Semester 2

Part IV

Reclamation and Remediation
Legal Aspects and Mandatory Regulations
Internship

PG Diploma in
Waste Management & Environmental Hygiene

सत्यमेव जयते

Department of Higher Education
Ministry of Human Resource Development, Government of India

Where there is Rural Wellbeing
there is Universal Prosperity

Course 9 Reclamation and Remediation

PG Diploma in Waste Management & Environmental Hygiene

Mahatma Gandhi National Council of Rural Education
Hyderabad - 500004

Foreword

Ecosystems bear the brunt of developmental activities of mankind. Activities intended to improve injured ecosystems are referred to as “restoration,” “rehabilitation,” “remediation,” “reclamation,” etc., sometimes used interchangeably in practice. Ecologicalrestoration is defined as an intentional activity that initiates or accelerates the recovery of a degraded, damaged, or destroyed ecosystem (both floral and faunal organisms) with respect to its health, integrity, services, and sustainability.A resource is considered recovered when it can sustain itselfstructurally and functionally. Restoration, reclamation, rehabilitation, and remediation activities are often very costly and leave decision makers apprehensive. The outcomes of reclamation and remediation need to be quantified and the challenge is to develop the metrics to value outcomes of restoration. A successful process includes effective segregation, handling, treating and disposing of contaminated soil, water and hazardous waste.

Through reclamation and remediation unique environmental challenges are addressed. Minimizing the impact of development and safeguarding the future needs to be our goal.

This course on Reclamation and Remediation is suitable for students of all streams - Commerce, Humanities, Science, Management, Journalism, Mass Media, Healthcare services (B Pharm, Social Work), Education, and Engineering. The extent of environmental damage and the innovations in combating the issues require scientific understanding of the subject.

The subject has vast possibilities and several interlinking themes. There is extensive scope to explore and experience different aspects of sanitation, pollution, environmental hygiene and waste management during classroom learning, practical experiments in field and laboratory, internship and dissertation. There is a sea of opportunity in this field of waste management and environmental hygiene, and an urgent need of skilled as well as dedicated workers to make our country clean and green.

Nature has interlinked realms. Similarly, subjects dealt in this course cannot be compartmentalized. They necessarily have to merge with one another. It is therefore important that students try to make these linkages in their minds rather than treating subjects in isolation. Students can make the most of this learning opportunity as they prepare to launch their careers in a field that holds great premise.

Dr. W G Prasanna Kumar

Chairman, MGNCRE

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This Post Graduate Diploma course on Waste Management and Environmental Hygiene is a cumulative effort of several sincere and committed visionaries and academicians. Envisioned by Shri VLVSS Subba Rao, Senior Economic Advisor, MHRD, the curriculum took shape under his keen guidance.

The sincerity with which the course curriculum was completed and published can be assessed from the fact that a prior National Consultation Workshop was held with several subject matter experts and academicians across the country, to review the contents of the course material.

The workshop was held to familiarize Central, State and Private Universities, local and social bodies with the contents of the curriculum and to discuss and share feedback on ways to improve the course curriculum. The workshop also focused on building industry–academia partnerships in Waste Management and Environmental Hygiene through an intellectual interaction. The findings and inputs of the consultation were subsequently incorporated in the course material.