters such as dredging, sand mining, discharge of waste from ships, etc. including reclamation which have serious impacts on fishing and allied activities;
- Enable studies of the coastal and marine waters with regard to the impact of climate change and the occurrence of disasters which have serious impacts on the livelihood and property of the fisher-folk communities;

It may be noted that **no restrictions are being imposed on any fishing activities and allied activities of the traditional fishing communities** in this area.

(ii) At several coastal stretches of the country the fishermen and their dwelling units are in danger due to erosion which is occurring primarily due to manmade activities. The development of such manmade foreshore activities shall be regulated after identifying and demarcating the coast as falling in the high eroding category, the medium eroding category or the stable sites category.

(iii) While preparing the Coastal Zone Management Plans, the infrastructures essential for fishing communities must be clearly demarcated and fishing Zones in the water bodies and the fish breeding areas shall also be clearly marked.

(iv) The 2011 Notification requires the Coastal Zone Management Authorities to invite comments on the draft Coastal Zone Management Plan from stakeholders. This will ensure that the local communities including fishermen communities, will have a say in the preparation of the CZMPs.

(v) The Notification allows infrastructural facilities for the local fishing communities to be constructed in the CRZ-III area.

(vi) Reconstruction, repair works of dwelling units of local communities including fisheries in accordance with local Town and Country Planning Regulations has been made permissible.

(vii) In CRZ-III areas where 0-200 meters is a No Development Zone (NDZ), to meet the demands of dwelling units of traditional coastal communities including fisher-folk, the NDZ has been reduced to 100 meters. Hence, dwelling units of such communities can be constructed 100-200 meters from High Tide Line along the seafront with the approval of the State Government and the MoEF.

1.5 State-specific Provisions

Special provisions have also been incorporated for the fishermen communities living along the coastal areas in Maharashtra, Goa, Kerala, Sunderban and other ecologically sensitive areas.

- **Greater Mumbai:** For the traditional fishing communities (namely, the Koliwadas) living in Greater Mumbai a provision has been provided, wherein, the area concerned shall be mapped and declared as CRZ-III and development including construction and reconstruction can be taken up as per local Town and Country Planning Regulations.

- **Goa:** The Government of Goa shall survey and map the fishing villages all along the Goa coast and all facilities required for fishing and allied activities shall be provided. As per the CRZ Notification, 1991, expansion /

reconstruction / repair of dwelling units of local communities in CRZ areas were viewed as violations of the Notification if the requisite permission had not been taken from the authorities. Such units (approximately 5,000) were ordered to be demolished by the Hon'ble High Court of Bombay. However, the 2011 Notification provides that reconstruction and repair of the structures of local communities shall also be permissible in CRZ areas.

- **Kerala:** The CRZ area in Kerala is reduced to 50 metres from High Tide Line (HTL) on the landward side. This area is a 'No Development Zone' where no new constructions can be carried out. However, dwelling units of local communities within this area may be repaired and reconstructed. Necessary foreshore facilities such as fishing jetty, fish drying yards, net mending yard, fishing processing by traditional methods, boat building yards, ice plant, boat repairs etc. can also be constructed within the 0-50 meters area. Beyond 50 meters from HTL on the landward side, dwelling units of local communities may be constructed with the permission of the local panchayat.

- **Sunderban:** In order to regulate development in Sunderban and other ecologically sensitive areas, and to take up conservation and protection of these areas for the benefit of local communities an integrated management plan (IMP) is required to be prepared in consultation with the communities. The housing needs of the local communities including fisher-folk who are living in such ecologically sensitive areas shall be also addressed in the IMP.

1.6 Measures to Combat Pollution

The 2011 Notification lists out certain measures that have to be taken to prevent pollution in the coastal areas / coastal waters. The disposal of wastes and effluents into coastal waters is a prohibited activity. All coastal states are required to ensure that :

- the existing practice of discharging untreated waste and effluents is phased out within a period not exceeding two years.
- Dumping of solid waste is phased out within one year from the commencement of the Notification.

- There should be an Action Plan prepared for dealing with pollution in coastal areas and waters and in a time bound manner.
- The Action Plan should be submitted to MoEF who would provide technical and financial assistance.

1.7 Procedure for Clearances

Unlike the 1991 Notification which did not lay down the process for obtaining CRZ clearance, a specific procedure has been provided in the 2011 Notification for obtaining such clearance. This procedure is as follows:

(i) The project authorities shall submit the proposal to the concerned State / UT CZMA along with the following documents/reports :

- Form-1 (Annexure-IV of the Notification);
- Rapid Environment Impact Assessment (EIA) Report including marine and terrestrial EIA.
- Comprehensive EIA and cumulative studies for port and foreshore requiring projects as per guidelines issued by MoEF from time to time;
- Disaster Management Report and Risk Management Report;
- CRZ map indicating HTL and LTL demarcated by an authorized agency (1:4000 scale);
- Project layout superimposed on the above mentioned map;
- The CRZ map shall normally indicate a 7 km radius around the project site.
- The CRZ map shall indicate the CRZ-I, II, III and IV areas;
- No Objection Certificate from the concerned Pollution Control Boards or Committees for the projects which envisage discharge of effluents, solid wastes, sewage etc. (NOC from the Pollution Control Boards or Committees has been made mandatory in view to minimize pollution in the coastal waters)

(ii) The concerned CZMA shall examine the above documents in accordance with the approved CZMP and CRZ Notification and make recommendations within a period of sixty days from date of receipt of above document to :

- SEAC (State Expert Appraisal Committee) or EAC (Expert Appraisal Committee) in case of the project attracting EIA Notification, 2006
- MoEF or State Government for the project attracting CRZ Notification

(iii) MoEF or State Government shall consider such projects based on the recommendations of the concerned CZMA within a period of sixty days.

The clearance accorded to the projects under the 2011 Notification shall be valid for the period of five years from the date of issue of such clearance. Once the clearance has been accorded to projects under the 2011 Notification, the following post clearance mechanism has to be followed :

- It shall be mandatory for the project management to submit half-yearly compliance reports in respect of the terms and conditions stipulated for granting environmental clearance in hard and soft copies to the concerned regulatory authority, on 1st June and 31st December of each calendar year;
- All such compliance reports submitted by the project management shall be public documents;
- Copies of the same shall be given to any person on application to the concerned regulatory authority;
- The latest compliance report shall also be displayed on the website of the concerned regulatory authority and shall be valid for the period of five years from the date of issue of clearance.

1.8 Enforcement Measures

The CRZ Notification, 2011 lays out the method and the time frame in which actions shall be taken against any violations of the Notification. The CZMAs at the State level and the NCZMA, at the Central level shall be strengthened in a time bound manner and their capacities enhanced by MoEF for effectively enforcing the Notification. The violation shall be identified by using latest appropriate maps, satellite imagery and information technology within a period of four months from date of issue of the 2011 Notification and necessary action will be initiated in accordance with the Environment (Protection) Act, 1986 within a period of four months thereafter.

To ensure transparency in the working of the CZMAs, the Coastal Zone Management Authority has to create a website and post on such website the agendas, minutes, decision taken, clearance letters, violations, action taken, court cases etc. including the CZMPs.

1.9 Special Provisions for Specific Coastal Stretches

The 1991 Notification provided for the uniform regulation of the coastal areas in the entire country irrespective of the environmental diversity, socio-economic conditions, developmental pressures etc. In the 2011 Notification, special provisions have been inserted, keeping in view the diverse problems faced by local communities like those individuals living in slums, those inhabiting old and unsafe buildings in Mumbai, people living in islands in the backwaters in Kerala, local communities living in the coast of Goa and the communities living in ecologically sensitive areas of the Sunderban etc.

1.9.1 Special Dispensations given to Greater Mumbai

Keeping in mind the fact the Mumbai faces some unique environmental and social issues the following provisions have been drafted:

A. CRZ-I areas:

- All approved roads and links must be constructed on stilts to ensure free flow of tidal waters.
- Five times the number of mangroves destroyed / cut during the above construction process shall be replanted.
- Within one year of issue of this Notification, all mangrove areas must be mapped, notified and measures for conservation must be initiated, solid waste disposal sites must be relocated outside CRZ area and an action plan must be launched to protect habitations and structures located on the seaward side of the hazard line.

B. CRZ-II area:

- The State Government may undertake slum redevelopment schemes in the CRZ-II areas in compliance with the Floor Space Index or Floor Area Ratio as specified in the Town and Country Planning Regulations, prevailing as on the

date of the project being sanctioned. However, the stake of the State Government or its agencies shall not be less than 51% in such projects.

- Redevelopment and reconstruction of old, dilapidated, and unsafe buildings in the CRZ-II area shall be allowed. All such projects must be taken up by the owners of the buildings, directly or with private developers. All construction must be in accordance with the Town and Country Planning Regulations prevailing as on the date on which the project is granted approval by the competent authority.
- In order to protect and preserve the 'green lung' of the Greater Mumbai area, all open spaces, parks, gardens, playgrounds indicated in development plans within CRZ-II shall be categorized as CRZ-III, that is, 'no development zone'. Only construction of civic amenities and facilities for recreational sports shall be permitted if the floor index is up to 15%. Residential and commercial use of such spaces is prohibited.
- Reconstruction and repair of the dwelling units belonging to local communities in CRZ-II areas shall be permitted by the Competent Authorities on a priority basis.
- Fishing settlement areas including Koliwada, and those identified in the Development Plan of 1981 or relevant records of the Government of Maharashtra, shall be mapped and declared as CRZ-III so that any development, including construction and reconstruction of dwelling units within these settlements shall be undertaken in accordance with applicable local Town and Country Planning Regulations.

1.9.2 Mechanisms to Regulate Such Special Dispensations

In order to ensure that the redevelopment of slums and dilapidated structures in Mumbai are done in the most transparent and accountable manner, the following measures are provided :

- The Right to Information Act, 2005 shall be applicable to all redevelopment or reconstruction projects granted clearance by the Competent Authorities.
- Auditing shall be done by the office of the Comptroller and Auditor General (C&AG) of India in case of projects relating to slum redevelopment and by the

empanelled statutory auditor of C&AG in case of redevelopment of dilapidated, cessed and unsafe structures.

- A High Level Oversight Committee shall be set up for periodic review by the Government of Maharashtra. This Committee shall include eminent representatives of Architects, Urban Planners, Engineers, and members of Civil Society, besides the local urban bodies, the State Government and the Central Government.

1.9.3 Special Dispensations Given to Kerala

Kerala has one of the most unique coastal environments wherein more than 300 islands are located within its backwaters. Keeping in view the distinctive geographical layout of Kerala, special allowances have been provided for coastal stretches of Kerala in the Notification. Since the islands in the backwaters of Kerala are narrow stretches of land, the CRZ area is reduced to 50 metres from HTL on the landward side. This area is a 'No Development Zone' where no new constructions can be carried out. Existing dwelling units of local communities within this area may however be repaired and reconstructed. Necessary foreshore facilities such as fishing jetty, fish drying yards, net mending yard, fishing processing by traditional methods, boat building yards, ice plant, boat repairs etc. can also be constructed within the 0-50 meters area. Beyond 50 meters from HTL on the landward side, dwelling units of local communities may be constructed with the permission of the local panchayat.

1.9.4 Special Dispensations Given to Sunderban

Sunderban is the largest mangrove area in the country. Nearly 5 lakh people live within the biosphere itself. It is being greatly affected by the rising sea levels and changing weather patterns caused by climate change. Further, the local communities face immense hardship due to lack of infrastructure facilities. An integrated management plan is proposed to be drawn up, under the Notification, for Sunderban and such ecologically important areas such as Gulf of Khambat and Gulf of Kutch in Gujarat, Malvan, Achra-Ratnagiri in Maharashtra, Karwar and Coondapur in Karnataka, Vembanad in Kerala, Bhaitarkanika in Orissa, Coringa, East Godavari and Krishna in Andhra Pradesh. These areas would be declared as Critical Vulnerable Coastal Areas (CVCA) and the integrated management plan would be prepared for

each of these areas in consultation with the local communities. Until the integrated management plans are drawn up and initiated, all necessary infrastructure developments for the local inhabitants in these areas shall be permitted on a case to case basis by the Coastal Zone Management Authority.

1.9.5 Special Dispensations Given to Goa

Specific provisions have been provided for the State of Goa with a stringent regulatory mechanism for sustainable development and ecological protection of coastal areas. Other provisions include the following:

- Since the traditional occupation of the population living along the coast is mainly the fishing and allied activities and fishing communities require basic infrastructure facilities for their livelihood, such facilities shall be provided by the Government of Goa after conducting a comprehensive survey.
- Reconstruction, repair of the structures of local communities shall be permissible in the CRZ areas.
- The eco sensitive low lying areas influenced by tidal action shall be mapped. All mangroves along such land shall be protected and a management plan shall be prepared. No developmental activities shall be permitted in the khazan land.
- Sand dunes, beach stretches along the bays and creeks shall be surveyed and mapped. No activity shall be permitted on such sand dune areas.
- Beaches such as Mandrem, Morjim, Galgiba and Agonda have been designated as turtle nesting sites and protected under the Wildlife Protection Act, 1972. These areas shall be surveyed and management plan prepared for protecting these sites. No developmental activities shall be permitted in these areas.

Ministry of Environment, Forest and Climate Change
Government of India

CRZ Notifications

Coastal Regulation Zone - Legislations

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Chapter 2

Present Scenario

Chapter 2

Present Scenario

2.1 Introduction

Ports from all over the globe are committed to the protection of environment and are taking steps and endeavors to become clean, green and environment-friendly. They have the responsibility to adopt greener practices in regard to prevention of air, water and soil / sediment pollution. With these objectives in mind, Ministry of Shipping, Government of India desires that all Major ports should prepare their Environmental Management and Monitoring Plan (EMMP), which should comprehensively cover various aspects of environmental measures, Green Port measures as well as sustainability measures.

Marine ports are major hubs of economic activity and also one of the major sources of pollution. In particular, the following activities result in highly significant environmental, ecosystem and human health impacts :

- Number of ships with engines continuously running on pollution discharging fuels
- Thousands of diesel trucks per day
- Diesel locomotives hauling cargo and other polluting equipments

Major ports mainly handle containerized cargo, dry bulk like food grain, timber, coal, iron ore, china clay, cement, fertilizer, liquid cargo including POL (Petroleum, oil and lubricants). The cargo is stored at the port for transitory period and then evacuated to the destinations through rail road or pipelines.

The impacts of these port related activities mainly manifest in terms of deterioration of air, water and sediment / soil quality. They also increase the noise levels. Subsequently, they affect ecosystem as well as human health and thus can increase risk of illness, respiratory diseases or cancer etc.

Ports always undergo expansions so as to accommodate ever-increasing cargo volumes due to the continuous growth of international trade. Moreover, Marine ports are one of the most poorly regulated sources of pollution releasing largely unchecked quantities of health-endangering air and water pollution, noise and light pollution. Ultimately, all these adversely affect the nearby communities, and harm even the marine habitats.

EMMP (Environment Management Monitoring Plan) is an effective tool to work on micro-level to identify and address various effects of port operations on the environment. Moreover, EMMP also helps in assisting and ensuring the effectiveness of the EIA process and implementation of the commitments made.

EMMP is mainly aimed at minimizing various adverse impacts on environment. It is important that port authorities ensure that the cargo handling operations and other allied activities do not violate regulatory environmental standards and norms. At the same time, they should also adopt the necessary mitigation measures. Ultimately, EMMP acts as a comprehensive manual for environmental protection, reduction in carbon (GHG) emission and finally it helps in converting major ports into "Green Ports".

This report, inter alia, discusses solutions to port pollution problems and provides requisite information on the health and environmental impacts of port operations; an overview of policies governing marine ports; and detailed analysis for developing a green plan for ports' environmental management and monitoring. It focuses on the following main operations at the ports :

- Cargo handling at berths
- Stacking and handling of cargo at yards
- Evacuation of cargo

This report has been prepared on the basis of various international reports available on these ports and the data and information contained in those. Essentially, the report looks into (a) identification of sources of pollution and relevant monitoring plans in accordance with CPCB (Central Pollution Control Board)-standards, norms and guidelines; (b) corrective and preventive measures; (c) CRZ-notification and land use planning; (d) various developmental aspects; (e) national, international laws and treaties; (f) associated and relevant carbon and ecological footprints and various interrelated socio-economic (health, education, environmental awareness, costs and benefits etc.).

2.2 Mumbai Port

Mumbai port has been the principal gateway to India and has played a pivotal role in the development of the national economy, trade and commerce and prosperity of Mumbai city in particular. It caters to 11.29 % of the country's sea-borne trade in terms of volume. The port has achieved this position through continuous endeavour to serve the changing needs of maritime trade. Though traditionally designed to handle general cargo, over the years, the port has adapted to changing shipping trends and cargo packaging from break bulk to unitization / palletization and containerization. Having weathered and survived many a change in maritime trade in its long history, Mumbai Port is today facing challenges posed by competition from adjoining ports, changing traffic patterns, inherent physical constraints and continuing labor intensive operations.

Source : http://joseph-dixon.blogspot.in/

Mumbai port wishes to implement a green port plan for the minimization of carbon footprint and ecological footprint. Port falls in CRZ 3 and off shore structure falls in CRZ 4. The main source of water is through MCGM, average annual water use of port is 65, 27000 KL, and port has installed water consumption meters for different activities. Port is having STP of 200 KL/Day capacity and treated water is used for gardening purposes. Many water conservation measures are taken recourse to at the port such as routine inspection for leakages, intermittent regulations of water supply to colonies and other operational areas.

Consent to operate for Mumbai port trust as per the "The water (prevention and control of pollution) Act, 1974 is issued by the MPCB. As per consent for the Domestic effluent permitted quantity of discharge is 8774.23 cubic meter per day, which is disposed in MCGM sewer. Port is having a site drainage plan for storm water drains, sewer drains, municipal water drains, water points for boats at various docks, pumping stations, water meters, fire hydrant points etc.

The total open surface area of the port is 75, 30,000 sq. m and 39, 90,000 sq. m of this area is cemented and 35, 39,100 sq. m area is covered with grass. Air emissions are monitored on the regular basis. Consent to operate for Mumbai port trust as per the "The Air (prevention and control of pollution) Act, 1981" is issued by MPCB.

Air pollution control system includes one stack attached to Slipway steam boiler, two stacks at DG set (100 KVA x 2) , Four stacks at DG set (160 KVA x 4). In addition port has already given a consultancy contract for solid as well as hazardous waste, garbage, kitchen waste etc.

For port activities at Marine Oil Terminal (MOT), Jawahar Dweep, annual consumption of electricity is 12, 80,790 kWh. Electricity used for OPL (Oil Pipe Line), Pir Pau manifold is 3,24,000 kwh, for Chowkey No.3 + Manifold (440 V supply), it is 9000 kwh and for first Chemical Berth (NPJ) Pump house, Jetty light, Road way (22 KV Substation) is 3,34,991 kwh.

Annual High speed diesel fuel consumption for Ship (Passenger launch Kalpana) is 70,000 liters approx, For Mooring Tug, M.T. Sushil is 26,000 liters approximately and for survey launch, Sanshodhinee is 22,700 liters approximately. 28800 liters diesel fuel is required for transportation of staff, 1400 kg of CNG is required for patrolling and maintenance at OPL-PP & Wadala, 1800 liters of diesel for firefighting equipment and 360 KL (approx.) is required for operating MbPT owned shunting Locomotives for handling exim cargo Trains, Forklifts for shifting cargo in the Docks and port vehicles like jeeps/cars in outlying areas.

2.3 Air, Water and Noise Quality Indices

An Environmental Quality Analysis has been performed under this section to establish a baseline for existing environmental quality and ***to demonstrate that this kind of exercises need to be regularly done as a part of the Environmental Monitoring and Audit exercise. This, inter alia, would help in identifying which sectors need management priorities.***

2.3.1 Methodology of Calculation of Air Quality Index

- For every parameter (parameters *given are concentration of* **SO_2, NO_x , NH_3** in $\mu g/m^3$) the exceedance factor is calculated.

- Inverse Exceedance factor (**I.E**)

$$= \frac{Permissible\ limit\ of\ concentration\ in\ \mu g/m3}{Given\ Concentration\ of\ in\ \mu g/m3}$$

- AQI is un-weighted average of inverse exceedance factors. $I_{E\,n}$

$$AQI = \frac{\sum_1^n I.E\ n}{n}$$

Where n is the number of parameters considered. Thus a higher value of AQI means that the better is the air quality and vice-versa.

2.3.2 Methodology of Calculation of Water Quality Index

The methodology for calculation is given by National sanitation foundation (NSF).

- Quality index (Q.I) for each parameter *(parameters given are %age D.O saturation, B.O.D (mg/l), Turbidity (NTU), T.S.S (mg/l))* is calculated from the graphs.(graphs given at: http://www.water-research.net/index.php/water-treatment/water-monitoring/monitoring-the-quality-of-surfacewaters)

- The graphs (for calculation of WQI from the bulk data) are reconstructed in M.S Excel-Software. For reconstructing the graph, data points are fetched from the online programming of the aforementioned web link. Interpolation is done by considering linear slope between known data points.

- Weighted average of individual Quality Indices (Q.I) form the Water Quality index (WQI) :

- $$WQI = \frac{\sum_1^n Q.In\ \mathrm{X}\ \mathrm{Wn}}{\sum_1^n \mathrm{Wn}}$$

- Where Wn is the weight assigned to parameter n (say any of the aforementioned water quality parameter) and Q.In is the quality index of respective parameter.

Water Quality Parameter	Weight (Wn)
%age D.O saturation	0.17
B.O.D (mg/l)	0.11
Turbidity (NTU)	0.08
T.S.S (mg/l)	0.07

2.3.3 Methodology of Calculation of Noise Quality Index

- Ln chart is made which shows the percentage of sampling time for which the given noise level is exceeded. The X axis has noise levels in dB(A) and Y-axis has percentage of time for which the noise level is more than that on the X-axis.
- Sound levels in the range of 55 to 75 dB(A) *(daytime)* and night time 50 to 70 dB(A) *(night)* are taken and arranged at regular intervals on X axis.
- Using function to calculate the number of hours with noise level greater than a given value, the % age exceedance (% of sampling time for which noise level exceeds value on X axis is calculated).
- L_{eq} *(which represents the equivalent continuous sound produced by same energy that produces sound varying over given intervals)* is calculated separately for day hours (06:00 to 21:00 HRS) and night hours (22:00 to 05:00 HRS) using the given formula:
- $L_{eq} = 10 \log_{10}(\sum 10^{\frac{Li}{10}} X \ ti)$: Where Li is the loudness in dB(A) for the given sampling and ti is the fraction of time of sampling hours for the corresponding loudness reading.

Chapter 3

Objectives of the Present Exercise

Chapter 3

Objectives of the Present Exercise

3.1 Preamble : Preparation and Submission of Environmental Monitoring Management Plan and Green Plan for Mumbai Port

As per the directions of Ministry of Shipping, Mumbai Port Trust (MbPT) has to upgrade the existing Environmental Management Plan (EMP) and has to prepare an Environmental Monitoring Management Plan (EMMP) and Green Plan as per the issued Guidelines. MbPT, therefore, proposes to retain CSIR-National Environmental Engineering Research Institute (NEERI), Nagpur to conduct this study.

3.2 Background

Mumbai Port Trust (MbPT) has Environmental Management Plan (EMP) in place since 2009 and MbPT has been carrying out monitoring of the following parameters :

- Harbour Water Samples
- Ambient Air Quality (using portable gas sampler)
- Ambient Air Quality (using High Volume Air Sampler)
- Effluents of Sewage Treatment Plant
- Biological and physico-chemical parameters of harbour water samples and marine sediments
- Noise Quality

The above-mentioned data would be made available by MbPT to CSIR-NEERI.

3.3 Scope of Work

Upgrading MbPT's existing EMP as mentioned above and preparation of EMMP and Green Plan for Mumbai Port Trust

3.4 Objectives of the Study

The objectives of the study would be :

- To check the Mumbai Port's monitoring data's compliance with the standards
- To study the trend analysis of pollutants in spatial and temporal scales
- To identify possible sources of pollution
- To recommend control / mitigation strategies that can help develop the port in an environmentally sustainable manner
- To use the database collected, whenever needed for land use planning, investigation of complaints and suggestions in regard to mitigating impacts of developmental activities in and around
- To use the information collected, whenever needed for land use planning, investigation of complaints and for EIA of other developmental activities in and around the port
- To prepare and submit Green Plan for Mumbai Port Estate

Chapter 4

Structure and Contents of EIA

Chapter 4

Structure and Contents of EIA

4.1 Framework

The Ministry of Environment and Forests (MoEF), Govt. of India vide its Gazette Notification published on September 14, 2006 has indicated a frame work for structuring the report and the issues that should be addressed in an environmental impact assessment document. The structure of EIA and SIA report should have following components :

Sr. No.	EIA STRUCTURE	CONTENTS
1.	Introduction	• Purpose of the report • Identification of project & project proponent • Brief description of nature, size, location of the project and its importance to the country, region • Scope of the study – details of regulatory scoping carried out (As per Terms of Reference)
2.	Project Description	• Condensed description of those aspects of the project (based on project feasibility study), likely to cause environmental effects. Details should be provided to give clear picture of the following: • Type of project • Need for the project • Location (maps showing general location, specific location, project boundary & project site layout) • Size or magnitude of operation (incl. associated activities required by or for the project) • Proposed schedule for approval and implementation • Technology and process description • Project description. Including drawings showing project layout, components of project etc. Schematic representations of the feasibility drawings which give information important for EIA purpose • Description of mitigation measures incorporated into the project to meet environmental standards, environmental operating conditions, or other EIA requirements (as required by the scope) • Assessment of new & untested technology for the risk of technological failure

Sr. No.	EIA STRUCTURE	CONTENTS
3.	Description of the Environment	• Study area, period, components & methodology • Establishment of baseline for valued environmental components, as identified in the scope • Base maps of all environmental components
4.	Anticipated Environmental Impacts & Mitigation Measures	• Details of Investigated Environmental impacts due to project location, possible accidents, project design, project construction, regular operations, final decommissioning or rehabilitation of a completed project • Measures for minimizing and / or offsetting adverse impacts identified • Irreversible and Irretrievable commitments of environmental components • Assessment of significance of impacts (Criteria for determining significance, Assigning significance) • Mitigation measures
5.	Analysis of Alternatives (Technology & Site)	• In case, the scoping exercise results in need for alternatives: • Description of each alternative • Summary of adverse impacts of each alternative • Mitigation measures proposed for each alternative and • Selection of alternative
6.	Environmental Monitoring Program	• Technical aspects of monitoring the effectiveness of mitigation measures (incl. Measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules)
7.	Additional Studies	• Public Consultation • Risk assessment • Social Impact Assessment. R & R Action Plans
8.	Project Benefits	• Improvements in the physical infrastructure • Improvements in the social infrastructure • Employment potential – skilled; semi-skilled and unskilled • Other tangible benefits
9.	Environmental Cost Benefit Analysis	If recommended at the Scoping stage
10.	EMP	• Description of the administrative aspects of ensuring that mitigation measures are implemented and their effectiveness monitored, after approval of the EIA
11	Summary & Conclusion (This will constitute the summary of the EIA Report)	• Overall justification for implementation of the project • Explanation of how, adverse effects have been mitigated
12.	Disclosure of Consultants engaged	• The names of the Consultants engaged with their brief resume and nature of Consultancy rendered

Chapter 5

Components of Environmental Concern

Chapter 5

Components of Environmental Concern in Port Related Activities

5.1 Components of Concern

The major components of concern are :

- Impact on the ground water of the coastal area due to impounding
- Impact of transportation of material by road and rail
- Impact on hydrodynamics of the sea, changes in marine and coastal ecology
- Impact on social activities including fishing and agriculture
- Impact during construction, maintenance and operation
- Impact on associated industries

5.2 Broad Environmental Issues

- Air, Water, Noise and Land Quality
- Socio-economics and Marine Ecology
- Impacts due to land reclamation and its use for agriculture, woodland, plantation, nature reserves, recreational, residential and industrial areas
- Impacts connected with wetlands (new and old)
- Socio-economic growth profile and fishery-potential in the surrounding area
- Impact due to increase in vehicular traffic

5.3 Environmental Management Plan (EMP)

The impacts (identified through baseline assessment, quantified through predictive exercise and evaluated subsequently) need to be properly prevented or mitigated through a pragmatic Environmental Management Plan (EMP). The EMP would include the impacts from all the components.

5.4 Issues to be addressed Phase Wise

Three phases should be considered :

- Construction Phase
- Transition Phase
- Operation Phase

The issues that arise during these three phases are delineated below.

5.4.1 Construction Phase : Construction material (quarrying, blasting and related impacts)

- Construction Activities
- Construction Material Transport
- Aquatic Ecosystem (Marine) Impacts : Air, Water, Noise & Sediment
- Socio-economic Impacts

5.4.2 Transition Phase

- Land based Impacts (geo-morphology, drainage pattern, sedimentation and effect on saline soil along the shore line)
- Aquatic / Marine Ecosystem Impacts
- In-flow of pollutants from rivers
- Water quality assessment including algal bloom
- Impact on shipping, fishing, salt industries etc.
- Change in flora / fauna
- Socio-economic Impacts

5.4.3 Operational Phase

- Global Impacts including climate change
- Ground water quality and salinity in coastal areas
- Land based Impacts : geomorphology, drainage, sediment flow, land reclamation, road- rail transport etc.
- Aquatic/ Marine Impacts
    - Industrial and domestic pollutants
    - Water quality vis-à-vis urban, industrial, agricultural development
    - Oil Spills from Ports and harbours
    - Impact on Fisheries

- Salinity intrusion
- Impact on Flora/fauna

❖ Socio-economic Impacts

5.5 Environmental and Social Issues

5.5.1 Potential impacts during different phases

❖ **Construction Phase :**

- Land Environment
  - Pollution due to large scale activities
  - Impacts on natural drainage and aesthetics
  - Pollution due to increased soil erosion from the construction sites

- Water Environment
  - Water pollution due to disposal of untreated sewage other waste water discharges
- Ecology
  - Impacts on benthic ecology due to dredging and disposal of construction material
  - Increase in turbidity with corresponding reduction in photosynthetic activity and primary productivity
  - Degradation of terrestrial flora as a result of congregation of large labour population
- Air Environment
  - Deterioration of ambient air quality as a result of operation of various construction equipments, increased vehicular traffic etc.
- Noise Environment
  - Increase in noise levels as a result of operation of various construction equipments, blasting, increased vehicular traffic etc.
- Socio-economic Environment
  - Improvement in the employment scenario as a result of absorption of local labour in the construction activities
  - Traffic congestion and traffic safety aspects
  - Social stress due to migration and influx of labour

❖ **Transition Phase:**

- Land Environment
  - Sedimentation in rivers and surrounding coastal area
  - Impact on saline soil along the shore line
- Water Environment
  - Disposal of effluents from surface and sub-surface drainage system
  - Impact on water quality due to pollutants inflow from rivers
- Ecology
  - Impact on marine flora and fauna
  - Effect on migratory birds
- Socio-economic Environment
  - Acquisition of land for construction of various project components e.g. construction of road network joining the construction sites
  - Impact on employment generation and pattern

❖ **Operational Phase:**

- Land Environment
  - Land reclamation, change in land use
  - Impact on groundwater quality
- Water Environment
  - Impact of use of agro-chemicals in the surrounding area
  - Impact on water quality due to disposal of treated and untreated effluents
  - Impact on human health due to bio-accumulation of heavy metals, pesticides, etc.
- Ecology
  - Impact on bio-diversity (migratory birds, mangrove forests and migratory fish species etc.)
- Socio-economic Environment
  - Impact on employment generation and pattern
  - Impact on overall quality of life (public health, educational status, women-empowerment, etc.)
  - Impact on livestock

5.6 Assessment of baseline environmental quality and social status

In order to make a relevant and reliable assessment of project impacts, it is essential that the baseline situation is known. The baseline assessment includes data on the relevant environmental characteristics of the study area, as well as information on any likely changes. The relevant information, inter alia, should include the following aspects:

5.6.1 Physical Environment

- Climatic conditions
- Coastal and oceanic parameters (tidal currents, shoreline, bottom sediment, wave data etc.)
- Data on geology and mineral resources, topography, soils
- Surface water and ground water (level of pollution in surface water, ground water, river sediment)
- Sources of pollution and their quantification and current fate of pollutants entering the sea
- Ambient air quality, existing sources of air emissions (traffic and industries, etc.)
- Noise and offensive odour levels

5.6.2 Biological Environment

- Existing terrestrial and marine flora and fauna in the area, rare and endangered species, micro-biological entities, primary productivity and plankton distribution
- Bio-diversity in the ecologically sensitive areas
- Breeding and nesting grounds for indigenous and migratory birds
- Species of commercial importance
- Nuisance causing harmful species, disease-vectors etc.
- Forest cover, natural vegetation and mangroves

5.6.3 Socio-cultural Environment

- Agricultural practices; cropping patterns, energy use, use of agro-chemicals
- Existing Land Use and Future Plans

- Quality of life
- Cultural and recreational activities
- Public health facilities
- Demography and associated socio-economic conditions
- Fisheries and employment generation
- Legal and institutional frame work
- Solid waste disposal

For generating baseline information, standard methods recommended by the Bureau of Indian Standards, Central Pollution Control Board, Ministry of Environment and Forests are available. A comprehensive overview of sampling procedures and measurement methods is given in the manual of EIA of MoEF, January 2001. Relevant details are also available on the MoEF web-site (http ://envfor.nic.in:80/divisions/iass/eia/Cover.htm).

5.6.4 Identification and Evaluation of Mitigation Measures

The environmental management plan (EMP) should include proposed work program, budget estimates, schedules, staffing and training requirements, institutional needs (in terms of authority and/or regulation) and other necessary support services for the implementation of the mitigation measures. The EMP should also include a plan to monitor the implementation of mitigation measures and the impacts of project during construction and operation provided with an estimate of capital and operating costs and a description of other inputs (such as training and institutional strengthening) needed to carry it out. Feasible and cost effective measures to prevent or reduce significant negative impacts to the acceptable levels need to be developed.

Chapter 6

Individual Components

Chapter 6

Individual Components

6.1 Overall Important Issues

- Water quality impact
- Hydraulic and morphological impact
- Economics and financial impact
- Heavy metals and their bio-accumulation and impacts on the human beings and livestock.
- Soil and groundwater impacts
- Appropriate effluent disposal
- Labor colonies and various infrastructural facilities
- Marine ecology, spawning and breeding of various species, phytoplanktons, zooplanktons, macro and meio-fauna, benthic fauna etc.
- Fisheries and the related impacts
- Impacts on mangrove ecology
- Vehicular movement and their air, water and noise quality impacts
- Socio-economics (including health related issues)

6.2 Associated Industrial and Domestic Activities Around the Port

The information about the major industries in terms of their gaseous emissions, water discharges, solid waste generation and the environmental management plan should be integrated. This should include :

- Baseline environmental quality data with respect to air, water, noise, land, socio-economic and biological components
- Prominent endemic diseases and mortality rates in the surrounding industrial area

- Emission-inventories and the associated management plans so as to understand, quantify and manage adverse impacts
- Industry specific pollutants such as VOC's, hydrocarbons, ammonia, chlorine and any other toxic compound
- Characterization and quantification of wastewater generated from the industries and the nature of effluents discharged into surface and ground water bodies
- Evaluation of wastewater treatment plants and other associated facilities for their adequacy and performance, recycle, reuse practices
- Identification of wastewater discharge locations and their likely diversions to the safe disposal site
- Assessment of feasibility of water reuse for greenbelt development and irrigation
- Assessment of solid wastes generated from the industries and the methods of collection, treatment, transportation and disposal
- Evaluation of sites for safe and proper land filling of the solid waste, development plan for landfill site and adequacy of TSDF (Treatment Storage and Disposal Facility) for waste disposal.
- Assessment of impact of TSDF on ground and surface water quality in the port area
- Assessment of biodiversity, flora, fauna and measures for biodiversity-conservation
- Assessment of over all impacts on ecological and human health
- Assessment of economic benefits and likely changes in quality of life
- Latest inside/outside port development with navigation routes and draft available, proposed and existing cargos including chemical cargos
- Proposed coastal infrastructure projects including inside/outside ports along with projected traffic in the ports
- Impact on change in draft due to any sedimentation in navigation channel related to change in hydrodynamics (tide and current)
- Impact of deposition of sediment in the navigation channel and estimation of related maintenance dredging

6.3 Impact due to On-going Activities

- Impact on land use pattern, associated agriculture, forestry and fisheries
- Impact of vibrations on the surrounding environment including damage to materials / structures
- Impact of noise and mitigation measures for noise abatement
- Impact of wastewater-discharges on water resources
- Soil-erosion and soil-loss
- Impact of solid waste treatment and disposal
- Loss of forest resource, economically important plants, medicinal plants, and threat to rare and endangered species
- Impacts on biodiversity, wildlife habitats, migratory corridors, migratory avi-fauna, rare and endangered species, medicinal plants etc.
- Impact on fishery resources and agricultural production
- Habitat fragmentation and blocking of migratory corridors (terrestrial as well as aquatic) due to port activities (on-going and envisaged)
- Implementation of pollution control measures to minimize the pollutants that have adverse impact on environment
- Identification of suitable native tree species for compensatory afforestation, green belt

6.4 Impact on Coastal, Intertidal and Marine Ecology

- Impacts due to various construction activities
- Impact on sediment quality (physico-chemical, nutrients, bio-productive status, levels of pollutants including heavy metals and pesticides)
- Impact of soil and water pollution due to industrial effluent discharges and agricultural wastewaters (fertilizers and pesticides)
- Impact of heavy metal pollution, rise in suspended particles leading to turbidity, reduction in photosynthetic activity and resultant decrease in primary and secondary productivity
- Impact on marine algae, its abundance and its role in ecosystem
- Impact on benthic fauna and its loss due to dredging

- Impact on mangroves and consequent loss of breeding ground for crustaceans, fishes and sea birds
- Impact of changed sediment quality on flora and fauna
- Impact on species composition as (planktons both phyto and zoo, microbes, benthos, fishes, birds etc.)
- Bioaccumulation of pesticides and heavy metals by flora and fauna species (bivalves, fishes) and associated human health hazards as well as other species preying on them (e.g. migratory birds etc.)
- Impact on the microbial population structures
- Impact on the existing abundance and quality of benthic population

Chapter 7

Coastal Pollution and MARPOL Convention

Chapter 7

Coastal Pollution and MARPOL Convention

7.1 Introduction

Ocean Pollution is caused due to several reasons including the following :

- Oil pollution
- Marine debris
- Toxic materials
- Ocean dumping and mining
- Tanker spills
- Runoff from land and industrial wastes

Amongst total sea pollution, land based discharges contribute about 44%, atmospheric input is 33%, maritime transport is 12%, while dumping and oil exploration (and production) contribute about 10% and 1% respectively. At the same time, the global cargo carrying fleet is 54,897 ships of 1,349.4 million Dwt and average age of 19 years. Moreover, following statistics is also worthy of taking note :

- More than 90 % of global trade is carried by sea.
- Annual sea trade is about 8 billion tons.
- It is estimated that by 2060, it will grow to 23 billion tonnes.
- Therefore, unless until adequate measures are taken the associated Carbon Footprint (CF) may grow by 300%.

The % distribution of various cargo materials is provided in the following table (http://www.faroproject.eu/archivos/documentos/2012_%20SETAC%20Congress/Poster_SETAC_EF_APV.pdf):

S. No.	Type of Cargo	Percentage (%)
1.	Fish	25.7 %
2.	Car	20.08 %
3.	Fuel	17.58 %
4.	Containers and Packaging	5.95 %
5.	Auto	4.6 %
6.	Metals etc.	4.4 %
7.	Machinery	4.34 %
8.	Wood, Staves and Sleepers etc.	3.95 %
9.	Fish Meal	2.98 %

7.2 Potential Impacts During Port Construction

- Pile driving, deposition of rubble, dredging, sand compaction and other construction work in water cause re-suspension of sediments and turbid water.
- Re-suspension of sediments in water leads to an increase in the level of suspended solids and in the concentration of organic matter, finally leading to toxic or harmful levels.
- It also reduces sunlight penetration.
- Work vessels can cause oil spills, garbage discharge, and leakage of other substances into water.
- Dredging and disposal of dredged material also lead to significant impacts.

7.3 Impacts During Port Operations

- Discharges including bilge water,
- ballast water,

- oily wastes,
- sewage,
- garbage and other residues in a ship.

- Spills of oils,
  - lubricants,
  - fuels and
  - other oily liquids

7.4 Impacts Due to Cargo Operation

- Runoff from raw material storage
- Spills from bulk cargo handling
- Wind-blown dust
- Accidental spills of toxic, harmful materials, oils or oily compounds and other raw materials

7.5 Pollution Due to Location of the Port

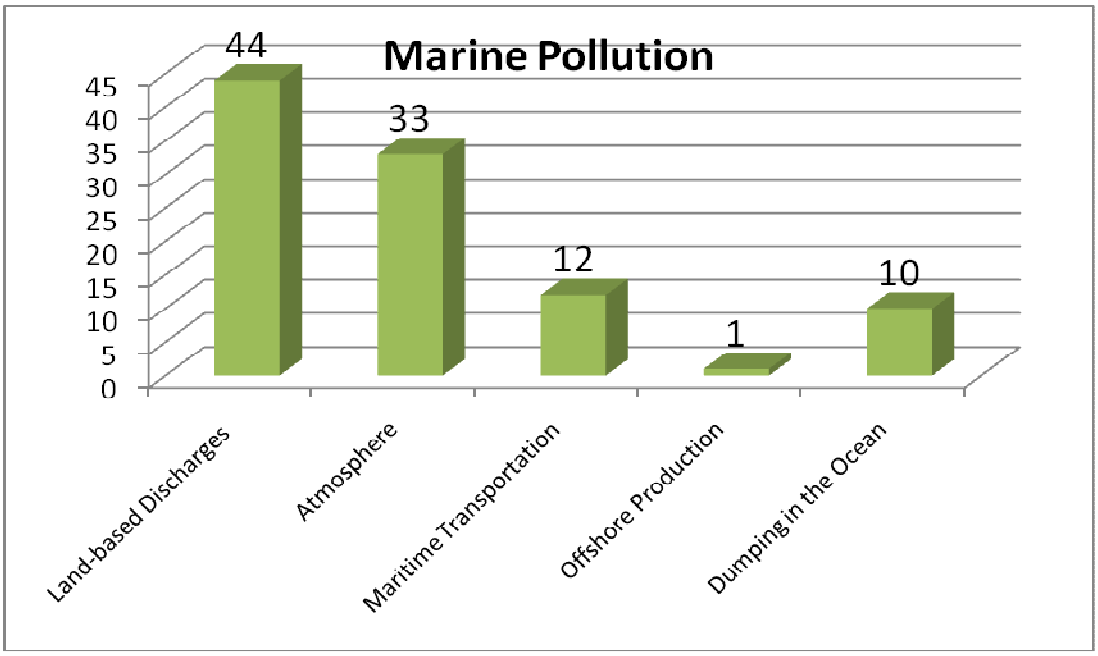
- Changes in current patterns, littoral drifts due to wave refraction, diffraction and reflection.
- Changes in littoral drifts may lead to accretion and erosion of the shore- zone.
- Sedimentation and contamination of sea-bottom
- Increase in organic matter contents
- Eutrophication of water and alterations in food-web interactions

7.6 Maritime Pollution vs. Pollution from Land-based Activities

Estimates by GESAMP (The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) suggested that land-based discharges

- Such as sewage, industrial effluents and urban / river run-off, together with atmospheric inputs from land industry sources – accounted, in 1990, for some 77% of marine pollution generated from human activities,
- While maritime transport was estimated to be responsible for only 12 % of the total.

- According to the report (2002) of UNEP's Global Programme of Action for the Protection of Marine Environment from Land-Based Activities,
    - 80% of the pollution in the world's oceans originate from the land-based activities,
    - With the maritime sector representing just 10% of human sources of marine pollution.



7.7 Solid Waste Generation

Cargo operations produce wastes such as the

- Remains of bulk cargo storage,
- Rubbish from unpacking,
- Floating garbage and
- Other wastes, such as generation of garbage from the offices and town-ships
- Pesticides, herbicides and many other chemicals are used in common consumer products.
- Some of these chemicals including radio-active wastes find their way (through run-off) to the sea or ocean.
- Oceans have been very convenient dumping ground for waste generated on land.

- One of the most important contaminants / pollutants are the nets and plastics, which can be swallowed and caught in an animal's (whales, dolphins, seals, turtles etc.) digestive system.
- There is an accumulation of various toxic materials also. For example, mercury, dioxin, PCBs, PAHs and even radio-active substances.
- Incineration at Sea (mostly of liquid chlorinated hydrocarbon) was phased out in early 1991, followed by the decommissioning of the last incineration vessel. Dumping of radioactive Wastes is banned according to London-Convention. Other categories of wastes dumping of which is reported annually to IMO include :
- Inert, geological materials such as mine tailings (1.5 – 7 million tonnes annually);
- Decommissioned vessels of all kinds and sizes and fish wastes (0.05 – 0.1 million tonnes annually)

7.8 Water Environment : Likely Impacts

- Impact due to associated and ancillary port activities
- Breakwaters and land-fills may change current patterns and cause stagnation of water behind structures
- If municipal or industrial effluents flow into a port, stagnant port water may further deteriorate.
- Municipal sewage also brings pathogens into the port-area and may lead to unacceptable contamination of the harbor.
- In many parts of the globe, sewage flows into the oceans, seas and gulf untreated or undertreated.
- For example, 80% of urban sewage discharged into the Mediterranean Sea is untreated.
- Sewage can lead to eutrophication, and ultimately many types of micro-organism-related human diseases.

7.9 Food-chain and Bio-concentration

- Small species at the bottom of the food-chain, such as planktons in the ocean absorb the chemicals as they feed.
- The chemicals accumulate in these organisms and become much more concentrated in their bodies than in the surrounding water or soil.
- These organisms are eaten by small animals, and the concentration rises again.
- These animals are in turn eaten by larger animals, and this leads to even further increased chemical load in them (some times even million times higher).
- Polar beers, which feed on seals, can have contamination levels up to billion times higher than their environment.
- One of the most important contaminants / pollutants are the nets and plastics, which can be swallowed and caught in an animal's (whales, dolphins, seals, turtles etc.) digestive system.
- There is an accumulation of various toxic materials also. For example, mercury, dioxin, PCBs, PAHs and even radio-active substances.

7.10 Impact of Oil Pollution

- When there is an oil spill on water, spreading immediately takes place.
- The gaseous and liquid components evaporate.
- Some get dissolved in water and even oxidize.
- Some undergo bacterial changes and eventually sink to the bottom by gravitational action.
- Oil kills plants and animals in the estuarine zone.
- Oil settles on beaches and kills organisms that live there.
- It also settles on ocean floor and kills benthic (bottom-dwelling) organisms such as crabs.
- Oil poisons algae and disrupts the major food chain.
- It also coats birds, impairing their flight or reducing the insulative property of their feathers.
- This makes them (birds) more vulnerable to cold.

- Oil endangers fish hatcheries in coastal waters and contaminates the flesh of commercially valuable fish.
- *One of the most significant impact is on MANGROVES*

7.11 Impact on Air Environment

- Emissions of dust and gases during construction and cargo handling
- VOC-emissions from liquid cargo handling
- Accidental releases of toxic gases, explosions, fumes, odours and hazardous air-borne emissions.

7.12 Sources of Noise-Pollution

- Construction activities
- Transportation-vehicles
- Work-vessels
- Cargo-handling equipments

7.13 Socio-economic Impacts

- Relocation of the local community
- Damages to the fishing nets and navigational problems to the fishing community
- Cultural traditions of the local community, their recreational avenues like
    - pleasure-boat-cruising,
    - fishery boat operations
- Shipping-operations also create several job opportunities including
    - pilotage,
    - tug-services,
    - bunker and crew services

7.14 The MORPOL-Convention : An Introduction

- The MORPOL convention remains the most important International Treaty instrument covering the prevention of pollution by ships.
- It sets out regulations dealing with pollution
  - Due to oil-spill;
  - Due to noxious liquid substances carried in bulk;
  - By harmful substances carried by sea in packaged form;
  - By sewage and garbage; and
  - Due to air pollution from various shipping operations.
- The issue of SHIP RECYCLING has also become a growing concern, not only from the environmental point of view but also with regard to the occupational health and safety of workers in that industry
- In May 2007, IMO adopted a new convention on the removal of Wrecks that may present either a hazard to navigation or a threat to the marine and coastal environments, or both
- IMO's Environmental Work in recent years has covered a remarkably broad canvas, embracing every thing, from the management of ship's ballast water and the removal of shipwrecks from the sea-bed to the prohibition of certain toxic substances in ships' anti-fouling systems.
- Other IMO Conventions deal with issues such as preparedness, response and co-operation in tackling pollution from oil and from hazardous and noxious substances; the right of states to intervene on the high seas to prevent, mitigate or eliminate danger to their coastlines or related interests from pollution following a maritime casualty; and
- The safe and environment-friendly recycling of ships that have reached the end of their lifetimes.
- Furthermore, IMO has also developed a comprehensive range of measures aimed at ensuring that proper compensation is paid to the marine pollution victims.
- IMO is also tackling various issues connected with the protection and preservation of Marine Biodiversity, such as
  - The transfer of invasive species through ships' bio-fouling;

- Effects of under water noise from ships on living sea creatures

- Three themes will dominate the Shipping Industry : (a) Shipyard Over-Capacity; (b) Energy Costs; and (c) The Environment
- Likely Solutions would be : New Technologies, such as Dual-Fuel Engines; Cutting Energy Costs by lowering Speed, Modifying Design and Using Multiple Fuel Systems
- Some more technological interventions may also include : (a) the use of liquefied natural gas as a fuel; (b) air lubrication, aimed at reducing the friction between hull and the sea water so as to reduce the fuel consumption; (c) application of fuel cell technology as a replacement for auxiliary engines aboard larger ships

7.14.1 International Convention for the Prevention of Pollution from Ships (MARPOL)

[http://www.imo.org/about/conventions/listofconventions/pages/international-convention-for-the-prevention-of-pollution-from-ships-(marpol).aspx]

- The International Convention for the Prevention of Pollution from Ships (MARPOL) is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes.
- The MARPOL Convention was adopted on ***2 November 1973*** at IMO.
- The Protocol of ***1978*** was adopted in response to a spate of tanker accidents in ***1976-1977.*** As the ***1973 MARPOL Convention*** had not yet entered into force, ***the 1978 MARPOL*** Protocol absorbed the parent Convention.
- The combined instrument entered into force on 2 October 1983.
- ***In 1997***, a Protocol was adopted to amend the Convention and a new Annex VI was added which entered into force on ***19 May***

2005. MARPOL has been updated by amendments through the years.

7.14.1.1 Annex I Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983)

- Covers prevention of pollution by oil from operational measures as well as from accidental discharges;
- The 1992 amendments to Annex I made it mandatory for new oil tankers to have double hulls and brought in a phase-in schedule for existing tankers to fit double hulls, which was subsequently revised in 2001 and 2003.
- The Convention includes regulations aimed at preventing and minimizing pollution from ships - both accidental pollution and that from routine operations - and currently includes six technical Annexes. Special Areas with strict controls on operational discharges are included in most Annexes.

7.14.1.2 Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983)

- Details the discharge criteria and measures for the control of pollution by noxious liquid substances carried in bulk; some 250 substances were evaluated and included in the list appended to the Convention;
- The discharge of their residues is allowed only to reception facilities until certain concentrations and conditions (which vary with the category of substances) are complied with.
- In any case, no discharge of residues containing noxious substances is permitted within 12 miles of the nearest land.

7.14.1.3 Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992)

- Contains general requirements for the issuing of detailed standards on packing, marking, labelling, documentation, stowage, quantity limitations, exceptions and notifications.
- For the purpose of this Annex, "harmful substances" are those substances which are identified as marine pollutants in the International Maritime Dangerous Goods Code (IMDG Code) or which meet the criteria in the Appendix of Annex III.

7.14.1.4 Annex IV Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003)

- Contains requirements to control pollution of the sea by sewage;
- The discharge of sewage into the sea is prohibited, except when the ship has in operation an approved sewage treatment plant or when the ship is discharging decontaminated and disinfected sewage using an approved system at a distance of more than three nautical miles from the nearest land;
- sewage which is not decontaminated or disinfected has to be discharged at a distance of more than 12 nautical miles from the nearest land.
- *In July 2011,* IMO adopted the most recent amendments to MARPOL Annex IV which are expected to enter into force on 1 January 2013.
- The amendments introduce the Baltic Sea as a special area under Annex IV and add new discharge requirements for passenger ships while in a special area

7.14.1.5 Annex V : Prevention of Pollution by Garbage Disposal (Came into Force on 31st December 1988)

- It specifies the distances from land in which materials may be disposed of and subdivides different types of garbage and marine debris.
- The requirements are much stricter in a number of "special areas" but perhaps the most prominent part of the Annex is the complete ban of dumping plastic into the ocean.

7.14.1. Annex VI : Prevention of Air Pollution (Came into Force on 19 May 2005)

- It introduces requirements to regulate the air pollution being emitted by ships, including the emission of ozone-depleting substances, Nitrogen Oxides (NOx), Sulphur Oxides (SOx), Volatile Organic Compounds (VOCs) and shipboard incineration.
- It also establishes requirements for reception facilities for wastes from exhaust gas cleaning systems, incinerators, fuel oil quality, for off-shore platforms and drilling rigs and for the establishment of SOx Emission Control Areas (SECAs).

Chapter 8

Data Analysis

Chapter 8

Data Analysis

8.1 Introduction

Different activities related to the operation of ports and their carbon footprints for different ports are as follows :

Sr. No.	Port-Related Activities
1.	Cargo Handling
2.	Marine Oil Terminals
3.	Dry Dock
4.	Storing
5.	Operational Vessels
6.	Gate Activities
7.	Import and Export Processing
8.	Container Stuffing and Stripping (De-stuffing)
9.	Locomotives
10.	Cargo Handling Equipments
11.	Container Handling Equipments

So as to identify the activities, which contribute maximum towards environmental pollution, an analysis (based on the available information) was carried out in terms of carbon footprints of different port related activities. They have been depicted in the ANNEXURE of this chapter. It is evident from these graphs that for most of the ports, carbon footprints of vessel related activities are much more than those of other activities. This means that the focus of environmental monitoring and management

plans should be on these operations. This exercise helps in identifying the activities with maximum and minimum contribution to pollution generation. Inter alia, it would help in focusing the environmental management strategies in the appropriate sectors. The carbon footprint analysis has been carried out for the following ports :

- Jurong Port
- Gothenberg Port
- Koper Port
- Los Angeles Port
- Rotterdam Port
- Oslo Port
- Seattle Port

Chapter 9

Methodology for Data Collection

Chapter 9

Methodology for Data Collection

9.1 General Methodology for Collection of Data and Regulatory Requirements

Sampling criteria for air quality parameter for noise levels for land, for water, for ecology, sediment, socio-economic is listed in **Tables 1 – 8**. The parameters for ecological assessment are given in **Table 9** The source characterization for air pollutant is given in **Table 10.** The parameters for health impacts are given in **Table 11.** The relevant acts and policies and the standards for various components are given in **Table 12-24,** the models and data collection required for air quality assessment are given in **Table 25,** the models available for water quality assessment are given in **Table 26** evaluation of significant impact is shown in **Table 27.** The criteria for evaluating the species within the habitat are given in **Table 28**. The criteria for evaluating the site and habitat are given in **Table 29**.

9.2 Sampling criteria for different components is shown in the following table.

Table 1
Air Quality Parameters

Parameter	Type of data collection	Specification	Frequency	Source
Wind direction	Secondary Primary	Distribution of wind direction with height, Data for a minimum of 5 years	Daily	IMD, Pune
Wind speed	Secondary Primary	Distribution of wind speed with height, Data for a minimum of 5 years	Daily	IMD, Pune
Temperature	Secondary Primary	Temperature distribution with height Data for a minimum of 5 years	Daily	IMD, Pune

Atmospheric stability	Secondary Primary	Stability variation with height Data for a minimum of 5 years	Daily	IMD, Pune
Rainfall	Secondary	Data for a minimum of 5 years	Daily	IMD, Pune
Nox	Primary	Sampling for 3 seasons	24-hr samples twice a week	
SO_2	Primary	-Do-	-Do-	-
SPM	Primary	-Do-	-Do-	-
RSPM	Primary	-Do-	-Do-	-
CO	Primary	-Do-	-Do-	-
HC	Primary	-Do-	-Do-	-
Land use	Secondary	Land use map of the site is required to locate the target receptors	-Do-	Metropolitan Development Authority

Table 2
Noise Levels

Parameter	**Type of data collection**	**Specification**	**Frequency**	**Source**
Noise levels	Primary	To be measured at the site at selected sampling locations	One sample each during day and night	-
Noise attenuating factors	Primary Secondary	To be examined at the project site by means of a site visit or by use of landuse map	Once	State Metropolitan development Authority
Noise sensitive receptors	Secondary Primary	Landuse map or site visit is required to locate the sensitive receptor	Latest land use map to be Used	State Metropolitan development Authority
Wind direction	Secondary	Data for 5 years using the wind rose diagram	Daily	IMD, Pune

Table 3
Land Parameters

Parameter	Type of data collection	Specification	Source
Land use	Secondary	Land use maps	State Metropolitan Development Authority
Soil, slope, & drainage Characteristics	Secondary	Toposheet	Survey of India (SOI)
Topography	Secondary	Hills, valleys etc	Revenue Department
Terrestrial Ecology	Secondary Primary	Site visit, land use maps	State Metropolitan Development Authority

Table 4
Water Quality Parameters

Parameter	Type of data collection	Description	Frequency	Source
Bathymetry	Secondary	Depth contours up to 30m depth	-	
Hydrodynamics - Tides, waves, currents,	Secondary Primary	High tide/ low tide Maximum and significant wave height Current speed and direction	Continuous measurement for one month per season	Ocean R&D Institutes, DOD
Physical – pH, salinity, temperature, Oil & grease, TSS, TDS, turbidity	Primary	Samples shall be collected for 3 seasons in case of a comprehensive EIA and one season for a rapid EIA	1 sample each for high tide and for low tide for each season	-
Chemical - DO, BOD, Nutrients, Heavy metals and toxic compounds	Primary	- Do-	- Do-	-
Biological – Fecal coliforms, phytoplankton, zooplankton	Primary	- Do-	- Do-	-

Water demand or consumption	Secondary	Total water consumption without the project	Latest data	PWD, Water Supply & Drainage Board
Water resources	Secondary Primary	Surface or groundwater sources and rate of supply from Each	Latest data	PWD, Water Supply & Drainage Board

Table 5
Ecological Parameters

Parameter	**Type of data collection**	**Description**	**Source**
Mangroves	Secondary & Primary	Proximity to the project site, area covered, height and density	Zoological Survey of India (ZSI), DOD
Coral reefs	Secondary	Proximity to the project site and area covered	ZSI, DOD
Endangered species / other critical habitats	Secondary	Type of species, proximity to site	ZSI, DOD
Fishing, breeding areas	Secondary	Type of species, proximity to site	ZSI, Fisheries Survey of India

Table 6
Sediment Quality Parameters

Parameter	**Type of data collection**	**Description**	**Frequency**	**Source**
Sediment transport or littoral Drift	Secondary Primary	Annual estimates Derived from waves data on direct field Measurements	Weekly estimates for an year	Ocean R&D Institutes, DOD
Sediment biology	Primary	Macro-benthos Micro-benthos	1 sample for each season	
Sediment Toxicity	Primary	-Do-	-Do-	-

Table 7
Socioeconomic Parameters

Parameter	Description	Source
Population (target receptors) Primary	Data for the past 10 years	Revenue department
Standard of living (water supply & sanitation, electricity, roads, education, health etc)	Data for the past 10 years	Revenue department
Commercially valuable materials & species	Site visit Land use maps For past 10 years	Revenue department, Fisheries

Table 8
Studies Required for Ecological Assessment and Management

Sr. No.	Activity	Geographical Domain	List of Parameters to be Studied			
			Water	Sediment	Biological	Other Aspects
1.	Ecological restoration and planning for the areas which are already degraded	Intertidal and Offshore	Temp., pH, TDS, TSS, DO, BOD, Chlorides, Salinity, NO_2-N, NO_3-N, PO_4-P, TP, Heavy metals, Silicates, Phenols	Organic Carbon, Heavy Metals, Persistent organic pollutants	Benthos (Density & diversity), Phytoplankton (Cell count, density & diversity), Zooplankton (Biomass, density, diversity & % composition)	Socio-economic aspects, terrestrial ecology

Sr. No.	Activity	Geographical Domain	List of Parameters to be Studied			
			Water	**Sediment**	**Biological**	**Other Aspects**
2.	Coastal & Marine Environment	Total area	Access information on all the parameters listed under 1 from Secondary sources	Secondary Data	Secondary Data	Socio-economics of coastal zone
3.	GIS based information system	Total area	Temp., pH, TDS, TSS, DO, BOD, Chlorides, Salinity, NO_2-N, NO_3-N, PO_4-P, TP, Silicates, Phenols	Organic Carbon, Grain size composition	Benthos (Density & Diversity), Phytoplankton (Cell count, density & diversity), Zooplankton (Biomass, density, diversity & % composition)	
4.	Monitoring of inshore waters	Estuarine zone	Temp., pH, TDS, TSS, DO, BOD, Chlorides, Salinity, NO_2-N, NO_3-N, PO_4-P, TP, Silicates, Phenols	Organic Carbon, Grain size, composition	Benthos (Density & Diversity), Phytoplankton (Cell count, density & diversity), Zooplankton (Biomass, density, diversity & % composition)	Mangroves, Fishery

Sr. No.	Activity	Geographical Domain	List of Parameters to be Studied			
			Water	**Sediment**	**Biological**	**Other Aspects**
5.	Marine Environment	Total Area	Temp., pH, TDS, TSS, DO, BOD, Chlorides, Salinity, NO_2-N, NO_3-N, PO_4-P, TP, Silicates, Phenols	Organic Carbon	Benthos(Density& Diversity), Phytoplankton (Cell count, density & diversity),Zooplankton (Biomass, density, diversity & % composition)	Mangroves
6.	Mangroves	Estuarine Zone		Salinity and grain size distribution	Existing mangroves along the coastal areas. Diversity and density	Fish breeding areas
7.	Ecology of the inter-tidal zone	Intertidal area	Temp., pH, TSS, DO, BOD, Chlorides, Salinity, NO_2-N, NO_3-N, PO_4-P, TP, Silicates, PHC (fresh primary data and secondary data for previous years if available should be collected)	Organic Carbon	Benthos (Density and Diversity) Chlorophyll, Pheophytin, Phytoplankton (Cell count, density & diversity), Zooplankton (Biomass, density, diversity & % composition)	Intertidal data of flora and fauna, socio-economic aspects

Sr. No.	Activity	Geographical Domain	List of Parameters to be Studied			
			Water	Sediment	Biological	Other Aspects
8.	Industrial pollution	Estuary and Coastal areas	Temp., pH, TSS, DO, BOD, Chlorides, Salinity, NO_2-N, NO_3-N, PO_4-P, TP, Silicates, PHC (fresh primary data and secondary data for previous years if available should be collected)	Organic carbon	Benthic flora, fauna, estuarine zone and the coastal area, bacterial quality and diversity. Gene pool can be established.	

Table 9
Air Pollution source characteristics

Activity	Geometry of source	Source type	Location of source	Pollutant type
Site clearing	Area	Continuous	Ground level	SPM and RPM
Soil excavation/Quarrying	Area	Continuous	Ground level	SPM and RPM
Transportation of raw materials	Line	Continuous	Ground level	NOx, CO, HC, Pb, RPM, and SPM
Construction activities	Area	Continuous	Ground level	SPM and RPM
Laying of roads/railway/Crane tracks	Area	Continuous	Ground level	NOx, CO, HC Pb SPM & RPM
Vehicular traffic during operation	Line	Continuous	Ground level	Nox, CO, HC Pb and SPM and RPM

Storage of dry cargo	Area	Continuous/ Instantaneous	Ground level	SPM and RPM
Loading and unloading of dry cargo	Point	Instantaneous	Ground level	SPM and RPM
Storage of liquid cargo	Area	Instantaneous/Continuous	Ground level	Depends on properties of liquid
Loading and unloading of liquid cargo	Point	Instantaneous	Ground level	Depends on properties of liquid
Pipeline operations	Point/Area	Instantaneous/Continuous	Ground level	Depends on properties of liquid
Ship/Barge emissions	Point	Continuous	Ground level	NOx, CO, HC, Pb and SPM and RPM

Respirable Particulate Matter – RPM
Suspended Particulate Matter - SPM

Table 10
Health Impacts

Parameter Affected	**Cause**	**Effect**	**Type of Impact**
Human health	**Air attributes**	Increased mortality & morbidity in exposed population	Long-term
Human health	Particulate matter	Aggravates bronchitis, Respiratory diseases, emphysema, Cardio-vascular diseases, eye irritation	
Vegetation	Sulphur oxides Hydrocarbons	Chronic plant injury, excessive leaf dropping, reduced Productivity in plants & trees	
Materials	Nitrogen oxides	Soils clothes & structures	
	Lead	Deterioration, corrosion of steel & other metal structures	
Risk to humans	Carbon monoxide	Visibility problems, increased accidents	
	Photo-chemical Oxidants		
Human Health	**Noise attributes**	Increased tension and fatigue	Long -term

Human Health	Physiological effects	Increased pulse and respiration rates	
Human Health	Psychological effects	Dizziness and loss of balance	
Human Health	Communicating effects	Anger, irritation and nervousness Partial hearing loss Sleep loss Degradation/effect on structures Detrimental effects on worker performance	
Health	**Water attributes**	Coating of free oil on algae and plankton causing destruction	Long -term
	Water quantity	Interference with re-aeration and photosynthesis	
Aquatic life	Suspended solids	Water soluble fractions of oil likely to cause direct toxic action	
Aesthetics	DO	Destruction of benthic organisms	
	Oil	Direct deleterious effect on fish due to coating on gills and blanketing bottom organisms by suspended solids	
Socio-economics	Dissolved solids Nutrients	Interference with fish spawning areas and loss of fish production	
Socio-economics	Faecal coliform	Reduced recreational and economic benefits	

Table 11
Relevant Acts/Policies/Guidelines

Sr. No.	**Relevant Act of Provision**	**Enforcement Agency**	**Applicability**
1.	Environment (Protection) Act .1986	MoEF, SPCB	Framework legislation giving power to other environmental Rules and Notification including those for EIA (existing) and CRZ
2.	EIA notification, 2006 from MoEF	MoEF, (State Environmental Impact Agency)	Getting environmental clearance
3.	Siting for Industrial Projects Rules, 1999	SPCB, MoEF	For siting of industries based on the criteria given in the document
4.	CRZ notification 1991 (as amended)	State Forest Department, MoEF	Zoning regulation for areas adjoining to the coast and estuaries
5.	Forest (Conservation) Act, 1980 (as	State Forest Department,	Control over using of forest land (including mangroves) for other

	amended)		purposes
6.	Environment Appellate Authority Act, 1997	Environment Appellate Authority	Appeal by public as far as siting of project is concerned
6.	Air Act, 1981 (as amended)	SPCB	Consent to Establish (CTE and Consent to Operate (CTO) with respect to air emissions from port operations)
7.	Water Act,1974	SPCB	CTE and CTO with respect to wastewater discharges
8.	Hazardous Waste (Management and Handling Rules), 1989 (as amended)	SPCB, MoEF	Management, handling and transport of hazardous wastes
9.	Manufacture, Storage and import of hazardous Chemical Rules, 1989 (as amended)	SPCB, MoEF	Manufacture, Storage and Import of Hazardous Chemicals
10.	Land Acquisition Act	Revenue Department	Acquisition of land
11.	Public Liability Insurance Act and Rules, 1991	MoEF	Application for claim and relief

Table 12
National Ambient Air Quality Standards (NAAQS)

Pollutants	Time weighted average	Concentration in ambient air			Method of measurement
		Industrial Areas	Residential Areas	Sensitive Areas	
Sulphur Dioxide (SO_2)	Annual Average	80 μg/m^3	60 μg/m^3	15 μg/m^3	Improved West and Gaeke Method Ultraviolet Fluorescence
	24 hours	120 μg/m^3	80 μg/m^3	30 μg/m^3	
Oxides of Nitrogen as NO_2	Annual Average	80 μg/m^3	60 μg/m^3	15 μg/m^3	Jacob & Hochheiser Modified (Na-Arsenite) method Gas Phase Chemiluminescence
	24 hours	120 μg/m^3	80 μg/m^3	30 μg/m^3	
Suspended particulate Matter (SPM)	Annual Average	360 μg/m^3	140 μg/m^3	70 μg/m^3	High Volume Sampling. (Average flow rate not less than 1.1 m^3 /minute)
	24 hours	500 μg/m^3	200 μg/m^3	100 μg/m^3	
Respirable particulate matter (RPM) (size <10μ)	Annual Average	120 μg/m^3	60 μg/m^3	50 μg/m^3	Respirable particulate Matter sampler
	24 hours	150 μg/ m^3	100 μg/m^3	75 μg/m^3	
Lead (Pb)	Annual Average	1.0 μg/ m^3	0.75 μg/ m^3	0.50 μg/ m^3	ASS Method after sampling using EPM 2000 or eqivalent Filter paper
	24 hours	1.5 μg/ m^3	1.00 μg/ m^3	0.75 μg/ m^3	
Ammonia (NH_3)	Annual Average	0.1 mg/m^3	0.1 mg/m^3	0.1 mg/m^3	Colorimetric method
	24 hours	0.4 mg/m^3	0.4 mg/m^3	0.4 mg/m^3	
Carbon Monoxide (CO)	8 hours	5.0 mg/m^3	2.0 mg/m^3	1.0 mg/m^3	Non Dispersive Infra Red (NDIR) Spectroscopy

Note: Pollutants reviewed by WHO but for which no guidelines were set, because of the lack of reliable evidence or evidence of a ‘safe` level, included particulate matter, 1,3 butadine, PCBs, PCDFs, fluoride and platinum.

Table 13
Air Quality Guideline Values by World Health Organization

Pollutant	**Value**	**Average time**
Carbon monoxide	100 mg/m^3	15 min.
	60 mg/m^3	30 min.
	30 mg/m^3	1h
	10 mg/m^3	8h
Ozone	120µg/ m^3	8h
Benzene	6 X 10^{-6} (µg/ m^3) $^{-1}$	UR (Unit Risk) / lifetime
Dichloromethane	3 mg/m^3	24 h
Formaldehyde	0.1 mg/m^3	30 min.
PAH**	8.7 X 10^{-5} (ng. / m^3) $^{-1}$	1 wk
Styrene	0.26 mg/m^3	UR/lifetime
Tetrachloroethylene	0.25 mg/m^3	Annual
Toluene	0.26 mg/m^3	1wk
Trichloroethylene	4.3 X 10^{-7}(µg/ m^3) $^{-1}$	UR/ lifetime
Arsenic	1.5 X 10^{-3}(µg/ m^3) $^{-1}$	UR/ lifetime
Cadmium	5 ng. / m^3	Annual
Chromium	0.04(µg/ m^3) $^{-1}$	UR/ lifetime
Lead	0.5 µg/ m^3	Annual
Manganese	0.15 µg/ m^3	Annual
Mercury	1.0 µg/ m^3	Annual
Nickel	3.8 (µg/ m^3) $^{-1}$	UR/ lifetime

- Benzene is carcinogenic to humans, and no safe level of exposure can be recommended. For general guidance, the concentrations of airborne benzene associated with an excess lifetime risk of leukaemia of 10^{-4}, 10^{-5} and 10^{-6} are 17, 1.7 and 0.17 µg/m^3, respectively.[4]

- UR=excess risk of dying from cancer following lifetime exposure. Thus for benzene, 6 people in a population of 1 million will die as a result of a lifetime exposure of 1 μg/ m^3 ; for PAHs, 87 people in a population of 1 million will die from cancer following lifetime exposure to 1 ng/ m^3 **Specifically benzo[a]pyrene

Note: Pollutants reviewed by WHO but for which no guidelines were set, because of the lack of reliable evidence or evidence of a 'safe` level, included particulate matter, 1,3 butadine, PCBs, PCDFs, fluoride
and platinum.

Table 14
Key Air Pollutants and their Anthropogenic Sources

Pollutant	**Anthropogenic sources**
Sulphur Dioxide (SO_2)	Coal and oil-fired power stations, industrial boilers, waste incinerators, domestic heating, diesel vehicles, metal smelters, paper manufacturing
Particulars	Coal and oil-fired power stations, industrial boilers, waste incinerators, domestic heating, diesel vehicles, construction mining, quarrying, cement manufacturing
Nitrogen ox0ide (NOx, NO, NO_2)	Coal, oil and gas-fired stations industrial boilers, waste incinerators, motor vehicles
Carbon monoxide (CO)	Motor vehicles, fuel-combustion
Volatile organic compounds (VOCs) e.g. benzene	Petrol-engine vehicle exhausts, leakage at petrol stations, paint manufacturing
Toxic organic micro-pollutants (TOMPs) e.g. PAHs, PCBs, dioxins	Waste incinerators, coke production, coal combustion
Toxic metals, e.g. lead, cadmium	Vehicle exhausts (leaded petrol), metal processing, waste incinerators, oil and coal combustion, battery manufacturing, cement and fertilizer production
Toxic chemicals, e.g. chlorine, ammonia, fluoride	Chemical plants, metal processing, fertilizer manufacturing
Greenhouse gases, e.g. carbon dioxide (CO_2), methane (CH_4)	(CO_2): fuel combustion, especially power stations; (CH_4): coal mining, gas leakages, landfill sites
Ozone (O_3)	Secondary pollutant formed from VOCs and nitrogen oxides
Ionizing radiation (radionuclides)	Nuclear reactors and waste storage, some medical facilities

Odours	Sewage treatment works, landfills sites, chemical plants, oil refineries, food processing paintworks, brickworks, plastics manufacturing, pulp and paper mills,distilleries,cheese factories and tanneries

Table 15
National Ambient Noise Quality Standard

Category of Area	**Limit in dB(A)**	
	Day time	**Night time**
Industrial Area	75	70
Commercial Area	65	55
Residential Area	55	45
Silence Zone	50	40

Day time is reckoned between 6 am to 10 pm; Night time is reckoned between 10 pm to 6 am; Silence zone is defined as areas, which are 100 m around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by the competent authority.

Table 16
Noise Standards for Continuous Exposure (CPCB)

Exposure time	**Sound pressure Level (dB(A))**
8	90
6	92
4	95
3	97
2	100
1.5	102
1	105
0.5	107
0.25 and less	115

Table 17
Water Quality Criteria for Irrigation (CPCB)

Parameters	Acceptable	Relaxation for special Planned cases	Note
Faecal coliform	< 5000	-	No limit for in-edible irrigation crops
pH	6.0-9.0	-	-
Absorption Ratio	< 26	-	SAR beyond 26 may causes salinity and sodicity in the soil
Total heavy metals. mg/lit	< 0.5	< 5.0	-
Boron, mg/lit	< 2	-	Boron is essential nutrient
BOD, mg/lit	00	-	Land can absorb organic matter faster than water, however the conditions of water logging should be avoided
Floating matter	Absent	-	Inhibit water percolation
Conductivity, mili mho/cm	< 2250	< 4000	More conductivity may reduce yield of crops and vegetative growth. It may also increase soil salinity and affects its fertility

Table 18
Recommended Methods of Monitoring and Analysis for Various Parameters

Attributes	Measurement Technique
Meteorological parameters Mechanical or Automatic Weather Station Wind speed, Wind direction, Ambient temperature, Solar radiation	Mechanical or Automatic
Air Pollutants	
• Suspended Particulate Matter (Particulate size 0.5μ to 100μ)	• High volume sampler (Gravimetric) • High volume sampler with cyclone

• Respirable Particulate Matter (< 10μ) • Sulphur dioxide (0.005 to 5 ppm) • Oxides of nitrogen • Carbon monoxide • Hydrogen sulphide (20 to 700μg/m^3) • Ammonia (0.3 to 600 μg/m^3) • Hydrocarbon • Fluoride • Lead	(gravimetric) • West and Gaeke Method (Spectrophotometric) • Modified Hocheiser Method (Spectrophotometric) • Non Dispersive Infra Red Technique • Methylene Blue Method (Spectrophotometric) • Nesslers Method (Spectrophotometric) • Gas Chromatography or Infra Red Analyser • SPADNS Method (Spectrophotometric) • Collected over EPM 2000 filter and analyzed by AAS
Noise	Sound level Meter
Water and Wastewater	Standard Methods for Examination of Water and Wastewater Analysis by APHA
Soil	Reference book by M.L. Jackson Reference book by C.A. Black
Solid Waste	Vogel's Textbook of Quantitative Chemical Analysis
Biological Environment	Standard Methods for Examination of Water and Wastewater Analysis by APHA Secondary data from Govt. offices and published Literature Flora : Sample plot method, Transects and line intercepts method, Plot less sampling method
Socio-economic Environment	Secondary data from census records, Statistical handbook, Toposheet, Health records available with government agencies
Topography and Landuse	Toposheet of Survey of India and / or Digital Analysis Techniques

Table 19
Landuse / Land Cover Classification System

Sr. No.	Level-I	Level-II
1.	Built-up Land	1.1 Built-up land
		1.2 Road
		1.3 Railway
2.	Agricultural land	2.1 Crop land
		2.2 Fallow (Residual)
		3.1 Evergreen/Scrub land
		3.2 Deciduous forest
		3.3 Degraded Scrub land
		3.4 Forest blank
		3.5 Forest plantation
		3.6 Mangrove
		3.7 Cropland in forest
4.	Wasteland	4.1 Salt affected land
		4.2 Waterlogged land
		4.3 Marsh / Swampy land
		4.4 Gullied / Ravinous land
		4.5 Land with or without scrub
		4.6 Sandy area (coastal and des)
		4.7 Barren rocky / stony waste /sheetrock area
5.	Water bodies	5.1 River/Stream
		5.2 Lake/ Reservoir
		5.3 Tank/Canal

6.	Others	6.1	Grassland/ grazing land
		6.2	Shifting cultivation
		6.3	Snow cover/ Glacial area

Table 20
References for facilitating field studies

Topics	**Key references**
Vegetation ecology	*labs.bio.unc.edu/Peet/courses/bio669/papers/DeMaarel.pdf*
Ecological surveys	*www.wiltshire.gov.uk/.../writing**ecologicalsurveys**planning.htm*
Vegetation classification	*www.tidalmarshmonitoring.org/.../USGS-WERC-**Vegetation**-Transects-a; www.epa.nsw.gov.au/resources/forestagreements/**vegetationsurvey**.pdf*
Wildlife surveys methods	*bexar-tx.tamu.edu/files/2011/11/**Wildlife-Survey-Methods**-Heilbrun.pdf; www.tws-west.org/transactions/Raphael%20Barrett.pdf*
Wildlife census techniques	*www.tandfonline.com/doi/pdf/10.1080/01621459.1937.10502323; https://www.panthera.org/.../**Wildlife**FieldResearchandConservationTrain..*
Identification guides **Animal**	
Mammals	Prater, S.H. 1980. The Book of Indian Animals. 3rd Ed. Bombay Natural History Society, Bombay, 428 pp.
Birds	*https://books.google.co.in/books?isbn=1462914853*
Reptiles	http://www.amazon.com/The-Book-Indian-Reptiles-Amphibians/dp/0195660994
Amphibians	*indiabiodiversity.org/biodiv/content/documents/document.../381.pdf*
Fishes	http://fsi.gov.in/LATEST-WB-SITE/fsi-pub-frm.htm
Insects	*ces.iisc.ernet.in/hpg/envis/cesinseLZ.html*
Butterfies	*www.ajcb.in/journals/full.../AJCB-Vol3-No1-Sethy%20et%20al.pdf*
Plants	
Vascular plants	*https://books.google.co.in/books?isbn=0521414210*
Pterdophytes	*tai2.ntu.edu.tw/Taiwania/pdf/tai.2000.45.1.38.pdf*
Gymnosperms	*nsdl.niscair.res.in/.../**Gymnosperms**%20I%20-*

	%20General%20Features%...
Bryophytes	*tnenvis.nic.in/tnenvis_old/images/**Bryophyte**_Database.pdf; people.exeter.ac.uk/rwfm201/cbbia/downloads/.../Asia-guidance-pt3.pdf*
Algae	*ir.nmu.org.ua/bitstream/.../a2e5daa96084da1deb7ee1e4d484064d.pdf?...1*
Fungi	*people.exeter.ac.uk/rwfm201/cbbia/downloads/.../Asia-guidance-pt3.pdf*
Conservation Status	
Animals	IUCN Red List of THREATENED Animals (1996)
Plants	IUCN Red Data Book for Plants (Nayar and Sastry 1987)
General EA guide for Asia	*adb.org/sites/default/files/pub/**1997**/eia-developing-countries-**asia**.pdf*
Overview of EIA methods	*https://www.**iaia**.org/publicdocuments/**EIA**/.../Vol1_**EIA**_Manual.pdf*

Source: Roads, Sensitive Habitats and Wildlife – Environmental Guidelines for India and South Asia by Dr. Asha Rajvanshi et.al, 2001

Table 21

Techniques for baseline Data Collection for Biological Environment

Parameters	**Methods**	**Remarks**
Floristic inventory and description of major plant communities	Simple checklists of plant names and references of local and regional flora can be useful. Plant checklists are also the major data sources for community description	Use of classification system of forests provided by Champion and Seth (1968) can be useful in developing ecological understanding of plant communities in the study area
Habitat assessment Estimation of ground cover	`Two step' method and circular plot and frame method	This method is suitable in some situations
Vegetation and habitat mapping	Remote sensing and GIS techniques	The degree of details of information on the maps depends upon the precise objective of study
Estimation of animal abundance	Direct method	-
Large and	Direct method include direct	Fairly reliable and most commonly

medium bodied species	sighting	used methods for estimating density and abundance
Primates	Scan and focal sampling	The methods can be effective if the population being studied is not very disturbed by human presence which might `freeze' them
Reptiles and amphibians	Spotlight counts and pitfall traps	Parameters such as time and location of sighting, weather condition, moon stage and water level could influence the survey results.
Birds	Belt transects, mist nets and territory mapping	Location of transects (example along roads and disturbed areas) can influence sampling. Mist nets are generally useful for birds of the under storey (up to 3 meters above ground). Territory mapping depends on locating singing males in the area and is therefore limiting to use during the breeding seasons
Large and medium size species	Counts of pellets/scats, quills, prints, claw mark, other surface markings (scrape marks, debarking signs) and dens, burrows and nests	The method poses some difficulties in using pellet counts for estimating abundance of species with closely resembling pellet e.g. chital and domestic goat pellet look alike and pose problems of estimating species abundance.
Birds	Calls	Fairly reliable method of identification of species and their abundance

Sources: W.A.Rodgers (1991), Techniques for wildlife Census in India – A field Manual, Wildlife Institute of India, Dehradun and Sale J.B. and K. Berkmuller (1988), Manual of Wildlife Techniques for India, Field Document No. 11, Wildlife Institute of India, Dehradun.

Table 22
Socio-economic Impacts

Impact Area	Potential Changes
General characteristics and trends in population of region	Increase or decrease in population
Migration trends in study area	Increase or decrease in migration trends
Population characteristics in study area, including distribution by age, ethnic groups, educational level and family size	Increase or decrease in various population distribution, people relocations
Distinct settlement of ethnic groups or deprived economic/minority groups	Disruption settlement patterns, people relocations
Economic history for the region	Changes in economic patterns
Employment pattern in study area, including occupational distribution and location and availability of work force	Increase or decrease in overall employment or unemployment levels and change in occupational distribution
Income level and trends for study area	Increase or decrease in income levels
Land values in study area	Increase or decrease in land values
Housing characteristics in study area, including types of housing and occupancy levels	Changes in types of housing and occupancy levels
Health and social services in study area, including health, workforce, law enforcement, fire protection, water supply, wastewater treatment facilities, solid waste collection and disposal and utilities	Changes in demand on health and social services
Public and private educational resources in study area	Changes in demand on educational resources
Transportation systems in study area, including highway, rail, air and waterway	Changes in demand on transportation systems
Community cohesion, including organized community groups	Disruption of cohesion
Tourism and recreational opportunities in study area	Increase or decrease in tourism and recreational potential
Religious patterns and characteristics in study area	Disruption of religious patterns and characteristics

Area of unique significance such as cemeteries or religious camps	Disruption of unique areas
Change due to reservoir	Protection or danger from flood
Income levels	Increased income levels through agriculture or through other means

Table 23

Models and Data Requirements for Air Quality Assessment

- General information (ISCST3, AERMOD, FDM, CALINE4)
- Model Equations
- Data on :
  - Sources (P, A, L, V)
  - Receptors
  - Meteorology (Surface/Upper air)
  - Deposition
- Case Study
  - ISCST3
  - FDM

Air Quality Models – General Information

MODEL	**ISCST3**	**AERMOD**	**FDM**	**CALINE4**
Sources	Point, Area, Volume, Line, Open Pit	Point, Area, Volume, Line	Point, Area, Volume, Line	Line
Pollutants	SO_2, SPM, NOx and other pollutants	SO_2, SPM, NOx and other pollutants	Particulate matter	CO and NO_2
Concentration	Concentration	Concentration	Concentration	Concentration
Deposition	Dry deposition, Wet deposition, Dry gas deposition	Not Yet Ready	Dry deposition	Dry deposition
Receptor	Cartesian Polar	Cartesian Polar	Cartesian	Cartesian

Surface Meteorological Data Needs

ISCST3	AERMOD	FDM	CALINE4
(m/s) WD (deg) T (K) AS (1-6) MHR (m) MHU (m)	SHF (W m-2) u* (m s-1) w* (m s-1) dθ/dz hc (m) & hm (m) L (m) z0 (m) Bowen ratio Albedo WS (ms-1) WD (deg) Zag (m) T (K) zat (m) Ppt code Ppt amount (mm) RH (%) Ps (mb) & CC (tenths)	WS (m/s) WD (deg) AS (1-6) MH (m) T (K)	WS (m/s) WD (deg) AS (1-6) MH (m) Wind direction standard deviation (deg) Ambient concentration (ppm)

Note : The selections of appropriate model depends on site-specific conditions.

Table 24

Water Quality Models

Mike Series : Mike 21, Mike HD, Mike SHE, Mike 3, Mike Ecolab; Dam Break Model; CORMIX; WASP; HEC – 5Q

Note : The selections of particular models depend upon the site specific condition.

Table 25
Evaluating the significance of an ecological impact

Criteria	Remarks
Habitat quality	The impact will be more significant if ecologically important habitats are affected.
Species	The impact will be more significant if ecologically important species are affected.
Size/Abundance	The importance will be greater if larger habitat or greater numbers of organisms are affected
Duration	Long term impacts are usually more significant than short term
Reversibility	Permanent and irreversible impacts are usually more significant than temporary and reversible ones.
Magnitude	Usually the greater the magnitude of the environmental changes (e.g. increase in pollution loads, decrease in food supply), the more significant is the impact

Table 26
Evaluating species found within a site/habitat

Criteria	Remarks
Protection status	Species listed by MoEF, ZSI, BSI, and international conventions for conservation of wildlife shall be given special attention
Distribution	Species with restricted distribution (locally or regionally) will be rated higher than those more widespread ones
Rarity	Normally rarer the species the more value it has. Care should also be exercised in assessing exotic weeds, captive species, and introduced species which have lower value.

Table 27
Evaluating the site / habitat

Criteria	**Remarks**
Naturalness	Truly natural habitats (i.e. not modified by man) are usually highly valued.
Size	In general, larger habitat-area shall be more valuable than smaller ones.
Diversity	The more diverse the species assemblages and communities of a site, the higher is its conservation value.
Rarity	Rarity can apply to habitats as well as species. The presence of one or more rare habitats and species will give a site higher value than those without rarity
Re-creatability	Habitats, which are difficult to be re-created naturally or artificially, are usually valued higher.
Fragmentation	In general, the more fragmented habitat has lower value.
Ecological linkage	The value of a habitat increases if it lies in close proximity and / or links functionally to a highly valued habitat of any type.
Potential value	Certain sites, through appropriate management or natural processes, may eventually develop a nature conservation interest substantially greater than that existing at present.
Nursery / breeding ground	Such areas are very important for the regeneration and long-term survival of many organisms and their populations.
Age	Ancient natural or semi-natural habitats are normally highly valued. For some habitats such as woodlands, older ones are normally valued much higher than recent ones.
Abundance / Richness of wildlife	In general, sites supporting more wildlife will be rated higher.

Chapter 10

Emissions, Monitoring and Sampling

Chapter 10

Emissions, Monitoring and Sampling

10.1 Introduction

Environmental monitoring can be defined as the systematic sampling of air, water, soil, and biota in order to observe and study the environment, as well as to derive knowledge from this process. Monitoring can be conducted for a number of purposes (Mitchell, 2002; Artiola *et al*., 2004; Wiersma, 2004), viz.

- to establish environmental baselines, trends, and cumulative effects,
- to test environmental modeling results,
- to educate the public about environmental conditions,
- to inform policy design and decision-making,
- to ensure compliance with environmental regulations,
- to assess the effects of anthropogenic influences, and
- to construct an inventory of natural resources.

Environmental monitoring programs can vary significantly in the scale of their spatial and temporal boundaries. They can also vary significantly in scope, ranging from community- based monitoring on a local scale, to large-scale collaborative global monitoring programs such as those focused on climate change. It (Environmental monitoring), inter alia, can be conducted by various public and private organizations, concerned individuals, non-governmental environmental organizations, and government agencies (Conrad & Daoust, 2008; Lovett *et al*., 2007).

In order for monitoring activities to be effective and to deliver high quality data, it is important to identify focused, relevant, and adaptive questions that can be used to guide the development of a monitoring plan. The successful management of an efficient monitoring program can often times be highly challenging. Other fundamental components of effective monitoring programs include : application of quality assurance and quality control measures during the data collection process, data storage and access, and the consultation of experienced statisticians during the sampling design process (Lindenmayer & Likens; Lovett et al., 2007; McDonald, 2003; Wiersma, 2004).

10.2 Different Components of Environmental Monitoring

Earth System can be subdivided into the following components (De Blij *et al.*, 2005) :

- the atmosphere,
- the hydrosphere,
- the biosphere,
- the lithosphere, and
- the cryosphere.

Environmental monitoring can be conducted on biotic and abiotic components of any of these spheres, and can be helpful in detecting baseline patterns and patterns of change in the *inter* and *intra* process relationships between and within these spheres. The interrelated processes that occur between the five spheres are characterized as physical, chemical, and biological processes. The sampling of air, water, and soil through environmental monitoring can produce data that can be used to understand the state and composition of the environment and its processes (Artiola *et al*., 2004; Wiersma, 2004).

Environmental monitoring uses a variety of equipments and techniques depending on the focus of the monitoring. For example, surface water quality monitoring can be measured using remotely deployed instruments, handheld in-situ instruments, or through the application of bio-monitoring in assessing the benthic macro invertebrate community (CBEMN, 2010). In addition the techniques and instruments that are

used during field work, remote sensing and satellite imagery can also be used to monitor larger scale parameters such as air pollution plumes or global sea surface temperatures (Mitchell, 2002; Artiola *et al*., 2004).

Moreover, now there is a global recognition that "environmental issues are best handled with the participation of all concerned citizens", a principle first articulated in the United Nation's Earth Summit Agenda 21 (UN, 1992). This principle was strengthened further in July, 2009, with the formal ratification of the Aarhus Convention which mandates participation by the public in environmental decision-making and access to justice in environmental matters (UNECE, 2008). Different countries have different ways of doing environmental monitoring and the following section presents an overview of the methodologies adopted by them in the area of environmental monitoring and management.

10.2.a Canada

In Canada, environmental monitoring on the national level is conducted by federal departments such as the Department of Fisheries and Oceans, Natural Resources, Environment Canada, and Parks Canada. On the provincial level, monitoring is conducted by parallel provincial government agencies. The Ecological Monitoring and Assessment Network (EMAN) was established in 1994 in order to monitor and report on ecosystem changes at a national level (Environment Canada, 2010). This national network is capable of facilitating the central coordination of monitoring initiatives from all government agencies, and of providing comprehensive data to aid in effective, adaptive setting of policies and priorities (Vaughan *et al*., 2001). In 2008, EMAN was "reorganized within the Wildlife and Landscape Science Directorate" (Environment Canada, 2010).

EMAN significantly enhanced national conservation and sustainability initiatives through comprehensive data collection and the potential for well informed decision-making (Vaughan *et al*., 2001). An important component of EMAN's research is that it has the standardized monitoring protocols that have been developed for marine, freshwater, and terrestrial ecosystems (Environment Canada, 2010). These

protocols are available in the Ecological Monitoring section of Environment Canada's website (Environment Canada, 2010).

10.2 b United States

In the United States, environmental monitoring is conducted by government agencies organized in an administrative structure similar to that of Canada. Monitoring is undertaken by relevant state and federal departments, such as natural resource and environmental protection agencies (Artiola *et al*., 2004). The Environmental Monitoring and Assessment Program (EMAP) was established by the national Environmental Protection Agency in 1990 in order to assess and monitor the trends and status of national ecological resources (Stevens, 1994; USEPA 2010). Similar to EMAN in Canada, the EMAP program was intended to coordinate information sharing between all government agencies that are involved in conducting the monitoring of natural resources (Artiola *et al*., 2004).

At local level, the Charles River Watershed Association (CWRA) in Massachusetts has established formal linkages with government in order to provide comprehensive data that is used by the Massachusetts Department of Environmental Protection in the decision-making process (CRWA, 2008). The CWRA has been conducting water quality monitoring on the Charles River since 1995, and the data set that has been compiled will assist managers in addressing harmful pollution-loads present in the river (CRWA, 2008). Quality assurance and quality control measures have standardized the data collection process, and thus facilitated the compilation of an extensive, credible data set that would otherwise be beyond the reach of government resources alone.

10.2 c Sweden

The Swedish Environmental Protection Agency's (SEPA) national monitoring program is a comprehensive, ongoing, national monitoring program that facilitates knowledgeable state of the environment reporting and the nationwide protection of natural resources and the environment (SEPA, 2010). The SEPA has compiled valuable observation series that span the longest timescale of any existing observation series in the world, and the agency provides national coordination of

monitoring initiatives in order to maximize the efficiency of monitoring programs across the country (SEPA, 2010).

Monitoring data collected by national and municipal government agencies, private industry consultants monitoring for regulatory compliance, and non-governmental organizations is all vetted through SEPA to ensure quality and accuracy and is used to provide a comprehensive national data set that would be otherwise unfeasible to achieve through government resources alone (SEPA, 2010). Detailed monitoring guidance criteria and regulation are provided by SEPA to ensure consistency and quality assurance and quality control of data collected by different agencies and organizations (SEPA, 2010).

An additional strength of this program is that data records have been consistently maintained and are readily available through the Agency's website (SEPA, 2010). The national monitoring program has been divided into ten programme areas, each containing sub-programmes, in order to provide a comprehensive description and inventory of the state of the Swedish environment (SEPA, 2010). The ten programme areas include air, mountain areas, forests, agricultural land, landscapes, wetlands, freshwater, seas and coastal areas, health-related environmental monitoring, and toxic substances coordination (SEPA, 2010). Highly coordinated, national environmental monitoring is essential in order to maximize the efficiency of monitoring that is being conducted in separate government departments. National coordination can help to ensure that all areas of concern are being monitored and that there is no duplication of costly data collection by different departments. This type of national monitoring initiative presents a logical approach to addressing global environmental change that is occurring at an unprecedented rate and on an unprecedented scale.

10.2 d Global-Scale Monitoring Initiatives

There are several global-scale organizations that are responsible for the collection and distribution of environmental data internationally (Artiola *et al.*, 2004). For example, there are multiple programs operated by the United Nations that participate in global environmental monitoring activities, such as the World

Meteorological Organization (WMO), the Global Atmosphere Watch, and the World Conservation Monitoring Centre (Artiola *et al*., 2004; UNEP, 2011). The WMO, the World Weather Watch, and the World Health Organization collectively manage the Global Environment Monitoring System (GEMS), which is responsible for monitoring and reporting on the "global state of water, air, climate, atmosphere, and food contamination" (Artiola *et al*., 2004). Through the administration of these programs, the United Nations is providing a valuable mechanism for data collection and dissemination on a global scale, making it possible to address global scale issues such as water security and climate change (GEMS, 2011).

Monitoring programs usually cost much little in comparison to the resources that can be protected and the policy design that can be informed (Lovett *et al*., 2007). Successes and failures of monitoring programs have been thoroughly analyzed by the scientific community, and practical solutions for addressing the standard challenges of monitoring programs are readily available in scientific literature (Lindenmayer & Likens, 2009; Lovett *et al*., 2007).

In order to achieve valuable results from environmental monitoring activities, it is necessary to adhere to sampling processes that are supported by the traditional scientific method (Artiola *et al*., 2004), and any effective monitoring program must include focused and relevant questions, appropriate research designs, high quality data collection and management, and careful analysis and interpretation of the results (Lovett *et al*., 2007).

Long-term monitoring programs are often faced by the challenge of securing long-term funding (Lindenmayer & Likens, 2009; Lovett *et al*., 2007). In view of the increasing frequency and magnitude of environmental issues that are emerging in this era of globalization, government funding institutions are encouraged to commit to meaningful, stable, and long-term funding of monitoring programs in acknowledgement of the cost savings associated with the protection of natural resources and the improved efficiency of policy design (Lovett *et al*., 2007). In

order to encourage a greater commitment to monitoring on behalf of funding agencies, management relevancy, as well as the quality and effectiveness of monitoring programs, program design should include a collaborative effort on behalf of scientists, statisticians, policy makers, and natural resource managers (Lindenmayer & Likens, 2009).

Despite various challenges, monitoring remains an important tool in the achievement of major advances in environmental science (Lovett *et al.*, 2007). One of the most prominent examples of the significance of environmental monitoring is in the record of atmospheric CO_2 concentrations recorded in Mauna Loa, Hawaii by C.D. Keeling (Lovett *et al.*, 2007; Vaughan *et al.*, 2001). This long-term record has led to an increased understanding and awareness of global climate change, one of the greatest environmental challenges that has ever been faced in human history. The relevance of environmental monitoring in environmental science and policy design is well-established. Environmental monitoring will continue to improve its methodology through advancements in modern science, and government and other funding institutions should increase meaningful, long-term funding towards the establishment of effective monitoring programs distributed from the local to global scales.

10.3 Essence of Environmental Monitoring

Following are the essential features of a well designed and co-ordinated monitoring program :

- The monitoring program should be ***designed around very clear and compelling scientific questions.***
- The monitoring plan should continuously be reviewed and revised by way of taking regular feedbacks.
- Quality and consistency of data should be continuously maintained.
- There should be a well designed plan for long-term data-accessibility, interpretation and analysis.

10.4 The Details of Environmental Monitoring

Monitoring implies use of routine measurements to detect changes in the

environment or ecosystem-health. It (Monitoring) is mainly carried out for assessing impacts of pollution on ecosystem and human health so as to identify cause and effect relationship between pollutant concentration and the impacts. Through these cause and effect relationships, one can achieve the desired environmental management objectives.

It also helps in :

- Evaluating various pollution interactions and patterns
- Assessing the need for legislative controls and emissions of pollutants and to ensure compliance with emission standards.

The control of environmental hazards depends on defining acceptable levels of exposure. Health risk and the levels of control are needed to keep exposure below specified thresholds. For any potential environmental hazard one of the main principles for monitoring and control is to identify the critical agents, pathways and populations at risk. Such considerations guide various methods to be adopted for monitoring and surveillance. Data can also be collected from a range of sources, including :

- Emissions inventories (records of the permitted or actual level of emissions from specified sources);
- Environmental data (measurements of the concentrations of pollutants in the environment);
- Bio-monitoring data (measurements of specific agents or their metabolic products in biological samples);
- Routine (surveillance) data;
- Health data & Clinical surveillance (relevant to specific exposed populations), which might include :
    - health care utilization data (hospital admissions, primary care consultations);
    - infectious disease monitoring data
    - births, congenital anomalies and related data;
    - cancer registrations;
    - mortality statistics;
    - epidemiological surveys.

The cornerstone of the environmental quality objectives is that the authorities are required periodically to review and assess the current, and likely future environmental quality in their areas against national quality standards for all the pollutants. Local measures may include:

- working with relevant authorities responsible for highways and / or environmental regulation on possible emissions reduction measures;
- local traffic management schemes, including use of low emission zones and congestion charging in some areas where appropriate;
- commitment to developing or promoting green plans and / or to using cleaner technologies;
- information dissemination to the public;

10.5 Design of the Monitoring Program

Environmental monitoring is used in the preparation of environmental impact assessments, as well as in those circumstances in which human activities carry a risk of being affected by the harmful effects. All monitoring strategies and programmes are often designed to establish the current status of an environment or to establish trends in environmental parameters. The results of monitoring are subsequently reviewed, analyzed statistically and reported. Therefore, the monitoring programme should be so designed as to make it amenable for appropriate and useful analysis [http : // en.wikipedia.org / wiki / File : WQ_sampling_station_USGS_2004.jpg].

Monitoring programmes invariably would, in some way or other, be invasive of the environment under study except probably the remote sensing. Thus, an extensive and poorly planned monitoring carries the risk of damaging the environment. This should be a critical consideration in ecologically sensitive areas or when monitoring very rare organisms.

Monitoring the environment may be carried out for a number of reasons, however the most important factor when designing such a programme is to ensure that the samples obtained provide adequate data for the purpose intended i.e. the samples should be representative of conditions prevailing in the environment at the time and place of

collection. Not only must the sampling location be carefully chosen but also the sampling position at the chosen location.

The selection of a specific monitoring site requires consideration of four steps.

- Identify the purpose to be served by monitoring
- Identify the monitoring site types that will best serve the purpose
- Identify the general location where the sites should be placed
- Finally, identify specific monitoring sites.

A basic problem in the design of a monitoring programme is that the reasons for carrying out monitoring demands different answers to a number of questions e.g. number and location of sampling sites, the duration of the survey, and the time resolution of sampling will vary depending on the specific objectives of the study. Decisions on what to monitor, when and where to monitor and how to monitor are often made much easier once the purpose of monitoring is clearly defined. It is most important that the first step in the design of a monitoring programme should be to set out the objectives of the study very clearly (unaab.edu.ng / attachm**ent**s / Environmental%20Monitoring%20Systems%2..).

Moreover, sources of pollution may be classified by their spatial distribution as point sources, (e.g. industrial chimneys, liquid waste discharge pipes); line sources or area sources (e.g. high ways, airline routes and non-point sources like run-off from agricultural land). Sources may also be classified as either stationary or mobile or on the basis of height of discharge for air pollutants i.e. at street level, building level, stack level or above the atmospheric boundary layer level. An important distinction may be made between planned, fugitive and accidental emissions to the environment.

- ***Planned emission*** arises when it is economically or technically impossible to completely remove all the contaminants in a discharge and hence the process operation allows pollutants to be discharged to the environment at known and controlled rates. For example, SO_2 from power generation plants and low level radioactive effluent during nuclear fuel reprocessing.

- ***Fugitive emission*** arises when pollutants are released in an unplanned way. They generally originate from operations which are uneconomic or impractical to control, have poor physical arrangements for effluent control or are poorly maintained or managed.
- ***Accidental emissions*** results from plant failure, such as burst filter bag or faulty valve, or from an accident involving either equipment or operator error. Accidental emissions can give rise to very high concentration but they normally occur infrequently.

10.6 Types of Monitoring Methodologies

Monitoring methodologies can also be divided into three categories according to cost and the required level of accuracy and precision.

10.6a Continuous Monitoring Methods

These are high-resolution methods that provide continuous records of contaminant levels. They can operate over extended periods (weeks or months) with minimal operator intervention. Remote communication is possible by telemetry. They have a high degree of measurement precision. As might be expected, these are the most expensive monitoring methods. A high standard of maintenance, calibration, and operational and quality control procedures are required for good data quality.

10.6b Semi-continuous and Continuous Sampling / Monitoring

There are specialized sampling equipments available that can be programmed to take samples at fixed or variable time intervals or in response to an external trigger. For example, a sampler can be programmed to start taking samples of a river at 8 minute intervals when the rainfall intensity rises above 1 mm / hour. The trigger (in this case) can be a remote rain gauge communicating with the sampler by using cell phone or meteor burst technology. Samplers can also take individual discrete samples at each sampling occasion or bulk up samples into composite. Continuous or quasi-continuous monitoring involves having an automated analytical facility close to the environment being monitored so that results can, if required, be viewed in real time.

Such systems are often established to protect important water supplies, but may also be part of an overall monitoring strategy where early warning of potential problems is essential. Such systems routinely provide data on parameters such as *pH, dissolved oxygen, conductivity, turbidity and colour.* In all examples of automated analysis there is a requirement for water to be pumped into the monitoring station. Choosing a location for the pump inlet is equally as critical as deciding on the location for a grab sample. The design of the pump and pipe work also requires care.

10.6c Passive Sampling

The use of passive samplers greatly reduces the cost and the need of infrastructure on the sampling location. Passive samplers are semi-disposable and can be produced at a relatively low cost, thus they can be employed in great numbers, allowing for a better cover and more data being collected.

10.6d Remote Surveillance

Although on-site data collection using electronic measuring equipment is common-place, many monitoring programmes also use remote surveillance and remote access to data in real time. This requires the on-site monitoring equipment to be connected to a base station via either a telemetry network, land-line, cell phone network or other telemetry system such as Meteor burst. The advantage of remote surveillance is that many data feeds can come into a single base station for storing and analysis. It also enables trigger levels or alert levels to be raised for individual monitoring sites and / or parameters so that immediate action can be initiated if a trigger level is exceeded. The use of remote surveillance also allows for the installation of very discrete monitoring equipment which can often be buried or camouflaged. Use of such equipment tends to reduce vandalism and theft when monitoring in locations, which are easily accessible by the public.

10.6e Remote sensing

Environmental remote sensing uses aircraft or satellites to monitor the environment using multi-channel sensors. There are two kinds of remote sensing. Passive sensors detect natural radiation that is emitted or reflected by the object or surrounding area

being observed. Reflected sunlight is the most common source of radiation measured by passive sensors and in environmental remote sensing, the sensors used are tuned to specific wavelengths from far infra-red through visible light frequencies to far ultra violet.

The volumes of data that can be collected are very large and require dedicated computational support. The output of data analysis from remote sensing are false colour images which differentiate small differences in the radiation characteristics of the environment being monitored. With a skilful operator choosing specific channels it is possible to amplify differences which are imperceptible to the human eye. In particular, it is possible to discriminate subtle changes in chlorophyll 'a' and chlorophyll 'b' concentrations in plants and show areas of an environment with slightly different nutrient regimes.

Active remote sensing emits energy and uses a passive sensor to detect and measure the radiation that is reflected or backscattered from the target. LIDAR is often used to acquire information about the topography of an area, especially when the area is large and manual surveying would be prohibitively expensive or difficult. Remote sensing makes it possible to collect data on dangerous or inaccessible areas. Remote sensing applications include monitoring deforestation, the effects of climate change on glaciers and Arctic and Antarctic regions, and depth sounding of coastal and ocean depths.

10.6f Gravimetric Particulate Methods

Gravimetric particulate methods have formed the mainstay of particulate monitoring. These methods are also used for the analysis of airborne lead, and screening surveys. Monitoring starts when a known volume of air is pumped through a pre-weighed filter for a known length of time (typically 24 hours). The filter is reweighed after exposure and a concentration determined. Most systems require manual changes of the sampling filters between each sample, although a number of semi-automated systems are also available.

10.6g Passive Monitoring Methods (Diffusion Tubes and Badges)

Diffusion tubes work when a contaminant is diffused into a tube containing either an adsorbent or reactive material. Analysis of the tubes following a known exposure time (typically two to four weeks) will provide a time-averaged contaminant concentration. Badges work in a similar way, the difference being the sampler configuration. Badges typically have higher uptake rates and are used more widely because these methods are simple and cheap, they can provide a good picture of spatial variation over a large area. They are particularly useful in screening surveys and during the initial stages of an air quality monitoring programme.

Though a cheap screening tool, there are a number of limitations to this method, such as lower accuracy and no indication of peak levels. Quality control and assurance during laboratory analysis must be of the highest standard to attain consistent results. The results from passive samplers can be used in conjunction with high-resolution instruments to determine spatial variation across an air shed over a relevant averaging time-period. This method can also be useful for comparison with annual guidelines. Wet chemical methods are also used to monitor levels of gaseous contaminants. These methods have lower resolution. High-resolution instrumental methods are now recommended.

10.6h Open-path Monitoring Systems

Open-path monitoring systems measure a range of contaminants based on absorption of a light beam transmitted over distances of up to several kilometres. As such, they are totally different from most other monitoring methods in common use. The main difference is that the open-path system records the average concentration simultaneously for a number of contaminants over the full measured distance rather than at a specific point. The measured results will therefore be lower than those at some points along the path and higher than at others. This method is particularly suitable for measuring along site boundaries of industrial processes, but is not often

used for measuring ambient air quality at discrete points. These methods are usually only used for research purposes.

One of the main attractions of the open-path systems is that they can be used for a wide variety of different contaminants, including most of the volatile organics. The main disadvantage is their cost, which is typically three to five times the cost of any of the more traditional instruments. Furthermore the concentration of a particular contaminant is averaged over the beam length, which can underestimate the ground-level concentration where there are one or more point sources of contamination present.

10.7 Source Monitoring

This may be carried out for the following reasons :

- Determination of the mass emission rates of pollutants from a particular source and assessment of how these are affected by process variations
- Evaluation of the effectiveness of control devices for pollution abatement
- Evaluation of compliance with statutory limitations on emissions from individual sources.

10.8 Stationary Sources and Gaseous Emissions

Two requirements are generally specified for valid source monitoring. First the sample should accurately reflect the true magnitude of the pollutant emission at a specific point in the stack at a specific time. This requirement is met by adequate sampling instrument design. Secondly, *enough measurements should be obtained over time and space so that their combined result will accurately represent the entire source emission.* Generally, 8-12 sampling points are adequate to *compensate for any deficiencies in the location of the sampling site with respect to the length of the stack and to non-ideal flow conditions at the site caused by bends, inlets or outlets.*

10.7.2 Mobile Source Sampling for Gaseous Effluents

Vehicle and air craft emission are heavily dependent upon the engine operating mode (i.e. idling, accelerating, cruising or decelerating) and the results obtained by sampling must be considered specific to the type of operating cycle used during the test.

10.9 Source Monitoring for Liquid Effluents

Liquid wastes and effluents like gaseous effluents tend to be inhomogeneous and care is needed in selecting sampling position. Several samples may have to be taken across the cross – section of a pipe or channel. In cases where suitable homogeneous regions for sampling cannot be found, samples may have to be taken from several positions along the effluent stream. Where the composition of a liquid effluent is known to vary with time, grab samples may be collected at set intervals either manually or by use of an automatic sampler. An alternative approach is to sample at intervals varying with the flow rate so that a more representative composite may be obtained.

10.10 Source Monitoring for Solid Effluents

Solid effluents may arise from a number of different processes including sludge after sewage treatment, ash residue from municipal incinerators, or low grade gypsum from desulphurization plants attached to coal fired power stations. In general solid wastes are even less homogeneous than either liquid or gaseous effluents, therefore great effort must be made to ensure that samples are representative of the bulk waste. Monitoring of sewage sludge is particularly common due to sludge acting as an efficient sorption material for heavy metals. Consideration must therefore be given to the concentration of pollutants in the material before it is used as fertilizer, incinerated, dumped at sea or used as land fill.

10.11 Monitoring of Ambient Environmental Quality

10.11.1 Air Quality

Air pollution problems vary widely from area to area and from pollutant to pollutant. Differences in meteorology, topography, source characteristics, pollutant behaviour and legal and administrative constraints mean that monitoring programmes will vary in scope, content and duration along with the types of stations chosen. Ambient air quality monitoring is required to determine the existing quality of air, evaluation of the effectiveness of control programmes and to identify areas in need of restoration and their prioritization. The objectives of air quality monitoring are :

- To determine status and trends of ambient air quality;

- To ascertain whether the prescribed ambient air quality standards are exceeded;
- To identify non-attainment areas where air pollutants exceed prescribed standards.
- To obtain the knowledge and understanding necessary for developing preventive and corrective measures and
- To understand the natural cleansing process undergoing in the environment through pollution dilution, dispersion, wind based movement, dry deposition, precipitation and chemical transformation of pollutants generated.

10.11.2 Water Quality

The range of chemical parameters that have the potential to affect any ecosystem is very large. Therefore, in all monitoring programmes, it is necessary to target a set of parameters based on local knowledge and past practice for an initial review. The list can be expanded or reduced based on developing knowledge and the outcome of the initial surveys.

Pollutants enter the aquatic environment from the air (by dry deposition or in precipitation occurring either directly onto the water surface or elsewhere within the catchments area from the land or directly through effluent discharges (either domestic, industrial or agricultural). The undesirable effects of pollutants in natural water may be due to stimulation of phytoplankton growth (eutrophication) which ultimately leads to de-oxygenation of the water and major ecological change.

10.11.3 Sediment, Soil and Biological Monitoring

Soil and sediments may become polluted in a number of ways (disposal of industrial and domestic solid wastes, wet and dry deposition from the atmosphere and infiltration by contaminated waters. Some potentially harmful substances such as mercury or lead are naturally present in soils but at concentration which are not normally deleterious. Some activities however can cause elevated levels of these compounds e.g. mining may cause soils to be contaminated by metals and the dumping of solid wastes in land will invariably introduce a wide variety of pollutants

to the soil. On the other hand, there are compounds which do not occur naturally, and their presence in soils and sediments is due entirely to man's activities. These substances, inter alia, include pesticides (particularly the organo-chlorine compounds such as DDT, aldrin, dieldrin etc.).

Monitoring should be carried out following the application of sewage sludge or waste water to agricultural land. Samples of surface water, ground water, site-soil, vegetation and the sludge applied would normally be tested for faecal coli form, various nutrients, heavy metals and pH. The results may then be compared with predicted levels derived from the application rates of sludges' to land, soil type, nitrogen, phosphorus and heavy metal contents of the waste and the nutrient uptake characteristics of the cover crop.

When monitoring back ground levels and more specific pollution on land or in the sediments of a water body, measurements should often be made of levels in the plants or organisms that the soil or sediments support. In many cases, flora or fauna provide excellent indicators of the degree of pollution as they may act as bio-indicators / bio-concentrators (e.g. heavy metals from suspended material in shell fish). Also it is important to monitor pollution levels in food and through the food chain. This necessitates simultaneous measurement of pollutant levels in soils as well as in water, sediments and aquatic biota.

10.11.4 Ecosystem Health

Apart from the monitoring of pollutants in liquid effluents, sampling may be carried out in rivers, lakes, estuaries and the sea in order to obtain an overall indication of water quality. Sampling is also carried out at points where water is taken for supply, to check its suitability for a particular use. Sediments and biological samples can be used in order to assess the accumulation of pollutants and as indicators of pollution. Apart from the measurement of chemical and physical parameters the quantitative or qualitative assessment of aquatic flora and fauna is often used to give an indication of the presence or absence of pollution, and well recognized relationships exist between the abundance and diversity of species and the degree of pollution. This is often used to assess the cleanliness of natural fresh waters (biological monitoring).

The use of living organisms as monitoring tools has many advantages. Organisms living in the environment under study are constantly exposed to the physical, biological and chemical influences of that environment. Organisms that have a tendency to accumulate chemical species can often accumulate significant quantities of material from very low concentrations in the environment. For example, *Mosses* have been used by many investigators to monitor heavy metal concentrations because of their tendency to selectively adsorb heavy metals. Similarly, eels have been used to study halogenated organic chemicals, as these are adsorbed into the fatty deposits within the eel.

In biological monitoring, the monitoring strategy and effort is directed at the plants and animals in the environment under review and is specific to each individual study. However, in more generalized environmental monitoring, many animals act as robust indicators of the quality of the environment that they are experiencing or have experienced in the recent past.

One of the most familiar examples is the monitoring of numbers of Salmonid fish such as Brown trout or Salmon in river systems and lakes to detect slow trends in adverse environmental effects. The steep decline in salmonid fish populations was one of the early indications of the problem that later became known as acid rain. In recent years much more attention has been given to a more holistic approach in which the ecosystem health is assessed and used as the monitoring tool itself.

10.11.5 Radiological Monitoring

Radiation monitoring involves the measurement of radiation dose or radionuclide contamination for reasons related to the assessment or control of exposure to ionizing radiation or radioactive substances, and the interpretation of the results. The ‘measurement’ of dose often means the measurement of a dose equivalent quantity as a proxy (i.e. substitute) for a dose quantity that cannot be measured directly. Also, sampling may be involved as a preliminary step to measurement of the content of radio nuclides in environmental media. The methodological and technical details of the design and operation of monitoring programmes and systems for different radio-

nuclides, environmental media and types of facility are given in IAEA Safety Guide RS–G-1.8 and in IAEA Safety Report No. 64. Radiation monitoring is often carried out using networks of fixed and deployable sensors such as the US Environmental Protection Agency's Radnet and the SPEEDI network in Japan. Airborne surveys are also made by organizations like the Nuclear Emergency Support Team.

10.11.6 Microbiological Monitoring

Bacteria and viruses are the most commonly monitored groups of microbiological organisms. They are of great relevance where water in the aquatic environment is subsequently used as drinking water or where water contact recreation such as swimming is practiced. Although pathogens are the primary focus of attention, the principal monitoring effort is almost always directed at much more common indicator species such as *Escherichia coli*, supplemented by overall coli form bacteria counts.

The rationale behind this monitoring strategy is that most human pathogens originate from other humans via the sewage stream. Many sewage treatment plants have no sterilization final stage and therefore discharge an effluent which, although having a clean appearance, still contains many millions of bacteria per liter, the majority of which may however be harmless. Counting the number of harmless (or less harmful) sewage bacteria allows a judgment to be made about the probability of significant numbers of pathogenic bacteria or viruses being present.

10.11.7 Meteorological Monitoring

It is important to monitor meteorological conditions at the air quality monitoring site since weather is a significant factor which influences air contaminant concentrations. Measurements of wind speed, wind direction and air temperature are the minimum meteorological parameters to be monitored. Additional measurements that provide an improved picture of weather conditions during monitoring are : relative humidity, solar radiation, rainfall, and a temperature profile at two heights.

Wind direction, by convention, is the direction the wind is blowing *from* and is quoted with reference to north . An exception to this is meteorological data collected for oceanographic monitoring purposes. In this case, the wind is recorded in the direction

it is blowing *towards*. Care should be taken to determine the meteorological wind convention when using data collected from the marine environment. Wind speeds are often quoted in different units. The preferred reporting unit is metres per second (m/s). The minimum monitoring required is as follows:

- wind speed (resolution 0.1 m/s, accuracy ± 0.2 m/s, start-up 0.2 m/s)
- wind direction (resolution 1°, accuracy ± 2°, referenced to true north)
- air temperature (resolution 0.1°C, accuracy 0.2°C)

Desirable measurements are:

- humidity (or dew point) (resolution 1% relative humidity (rh), accuracy ± 5% rh)
- solar radiation (for stability estimates) (resolution 1 W/m^2, accuracy 10 W/m^2)
- rainfall (resolution 1 mm)
- temperature profile (T at two heights, 1.5 m and 10 m, needs 0.1°C accuracy) using identical sensors at both heights.

10.11.7.1 Specific siting requirements:

Must be free of influence of trees, buildings, structures – should be at least two times the height away from the obstacle, and for wind sensors it should be at least 10 times the height away from obstacles as provided in the *Guide to Meteorological Instruments and Methods of Observation* (World Meteorological Organization, 1996; Oke, T. R. 2006).

10.11.8 Population Monitoring

Monitoring strategies can some times lead to misleading conclusions when relying on counts of species or presence or absence of particular organisms if there is no regard to population size. Understanding the populations dynamics of an organism being monitored is also critical.

10.12 Location of Sampling Sites

For air quality monitoring, sites can be divided into following categories :

- Source-oriented sites for monitoring individual or small groups of emitters as part of a local surrey (e.g. a particular factory)

- Sites in a more extensive way, which may be located in areas of highest expected pollutant concentrations, high population density or in rural areas to give a complete picture and coverage.
- Base-line stations to obtain background concentrations usually in remote or rural areas with no anticipated changes in land use.

For assessing water quality, the sampling locations should generally be away from the river or lake banks or the walls of channels or pipes. Often it will be desirable (necessary) to take samples from several locations in order to obtain the required information. Downstream of effluent discharge, longitudinal, transverse and vertical sampling arrays may be necessary to ensure that truly representative data are obtained.

Studies of pollutants require sampling at considerable distances downstream of effluent inputs e.g. investigating the decrease in DO-content. When a temporarily varying effluent discharge is under study, it may be desirable to sample as close to the point of discharge as mixing allows in order to monitor short-term variations in concentration. However if long-term average water quality is of interest then sampling should be carried out further down-stream where longitudinal dispersion and mixing will smoothen out the short time variations.

Sampling in estuaries is more difficult in regard to spatial and temporal variability. Appropriate location for sampling will vary from estuary to estuary and will depend on the parameters of interest but a minimum of 50 samples per survey might be appropriate. Vertical stratification of pollutants may be pronounced due to a reduction in dissolved oxygen from the surface downwards.

Monitoring is also required to establish actual levels of contamination in land or sediments known to be affected by pollutants. In this case much more specific and localized monitoring may be required in order to quantify the degree of contamination. The contamination of sites often arises from their previous uses, particularly as coal gas manufacturing plants, smelters, waste disposal sites, chemical plants and scrap yards. A typical contaminant site may be found to contain variable

concentrations of toxic elements and organic compounds, phenols, coal tars and oils etc.

Some sites may contain underground pipe work and so present sampling problems. Site investigation of this type is very expensive. Common problems that have been encountered include :

- An inadequate number of samples
- Inadequate range of determinants
- Bulking of samples when individual samples from specific locations are preferable
- Inappropriate analytical methods
- Inadequate referencing of sample locations
- Inadequate description of samples
- An ignorance of the nature of the required information.

10.13 Sampling Methods

There are a wide range of sampling methods which depend on the type of environment and the material being sampled. At its simplest, a sample can be filling a clean bottle with river water and submitting it for conventional chemical analysis. At the more complex end, sample data may be produced by complex electronic sensing devices taking sub-samples over fixed or variable time periods. Sampling requires careful planning to be representative and as non-invasive as possible. Sediments and soils require specialized sampling tools to ensure that the material recovered is representative. Such samplers are frequently designed to recover a specified volume of material and may also be designed to recover the sediment or soil living biota.

10.13.1 Air Sampling

The methods most commonly used for the collection of atmospheric particulate samples are : Filtration impingement (wet or dry impingers, cascade impactors, sedimentation by gravity in stagnant air, thermal precipitators, cyclones), whereas for gaseous samples are adsorption, absorption, condensation and grab sampling

10.13.1a Filtration

Filtration is the most common technique for sampling particulate matter. The filter materials are (a) cellulose filter paper for determination of metals and anions (b) glass fiber for analysis of organic compounds and (c) silica felts for trace inorganic species and organic compounds. The type of filter medium chosen will depend on a number of factors. These include the collection efficiency for a given particle size pressure drop and flow characteristics of the filter type. There are following types of filters :

10.13.1b Impingers

The device is a dry impinger when the collecting surface is dry and wet impinger when the collecting surface is wet. Dry impingers of the cascade impactor type can differentiate particles according to their sizes. Cascade impactors use the aerodynamic impaction projectiles of particles to separate the sample into different size fractions by use of sequential sets and collection surface. In principle, the smaller orifices consist of up to seven stages backed by a membrane filter, each stage containing accurately drilled holes which align over a solid portion of the adjacent plates. The holes in each successive stage are smaller than those in the preceding plate and since air is drawn through the instrument at a constant flow rate. The largest particles are impacted on the first stage and the smallest are collected on the back-up filter. Other problems of cascade impactor sampling include wall losses and the aggregation of particles and the mechanical breaking of agglomerates which result in inaccurate site distribution measurements.

10.13.1c Sedimentation

This is the collection of particulate material by allowing it to deposit into a collection vessel by gravity. However the presence of the bowl or cylinder in the path of the falling particles will change their flow pattern and it is not clear whether the collected materials are truly representative of actual conditions. During wet weather dust is washed down from the bowl but during dry weather high winds may blow dust out of or into the bowl so producing erroneous dust loading. At the end of the sampling period (usually one month) a measured volume of water is used to wash any dust in the bowl into the collection bottle and the pH, total particulate mass, and water volume determined.

A major disadvantage of the standard deposit gauge is that no directional resolution of the particulate material is possible. This has been resolved with the introduction of the directional deposit which consists of four cylinders mounted on a common post with open slots facing the four quadrants of the compass. Each cylinder has removable collection bottle at its base. The siting of deposit gauges often presents problems e.g. when attempting to monitor emissions from one major source, the use of several directional gauges around the source may be successful in confirming that emissions occur from that source, however in areas of multiple sources or where there is significant atmospheric turbulence (e.g. in built up areas) inconclusive data may be obtained. It should be noted however that the standard deposit gauge (SDG) is more effective in collection of large particles which settle under gravity.

Electrostatic samplers are usually very efficient for collection of small particles. There are also smaller versions of pollutant control devices. On entering the sampler, articles pickup charge as they pass through an electrical discharge between electrodes maintained at a potential difference of up to 30, 000 V. The small charged particles in a gas steam lose their charge in contact with an electrode (oppositely charged) and accumulate on the electrode.

Thermal precipitators may be used for collection of aerosol particles of 0.00l µm size with high efficiency. They work on the principle that suspended particles move to lower temperature regions when exposed to a high temperature gradient.

10.13.1d Adsorption

The adsorption of gases is a surface phenomenon. Gas molecules become bound by intermolecular attraction to the surface of a collection phase and so become concentrated. Under equilibrium conditions at constant temp, the volume of gas adsorbed on the collection phase is proportional to the positive power of the partial pressure of the gas and is also dependent upon the relative surface area of the adsorbent. Materials commonly used as adsorbents include activated carbon, silica-gel, alumina and various porous polymers. Certain precautions must be taken in selecting a suitable adsorption medium :

- Relative affinity for polar or non-polar compounds e.g activated carbon (nonpolar) will absorb non-polar organic gases but exclude polar compounds.
- Adsorbent must not react chemically with the collected sample unless chemisorptions is being used.
- Analyte must not react with other constituents of the sampled air.
- The retention volume of the adsorbent must be known with respect to the species being collected
- Desorption property must also be known in order to ensure quantitative recovery of the sample

10.13.1e Absorption

A general method of collection of gaseous pollutants is absorption in a solvent such as by bubbling the gas through a liquid. Pure water is adequate for collecting some gaseous pollutants such as HF. Alkaline solutions are required for absorbing acidic gases, acidic solutions for collecting alkaline gases and oils for collecting hydrocarbon. Optimum conditions for efficient sampling are small bubble size and increased residence time of the absorbing device.

10.13.1f Condensation or Cold Trapping

It is possible to condense gases from the air and to concentrate them. Fractionation is achieved by using collectors maintained at progressively lower temperatures i.e. the first collector is maintained in an ice bath (0^oC) and the last collector in a liquid nitrogen bath (-196^oC). However a limitation of the method is that water vapor present in the air will also freeze and so progressively block the trap. This may be overcome by using a first trap of large volume designed to collect water and a second trap at a sufficiently low temperature to collect analytes.

10.13.1g Grab Sampling

Rather than utilizing a concentration technique in the field, samples may be collected in an impermeable container and returned to the laboratory for analysis. Air is drawn into the flexible bag which may be sealed when inflated. Samples can then be drawn at a later stage from the bag by hypodermic gas tight syringe.

Filters have been used in high volume air sampler. These are used to pump large volumes of air. The filters used consist of glass fibers and have a collection efficiency of more than 99% for particles with 0.8μ diameter. Particles with diameters exceeding 100 μ remain on the filter surface whereas particles with diameters down to about 0.1μ are collected on the glass fibers in the filters. Sampling is desirable at places where people work. For this purpose light weight battery operated pumps are used. Samples of polluted air are collected at several points to build up a picture of the distribution of an air pollutant. Samples collected by filters are analyzed chemically by weighing, by microscopes and by gravimetric and extraction techniques to extract the material for chemical analysis.

10.14 Water Sampling

For analysis of natural and waste water, grab sampling procedures are usually employed. A series of grab samples collected from different depths at a given site, reflect variations in constituents over a period of time. The total number of grab samples should satisfy the requirement of the sampling programme.

Grab samples provide a good snap-shot view of the quality of the sampled environment at the point of sampling and at the time of sampling. However, without additional monitoring, the results cannot be extrapolated to other times or to other parts of the ecosystem under study. In order to enable grab samples or rivers to be treated as representative, repeat transverse and longitudinal transect surveys taken at different times of day and times of year are required to establish that the grab-sample location is as representative as is reasonably possible. For large ecosystems such surveys should also have regard to the depth of the sample and how to best manage the sampling locations at times of flood and drought.

In stagnant waters(e.g. lakes), grab samples are relatively simple to take using depth samplers which can be lowered to a pre-determined depth and then closed trapping a fixed volume of water from the required depth. In all but the shallowest lakes, there are major changes in the chemical composition of lake water at different depths, especially during the summer months when many lakes stratify into a warm, well oxygenated upper layer (*epilimnion*) and a cool de-oxygenated lower layer *(hypolimnion*).

In the open seas (marine environment), grab samples can establish a wide range of base-line parameters such as salinity and a range of cation and anion concentrations. However, where changing conditions are an issue such as near river or sewage discharges, a grab sample can only give a very partial answer when taken on its own.

10.14.1 Composite Samples

Samples may be composited over any time period such as 4, 8, 24 hours depending on the purpose of analysis. Such composite samples are useful for determining the average condition which when correlated with flow can be used for computing the material balance of a stream of water body over a period of time. A recent innovation is the use of adsorption or filtration media to concentrate the species of interest in situ. Different determinants require different methods of preservation in order to prevent significant changes between the time of sampling and of analysis.

10.15 Soil and Sediment Sampling

Soil and sediments are typically very inhomogeneous media and large lateral and vertical variations in texture, bulk composition and pollutant-concentration may be expected. For this reason, large numbers of samples may be required to characterize a relatively small area. It is often necessary to obtain cores so that vertical profiles of the determinants may be obtained or cumulative deposition estimated.

Grab samples of soils are easily obtained manually and stored in cleaned plastic bags. Sometimes composite samples formed by the bulking together of a number of individual samples may be sufficient but generally analyses of individual samples is to be preferred. Alternatively a dredge may be used to obtain a composite sample

along a strip of the sediment surface. Some determinants in soils and sediments are liable to change during storage and require the use of preservation techniques. For example nitrate in soil can be extracted into potassium chloride solution and preserved with toluene. There are important effects associated with grain size which should be considered in the analysis of soil or sediment.

10.16 Duration and Extent of Monitoring

The duration of a pollution monitoring programme is entirely dependent upon the purpose and can vary from time to time. The choice of the frequency of sampling i.e. the duration of each sample period and the interval between successive measurements depends upon the objectives of the study.

Pollutant concentration in air and water fluctuate with varying degrees of rapidity and in order to characterize their behavior it is necessary to measure these changing levels, long term mean data may be sufficient for some purposes but will not be adequate where information of short term high level episodes is required. Generally it has been found that if random sampling techniques are used, the number of samples required will increase. The greater the fluctuation of the pollutant level, the more numerous the sample that must be taken to accurately assess the variation. As a more general guideline, it may be assumed to be necessary to have a sampling interval at least ten times shorter than the fluctuation cycle time.

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Chapter 11

Environmental Management

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11.1 Environmental Institutional Set-up

Realizing the importance of protection of the environment, the port authorities should constitute different groups at project, regional and Corporate Centre level to carry out specific environment related functions. An 'Environmental Monitoring Cell' overseen by an 'Environmental Monitoring Panel' may also be constituted with members from agencies such as Forest Department, Pollution Control Board, Academic / Research Institutions and Electricity Board etc.

The broad mandate of this panel may be to oversee the environmental monitoring cell and advise the management on environment related matters as and when required. The Environmental Monitoring Cell may oversee and ensure that the measures to be taken under the Environmental Management Plan is implemented strictly and to ensure the pollution parameters are within the prescribed limits. For this purpose, a monitoring group and a pollution control equipment maintenance group should be placed in the Environmental Management (EM) Cell. The EM cell should be started in the initial stages itself with the following responsibilities :

- Proper maintenance and operation
- Creating environmental awareness amongst the workers, supervisory staff and contract laborers

- Conducting Environmental Audits and Reporting to Pollution Control Board or any such authorities
- Regularly monitoring the environmental parameters and preparing reports as required by the statutory authorities.
- Recommending necessary measures to improve environmental conditions.
- Advising the concerned staff and workers in matters related to EMP or Environmental code of conduct and in terms of necessary steps to be adopted
- Training the staff and other workers on safety measures and conducting environmental safety drills to educate them

11.2 Monitoring Equipment

Choosing the appropriate monitoring equipment is important for achieving the aims of the environmental management programme. Equipment that does not measure the contaminant in the required measurement range clearly will not provide useful data. The following factors should be considered :

11.2.1 Purpose of monitoring **:** Is it screening, compliance monitoring or research ? Different sensitivities may apply to different types of monitors. For example, compliance monitoring may require a higher level of sensitivity and resolution than a monitor used for screening purposes.

11.2.2 Duration of deployment **:** If the instrument is to be used for short-term screening surveys then portability, size, weight and robustness may be factors to consider.

11.2.3 Detection limit, precision and measurement range : Will the instrument be able to measure within the required range, based on the monitoring objectives ?

11.2.4 Consumables : How frequently do parts need to be changed or replaced ?

11.2.5 Ability to conform to relevant monitoring standards : Does the instrument conform to monitoring standards such as those required ?

11.2.6 Frequency of calibration : The time taken to complete automatic checks, and operational and multipoint calibrations.

11.2.7 Ease of use : Some instruments can be extremely difficult to operate, which imposes costs in terms of training and person-hours spent resolving problems.

11.2.8 Ability to interface remotely : Most modern instruments will allow an operator to remotely operate an instrument.

11.2.9 Environmental requirements : The instrument may require air conditioning, temperature or humidity control ?

11.2.10 Cost : The cost of the instrument and the cost of consumables need to be taken into account.

11.2.11 Reliability : One has to find out who else has operated similar instruments and discuss the pros and cons with other organisations before going for a purchase.

11.3 Data Reliability, Constraints and Gaps

It is important that the monitoring equipment used is appropriately accredited (e.g. compliance with local or international standards), properly installed and regularly calibrated and serviced to ensure it is providing accurate and reliable data. Gaps in data can be due to :

- Errors during calibration
- Equipment failure at site or communications failure between instrument and data logger (variable)
- Power failures on the site (variable) (http : // www.environment.nsw.gov.au / aqms / uhaqmnfaq.htm)

11.4 Environmental Management

The organization should chalk out a set of well defined activities that are envisaged right from the project conceptualization stage so that during the entire life cycle of the plant, it is fully compliant with various environment regulations and a pristine environment and ecological balance is maintained in and around.

Performance enhancement and up-gradation measures should be undertaken by the organization during the post operational stage of the stations. These activities greatly help in minimizing the impact on environment and preserve the ecology in and around its sub-projects. Following is brief description of some of the measures which should be undertaken during the operation phase. The measures can be enumerated as follows.

11.4.1 Monitoring of Environmental Parameters : A broad based Environment Monitoring Programme should be formulated and implemented. All pollutants discharged from various activities should be monitored at the stipulated frequency at the source itself as also at the points of discharge. In addition to the above, ambient air, surface water and ground water quality in and around should be regularly monitored so as to assess and minimize the adverse impacts resulting out of the activities.

11.4.2 On-Line Data Base Management : In order to have better control on pollution and to achieve effective environmental management in and around, it is better to have an on-line, reliable and efficient environment information system on the plant operation and environmental performance parameters at local, regional and central (Corporate) levels. This would provide reliable storage, prompt and accurate flow of information on environmental performance of various stations. This system would also facilitate direct transfer of environmental reports and other environment related information from the project site to the Regional Headquarters and Corporate Centre, and help in achieving continuous improvement in environmental performance through improved monitoring and reporting system by using the trend analysis and advanced data management techniques.

11.4.3 Environmental Reviews : To maintain constant vigil on environmental compliance, environmental reviews should be carried out at all operating stations and remedial measures should be taken wherever necessary. As a feedback and follow-up of these environmental reviews, a number of retrofit and up-gradation measures can be undertaken at different stations. Such periodic environmental reviews and extensive monitoring of the facilities carried out at all stations would help in complying with the environmental norms and ***timely renewal of the Air and Water Consents.***

11.4.4 Up-gradation and Retrofitting of Pollution Control Systems : In order to keep pace with the changing norms and ensure compliance with statutory requirements in the field of pollution control, the authorities should have an open mind for Renovation and Modernization (R & M) and Retrofitting and Up-gradation of pollution monitoring and control facilities. It is important to mention that such modifications / retrofit programs not only help in betterment of environment but also in resource conservation.

High efficiency Electro-Static Precipitators (ESPs) should be provided for control of stack particulate emissions. Remedial measures should be taken up regularly and implemented to continuously improve the efficiency of the existing ESPs at various stations. ESP performance enhancement programme by adopting advanced microprocessor based Electrostatic Precipitator Management System (EPMS) should be installed at various stations. The ESPs should be designed so as to meet the likely stringent emission norms in the future also.

11.4.5 Resources Conservation

With better awareness about ecology and environment, the organization should continually look for innovative and cost effective solutions to conserve natural resources and reduce wastes. Some of these measures should include :

- Reduction in land requirements for main plant and disposal areas
- Capacity addition in plants, within existing land

- Reduction in water requirement for main plant and disposal areas through recycle and reuse of water
- Efficient use of Fuel (Coal, Natural gas and Fuel oil)
- Reduction in fuel requirement through more efficient combustion and adoption of state-of-the-art technologies such as super critical boilers

11.4.6 Waste Management

Various types of wastes such as Municipal or domestic wastes, hazardous wastes, bio-medical wastes get generated in plant areas, plant hospital and the associated townships. The wastes generated consist of a number of solid and hazardous wastes like used and waste oils, grease, lead acid batteries, other lead bearing wastes (such as gaskets etc.), oil and clarifier sludge, used resin, used photo-chemicals, asbestos packing, e-waste, metal scrap, electrical scrap, empty cylinders (refillable), paper, rubber products, canteen (bio-degradable) wastes, building material wastes, silica gel, glass wool, fused lamps & tubes, fire resistant fluids etc. These wastes fall either under hazardous wastes category or non-hazardous wastes category as per classification given in Government of India's notification on Hazardous Wastes (Management and Handling) Rules 1989 (as amended in 2003). Handling and management of these wastes should be done as delineated below :

11.4.6.1 Municipal Waste Management

Domestic or municipal waste is generated in households at townships. This waste should be segregated into bio-degradable and non-biodegradable wastes at source itself in different colored containers and thereafter the two types should be disposed separately. Bio-degradable waste should be spread uniformly in identified low lying areas and thereafter should be covered with soil for use later on as manure after composting. The segregated non bio-degradable waste should be disposed off separately in other identified low lying areas and should be spread out uniformly.

11.4.6.2 Hazardous Waste Management

The handling and disposal of hazardous wastes should be done as per the Hazardous Wastes (Management & Handling) Rules 1989 (as amended in 2003) guidelines issued by Government of India for the treatment, storage and disposal of hazardous wastes. There should be complete compliance with statutory requirements. The Hazardous Wastes (Recyclable) should be sold / auctioned to registered recyclers / refiners. The other hazardous wastes such as the activated carbon resins, used drums (hazardous) chromium (Cr-III electrolytes, used petro-chemicals, asbestos packing, used torch batteries, ribbon, toners / cartridges, mixed wastes (waste oil, water & cotton) filters, earth contaminated with synthetic oil, lamps & tubes etc. fall under the category of Hazardous Wastes (Non-Recyclable). These wastes should be stored in properly identified locations. As per the notification, hazardous wastes (non-recyclable) are to be sent to State Pollution Control Board (SPCB) approved common treatment storage and disposal facility (CTSDF).

11.4.6.3 Bio-Medical Waste Management

Hospital (or Bio-medical) wastes generated from hospitals include urine bags, human anatomical wastes, plaster of Paris waste, empty plastic bottles of water & glucose, blood & chemical mixed cotton, blood & urine tubes etc. these wastes should be segregated and placed in buckets of different colors as per the notification for Bio-Medical Waste (Management & Handling) Rules. The segregated bio-medical wastes should be either disposed through the SPCB approved agency or they have to be treated in autoclaves before disposal into bio-medical waste disposal pits. The treated bio-medical waste should be spread uniformly and covered with 10 cm thick soil in bio-medical waste disposal pits.

11.4.7 Land Use and Bio-diversity

There should be special emphasis on land use and Bio-diversity by way of developing more green belts, energy plantations, and continuous ecological monitoring in the project areas and its surroundings.

11.4.7.1 Green Belts, Afforestation & Energy Plantations

Appropriate afforestation programmes for plant, township and green belt areas of the project should be implemented at all project-sites in order to enhance green cover in the areas. The afforestation would not only contribute to the aesthetics but also would serve as a 'sink' for the pollutants released from the station and would thereby protect the quality of ecology and environment in and around the projects.

11.4.8 Environmental Audit and Impact Assessment Studies

Environmental Audit Studies should be inevitably undertaken to evaluate and prevent potential negative impacts as well as to formulate Environmental Management Plans to overcome the identified impacts. Based on the recommendations of Audit reports and studies, Environmental Management Plans (EMP) should be regularly tuned and fine-tuned.

11.4.9 Socio-economic Studies

Detailed socio-economic studies should be undertaken (on a continuous basis) to re-assess the socio-economic status of plant / project affected persons and look into the issues related to their rehabilitation and resettlement plans in consultation with the state government. In addition, community development activities in the surrounding villages should be undertaken in the form of Corporate Social Responsibility (CSR) etc.

11.4.10 Ecological Monitoring Programme

Comprehensive Ecological Monitoring Programme including Satellite Imagery Studies should also go hand in hand, in a continuous mode around the plants / projects / activities so as to ensure that there is an increase in : (a) dense forest area, (b) agriculture area, (c) average rainfall etc. Some examples of good environmental

practices, which are normally taken recourse to under various situations are given below. They serve as guidelines for green (environmental) plans.

11.5 Air and Noise Management

- Wherever coal is used, the ash left behind after combustion of coal should normally be controlled using high efficiency Electrostatic Precipitators (ESPs). The ash collected in the ESPs should be disposed into the Ash Ponds in slurry form.
- Tall Flue Gas Stacks should be provided for wide dispersion of the gaseous emissions (SO_X, NO_X etc) into the atmosphere.
- NO_x emissions should be controlled by provision of Low-NO_x Burners (dry or wet type) adopting best combustion practices.
- Dust Extraction (DE) and Dust Suppression (DS) systems should be installed to contain and extract the fugitive dust released.
- A first aid room should be provided for any emergency .
- Laborers involved should be made sensitive to the ecological importance of their area of work, nature conservation and be aware of the conservation strategies to avoid untoward effects.
- Movement of the workforce should be under strict control of the management responsible for environmental protection.
- Travel and transport should be minimized because transportation is one significant sector contributing to pollution.
- Staff should be equipped / trained to face any accidents such as fire or leakage of gases in the underground laboratory or elsewhere in their work area and or its surroundings.
- Sufficient provisions should be made to acquire fire fighting, communication equipments.
- Importance must be given to develop hospital facilities in the residential area.
- Suitable training for the staff with frequent refresher programmes should be arranged for them to remain well equipped.
- Regular training programmes should be held.

- The Environmental Monitoring Cell (EMC) should oversee the implementation of these measures.
- This should also include (a) monitoring the implementation of the environment management plans as well as (b) monitoring the pollution control and equipment maintenance measures.
- The EMC, to be stationed at the site, should include members from the Forest Department, the site engineer, representatives of panchayat-bodies, and environmental experts.
- In addition, there should be an Environment Management Panel to oversee the activities of the Environmental Monitoring Cell (EMC).
- It is important that a viable number of indigenous people are employed right from the beginning.
- Strict measures should be taken to avoid use of wood collected locally. The laborers should be provided with LPG instead of fuel wood.
- Proper facilities for their temporary residences should be given. They should be educated about nature conservation.
- They, in turn, can be engaged in monitoring vehicular movement, movement of wildlife, forest fire mitigation, etc.
- This should be an integral component of the conservation initiative.
- A watchtower located at a strategic point within the site would greatly aid the monitoring of wildlife movement both in short and long terms.
- Dedicated infrastructure like vehicles for environmental cell should be made available.
- Incremental pollution loads on the ambient air and noise quality should be closely monitored. Adequate measures should be undertaken to reduce ambient air and noise levels, so as to conform to the stipulated standards by CPCB.
- Movement of heavy vehicles should be well monitored and regulated.
- Care should be taken to reduce noise generated during construction.
- Use of well maintained machinery and vehicles would considerably help in this matter.
- Workshops and such other facilities, which are also sources of noise, may be located away from road.

- High intensity works like blasting etc. may be limited to the bare minimum, especially at the exposed areas such as entry portal and should be avoided if possible.
- Blasting work close to the surface may affect many species and cause stress to them. Therefore, the number of blasts should be minimized and spaced out to reduce the vibrations and their impact.
- Also, sophisticated drilling and blasting techniques may be adopted which would save time, resources and protect environment as well.
- The ground vibration may be measured continuously during blasting operations.
- Diesel power generating sets as sources of back-up power for elevators and common area illumination should conform to Environmental (Protection) rules.
- The location of the DG sets may be decided in consultation with the Pollution Control Board.
- During night time, the noise levels measured at the boundary of the building shall be restricted to the permissible levels to comply with the prevalent regulations.
- Traffic congestion near the entry and exit points from the roads adjoining the proposed project site must be avoided.
- Parking should be carefully planned and regulated.
- The diesel generator sets to be used during construction phase should be of low sulfur diesel type and should conform to Environmental (Protection) Rules prescribed for Air and Noise emission standards.
- The diesel required for operating DG sets shall be stored in underground tanks and if required, clearance from Chief Controller of Explosives shall be taken.
- Vehicles hired for bringing material to the site should be in good condition and should have a pollution check certificate and should conform to applicable Air and Noise Emission Standards and should be operated only during non-peak hours.
- Ambient noise levels should conform to residential standards both during Day and Night.

- Incremental pollution loads on the ambient air and noise quality should be closely monitored during construction phase.

11.6 Water Management

- Water quality should be monitored regularly.
- Rainwater harvesting for roof run-off and surface run-off should be implemented.
- Pre-treatment must be given to remove suspended matter, oil and grease before discharging the surface-run-off.
- Storm water control and its reuse as per water quality standards should be ensured.
- Soil and ground water samples should be tested to ascertain that there is no threat to ground water quality by way of leaching of heavy metals and other toxic contaminants.
- Safe disposal of waste water and solid wastes generated should be ensured.
- All required sanitary and hygiene measures should be in place.
- The installation of the Sewage Treatment Plant (STP) should be certified by an independent expert.
- The treated effluent emanating from STP should be recycled / reused to the maximum extent possible.
- Treatment of 100% grey water by decentralized treatment should be done.
- Discharge of unused treated effluent shall conform to the norms and standards of the Pollution Control Board.
- Necessary measures should be undertaken so as to mitigate the odor problem from STP.

11.7 Soil / Sediment Management

- Petroleum contamination is a very common problem these days. Many tanks are buried in the ground with no safeguards in place. These tanks sometimes leak oil and gas into the surrounding soil, and potentially, into groundwater sources. There are two effective ways to treat soil that has

been contaminated with petroleum. The first is incineration. This process destroys all contaminants in the soil, but unfortunately, it also destroys the soil.

- A process called thermal soil remediation is in vogue now in many countries (including USA) so that much of the soil that is contaminated can be reclaimed and reused. The temperatures are high enough to vaporize any petroleum contaminants in the soil, but not so much as to destroy the soil. The vaporized contaminants are collected by a mechanism called a bag house, which works much like a filter in a furnace. Any harmful chemicals within the contaminants collected by the bag-house are destroyed by an afterburner. This process needs to be taken recourse to in thermal soil remediation. After the process is complete, soil can often be put back in place and used.
- Another effective treatment for petroleum-contaminated soil is soil washing. In this process, soil is removed and washed with a solution typically containing mild solvents. The soil is then agitated very rapidly. This separates the larger, contaminated particles from the non-contaminated soil. These particles are then collected and destroyed, while the healthy soil is returned to the ground.
- If higher-than-normal levels of heavy metals are present in the soil, they can be harmful. An environment-friendly way of getting rid of heavy metals and pesticides is through phyto-remediation.
- Phyto-remediation uses plants to decontaminate the soil. Poplar and cottonwood trees are capable of absorbing many heavy metals and pesticides from the soil, converting them into environmentally benign forms. This process doesn't require removing the soil from the site, although it is slower than thermal remediation.
- If the soil is contaminated in only a very small area with a small amount of harmful chemicals, one can apply an absorbent, such as activated charcoal, to contain the chemical. This method is useful when there is an accidental chemical-spill on the ground. Charcoal will absorb much of the chemical, and it can then be discarded. The used charcoal should subsequently be disposed in an environmentally-responsible way.

- The green belt of adequate width and density preferably with local species should be raised so as to provide protection against air, noise, water and soil pollution.

11.8 Occupational Health and Safety Systems

Environmental Management System (EMS) ISO 14001 and the Occupational Health and Safety Assessment System OHSAS 18001 should be regularly pursued and monitored.

- The approval of the competent authority shall be obtained for structural safety of the buildings due to earthquake, adequacy of fire-fighting equipments, etc
- Regular supervision of the above and other measures for monitoring should be in place all through so as to avoid disturbance to the surroundings.
- The buildings should have adequate distances between them so as to allow movement of fresh air and passage of natural light, air and ventilation.
- Energy conservation measures should be in place.
- Use of solar energy should be practiced to the extent possible.
- Roof should meet prescriptive requirement as per Energy Conservation Building Code by using appropriate thermal insulation.
- Use of glass should be substantially reduced so as to reduce the electricity consumption and load on air conditioning. If necessary, high quality double glass with special reflective coating should be used in windows.
- Fixtures for showers, toilet flushing and drinking should be of low water and energy requirements.

11.9 Data Collection, Interpretation and Analysis

A number of quality indices can be devised to help classify and clarify the meaning of the considerable volumes of data involved. For example, stating that a river stretch is in "Class B" is likely to be much more informative than stating that this river stretch has a mean BOD of 4.2, a mean dissolved oxygen of 5.0, etc. In the UK, the Environment Agency uses a system called *GQA – General Quality Assessment* which

classifies rivers into six quality bands - a, b, c, d, e and f based on chemical and biological criteria.

111.9.1 Air Quality

Air has a relatively constant composition of gases and is utilized by most of the living organisms in the process of respiration for their survival. Its composition determines its quality and due to emission of large amount of un-natural compounds in the atmosphere (by industries and automobiles), it (air composition) has changed considerably in the recent past. This changed quality is a great threat to survival of life, properties, materials and ecosystem as a whole. Various contaminants continuously enter the atmosphere through natural and man-made processes and these contaminants interact with the environment to cause disease, toxicity, environmental decay etc.

In order to arrest further deterioration of air quality, Govt. of India enacted Air (Prevention & Control of Pollution) Act in 1981. This responsibility has also been emphasized under Environment (Protection) Act, 1986. Thus, it has become necessary to assess the present and anticipated air pollution through continuous air quality survey / monitoring programs.

11.9.1.2 Air (Prevention and Control of Pollution) Act 1981

Government of India enacted the Air (Prevention and Control of Pollution) Act 1981 to arrest the deterioration in the air quality. The act prescribes various functions for the Central Pollution Control Board at the apex level and State Pollution Control Board at the state level. The main functions of the *Central Pollution Control Board* are as follows:

- To advise the Central Government on any matter concerning the improvement of the environmental quality and the prevention, control and abatement of pollution
- To plan and get executed a nation-wide programme for the prevention, control and abatement of pollution
- To provide technical assistance and guidance to the State Pollution Control Board

- To carry out and sponsor investigations and research related to pollution prevention, control and abatement
- To collect, compile and publish technical and statistical data related to environmental pollution; and
- To lay down standards for the quality of environment and source-emission standards

The main functions of the *State Pollution Control Boards* are as follows :

- To plan a comprehensive programme for prevention, control or abatement of pollution and to secure the execution thereof
- To advise the State Government on any matter concerning prevention, control and abatement of pollution
- To collect and disseminate information related to environmental pollution. To collaborate with Central Pollution Control Board in programmes related to prevention, control and abatement of pollution and
- To inspect and assess environmental quality of and to take steps for prevention, control and abatement of pollution in appropriate areas.

11.9.1.3 National Ambient Air Quality Standards (NAAQS)

The ambient air quality objectives / standards are pre-requisite for developing management programme for effective management of ambient air quality and to reduce the damaging effects of air pollution. The objectives of air quality standards are :

- To indicate the appropriate levels of air quality with an adequate margin of safety to protect the public health, vegetation and property;
- To assist in establishing priorities for abatement and control of pollutants;
- To provide uniform yardstick for assessing air quality at national level;
- To indicate the need and extent of monitoring programme;

The Central Pollution Control Board had adopted first Ambient Air Quality Standards on November 11, 1982 as per section 16 (2) (h) of the Air (Prevention and Control of Pollution) Act, 1981. The air quality standards have subsequently been revised by the Central Pollution Control Board at various intervals.

11.9.1.4 Sensitive areas

Sensitive areas may include the following :

- 10 kms all around the periphery of health resorts so notified by State Pollution Control Boards in consultation with department of public health of the concerned state.
- 10 kms all around the periphery of biosphere reserves, sanctuaries and national parks, so notified by Ministry of Environment and Forest or concerned states.
- 5 kms all around the periphery of an archeological monument declared to be of national importance or otherwise so notified in consultation with State Pollution Control Boards.
- Areas where some delicate (or sensitive to air pollution) crops / important to the agriculture / horticulture of that area are grown so notified by State Pollution Control Boards in consultation with department of agriculture / horticulture of concerned state.
- 5 kms around the periphery of centers of tourism and / or pilgrim due to their religious, historical, scenic or other attractions, so notified by department of tourism of the concerned state with State Pollution Control Boards.

An inventory of air pollutants is a necessary first step towards control of air pollution. Air pollutants can be natural or may be the result of various anthropogenic activities like industrial emissions. Further, the air pollutants can be primary or secondary depending upon their formation mechanism. Primary pollutants are directly emitted from the source and secondary pollutants are formed in the atmosphere. Meteorological factors play a critical role in ambient concentrations of air pollutants. Even though the total discharge of air pollutants into the atmosphere may remain

constant, the ambient concentrations of air pollutants may vary depending upon the meteorological conditions.

The air quality monitoring networks, located across the country are integral to environmental protection and efforts to protect public health. The data collected from monitors provide critical information needed to develop and implement air quality regulations and policies. Outdoor (ambient) air monitoring networks support air quality management activities such as :

- Monitoring for compliance with the National Ambient Air Quality Standards (NAAQS)
- Providing public information regarding ambient air quality levels
- Measuring trends in air quality
- Establishing relationships between exposure to pollutants and health effects to inform regulatory decision-makers
- Developing and evaluating air quality modeling tools

To achieve these objectives, monitoring networks require accurate and reliable methods for collecting and analyzing air pollution samples to ensure high quality data. These methods are the result of extensive scientific development and evaluation, and include procedures for chemical and physical analyses of samples collected in the field. Instruments for sample collection or for standard monitoring are also developed or evaluated for widespread use. Special field studies are designed to validate these methods under a variety of meteorological and geographical conditions and to develop protocols for handling and shipping samples.

The key questions in methodology-development are driven by the various monitoring needs tied to compliance with the national air quality standards, real time public information, and support for atmospheric and health research studies. Specific method-development needs related to current air quality management include :

- Measurements of particulate matter (PM_{10} and $PM_{2.5}$ components)
- Measurements for heavy metals in the air
- Measurement of primary and secondary air pollutants
- Measurement of air toxics including hexavalent chromium.

Many of these needs are being addressed through various research programs and related efforts such as the source apportionment studies, which include development and evaluation of continuous speciation methods to determine the contribution of various pollution sources to a given location. Outdoor, indoor, or personal exposure measurements are used to achieve these objectives, and speciation methods while investigating the spatial (space) and temporal (time) variability of these particles (http://www.epa.gov/ord/ca/quick-finder/monitoring-science.htm).

11.9.1.5 Monitoring Locations and Parameters

Air pollutants including Sulphur Dioxide (SO_2), Oxides of Nitrogen as NO_2, Suspended Particulate Matter (SPM) and Respirable Suspended Particulate Matter (RSPM/$PM_{1.0}$), are monitored at selected (specified) locations. Besides this, additional parameters such as respirable Lead and other toxic trace metals, Hydrogen Sulphide (H_2S), Ammonia (NH_3) and Polycyclic Aromatic Hydrocarbons (PAH_s) are also monitored.

The monitoring of meteorological parameters such as wind speed and direction, relative humidity and temperature is also integrated with the monitoring of air quality. The monitoring of pollutants is carried out for 24 hours (4-hourly sampling for gaseous pollutants and 8-hourly sampling for particulate matter) with a frequency of twice a week to ensure the uniformity, consistency of air quality data and provide technical and scientific support for operating the monitoring stations.

11.9.1.6 Non-attainment Areas

The concentration ranges for different levels are selected based on the Notified Standards for different pollutants and area classes by calculating an Excedence Factor (the ratio of annual mean concentration of a pollutant with that of a respective standard).

The Excedence Factor (EF) is calculated as follows :

Excedence Factor (EF) = [Observed annual mean concentration of a criterion pollutant / Annual standard for the respective pollutant and area class]

The four air quality categories are :

• Critical pollution (C) : when EF is more than 1.5;

• High pollution (H) : when EF is between 1.0 - 1.5;

• Moderate pollution (M) : when EF between 0.5 - 1.0; and

• Low pollution (L) : when EF is less than 0.5

It is obvious from the above categorization, that the locations in either of the first two categories are actually violating the standards, although, with varying magnitude. Those, falling in the third category are meeting the standards as of now but likely to violate the standards in future if pollution continues to increase and is not controlled. However, the locations in Low pollution category have a rather pristine air quality and such areas are to be maintained at low pollution level by way of adopting preventive and control measures.

A wide variety of methods are available for measuring contaminants in ambient air, with an equally wide variation in cost and precision. Specific monitoring methods are chosen taking into consideration the purpose, objectives and budget of the monitoring programme. High-precision instrumental methods should be generally used for research studies or other specific investigations, where there is a need to understand the ways in which contaminant levels fluctuate over different time periods (hours or days). Ambient air quality guidelines carry recommended monitoring methods that should be used for the assessment of the contaminants covered by the guidelines. Similar procedures / methods are also followed by other countries like Australia / New Zealand and US.

Methods that involve lower resolution instruments can be used for an initial screening survey, where a detailed study is not warranted. These may be used as a prelude to more detailed monitoring. If contaminant levels are found to be low, then the same

method (s) could be used for repeat surveys over subsequent years. Low resolution methods are also useful for prioritising a number of different areas that have already been selected for detailed monitoring programmes.

11.10 Screening Methods

Screening methods maybe used to provide indicative data for monitoring purposes. A screening method's level of accuracy and precision must be suitable for the purpose of monitoring. Monitoring programmes should provide a good indication of where national environmental standards are likely to be breached. However, care must be taken when considering whether such ambient air quality monitoring can be used for the regulatory requirements of national environmental standards. The following points should be considered:

- Is the data sufficient and is there an appropriate time average ?
- Are monitoring methods appropriate for standards ?
- Are the appropriate contaminants being monitored ?
- Is it at an appropriate location ?

11.11. Environmental Quality : Measurement and Assessment

11.11.1 Air Quality

It is not sufficient to simply use an analyser that conforms to a standard: it is also necessary to operate the analyser in accordance with the operational requirements of that standard.

11.11.1a Carbon monoxide (CO)

CO monitoring instruments are predominantly gas filter correlation infrared (GFC-IR) absorption analysers. It is also measured through a non-dispersive infrared gas chromatograph with flame ionisation detector, or electrochemical sensor systems. These alternative methods, however, suffer from a variety of interfering species and are considered less robust than GFC-IR analysers.

In a GFC-IR analyser, ambient air is continuously sampled using a pump unit and the CO concentration in the sample air is measured by the absorption of infrared radiation at 4.5 to 4.9 nanometres (nm) wavelength. A reference detection system is used to alternately measure absorption due to CO in the ambient air stream and absorption by interfering species. An infrared detector and amplification system produce output voltages proportional to the CO concentration. The concentration is derived from the Beer–Lambert relation :

$$\mathbf{I_1 = I_0\, e^{-alc}}$$

where the sample passes through a cell tube of length 'l'. The analyser alternately measures the absorption I_0 of the air path with no CO present and the absorption I_1 of the ambient sample, with 'a' being the absorption coefficient, to provide the CO concentration, 'c'. GFC instruments use a filter wheel to allow alternate measurement of total IR absorption. The analyser continually displays current CO concentrations, and, depending on the make and model of analyser, other parameters can be selected as necessary.

11.11.1b Nitrogen dioxide (NO_2)

Nitric oxide (NO) in the sample air stream reacts with ozone (O_3) in an evacuated chamber to produce activated NO_2 :

$$\mathbf{NO + O_3 \rightarrow NO_2^* + O_2 \rightarrow NO_2 + O_2 + h\nu}$$

The intensity of the chemiluminescent radiation (hv) produced is measured using a photomultiplier tube (PMT) or photodiode detector. The detector output voltage is proportional to the NO concentration. The ambient air sample is divided into two streams : in one, ambient NO_2 is reduced to NO using a molybdenum catalyst before reaction. This gas stream gives total NO_x. The second stream measures NO directly by not passing through the molybdenum converter.

Separate measurements are made of total oxides of nitrogen NO_x (= NO + NO_2) and NO. The ambient NO_2 concentration is calculated from the difference ($NO_2 = NO_x - NO$). This is an important point to remember, because the contaminant of interest

(NO_2) is actually measured by inference rather than directly, and the efficiency of the molybdenum converter should be checked on a regular basis.

NO_x analysers are equipped with either a single or a double reaction chamber and PMT system. A solenoid valve is used to alternately switch between NO and NO_x measurements, typically at 15-second intervals. The analyser continuously displays current NO, NO_2 and NO_x concentrations, and, depending on the make and model of analyser, other parameters can be selected as necessary.

*11.11.1*c Ozone (O_3)

In an O_3 analyser, ambient air is continuously sampled using a pump unit. O_3 concentrations are calculated from the absorption of ultraviolet (UV) light at 254 nanometres (nm) wavelength. The absorption is measured using a UV detector. An O_3-removing scrubber is used to provide a zero reference intensity. The concentration is calculated using the Beer–Lambert equation :

$$\mathbf{I_1 = I_0\, e^{-alc}}$$

where the sample passes through a cell tube of length 'l', and the analyser alternately measures the absorption I_0 of the air with no O_3 present and the absorption I_1 of the ambient sample, with 'a' being the absorption coefficient (at 254 nm), to provide the O_3 concentration, 'c'. The analyser continually displays current O_3 concentrations, and, depending on the make and model of analyser, other parameters can be selected as necessary.

11.11.1d Particles

Particles (also known as 'particulate matter' or PM) is the term used for a mixture of solid particles and liquid droplets suspended in the air. The particles are made up of a number of components, including nitrates and sulfates, organic chemicals, metals and soil or dust particles. Some particles, such as dust, dirt, soot or smoke, are large or dark enough to be seen by the naked eye. Others are so small that they are invisible.

Particle pollution includes particles with diameters that are 10 µm or smaller (including particles smaller than 2.5 µm) and these are designated as PM_{10}. Particles

from vehicles on dirt roads and dusty industries, such as mining, crushing and grinding, are generally larger than 2.5 µm in diameter and are included in PM_{10}. Other smaller particles or 'fine particles' are those with diameters that are 2.5 µm or smaller (designated as $PM_{2.5}$), and are commonly found in smoke and haze.

11.11.1d.1 Formation of Particles

Some particles are natural while others are generated by human activity. Natural sources include bushfires, dust storms, pollens and sea spray. Particles generated by human activity can be emitted from sources such as motor vehicles, power plants, mining and materials handling, residential wood burning, agricultural burning, and some industrial processes; these are known as primary particles. Others are formed in complicated reactions in the atmosphere from chemicals such as sulfur dioxide and oxides of nitrogen emitted from power plants, industries and motor vehicles and are known as secondary particles.

11.11.1d.2 Movement of Particles

Large particles in the air usually cause reduced visibility for a short time and settle close to their source. Small or fine particles can remain in the atmosphere for several days and be transported great distances from their source by the wind. They are capable of scattering light which also leads to a reduction in visibility. Particles are generally removed from the atmosphere by rain or when they come into contact with surfaces.

11.11.1d.3 Environmental and Health Impacts of Particles

11.11.1d.3a Visibility reduction

Fine particles ($PM_{2.5}$) are the major cause of reduced visibility. They can also cause nuisance when they deposit and soil homes, buildings and other surfaces.

11.11.1d.3b Health Effects

While most healthy people can breathe in small amounts of particles without major long-term effects, extreme air pollution events such as bushfires and major dust storms can affect everyone. Some people (e.g. children, those with heart or lung disease and the elderly) can be sensitive to even relatively low levels of particle

pollution. Exposure to fine particle pollution has been linked to a variety of health problems including increased respiratory symptoms (e.g. irritation of the airways, coughing or difficulty in breathing), heart problems and premature deaths in people with heart or lung diseases. Moreover, these health effects depend on a number of factors, including:

- particle size
- intensity and duration of exposure
- the chemical nature of the particles
- a person's health and
- weather conditions, including wind, humidity and rainfall.

11.11.1d.4 Assessment of Air Quality

Two methods can be used to collect air quality data : the 'reference' methodology and the 'continuous monitoring' methodology. Reference methods involve batch collection of fine particles on filter paper over 24 hours : samples are collected and then transported to special laboratory facilities for weighing and reporting of results.

11.11.1d.5 Measurement of PM_{10}

Instruments fitted with a size-selective PM_{10} inlet draw (heated subsequently to remove humidity) a constant volume of ambient air through a filter. Particles are collected on the filter, which then increases in weight. The mass of the particles is determined. The mass is divided by the volume of air sampled by the instrument over the same time period to produce the mass/unit volume (micrograms / cubic meter - $\mu g/m^3$). Because the particles can include water (via rain or humidity) as part of their mass, it is important that the inlet is heated (to 30-50 degrees C) to dry out the particles before they land on the filter.

11.11d.6 Measurement of $PM_{2.5}$

These instruments are fitted with size-selective inlets and very sharp cut cyclones (VSCC) to collect the $PM_{2.5}$ sample stream which is then heated (to reduce the effects of humidity) and passed through a filter tape. The amount of heating is determined by the humidity levels of the incoming sample stream. The particles are deposited onto the glass fiber tape.

11.11e Sulphur dioxide (SO_2)

SO_2 monitoring instruments are predominantly molecular UV fluorescence analysers, which use flame photometric detector and electrochemical sensor systems. UV fluorescence systems operate on the principle that an ambient air sample stream exposed to UV light excites SO_2 molecules in the sample to higher, but unstable, excited states. These excited states decay, giving rise to the emission of secondary (fluorescent) radiation :

$$\mathbf{SO_2 + h\nu \rightarrow SO_2^* \rightarrow SO_2 + h\nu \ (fluorescence)}$$

The fluorescent radiation is detected by a PMT, causing an output voltage proportional to the SO_2 concentration. A permeable membrane is used to remove interfering hydrocarbons before reaction. Ambient air is drawn through the system via a pump unit, and the analyser continuously displays current SO_2 concentrations.

11.11f Other Recommended Ambient Air Monitoring Methods

- **Hydrogen sulphide (H_2S) :** The recommended method is based on the standard method for sulphur dioxide, with the addition of a catalyst to convert H_2S to SO_2.
- **Lead content of PM_{10} :** The recommended method for lead content of PM_{10} is high-volume gravimetric sampling.
- **Benzene and 1,3-butadiene :** The recommended methods for benzene and 1,3-butadiene are gas chromatography / mass spectrometry (GC/MS).
- **Formaldehyde and acetaldehyde :** The recommended method for formaldehyde and acetaldehyde is adsorbent cartridge followed by high performance liquid chromatography (HPLP).
- **Benzo(a)pyrene (BaP) :** The recommended methods for BaP are gas chromatography / mass spectrometry (GC/MS).
- **Mercury, Chromium and Arsenic :** The recommended method for mercury, chromium and arsenic is atomic absorption spectroscopy.

11.11g Additional Techniques, Summary and Overview

For PM_{10} concentration (suspended particulate matter fraction up to 10µm particle size), the **radiometric method** is also used. It is based on beta-ray absorption in a sample captured on filtering material. The difference between the beta-ray absorption of the exposed and non-exposed filtering material, which is proportional to the mass of the captured suspended particle matter, gives the information on its concentration.

The tapered element **oscillating microbalance** (TEOM) also measures the mass of the sample captured on a replaceable filter according to the oscillating tapered element frequency variation. The air sample passes through a filter where the dust particles are captured and runs through a hollow tapered element to a vacuum pump with an electronic flow control.

The average daily **sulfur dioxide** concentrations are measured by the spectrophotometric method using **West-Gaeke** method. The sulfur dioxide is absorbed into a sodium tetrachloromercury solution (TCM). The compound formed reacts in acid medium to yield a red-purple colour, which is measured spectrophotometrically at 586 nm. The average daily concentration is determined by drawing an air sample (1.2 to 2.4 m^3 per 24 h) through two absorbers containing absorption solutions, placed in series. The sampling apparatus consists of two capillary absorbers, a gas meter and a membrane pump. The sample must be fed to the absorber through a teflon tube.

A **spectrophotometric** method using **thorin** is applied at selected stations with lower **sulfur dioxide** pollution levels. The air is drawn through a filter to capture solid particles and then through another filter impregnated with sodium hydroxide to determine sulfur dioxide. After extraction from the filter, the sulphate ions are precipitated with barium perchlorate. Excess barium ions are determined spectrophotometrically at 520 nm after reaction with thorin. The sampling apparatus consists of a sampling head, membrane pump and dry gas meter. The volume of air drawn through the apparatus is between 2.5 and 10 m^3 per 24 hours.

SO_2 and **NO_2** concentrations are also measured by the **colorimetric method.** The average daily concentration of **nitrogen oxides** is normally measured by modified Jakobs - Hochheiser spectrophotometric method. Nitrogen oxides are sampled through an oxidation tube (NO present is oxidized to NO_2). All the NO_2 absorbed into the solution of sodium hydroxide with addition of guajacol reacts in acid medium of H_3PO_4 with a solution of sulfanilamide and N-(1-naphthyl) ethylene diamine dihydrochloride (NEDA) to form a red colour. The intensity of the colour is measured spectrophotometrically at 560 nm. The sampling apparatus consists of a teflon probe, which is connected to a tube filled with oxidation material at the entrance to a set of two capillary absorbers connected in series. The apparatus is then connected to a water gas meter and membrane pump.

The concentrations of **NO_3^-** and **HNO_3** are measured **spectrophotometrically** using NEDA and sulfanilamide (Griess reaction). Nitrates are captured on the teflon filter, gaseous **HNO_3** is captured on the filter impregnated with NaCl and then eluted by NaOH.

The concentration of **suspended particulate matter** is determined by a **gravimetric** method. The sample is taken through continuous filtration of ambient air on selected filtering material (membrane with a mean pore size of 0.85 µm, Teflon with a mean pore size of 1 µm or glass fiber with a capturing capacity more than 99.5 %) with a rate 33 - 55 $cm.s^{-1}$. The filter head is turned with the open side down, at a distance of 1.5 - 3.0 m above the surface. The amount of sample captured on the filter (in µg) is determined gravimetrically as a difference between the weight of the filter prior to and after the exposure.

The concentration of metals in the air is analyzed by the atomic absorption spectrometry (AAS) using membrane filters for sampling followed by mineralization using hot nitric acid. Polarographic method and inductively coupled plasma - atomic emission spectrometry (ICP-AES) are also used for the analysis of heavy metals or by a non destructive method of X-ray fluorescence (XRF) using a Teflon filter. The

resultant atmospheric concentration of SPM and metal in the air are given in $\mu g.m^{-3}$ and $ng.m^{-3}$ respectively. The concentration of SO_4^{2-} in SPM is measured by X-ray fluorescence (XRF) method using paper filters Whatman 40 for sampling.

The concentrations of $\mathbf{NH_3}$ and $\mathbf{NH_4^+}$ are measured by Berthelot method. Ammonium ions are captured on the first located teflon filter, gaseous NH_3 is captured on the filter impregnated with oxalic acid, $\mathbf{NH_4^+}$ ions eluated by demineralized water react with alkaline solution of phenol and NaClO.

Volatile organic compounds (VOCs) are determined by **gas chromatography** method using separation on a capillary column with an air sample taken in special steel canisters at the measuring site. The sample is fed into the chromatograph from the transportation canister through a pre-concentration unit.

Persistent organic pollutants (POPs) are captured on glass-fibre and polyurethan filters using high-volume pump sampling. After purification and pre-concentration, the selected POPs are measured by gas **chromatography** with mass detection (http : // old.chmi.cz / uoco / isko / tab_roc / 1998_enh / ENG / kap_01 / komentar_1_1.html)

The monitoring methods for the above air contaminants are based on procedures recommended by Standards Australia, the USEPA and the British Standards Institution (BSI).

Detailed specifications for these methods can always be obtained from the following websites:

- Standards Australia publications site (http://www.standards.org.au)
- USEPA site (http://www.epa.gov/ttn/amtic)
- BSI site (http://www.bsi-global.com).

More information on recommended monitoring methods for hazardous air contaminants can also be found in the reports available from the website (http : // www.mfe.govt.nz / publications / air / 11-hazardous-air-oct00.pdf).

11.12 Water Quality

Water quality is determined by assessing three classes of attributes : biological, chemical, and physical. There are standards of water quality set for each of these three classes of attributes. The national standards for drinking water are developed by the Ministry of Environment & Forests (Central Pollution Control Board). All municipal (public) water supplies must be measured against these standards.

Some attributes are considered of primary importance to the quality of drinking water, while others are of secondary importance. Therefore, the drinking water standards / guidelines categorize drinking water and bathing water quality standards etc. Primary drinking water standards regulate organic and inorganic chemicals, microbial pathogens, and radioactive elements that may affect the safety of drinking water. These standards set a limit - the Maximum Contaminant Level (MCL) - on the highest concentrations of certain chemicals allowed in the drinking water supplied by a public water system. Secondary drinking water standards regulate chloride, color, copper, corrosivity, foaming agents, iron, manganese, odor, pH, sulfates, total dissolved solids, and zinc, all of which may affect qualities of drinking water like taste, odor, color, and appearance.

State agencies are responsible for monitoring public water supplies and enforcing the primary and secondary drinking water standards set by CPCB. Local water bodies must test and treat drinking water and maintain the CPCB standards for quality. These water bodies are also responsible for informing the public when any water quality standards have been violated.

Given these standards, stream and groundwater supplies should be of high quality. Generally, one compares the values for the various measures of stream and groundwater quality at a given time and location to the average of those values across

the entire **watershed**. This "average" water quality across a watershed is referred to as the watershed's "baseline."

11.13 Biological Water Quality

Biological attributes of water can be important indicators of water quality. Biological attributes refer to the number and types of organisms that inhabit a waterway. When assessing water quality, it is also important to look at the quality of organisms that live in a waterway. Some species are more sensitive to chemical and physical changes in their habitat than other species. If species that tend to be sensitive to pollution are present in a waterway, then that waterway most likely has good water quality.

11.13.1 Common Biological Measures

Benthic macro invertebrates are frequently used as a biological water quality indicator because they are abundant, easier to capture than fish, and because they are easier to identify than algae or protozoa. Macro invertebrate samples can be collected using a Hess sampler in larger (fifth and sixth-order) streams or in smaller streams. Macro invertebrates are identified and enumerated, and the number of organisms at each site is estimated from the average of three same size sample areas. Benthic macro invertebrate densities are reported as the total number of organisms per square meter of stream bottom. In addition to the total number of those organisms, measures of diversity particularly at the taxonomic level of order should also be noted. The Shannon index and other bio-diversity indices measure the diversity and quality of an invertebrate community respectively.

11.13.2 Chemical Water Quality

Chemical attributes of water can be important indicators of water quality. Chemical attributes of water can affect aesthetic qualities such as how water looks, smells, and tastes. Chemical attributes of water can also affect its toxicity and whether or not it is safe to use. Since the chemical quality of water is important to the health of humans

as well as the plants and animals that live in and around streams, it is necessary to assess the chemical attributes of water.

Assessment of water quality by its chemistry includes measures of many elements and molecules dissolved or suspended in the water. Chemical measures can be used to directly detect pollutants such as lead or mercury. Chemical measures can also be used to detect imbalances within the ecosystem. Such imbalances may indicate the presence of certain pollutants.

Commonly measured physico-chemical parameters include pH, alkalinity, hardness, nitrates, nitrites and ammonia, ortho- and total phosphates, and dissolved oxygen and biochemical oxygen demand. The presence of fecal coli form, a bacteria, is also determined using a chemical test. This microscopic organism is too small to detect during the biological assessment of macro invertebrate populations. In addition, some "chemical" measurements actually indicate the physical presence of pollutants in water. These include measurements such as conductivity and density.

11.13.3 Common Chemical Measures

Assessment of water quality by chemical measures includes measures of various elements and molecules dissolved or suspended in water. Chemical measures commonly used in water-quality field surveys can reveal an imbalance within the ecosystem. For instance, **pH** identifies acid / base balance of water. Low pH values (indicating acidity) are particularly useful for detecting acid mine drainage. However, since some streams are naturally acidic, a low pH does not necessarily indicate acid mine drainage. Conversely, in systems with high alkalinity - a measure of the water's ability to buffer or resist changes in pH.

The level of nitrates in a body of water is another chemical measure of water quality. Nitrogen exists (in water) in numerous forms, two of which are nitrate (NO_3) and nitrite (NO_2). Of these two forms, nitrate is usually the most important. Nitrate is an essential nutrient for growth of algae and other aquatic plants, and can be present at high levels due to a variety of sources. Nitrate is very difficult to measure directly. A common procedure is to first measure the level of nitrite and then reduce the nitrate to

nitrite and measure the combined nitrite concentration. Subtracting the original nitrite level from the combined nitrite concentration will give the nitrate level.

Some chemical indicators are specific to particular forms of pollution. For instance, low dissolved oxygen often results from either the presence of raw sewage or acid mine drainage. Other "chemical" measures are actually physical measurements that indicate the presence of chemicals in the water. For instance, conductivity - the ability to conduct an electrical current - is a physical measurement that indicates the presence of chemical ions in the water sample. For example, when table salt (NaCl, sodium chloride) dissolves in water, it forms ions (Na^+ and $Cl^{-)}$ that allow a current of electricity to pass through the water. Water density is another physical measurement that indirectly indicates the presence of chemicals. The density of water is related to salt content (salinity) and water temperature. The salinity of a body of water is one of the main factors determining what organisms will be found there.

11.13.4 Physical Water Quality

Physical attributes of a waterway can be important indicators of water quality. The most basic physical attribute of a stream is the path along which it flows. Most streams are classified as "meandering" or S-shaped. Meandering streams have many bends. The bends are characterized by deep pools of cold water along the outside banks where faster-moving water scours the bank. Meandering streams also have riffles along the straight stretches between pools. The riffles appear as humps in a longitudinal stream profile.

The S-shaped path of meandering streams prevents water from moving too quickly and flooding downstream ecosystems. The deep, cold pools of water provide ideal habitat for many species of fish - even when overall stream-flow is reduced. The riffles help to hold water upstream during times of low stream-flow. Also, turbulence in the riffles mixes oxygen into the water. Natural stream-channel patterns, with their bends, pools, and riffles, are essential to decreasing flooding as well as providing a suitable habitat for certain aquatic plants and animals. For these reasons, it is important to assess the physical attributes of a stream when examining its water quality.

Measurements of a stream's physical attributes are used to describe the structure of a sampling site. This allows for the comparison of the biota and chemistry of similarly-structured streams at different locations. Measurements of a stream's physical attributes can also serve as indicators of some forms of pollution. For example, changes in temperature may indicate the presence of certain effluents, while changes in stream width, depth, and velocity and turbidity may indicate dredging in the area. Other commonly measured physical characteristics of a stream include : elevation and catchment area, stream order , forest canopy , and total solids etc.

11.13.5 Common Physical Measures

A variety of methods exist to determine several physical characteristics of surface water within a given watershed (http://cpcb.nic.in/Water_Quality_Criteria.php) :

- Stream order
- Catchment area (square kilometers)
- Built-up area (square kilometers)
- Percent built-up (percent)
- Elevation (meters)
- Water temperature(degrees Celcius)
- Stream width (meters)
- Average depth (meters)
- Maximum depth (meters)
- Minimum velocity (meters per second)
- Maximum velocity (meters per second)
- Average velocity (meters per second)
- Discharge [flow] (cubic meters per second)
- Forest canopy (percent shaded)
- Water transparency (Secchi disk or turbidity tube)

11.14 Soil / Sediment Quality

Concise definitions for soil quality include “fitness for use” and “the capacity of a soil / sediment to function.” Combining these, soil / sediment quality is its ability to perform the functions necessary for its intended use. These functions include :

- Sustaining biological diversity, activity, and productivity
- Regulating water and solute flow
- Filtering, buffering, degrading organic and inorganic materials
- Storing and cycling nutrients and carbon
- Providing physical stability and support

The quality of a soil/sediment, or its capacity to function, is evaluated using inherent and dynamic soil properties. These properties serve as indicators of soil/sediment function. Inherent, or use-invariant, soil properties change very little or not at all with management. Inherent soil properties form over thousands of years and result primarily from the soil forming factors : climate, topography, parent material, biota and time.

Examples of inherent properties are soil texture, type of clay, depth to bedrock, and drainage class. Dynamic, or management-dependent, soil properties are affected by human management and natural disturbances over the human time scale, i.e. decades to centuries. Significant changes in dynamic soil properties can occur in a single year or growing season.

Soil indicators are often divided into physical, chemical and biological categories depending on how they affect soil function. However, these categories are not always clearly defined since a soil property or indicator can affect multiple soil functions or categories. Depending on the indicator and the method used to evaluate it, properties are assessed in the field or the laboratory.

In short, soil quality is an assessment of how well soil performs all of its functions now and how those functions are being preserved for future use. Soil quality or health cannot be determined by measuring only crop yield, water quality, or any other single outcome. For assessing soil quality certain indicators are used. These indicators are measurable properties of soil or plants that provide clues about how well the soil can function.

11.14.1 Useful indicators

- are easy to measure,
- measure changes in soil functions,
- encompass chemical, biological, and physical properties,
- are accessible to many users and applicable to field conditions, and
- are sensitive to variations in climate and management.

Indicators can be assessed by various qualitative or quantitative techniques. After measurements, they can be evaluated through data analysis (http : // soils.usda.gov / sqi / assessment / assessment.html ; http : // soils.usda.gov / sqi / assessment / files / indicator_sheet_guide_sheet.pdf ; http://soilquality.org/indicators.html**).**

11.14.2 Ideal indicators should

- correlate well with ecosystem processes
- integrate physical, chemical, and biological properties of the soil & processes
- be accessible to many users
- be sensitive to management & climate
- be components of existing databases
- be interpretable

Organic matter, or more specifically soil carbon, transcends all three indicator categories and has the most widely recognized influence on soil quality. Organic matter is tied to all soil functions. It affects other indicators, such as aggregate stability (physical), nutrient retention and availability (chemical), and nutrient cycling (biological); and is itself an indicator of soil quality. Some examples of indicators that fall into three broad categories of chemical, physical and biological, are provided below :

11.14.3 Indicator Categories

Chemical indicators can give information about the equilibrium between soil solution (soil water and nutrients) and exchange sites (clay particles, organic matter); plant health; the nutritional requirements of plant and soil animal communities; and levels of soil contaminants and their availability for uptake by animals and plants. Indicators include measures of : (a) Electrical Conductivity; (b) Soil Nitrate and (c) Soil Reaction (pH).

Physical indicators provide information about soil hydrologic characteristics, such as water entry and retention, that influences availability to plants. Some indicators are related to nutrient availability by their influence on rooting volume and aeration status. Other measures tell us about erosion-status. Indicators include measures of :

- Aggregate Stability
- Available Water Capacity
- Bulk Density
- Infiltration
- Soil Crusts
- Soil Structure and Macro pores

Biological indicators tell us about the organisms that form the soil food web that are responsible for decomposition of organic matter and nutrient cycling. Information about the numbers of organisms, both individuals and species, that perform similar jobs or niches, can indicate a soil's ability to function or bounce back after disturbance (resistance and resilience). Indicators include measures of :

- Earthworms
- Particulate Organic Matter
- Potentially Mineralizable Nitrogen
- Respiration
- Soil Enzymes
- Total Organic Carbon

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Chapter 12

Green Port Plan

Chapter 12

Green Port Plan

12.1 Introduction

The Green Port Program is an umbrella program designed to achieve the Port's environmental sustainability goals in six key areas: water, energy, air, waste management, sustainable development and sustainable business practices. In many ports like the Port of San Diego, Port's Green Policy started as early as 2008. The ultimate goal of a Green Port Plan program is to achieve long-term environmental, societal and economic benefits through resource conservation, waste reduction and pollution prevention.

The Green Port Program unifies the Port's environmental sustainability goals (in many key areas) by way of setting measurable goals and evaluating progress in each area on an annual basis. The program encourages continuation of the Port's existing environmental efforts and expands these efforts through new programs and initiatives in the following key areas (https : // www.portofsandiego.org / environment / green-port.html?tmpl=component&print=1&page=) :

12.2 Energy

The ultimate goal under this area is to *Conserve energy and maximize energy efficiency of various Port operations. This can be achieved in the following manner :*

- Reduce the Port's operational energy use

- Conduct a pilot project to assess various applied and applicable energy efficiency technologies
- Investigate opportunities to participate in renewable energy projects
- Conduct a solar assessment to determine optimal locations for applying future photovoltaic systems
- Install photovoltaic systems on the Administration and General Services Buildings and pursue funding for other solar projects

12.3 Waste Management

The ultimate goal under this area is to *reduce waste from Port operations through material reuse, recycling and composting, which can be achieved in the following manner :*

- Explore ways to enhance the composting program
- Expand collection opportunities for electronic waste
- Investigate opportunities to expand the Port's current recycling program

12.4 Sustainable Development

The ultimate goal under this area is to *Enhance the environmental performance of Port buildings while maximizing long-term economic benefits. This can be achieved in the following ways :*

- Acquire LEED certification for the Administration Building.
- Acquire LEED certification for the General Services Building.
- Educate key Port employees on sustainable building principles.

Leadership in Energy and Environmental Design (**LEED**) is a set of rating systems for the design, construction, operation, and maintenance of green buildings, homes, and neighborhoods.

12.5 Water

The ultimate goal under this area is to *Improve water quality and reduce the Port's water usage to preserve water supply, which can be achieved in the following manner :*

- Conduct a sustainable landscaping project
- Develop and implement a water conservation strategy
- Replace plumbing fixtures in Port buildings with water efficient fixtures
- Explore opportunities to expand the Smart and Efficient water-use System on tidelands

12.6 Air

The ultimate goal under this area is to *Reduce greenhouse gas contributions and other air emissions from Port operations. This can be achieved in the following manner :*

- Define and publicly register the carbon and ecological footprints of Port operations, and establish goals to maintain or reduce this footprint.
- Explore ways to assist tenants in measuring and reducing their carbon footprint
- Monitor the Vessel Speed Regulation Program so as to control the speed-dependent air-emissions
- Monitor and manage shore power installation.

12.7 Sustainable Business Practices

The ultimate goal under this area is to *give equal weight to environmental, economic and social concerns in the decision-making process by way of doing the following :*

- Increase opportunities for employees and the public to participate in the Green Port Program to learn about ways to be more sustainable
- Establish the Port as a drop-off location for a Community Supported Agriculture Program
- Increase outreach efforts as part of the Green Port Education Program.
- Continue the Commuter Assistance Program
- Expand the use of environmentally-friendly products used in Port operations.

For monitoring and overseeing the Green Port Program, there should be a committee called "The Green Port Program Steering Committee". This committee should include representatives from a variety of departments throughout the Port and should be responsible for overseeing decisions related to the Green Port Program. The Steering Committee should be chaired by an environmental expert who can manage and coordinate the Green Port Program. This Committee should also provide overall guidance to the Green Port Program by identifying priorities and projects, measuring and assessing projects, and communicating the Port's progress to staff and the public. Projects selected for the Green Port Program must satisfy the criterion of benefitting the environment and must fall into at least one of the six areas of focus (water, energy, air, waste management, sustainable business practices, and sustainable development), and be above and beyond compliance. Once, these minimum requirements are met, projects should then be evaluated by an additional set of criteria, including environmental, economic, and societal benefits of the project, cost, educational value, and measurability.

12.8 Air / Noise Environment : Green Plan : Some Examples

Sr. No. / Port Name / References	***Likely Impacts***	***Green Plan***
1. Port of Long Beach, California, USA Green Port Annual, 2005; http://www.polb.com/civica/filebank/blobdload.asp?BlobID=2884	*Engine Emission* : • NOx that is key contributor to air smog formation • Carcinogenic risk due to diesel particulate matter (DPM) emissions. • SOx pollution leading to formation of H_2SO_4 in air. • *Dust from handling materials* such as grains or construction materials such as sand or cement.	(a) Use of clean fuel mixed with ethanol. (b) Minimize incidences of excessive smoke formation from vessels at berth, through use of shore- side-power (c) Use of oxidation catalysts for cleaner emissions. (d) Use of ultra low sulfur diesel in construction equipments. (e) Use of electric power dredges. (f) Establishing air monitoring

		stations.
2. Port of San Diego, California, USA Green Port Program, Port of San Diego https://www.portofsandiego.org/environment/green-port.html ; Clean Air Program, Port of San Diego, https://www.portofsandiego.org/environment/clean-air.html ;	• Green house gases emission from on shore and ship engines, air conditioning, • Engine emissions : CO, CO_2, SO_x, NO_x	Carbon footprint management plan : • Evaluate and estimate carbon footprint and establish goals to maintain and reduce it • Assist employees in reducing carbon footprint • Clean Air Program • Vessel Speed reduction Program • Reducing speeds in vicinity of San Diego bay ; Speed reduction zone 20 nautical miles radius. • Providing shore power to vessels at berth (cold ironing) • Truck replacement and retrofits • Replacement / Retrofits of Cargo handling equipments.

		• Integration into business plan
3. Port of Los Angeles, USA Port of Los Angeles Sustainability Report 2011 http://www.portoflosangeles.org/DOC/REPORT_Port_Sustainability_Report_2011.pdf	• Human and ecological health risk • Air quality at the port and of the surrounding areas. • Energy consumption and climate change related issues • Relationship with stakeholders regarding compliance of state laws on Air quality • Green Growth of port infrastructure	• Older trucks replaced by newer cleaner trucks through concessions, grants financial incentives • Paying incentives to vessel operators to use low sulfur fuel • Incentives for vehicles slower than 12 knots within 20 nautical miles of the port • Configuration of shore side power facility • Replacement or repowering cargo handling equipments • Replacement of harbor craft engines with better emission standards • Betterment of rail locomotive engines Initiation of regular technology advancement program for realizing cleaner air quality goals.

12.9 Water Environment : Green Plan : Some Examples

Sr. No. / Port Name / References	***Likely Impacts***	***Green Plan***
1. Port of Long Beach, California, USA Green Port Annual, 2005; http://www.polb.com/civica/filebank/blobdload.asp?BlobID=	• Storm water from paved port land, carrying pollutants from terminals, roads and construction sites into sea, thus inducing turbidity. • Vessel traffic and	• Remove trash from port streets so that storm water runoff doesn't contaminate seawater. • Install automatic sampling devices to verify compliance with storm water management

2884	dredging, stirred up sediments, some of which may contain pollutants • Dissolved oxygen concentration decreases due to mixing of organic contaminants from storm water runoff or stirred benthic sediments	practices. • Treatment of storm water and water from industrial areas rather than let it runoff from terminals. • Managing water quality around dredging projects to ensure contaminants do not exceed water quality standards. • Sampling and monitoring with automatic sampling devices for hard to sample sites around ports
2. Port of San Diego, California, USA Green Port Program, Port of San Diego, https://www.portofsandiego.org/environment/green-port.html	• General depletion and degradation of water quality	• Replace old plumbing fixtures with efficient ones. • Sustainable landscaping for parks at ports • Install irrigation system on tidelands

12.10 Sediment and Benthic Environment : Green Plan : Some Examples

Sr. No. / Port Name / References	***Likely Impacts***	***Green Plan***
1. Port of Long Beach, California, USA Green Port Annual, 2005; http://www.polb	• Contamination from past industrial use, illegal dumping, oil and storm water • Contamination of groundwater through	• Contaminated areas returned to productive use through "brown field development". • Removal of contaminated soil and disposed off in

.com/civica/ filebank/blobdload.asp?BlobID=2884 **[Brownfield** is a term used in urban planning to describe land previously used for industrial purposes or some commercial uses. Such land may have been contaminated with hazardous waste or pollution or is feared to be so.]	percolation of leachate • Mooring and anchoring leads to deterioration of sensitive marine animals and plants at the sea floor. • Oil and hazardous chemical spill near the ports results in contamination of sea floor.	approved landfill and recycling facility. • Contaminants removed every year and hazardous materials are disposed as encountered. • Maintenance dredging and safe disposal of disposed material. • Reuse of contaminated material as structural material underneath pier to isolate them from rest of the environment. • Land near harbors is controlled by restrictions so that public doesn't assess contaminated areas.

12.11 Socio-economic Environment : Green Plan : Some Examples

Sr. No. / Port Name / References	***Likely Impacts***	***Green Plan***
2. Port of San Diego, California, USA Green Port Program, Port of San Diego, https://www.portofsandiego.org/environment/green-port.html	• Decision making process lacking economic and social concerns. • Public and port employees do not participate in decision making process thus the program falls short of achieving the required sustainability. • Port buildings lacking environmental performance	• Establishing port as a drop-off location for community supported programs. • Make outreach efforts as a part of green port education program. • Expand the use of environmentally friendly products in port operations. • Green housekeeping and green purchase programs to be implemented. • Adapt sustainable building policy to

		enhance environmental performance leading to environmental certification for administrative and service sectors.

12.12 Some Special Issues : Coal Handling

The following measures are suggested for handling coal at ports :

- Place for handling coal should be at least 500 meters from Ecologically sensitive / forest areas, historical monuments, religious places, residential and school/colleges, railway line, expressway, state and national highways, district roads, water bodies like river, nallah, canal pond etc. Waste / barren land should be used for coal storage purposes.
- All ports and jetties must provide closed conveyor belts, silos and mechanisms for handling of coal.
- Coal heap not higher than 5 meters and adjacent distance between the heaps of coal at least 5 meters so that there is place for approach during fire.
- Loading/unloading operation at ports / jetties and storage yards should be mechanized to minimize dispersion of coal dust during these operations.
- Corrective measures to resolve air pollution problems caused at site by handling of coal
- All trucks before leaving the storage yard should be showered with water and covered with tarpaulin/sheet of any other suitable material so that there is no spillage.
- Weighing scale should be provided at the storage yard to ensure there is no overloading of trucks.
- Top of transport vehicle shall be covered to avoid any dusting of coal.
- Well built paved road at ports must be provided so that there is least spillage of coal during handling as well as transportation.
- Continuous water sprinkling at regular intervals shall be carried out at the top of heaps and at each loading/unloading stage in storage areas to prevent dusting, fire and smoke.

- Sweeping of coal dust from internal and main roads to ensure adequate space for movement of vehicles.

Following air pollution control measures to be provided :

- Dust containment cum suppression system for loading/unloading
- Prevention of suspension of particles from heaps
- Metal Road / RCC Pucca flooring at storage area
- System for regular wetting/cleaning of floor area
- Closed shed at the storage area
- Three row plantation with tall growing tress at the periphery of coal storage location to impede spread of coal dust during storage and handling operations.
- Proper drainage system so that water drained from sprinkling coal heap and runoff are collected in a common tank and released after treatment.

12.13 Safety

- Adequate fire fighting measures must be adopted including adequate water storage
- On site emergency plan needs to be prepared and implemented.

12.14 Pollution Monitoring

- Continuous Ambient air quality monitoring shall be done and results for SPM, RSPM, SO_2, NO_x, NH_3 shall be recorded and checked for exceeding the prescribed limit.
- In case of regular incidences of high exceedance, measures shall be taken for pollution abatement.
- In case of individual developers at port an MOU between port authority and the developer shall be made for regulating pollution control related activities and implementation of environmental guidelines.

Chapter 13

Action Plan : Recommendations

Chapter 13

Action Plan : Recommendations

13.1 Action Plan and the Broad Areas which Need Immediate Attention

The present action plan is based on the principle of Integrated Management enunciated first at the 1992 United Nations Conference on Environment and Development. Mainly it includes the following principles :

- Work together and bring various sectors and citizens on the same platform using more open and transparent management and advisory systems;
- Base decisions on strong scientific advice and ecosystem-based approaches; and
- Apply conservation and protection measures in the marine environment through actions such as Marine Protected Areas and "smart" regulations, and guidelines and standards to ensure marine environmental quality with focus on the following :

❖ Oil pollution, Sewage Discharges and Garbage Disposal
❖ Marine debris
❖ Toxic materials
❖ Ocean dumping and mining
❖ Tanker spills
❖ Runoff from land and industrial wastes

So as to take care of the following :

• Major declines in fish stocks and fluctuations;
• Fundamental changes in the structure of marine ecosystems, in the upper as well as bottom layers of the food web;
• Shifts in major oceanographic driving forces impacted by the climate change;
• Persistent introduction of pollutants and invasive species;
• Environmental / ecological risks to various marine species;

• Habitat alteration and degradation (in structure and functioning);
• Contamination of traditionally harvested resources; and,
• Declining biodiversity and ecosystem-productivity.

While the inherent challenges, for meeting the above-mentioned objectives, are many, Scientists and Ocean managers world-over agree that there are solutions to deal with these problems provided there are greater commitments for the following :

• More application of ecosystem-based science to look at various interactions among the diverse parts that make up the natural world,
• Utilization of scientific advice to turn information and research into definitive actions;
• Deployment of modern technology to support oceans understanding, monitoring and management;
• Integrated planning based on clear and well-understood ecosystem principles;
• Effective regulatory measures to protect the oceanic resources against over-harvest, as well as environmental degradation; and,
• Protection measures, especially the designation of marine protected areas in the ocean to protect the most important, productive and biologically diverse areas and vulnerable species.

13.1.1 Priorities for the EMP (Environmental Management Plan) & Green Plan

• to bring about a massive reduction in pollution from various sources;
• to protect marine and coastal habitats and threatened species;
• to make maritime activities safer and more conscious of the marine environment;
• to intensify integrated planning of coastal areas;
• to monitor and control the spreading of invasive species;
• to limit and intervene promptly on oil pollution.
• to promote sustainable development in the region

13.2 Immediate (Short Term) Action Plans

- **Reduce nutrient pollution to the marine environment**. In order to prevent hypoxic zones and harmful algal blooms, nutrient pollution (run-off) from land-based sources to the marine environment need to be reduced.
- **Reduce marine debris.** The inputs of debris, especially plastics, into the marine environment should be immediately reduced.
- **Stem the increase in ocean acidification** by reducing carbon emissions so as to take care of national commitments under various international agreements on Climate Change.
- **Create International State of Art and Capability to Monitor Coastal Pollution.** For this a dedicated ***ENVIRONMENTAL MANAGEMENT CELL (GREEN CELL)*** would be required with the following composition and responsibilities :

13.3 Environmental Management Cell (Green Cell) [EMC (GC)]

Realizing the importance of protection of the environment, the port authorities should constitute different groups at project, regional and Corporate levels to carry out specific environment related functions. An ***'Environmental Management Cell (EMC)'*** overseen by an ***'Environmental Monitoring Panel (EMP)'*** should therefore be immediately constituted with expert members from agencies such as Environment, Forest and Climate Change, Pollution Control Board, Relevant Academic / Research and other Institutions.

The broad mandate of this panel may be to oversee the ***environmental monitoring cell*** and advise the management on environment related matters as and when required. The EMC may oversee and ensure that the measures to be taken under the Environmental Management Plan is implemented strictly and to ensure that the pollution parameters are within the prescribed limits. For this purpose, employees/groups to look after monitoring and control of pollution, interaction and interfacing with various agencies, compilation of relevant data and publication of reports, equipment maintenance etc. should be placed in the Environmental

Management Cell (EMC). The EMC should be started in the initial stages itself with the following responsibilities :

▪ Proper maintenance and operation
▪ Creating environmental awareness amongst the workers, supervisory staff and contract laborers
▪ Conducting Environmental Audits and Reporting to Pollution Control Board or any such authorities
▪ Regularly monitoring the environmental parameters and preparing reports as required by the statutory authorities.
▪ Recommending necessary measures to improve environmental conditions.
▪ Advising the concerned staff and workers in matters related to EMP or Environmental code of conduct and in terms of necessary steps to be adopted
▪ Training the staff and other workers on safety measures and conducting environmental safety drills to educate them

13.4 Following Personnel Need to be Recruited on URGENT basis :

• Environmental Professionals (From various disciplines of Science and Engineering)
• Documentation Officers (Youngsters (preferably engineers with inter-disciplinary aptitude))
• Environmental Reviewers (Senior Persons)
• Environmental Professionals (Air, Water, Noise, Sediment, Biological, Socio-economic)
• Interface (Interdisciplinary) Officers (Young or Old)

With the help of the above-mentioned staff, continuously the total ***CARBON AND ECOLOGICAL FOOTPRINTS should be estimated and reduced*** so as to compare the impact of various pollution-control and associated remedial measures**.** Following projects can be undertaken (on priority basis) by the above mentioned staff :

Resource Conservation and Efficiency

• Implement online electricity monitoring and management services
• Install / Provide additional photovoltaic / solar electricity generation on various buildings
• Review fuel consumption and introduce green procurement standards for motor vehicles
• Implement recycling schemes for batteries, mobile phones and other electronic equipment

Stakeholder Consultation and Relations

• Continue to host regular community liaison group meetings
• Improve the layout and presentation of development and sustainability information on the website
• Establish Environment and Sustainability Working Groups
• Conduct staff environmental awareness training for all staff and contractors
• Continue to run and investigate opportunities for staff involvement in environmental and sustainability events

13.5 Some More Areas of Immediate Concern

- **Create more marine protected areas.** Conserve at least 10 percent of coastal and marine areas / effectively managed protected areas (https://www.cbd.int/sp/targets/rationale/target-11/).
- **Protect coastal ecosystems that provide critical services.** Conserve at least 20 percent of coastal ecosystems, such as mangroves, tidal marshes, sea grass beds, and coral reefs, that provide critical ecosystem services. These ecosystems provide habitat and nursery grounds for many species of marine life, store carbon, and protect vulnerable coastlines against storm surges (www.state.gov/documents/organization/228005.pdf).
- **End overfishing in the ocean** *with the goal of restoring overexploited, depleted, and recovering stocks. To achieve this, we must :*

• set fishing rules based on the best available science, even if it means foregoing catch in the near term;
• develop fair, equitable, and transparent procedures for allocating fishing rights;
• enforce fishing rules using all available technologies and impose meaningful penalties on violators;
• eliminate fishery-subsidies that contribute to overfishing and overcapacity of fishing fleets; and
• require fishing fleets to use gear and fishing techniques that reduce the by-catch of other species, waste, and discards of fish to an absolute minimum.

- **Prevent illegal, unreported, and unregulated (IUU) fishing.** *To achieve this, we must :*

• stop illegally harvested fish from entering the stream of commerce, consistent with international law, using all tools available;
• improve tracking of fishing vessels by ensuring that all large fishing vessels have obtained an International Maritime Organization (IMO) number – a unique and permanent identifier;
• build capacity to prevent wildlife trafficking of marine species through the regional Wildlife Enforcement Networks and through INTERPOL; and
• provide consumers with information to allow them to choose seafood that has been harvested legally and sustainably.

13.6 Some Activities Which Should be Immediately Controlled (Managed) :

• Over loading with trucks in the freeways and neighborhood streets
• Surrounding homes coated with soot
• Asthma incidences in the neighborhood
• Containers stacking
• Amount of dredged sludge forming toxic islands
• Impact on important marine habitats

13.7 Priority Areas Based on Data Analysis

• Activity-wise :
➢ ***Vessels Operation,***
➢ ***Cargo-handling***
• Environment-wise :
➢ ***Air Environment***

13.8 Specific Short Term and Long Term Strategies

S.No.	***Activity-Type***	***Strategies***
1.	**Ocean Going Vessels**	***Short Term*** • Vessel Speed Reduction • Operational Improvements • Clean Fuels ***Long Term*** • Emission Control Technologies • Shore Power Provisions
2.	**Harbor Craft**	***Short Term*** • Engine Replacement with Engines Meeting Cleaner Standards • Clean Fuels ***Long Term*** • Emission Control Technologies • Electrification (including Shore Power and Hybridization)
3.	**Cargo Handling Equipment**	***Short Term*** • Equipment Replacement (with Engines) Meeting Cleaner Standards • Operational Improvements • Clean Fuels ***Long Term*** • Emission Control Technologies
4.	**Heavy Duty Vehicles / Trucks**	***Short Term*** • Equipment Replacement (Along with Engines) Meeting Cleaner Standards • Operational Improvements • Clean Fuels ***Long Term*** • Emission Control Technologies • Idling Emission-Reduction Technologies

5.	**Light Duty Vehicles**	***Short Term*** • Equipment Replacement (With Engines) Meeting Cleaner Standards • Operational Improvements • Clean Fuels ***Long Term*** • Emission Control Technologies • Idling Emission-Reduction Technologies
6.	**Locomotives and Rail**	***Short Term*** • Equipment Replacement (with Engines) Meeting Cleaner Standards • Operational Improvements • Clean Fuels ***Long Term*** • Emission Control Technologies • Idling Emission-Reduction Technologies
7.	**Construction Equipment**	***Short Term*** • Equipment Replacement (With Engines) Meeting Cleaner Standards • Operational Improvements • Clean Fuels ***Long Term*** • Emission Control Technologies • Idling Emission-Reduction Technologies

13.9 Emission-Reduction from Ocean-going Vessels (OGV) : Effective Strategies (http : // wpci.iaphworldports.org / iaphtoolbox / GreenG_conmeas.html)

13.9.1 Vessel Speed Reduction (VSR)

Speed reduction down to 12 knots or lower reduces NOx from OGVs by slowing vessel speeds as OGVs are within the coastal waters of a port or within the port area. Technical considerations may include updating existing radars and communication devices to communicate with local navigation and communication centers. Vessel speed at which emissions are lowest is based on limited data and likely to vary with engine.

Compliance can be assured through tariff reduction incentives, lease requirements for renewed lease agreements, or voluntary programs. A memorandum of understanding with shipping companies, ports and regulatory agencies can be evolved. VSR has many benefits. In addition to NOx, PM and GHGs are also reduced. There may also be a fuel economy benefit. However, there could be additional operational costs. Some VSR programs have been put in place on the East Coast of the United States to protect endangered species.

13.9.2 Operational Improvements

• Reconfigure existing terminals,
• Deepen channels and berths and
• Improve inland access by rail and barge;
• Install infrastructure to support electric-driven cranes;
• Significantly enhance on dock and regional rail capabilities;
• Invest in gate improvements; and speed up vessel loading and unloading time. This further enhances air quality by reducing vessel dwelling time.

The adopted design must provide a reasonable return on investment through operational efficiencies, supporting a business case, and voluntary action. This would result in higher efficiency and lower emissions.

13.9.3 Clean Fuels

It requires the use of lower sulfur distillate fuels in auxiliary and / or propulsion engines of OGVs within the coastal waters of a port. A substantial reduction in Diesel Particulate Matter (DPM) can be achieved if OGVs use distillate fuels that have a low sulfur content. This, inter alia, requires co-ordination amongst port-authorities, fuel suppliers, shipping lines, and others to ensure low sulfur fuel availability. Implementation strategies may include the use of lease requirements and tariff changes.

There are various pros and cons. For instance, positive emission reduction benefits for NOx, PM and GHGs. However, challenges may arise with low sulfur fuel availability and putting in place an on-board tank / fueling station. Fuel contamination may also become a problem sometimes. So regular fuel tank cleaning may be required for ultra-low sulfur diesel fuels.

13.9.4 Emission Control Technologies (ECT)

Improvements in main and auxiliary engines help reduce DPM, NOx and SOx emissions. Measures for main engine improvements may include;

• Slide valves,
• Seawater scrubbing and
• Engine upgrades.

Measures for auxiliary engines include;

• Selective Catalytic Reduction (SCR) and
• Engine upgrades or repowers.

Operational and feasibility testing is required to ensure the function and appropriateness of an emission-control-technology (ECT) on marine applications. In particular, many ECTs require exhaust gas temperature analysis by conducting exhaust gas temperature data logging to measure exhaust gas temperatures. Many ECTs have exhaust temperature thresholds that are required for the operation and effectiveness of the technology.

Emission control technologies which have been certified or verified by regulatory agencies are most likely to deliver the claimed benefits. The strategy can be implemented through lease requirements, tariff charges, and incentives. A Technology Advancement Program (TAP) can be so designed that would demonstrate feasibility of ECTs on marine applications. The Technology Advancement Program (TAP) would consider use of newer technologies.

13.9.5 Shore Power

Shore Power focuses on reducing emissions from OGVs while at berth. This strategy has two approaches :

- Shore-power (transferring the electrical generation needs for OGVs while at berth – power generated by regulated / controlled stationary sources) and
- Idling emission-reduction requirements through alternative technologies for ships that do not fit the shore power model.

Shore power is best for OGVs that make multiple calls at a particular terminal for multiple years. The best candidates for shore power are container ships, reefer ships, and cruise ships. For them, shore power infrastructure needs to be provided on-dock and on-board vessels after finding out the necessary power needed and ensuring the adaptability.

Some power companies operate coal-burning power plants without the use of scrubbers and other types of emission control technologies. Therefore, it needs to be ensured that the electricity-provider (power company) is using a cleaner source of energy with use of emission control technologies. In some cases, it may be better not to use shore power if the local power company has polluting power plants. Implementation strategies include lease requirements, incentives, tariff changes and capital funding (http://wpci.iaphworldports.org/iaphtoolbox/ogv.html).

13.10 Effective Strategies for Reducing Emissions from Harbour Craft (HC)

Some effective strategies that can be applied to address emissions from Harbor Craft (HC) are presented below. Some of these strategies can also apply to dredging equipment.

13.10.1 Engine Replacement

- Repower HC main and auxiliary engine with cleaner engines that meet newest national air quality standards. For example, the United States has diesel engines that meet U.S. EPA Tier II and Tier III engine standards. Replacing a

Tier 0 engine with a Tier II engine will reduce NOx up to 47%. Tier III engines will reduce NOx and PM up to 90%. The European Commission has an equivalent engine that meets Stage IIIA engine standards (http://wpci.iaphworldports.org/iaphtoolbox/HC.html).

- Ensure technical feasibility. This involves very careful removal of the original engine and replacing it with a newer, cleaner engine.
- Carry out implementation through voluntary programs, incentives, and / or lease renewals / renegotiations.

There are some pros and cons of this strategy. Replacing main-propulsion engines with cleaner engines will provide great emission benefits. However, cleaner engines are costly and may cause an economic burden. Technology availability may also be a concern. Destroying old engines may increase costs. Ideally, engines should be rendered inoperable so that they do not go on polluting.

13.10.2 Clean Fuels

- Use of cleaner fuels with low sulfur content. Cleaner fuels include : low and ultra low sulfur diesel fuel, emulsified diesel fuels, oxygenated fuel (O_2 (Oxygenated) diesel fuel), and biodiesel.
- Port-authorities should work out (with fuel suppliers) the availability and supply of clean fuels. Depending on the type of clean fuel used, cleaning of the fuel tank may be required in order to avoid fuel contamination.
- Implementation strategies may include the use of lease requirements and tariff changes.
- There are significant positive emission reduction benefits for NOx, PM and GHGs. However, the use of biodiesel may present a slight increase in NOx and some times there may also be difficulties with fuel availability.

13.10.3 Emission Control Technologies

- Retrofitting HC with the best available engine controls, fuel additives and emission control technologies (ECTs).

- Depending on the appropriate application of ECT, ECTs can include exhaust after treatment devices such as : diesel oxidation catalyst (DOC), diesel particulate filter (DPF), or selective catalytic reduction (SCR) or engine and fuel efficiency technologies such as modern injectors, computer controls and software upgrades, which result in more efficient engine air fuel mixtures and fuel savings.
- The engine manufacturers and distributors of emission control technologies can provide technical guidance to HC owners and operators in the selection of appropriate ECTs for their vessel.
- While evaluating different emission control technologies, ECTs that have had proven success with HC should be given priority and preference.
- To further improve emission reductions from auxiliary engines, retrofit cleaner engines with ECTs.

Operational and feasibility testing is required to ensure the function and applicability of an emissions control technology on marine applications. In particular, many ECTs require exhaust gas temperature analysis by conducting exhaust gas temperature data logging to measure exhaust gas temperatures. Many ECTs have exhaust temperature thresholds that are required for the operation and effectiveness of the technology.

Emission control technologies which have been certified or verified by regulatory agencies are most likely to deliver the claimed benefits. These strategies need to be implemented through lease requirements, tariff charges, and incentives. A Technology Advancement Program (TAP) can be so designed that would demonstrate feasibility and effectiveness of various technologies (of ECTs) on marine applications.

The Technology Advancement Program (TAP) would consider use of newer technologies. Looking at the pros and cons, while ECTs have positive emission benefits in reducing particulate matter (PM), Oxides of Nitrogen (NOx), carbon monoxide (CO) and hydrocarbon (HC), not all ECTs reduce all pollutants. Retrofitting HC with ECTs can be challenging, careful evaluation and analysis is, therefore, a must.

13.10.4 Electrification (including Shore Power and Hybridization)

- Reduce harbor craft idling emissions by hybridization and providing shore power hook up .
- Similar to OGV, HC can utilize shore-power by transferring the electrical generation needs for HC while at berth to power generated by regulated / controlled stationary sources.
- Hybridization is best for HC that are in constant transit mode. However, one would require to determine necessary power needed and ensure adaptability.

Some power companies operate coal burning power plants without the use of scrubbers and other types of emission control technologies. It, therefore, needs to be ensured that the local power company is using a cleaner source of energy along with emission control technologies. In some cases, it is better not to use shore power if the local power company has polluting power plants.

The HC-engine and duty cycles should be evaluated in order to determine whether the vessel is a good candidate for hybridization which is currently being developed and used on tugboats and ferries. Substantial fuel savings can be realized in addition to lowering emissions by use of hybrid technology. Implementation strategies can include lease requirements, incentives, tariff changes and capital funding. There are significant and positive emission reduction benefits. However, there could be difficulties and problems with infrastructure cost and shore power hook up. Shore power requires extensive infrastructure improvements.

13.11 Cargo Handling Equipment (CHE)

Following are some effective strategies that can be applied to address diesel emissions from Cargo Handling Equipment (CHE) :

13.11.1 Equipment Replacement with Engines Meeting Cleaner Standards

- Buy new equipment with new engines rather than repower old cargo handling equipment with new engines. The cost of the CHE is a small fraction of the overall life cycle costs relative to

operations and maintenance costs. The labor costs for terminal maintenance shops to repower CHE also need to be factored into the decision making process. New CHE would come with warranties which could lower maintenance costs. Each fleet manager will need to consider the relative costs and benefits for their operation.

- Replace older off-road yard tractors, top picks, forklifts, reach stackers, RTGs, and straddle carriers with new equipment that meet cleaner on-road and off-road engine standards. The main aim is to implement the cleanest available NOx alternative-fueled engine or the cleanest available NOx diesel-fueled engine.
- In the Port of New York and New Jersey, the major container terminal operators are systematically replacing yard tractors, at the end of their five to ten-year duty cycle, with brand-new equipment that come equipped with the cleanest available, on-road engines, and are doing this voluntarily.
- These terminal operators are also investing heavily to replace older diesel-powered gantry cranes with pieces that feature regenerative electric capabilities. Strategy will involve the careful removal of original engine and replacing it with newer-cleaner engine.
- Equipment which includes regenerative electric capabilities (e.g. some of the new Rubber Tire Gantry (RTG) and Rail Mounted Gantry Cranes) will increase fuel efficiency and further reduce emissions.
- Implementation can be carried out through voluntary programs, incentives, and / or lease renewals / renegotiations.
- The purchase of newer cargo handling equipment that meet cleaner on-road or off-road engine standards will demonstrate great emission reduction benefits. The challenge may be the availability of cleaner engines internationally.

13.11.2 Clean Fuels

- Implement the use of cleaner fuels with low sulfur content. Cleaner fuels include; low to ultra low sulfur diesel fuel, emulsified diesel fuels, oxygenated fuel (O_2 diesel fuel), and biodiesel.
- Additional clean fuel options for CHE include LNG and CNG.
- For this, one has to work with ports and fuel suppliers on the availability and supply of clean fuels.
- Depending on the type of clean fuel used, cleaning of the fuel tank may be required in order to avoid fuel contamination.
- Implementation strategies may include the use of lease requirements and tariff changes.
- There are positive emission reduction benefits for NOx, PM and GHGs. However, the use of biodiesel may present a slight increase in NOx. Challenges may arise with fuel availability. Moreover, cleaner fuels often cost more than standard ones.

13.11.3 Emission Control Technologies

- Retrofit CHE with the best available emission control technologies (ECTs).
- ECTs can include : diesel oxidation catalyst (DOC), diesel particulate filter (DPF), or selective catalytic reduction (SCR).
- While evaluating different emission control technologies, consider ECTs that have had proven success with CHE and to further improve emission reductions, retrofit cleaner CHE engines with ECTs.
- Operational and feasibility testing is required to ensure the function and applicability of an emissions control technology on CHE. In particular, many ECTs require exhaust gas temperature analysis by conducting exhaust gas temperature data logging to measure exhaust gas temperatures.
- Many ECTs have exhaust temperature thresholds that are required for the operation and effectiveness of the technology. Emission control technologies which have been certified or verified by regulatory agencies are most likely to deliver the claimed benefits.
- Implement strategy through lease requirements, tariff charges, and incentives.

- Design a Technology Advancement Program (TAP) that would demonstrate feasibility of ECTs on CHE. The TAP would consider use of newer technologies.
- Applying ECTs has proved to have positive emission benefits in reducing particulate matter (PM), Oxides of Nitrogen (NOx), carbon monoxide (CO) and hydrocarbon (HC). However, retrofitting CHE with ECTs can be challenging. Therefore, careful evaluation and analysis is a must.

13.12 Heavy Duty Vehicles like Trucks

Here are some effective strategies that can be applied to address emissions from Heavy-Duty Vehicles like Trucks:

13.12.1 Equipment Replacement

- Maximize emission reductions by replacing frequent and semi-frequent older trucks that service the port with newer trucks that meet cleaner engine standards.
- Retire older equipment that has visible dark soot coming from the exhaust. Sometimes the color of the exhaust can depict several operational conditions that are of concern such as the need for filter replacement, oil changes, and engine upgrades.
- Frequent maintenance of newer trucks is very important to maintain clean operation in addition to extending sustainable use of vehicle.
- Implementation strategies may include : lease requirements, tariffs, and incentives.
- There are significant and positive emission reduction benefits.
- Consider NOx reduction technologies such as SCRs or Lean NOx Catalyst (LNC). However, the costs of replacing engines and / or vehicles may be considerable.

13.12.2 Operational Improvements

- Repower frequent to semi-frequent trucks with cleaner on-road engines.

- Redevelop infrastructure and use technology, such as radio frequency identification (RFID) and optical character recognition (OCR), to enhance the efficiency of gates and terminals, relieve congestion and reduce emissions.
- Extended / off-peak terminal hours and moving more cargo to rail and water (via short sea shipping) where feasible can also reduce congestion and air pollution.
- Cost of technology versus benefit achieved should be a consideration in assessing potential improvements.
- Implementation can be carried out through voluntary programs, incentives, and /or lease renewals / renegotiations.
- Some of these options involve capital investment; others could increase terminal operating costs. However, if designed and planned properly, it can result in a significant return on investment due to enhanced operational efficiencies.

13.12.3 Clean Fuels

- Implement the use of cleaner fuels. Cleaner fuels include : ultra low sulfur diesel fuel, emulsified diesel fuels, oxygenated fuel (O_2 diesel fuel), and biodiesel.
- Additional clean fuel options for trucks include LNG and CNG. Port-authorities can work with fuel suppliers on the availability and supply of clean fuels. Depending on the type of clean fuel used, cleaning of the fuel tank may be required in order to avoid fuel contamination.
- Implementation strategies may include the use of lease requirements and tariff changes.
- There are positive and significant emission reduction benefits for NOx, PM and GHGs.
- The use of biodiesel may, however, present a slight increase in NOx. Challenges may arise with fuel availability as cleaner fuels tend to be more costly.

13.12.4 Emission Control Technologies (ECT)

- Retrofit with emission control technologies that are less polluting. Consider technologies that have demonstrated a history of effectiveness and durability.
- ECTs include diesel particulate filters (active and passive), diesel oxidation catalyst (50% PM reduction or more), selective catalytic reduction (SCR), Lean NOx Catalyst (LNC), gas recirculation (EGR), closed crankcase ventilation systems (CCV) and or a combination of the above.
- Operational and feasibility testing is required to ensure the functioning and applicability of an emissions control technology on the truck. In particular, many ECTs require exhaust gas temperature analysis by conducting exhaust gas temperature data logging to measure exhaust gas temperatures. Many ECTs have exhaust temperature thresholds that are required for the operation and effectiveness of the technology.
- Considerations must include duty cycle, exhaust temperatures, and preventative maintenance schedules. Emission control technologies which have been certified or verified by regulatory agencies are most likely to deliver the claimed benefits.
- Implementation may be done through lease requirements, tariff charges, and incentives.
- Design a Technology Advancement Program (TAP) that would demonstrate feasibility of ECTs on trucks. The TAP would consider use of newer technologies.
- There are significant and positive PM, NOx, HC and CO emission reduction benefits. However, challenges may occur while assessing appropriate technologies. Some technologies such as DPFs have strict exhaust temperature requirements. Retrofitting may include exhaust reconfiguration and cutting of the exhaust pipe.
- Emission control technologies and / or vehicles vary in cost and can be expensive.

13.12.5 Idling Emission Reduction

- Stationary idling emission-reduction technologies include shore power for trucks also known as “Truck-Stop-Electrification” (TSE).
- TSE provides cab power for the truck while a truck is stationed in an area for a period of time. Reduction technologies also include : automatic shut down and start up systems, battery power, auxiliary power units etc.
- Many of these technologies are onboard technologies and could also be used for reefer trucks.
- Implementation through lease requirements, tariff charges, and incentives.
- Eliminating idling time by using an idle-reduction technology greatly reduces emissions that would be generated from idling. However, there could be problems with its availability.

13.13 Light Duty Vehicles

Given below are some effective strategies that can be immediately applied to reduce / mitigate emissions from Light-Duty Vehicles.

13.13.1 Equipment Replacement

- Maximize emission reductions by replacing light duty trucks serving the port with new equipment that meets cleaner engine standards.
- Prioritize vehicle modernization by first replacing vehicles with the highest vehicle miles traveled or usage levels to get the biggest emission reduction benefit for the investment.
- Retire older equipment that has higher emissions and more miles per year of operation, especially any that emits visible smoke which indicates the need for repairs such as the need for filter replacement, oil changes, and engine upgrades.
- Frequent maintenance of light duty vehicles and buses is very important to maintain clean operation in addition to extending sustainable use of vehicle.
- Emissions testing equipment is necessary for periodically verifying the fleet maintenance practices for minimizing emissions.

- Implementation strategies may include : technical support, lease requirements, tariffs, and incentives.
- There are significant positive emission reduction benefits for air toxics, VOCs, NOx and PM. The costs of replacing engines and / or vehicles may, however, be substantial.

13.13.2 Operational Improvements

- Encourage more efficient use of light duty vehicles.
- Evaluate current usage patterns and identify opportunities for reducing vehicle miles through schedule revisions, ride-sharing, and other alternatives.
- Implementation can be carried out through voluntary programs, incentives, and / or lease renewals / renegotiations.
- Light duty vehicles are relatively cleaner than heavy duty diesel equipment. Therefore, the total emissions from these engines at ports are relatively small. However, emissions of toxic air pollution and volatile organic compounds from gasoline-fueled engines can be significant.
- Some of these equipments are diesel-fueled and could be addressed by strategies similar to those outlined for heavy duty diesel equipment. As mentioned earlier, replacing older engines and vehicles with newer cleaner equipment can improve emission reductions. However, international availability may be a concern. The costs of replacing engines and/or vehicles may be prohibitive.

13.13.3 Clean Fuels

- Implement the use of cleaner fuels. Hybrid and all electric vehicles are good choices for on terminal light duty vehicles.
- Cleaner fuels include : biodiesel, natural gas, propane, ethanol blends, ultra low sulfur diesel fuel, emulsified diesel fuels, and oxygenated gasoline and diesel fuels (O_2 diesel fuel).
- For this, port authorities can work with fuel suppliers on the availability and supply of clean fuels, vehicles, and refueling stations. Depending on the type of clean fuel used, cleaning of the fuel tank may be required in order to avoid

fuel contamination. This is particularly true for fuels containing ethanol or biodiesel.

- Implementation strategies may include the use of lease requirements and tariff changes.
- There are significant and positive emission reduction benefits for air toxics, VOC, SOx, NOx, PM and GHGs. The use of biodiesel, however, may present a slight increase in NOx and there could be difficulties with fuel availability depending on international location.
- Some options such as natural gas, propane or electricity may require a substantial capital investment in refueling or repowering infrastructure.

13.13.4 Emission Control Technologies (ECT)

- Retrofit vehicles with emission control technologies that are less polluting. Consider technologies that have a demonstrated history of effectiveness and durability.
- Emission control technologies may include : diesel particulate filters (DPF) (active and passive), diesel oxidation catalyst (DOC) (50% PM reduction or more), selective catalytic reduction (SCR), Lean NOx Catalyst (LNC), Gas Recirculation (EGR), closed crankcase ventilation systems (CCV) and or a combination of the above.
- Operational and feasibility testing is required to ensure the function and applicability of an emissions control technology. In particular, many ECTs require exhaust gas temperature analysis by conducting exhaust gas temperature data logging.
- Many ECTs have exhaust temperature thresholds that are required for the operation and effectiveness of the technology. Considerations must include duty cycle, exhaust temperatures, and preventive maintenance schedules.
- Emission control technologies which have been certified or verified by regulatory agencies are most likely to deliver the claimed benefits. Implementation can be carried out through lease requirements, tariff charges, and various incentives.

- A Technology Advancement Program (TAP) can be suitably designed, which would demonstrate feasibility of ECTs. The TAP would consider use of newer technologies.
- There are significant and positive PM, NOx, HC and CO emission reduction benefits. However, difficulties may be encountered while assessing appropriate technologies.
- Some technologies such as DPFs have strict exhaust temperature requirements. Retrofitting may include exhaust reconfiguration and cutting of the exhaust pipe.
- DPFs require annual cleaning depending on the technology and can be costly. Moreover, the costs of emission control technologies and/or vehicles may be prohibitive.

13.13.5 Idling Emission-Reduction Technologies

- Reduce idling emissions by using idle-reduction technologies. These technologies include : automatic shut down and start up systems. These are on-board technologies that help provide power to the bus or light duty vehicle.
- Drivers' education is a necessary and effective component of idle-emission-reduction programs. Implementation can be carried out through education and outreach, lease requirements, tariff charges, and incentives.
- Eliminating idling time by using an idle-reduction technology greatly reduces emissions that would be generated from idling. However, technology-availability may create a problem for some ports. On the other hand, a major advantage of anti-idling programs for light duty vehicles is that they can save fuel costs with very little capital investment.

13.14 Locomotives and Rail

Following section delineates some effective strategies that can be applied to address emissions from Locomotives and Rail :

13.14.1 Equipment Replacement

- Replace older locomotives with locomotives that meet cleaner engine standards. New and cleaner locomotives could include electric or hybrid locomotives. For example, the San Pedro Bay Ports Clean Air Action Plan requires Class I locomotives to meet EPA Tier II and Tier III engine standards.
- Retire older locomotives. Implementation may include setting an operational agreement with the locomotive companies or creating a memorandum of understanding with the port, regulatory agencies and other stakeholders.
- Replacing old locomotives with newer locomotives has a significant emissions benefit. However, locomotive replacement is costly and international availability may be a concern.

13.14.2 Operational Improvements

- Ports should evaluate the feasibility of increased use of on-dock and near dock rail, address rail bottlenecks in and around ports, and use of RFID (Radio Frequency Identification) and OCR (Optical Character Recognition) at rail yards.
- Increasing the efficiency in how trains are stacked and queued, building trains to reduce drag and/or building longer trains for overall fuel efficiency will also reduce air emissions.
- Repower older locomotives with cleaner engines. Implementation may include setting an operational agreement with locomotive companies or creating a memorandum of understanding with the port, regulatory agencies, and other stakeholders.
- Engine repowers demonstrate great emission reduction benefits. However, locomotive engine replacement is a costly. Purchasing a new cleaner locomotive may prove to be a better option. International availability may be a concern.

13.14.3 Clean Fuels

- Implement the use of cleaner fuels with low sulfur content. Cleaner fuels include : low to ultra low sulfur diesel fuel, emulsified diesel fuels, oxygenated fuel (O_2 diesel fuel), LNG and CNG.
- For this, port authorities can work with ports and fuel suppliers on the availability and supply of clean fuels.
- Depending on the type of clean fuel used, cleaning of the fuel tank may be required in order to avoid fuel contamination. For LNG or CNG locomotives, a fueling infrastructure is required.
- Rail/roads interested in using LNG or CNG need to be converted to handle that fuel type. Implementation can be carried out through the use of incentives, lease requirements, tariff changes, or a memorandum of understanding.
- There are significant and positive emission reduction benefits for NOx, PM and GHGs. However, fuel availability may pose some problems.

13.14.4 Emission Control Technologies (ECT)

- Consider retrofitting locomotives with proven emission control technologies.
- Some of these technologies include diesel oxidation catalysts (DOCs), diesel particulate filters (DPFs) with PM emission reduction benefits, and selective catalytic reduction (SCR). The use of ultra low sulfur diesel (ULSD) fuel is mandatory for locomotives retrofitted with DPFs.
- However, at every stage, technical and operational feasibility testing is required. Emission control technologies which have been certified or verified by regulatory agencies are most likely to deliver the claimed benefits.
- Implementation strategies may include the use of incentives, lease requirements, tariff changes, or a memorandum of understanding.
- There are substantial and positive emission benefits from using emission control technologies. However, retrofitting locomotives with the appropriate ECT can occasionally be difficult. Due to various operational constraints, some ECTs may not be appropriate depending on the locomotive. Therefore, a

thorough technical assessment and feasibility study is required to carry out a successful retrofit.

13.14.5 Idling Emission Reduction Technologies

- Technologies include : automatic engine stop-start controls (AESS); auxiliary power unit (APU); diesel-driven heating systems (DDHS); shore power plug-in unit and a hybrid switching locomotive.
- Implementation strategies may include the use of incentives, lease requirements, tariff changes, or a memorandum of understanding.
- Eliminating idling time by using an idle-reduction technology greatly reduces emissions that would be generated from regular idling. International availability of idle-reduction technology may, however, present a challenge for some ports.
- Applying idle-reduction technologies to locomotives can yield significant fuel savings, which results in a significant cost savings.

13.15 Construction Equipment (CE)

Following are some effective strategies that can be applied to address diesel emissions from construction equipment.

13.15.1 Equipment Replacement

- Replace older on-road and off-road excavators, tractors, compactors, earth movers and cranes with new equipment that meet cleaner on-road and off-road engine standards.
- Implement the cleanest available NOx and PM alternative-fueled engine or the cleanest available NOx diesel-fueled engine.
- Implementation strategy will involve carefully removing the original engine and replacing it with a newer-cleaner engine through voluntary programs, incentives, lease renewals / renegotiations and / or contractual agreements.
- The purchase of newer construction equipment that meet cleaner on-road or off-road engine standards will demonstrate great emission reduction benefits.

However, there may be some difficulty with the availability of cleaner engines internationally.

13.15.2 Operational Improvements

- Repower construction equipment with cleaner on-road and off-road engines. Strategy would involve carefully removing the original engine and replacing it with a newer-cleaner engine.
- Implementation through voluntary programs, incentives, lease renewals / renegotiations and / or contractual agreements.
- Repowering older diesel engines with cleaner on-road or off-road engines can greatly improve emission reductions. However, international availability may be a concern.

13.15.3 Idling Emission Reduction Strategies

- Reduce idling emissions by automatic shut down and start up systems. These are on-board technologies that help provide power to the equipment.
- Operator education is a necessary and effective component of idle-reduction programs. Test feasibility of idle-reduction technology on construction equipment and implement the strategy through education and outreach, lease requirements, tariff charges, and incentives.
- Eliminating idling time by using idle-reduction policies, education and technology greatly reduces emissions. However, International availability of technology tools such as on board computer systems with anti-idling settings may create a challenge for some ports.
- A major advantage of anti-idling programs for construction equipment is that they can save fuel costs with very little capital investment.

13.15.4 Cleaner Fuels

- Implement the use of cleaner fuels with low sulfur content. Cleaner fuels include : low to ultra low sulfur diesel fuel, emulsified diesel fuels, oxygenated fuel (O_2 diesel fuel), and biodiesel.

- Port-authorities can work with fuel suppliers on the availability and supply of clean fuels. Depending on the type of clean fuel used, cleaning of the fuel tank may be required in order to avoid fuel contamination.
- Implementation strategies may include the use of lease requirements, tariff changes, or contractual agreements.
- There are significant and positive emission reduction benefits for NOx, PM and GHGs. The use of biodiesel may, however, present a slight increase in NOx and challenges may arise with fuel availability and cost.

13.15.5 Emission Control Technologies (ECT)

- Retrofit construction equipment with the best available emission control technologies (ECTs). ECTs include; diesel oxidation catalyst (DOC), diesel particulate filter (DPF), or selective catalytic reduction (SCR).
- While evaluating different emission control technologies, consider ECTs that have had proven success with construction equipment similar to the construction equipment under evaluation. To further improve emission reductions, retrofit cleaner construction equipment engines with ECTs.
- Operational and feasibility testing is required to ensure the functioning and applicability of an emission control technology on construction equipment. In particular, many ECTs require exhaust gas temperature analysis by conducting exhaust gas temperature data logging.
- Emission control technologies which have been certified or verified by regulatory agencies are most likely to deliver the claimed benefits.
- Implement strategy through lease requirements, tariff charges, incentives and / or contractual agreements.
- Applying ECTs has various positive emission benefits in reducing particulate matter (PM), Oxides of Nitrogen (NOx), carbon monoxide (CO) and hydrocarbon (HC).
- However, retrofitting construction equipment with ECTs can be challenging, careful evaluation and analysis is, therefore, a must.

13.16 Garbage Management Plans

New international regulations requiring a Garbage Management Plan for preventing marine pollution came into effect in 2013. The new requirements are part of the International Convention for the Prevention of Pollution from Ships (MARPOL), which is in force in 151 countries. A shipowner / operator of a commercial or recreational vessel is now required to carry on board a Garbage Management Plan in accordance with the regulation (http://www.amsa.gov.au/ Marine_Environment_Protection / Garbage_management_plan). All boat operators need to manage the use and disposal of all garbage generated onboard correctly. Types of waste that need to be disposed of appropriately include : food waste, paper products, rags, glass, metal, bottles, crockery, wire residues, fishing gear, nets, bait boxes, wood products, packaging material, deck sweepings and all types of plastics.

Most of our garbage today is made from non-biodegradable products such as plastic, which persists in the marine environment for many years. Garbage is hazardous to marine life and all users of the waterways. Some marine animals and seabirds can mistake plastic material for food. Others become entangled in garbage causing a slow and painful death. Ropes and plastic material can get caught in propellers and block water intakes causing major damage or even loss of income while a boat is out of service for expensive repairs.

Paint scrapings and residues that enter the water from hull-maintenance activities are also classified as garbage pollution. If not properly controlled, hull-maintenance activities including scraping, sanding, pressure washing and painting can put toxic pollutants into the marine environment. Following are the best practices to minimise potential impact on the marine environment and they should be put in vogue on priority basis :

13.16.1 Short Term and Continuous Action Plans

- Major maintenance activities should be conducted on land or in a commercial slipway.

- For cleaning purposes, least toxic substances such as phosphate-free and biodegradable soaps should be used. Alternatives to antifouling paints should be used.
- Drop cloths should be used to catch sawdust, scrapings, paint chips, debris or drips and so on, when conducting vessel maintenance.
- Mechanical sanders/scrapers equipped with vacuum bags are effective at removing paint in a way that prevents the spread of dust, debris and residue into the air and into the marine environment.
- All waste products and materials should be disposed off into appropriate receptacles. Boat operators should not throw anything overboard and should have secure bins or garbage bags to store garbage onboard.
- Stores should be bought in bulk to reduce the amount of packaging taken onboard and reusable airtight containers should be used to store food-items.
- Crockery , cups, plates and cutlery should be of reusable kind. In case, garbage inadvertently ends up in water, it should be retrieved and appropriately disposed.

13.17 Oil and Chemical Pollution : Short Term and Continuous Action Plans

Most of the oil and chemicals (petrol, gear box oil, motor oil, two-stroke oil, diesel, hydraulic oil, cooling system additives, cleaning agents, degreasers, acid and paints) in waterways come from refuelling, boat maintenance and bilge discharges. These oil and chemicals can be toxic to marine and human life. Thus our waterways must be protected from this pollution. All boat operators need to use and dispose of onboard oil and chemicals correctly and safely.

Once these toxins enter our waterways they have the potential to retard or prevent the reproductive development of many marine animals, which can have a cascading effect through the entire food-web of the marine ecosystem. When consumed, contaminated

fish stocks and filter feeders such as oysters and mussels can also pass on harmful chemicals to humans.

Thus, absorbents should be used to mop up excess oil or fuel. Bilges should be washed with biodegradable degreasers or detergents and subsequently disposed of. If oil does spill into the water, it should be mopped up by using appropriate absorbents and the regional harbour master or appropriate port authority should be informed about it so that it can be cleaned up as soon as possible. Dispersants or other cleaning chemicals should be avoided because they can increase the toxic effects of oil spills. Moreover, following steps must be followed and adhered to :

- During the time of refuelling, it must be ensured that the nozzle is properly inserted into the filler before starting the pump. Likewise the pump should always be turned off to ensure that the flow of fuel has stopped before removing the nozzle.
- The capacity of fuel tanks should always be checked before refuelling and overflow should always be avoided.
- Bilges must be cleaned before discharging and the operation of bilge pumps should be so as to ensure that no oil should be discharged with bilge water.
- Residues of degreasers or detergents, including biodegradable products (used for cleaning the bilge) should not be discharged into the waterways.
- Absorbents should be always used to clean waste oil from the bilge. Oil and fuel leaks should be repaired as soon as they are first noticed.
- For deck scrubbing only clean water should be used and chemicals should be used only for severe staining. The product information should be always read before its use. If it is toxic to humans, it should not be used. Phosphate free biodegradable detergents should be used.
- Absorbent material should always be onboard to clean up any accidental spills. In case, oil or chemicals get accidentally discharged into the water, the regional harbour master or appropriate port authority should be immediately informed so that it may be cleaned up promptly.

13.18 Sewage Management : Short Term and Continuous Action Plans

The discharge of sewage from boats contributes to reduced water quality, poses a human health risk and decreases visual aesthetics of waterways. Sewage discharged can be grouped under two categories : (i) treated sewage or (ii) untreated sewage. Treated sewage is one that has passed through an onboard sewage treatment system. Untreated sewage (or raw sewage) is the sewage that has not passed through a treatment system. This is sewage that is discharged directly from a toilet into a waterway (in areas where discharge is permitted) or contained in an onboard holding tank. Any untreated sewage, before its discharge even in the permitted zone, must first pass through a macerator.

13.18.1 Types of Vessels and Sewage Treatment

While, non-declared ships, include all recreational vessels and all class 2 and class 3 commercial vessels, a declared ship is a class 1 commercially registered passenger carrying vessel fitted with a toilet. In recognition of their potentially greater sewage generating capacity, declared ships must adhere to more stringent sewage discharge requirements. These include:

- the ship must be fitted with a sewage holding device
- the ship must carry a sewage disposal record book
- the ship must have a shipboard sewage management plan
- if the ship is fitted with a treatment system, records must be kept for all assessment and maintenance of the treatment system.

13.18.2 Types of Discharges

Sewage may lawfully be discharged from a toilet permanently fixed onboard any ship into waters outside of designated nil-discharge waters, provided it first

passes through a macerator that effectively reduces the solid wastes in the sewage into at least a fine slurry (by means such as grinding, shredding or pulping). Macerated sewage is, however, not treated sewage.

Prohibited discharge waters are waters where it is strictly prohibited to discharge any sewage. By definition, these waters actually form part of the larger designated nil-discharge waters. The discharge requirements for the remaining areas of nil discharge waters (that is outside prohibited discharge waters) are as follows:

- Absolutely no untreated sewage may be discharged from any ship into any nil-discharge waters.
- Treated sewage may only be discharged beyond the relevant precautionary discharge distances from sensitive areas.

13.18.3 International Maritime Organization MARPOL Sewage Treatment Systems

It should be noted that a sewage treatment system that has an International Maritime Organization (IMO) type approval and the relevant supporting documentation is deemed to comply with the Grade A sewage treatment system. As such, these systems may be lawfully installed and operated in accordance with the requirements for a Grade A sewage treatment system. Advice on the grade of a particular sewage treatment system (or any other relevant sewage treatment matter) should be obtained from any of the system manufacturers and/or their agents or distributors.

13.18.4 Sewage Management Options

The legislative requirements stipulate where sewage discharges cannot occur (that is nil discharge waters) and offers boaters a variety of sewage

management alternatives to achieve compliance with nil discharge provisions. The available sewage management options include :

- the use of onshore facilities (such as public toilets)
- the use of an onboard portable toilet for later disposal ashore or in open waters where discharge is permitted
- the use of an onboard sewage holding tank for later disposal ashore where pumpout facilities are provided (http://www.msq.qld.gov.au/Marine-pollution/Sewage.aspx#pumpoutfacilities) or in open waters where discharge is permitted
- the use of an onboard sewage treatment system.
- Boaters need to ensure sewage is managed appropriately and that any discharges are made in compliance with these requirements. Integral to this preparation is the need for boaters to give careful consideration to :

    - the type of waterway in which their boating activities will take place
    - the number of people that they intend having onboard their vessel
    - the amount of time to be spent boating in the various different waterway types
    - the discharge requirements of those waterways (that is nil discharge waters).

Regardless of vessel type or area of operation, all vessel owners and operators should ensure that all toileting arrangements on vessels be installed or modified by suitably qualified personnel and conform to the minimum requirements outlined.

13.19 Future (Continuous) Activities

• Evolve and adopt appropriate work-plans for achieving targets in different areas
• Formulate guidelines / manuals for various activities and the procedures to be followed in the implementation of the programme
• Create the budgetary provisions for different (sector-specific) activities and their work plans
• Continuous review (at regular intervals) of the progress made in implementing various programmes and careful evaluation of the results by appropriate environmental agency

13.20 Ecosystem Assessment Reports (Health Cards) and Integrated Management

These reports should address the ecosystem components and properties, causality and pressures, land-water interface, and water quality. Overviews and assessments will assist stakeholder advisory bodies in making recommendations and governments in making management decisions on long-term environmental trends. Resources should be used to gather and analyze existing scientific information, including the assistance of scientific experts.

Ecologically and biologically significant areas should be identified so as to evolve measures required for marine protected areas, species at risk, and critical habitat etc. Resources should be used to develop criteria to differentiate areas; identify significant features relative to the structure and functioning of an ecosystem and vulnerable areas; establish priorities; and, determine appropriate management options.

Seabed mapping should focus on providing imagery of the seabed characteristics and features. For high priority areas, seabed mapping will help in increasing scientific understanding of the physical environment and associated habitats to support

integrated management planning and the identification of marine areas in need of protection. These activities should include : producing maps, data bases and reports; conducting surveys to collect data; and developing web accessible databases and data collection.

This initiative would be an innovative way to apply ecosystem-based management approaches. It involves the development of objectives based on an understanding of the ecosystem. The aim would be to maintain the biodiversity, productivity and physico-chemical properties of marine ecosystems. The activities of oceans users can be assessed against these objectives to identify permissible types and levels of activity as well as measuring the effectiveness of marine environmental regulations and protection measures and the impact of oceans development. Ecosystem objectives will inform oceans management and marine environmental protection by guiding the activity of industry and other stakeholders, who in turn make recommendations about marine environmental quality and indicators of progress to oceans decision-makers (www.dfo-mpo.gc.ca/**ocean**s/publications/oap-pao/pdf/oap-eng.pdf.)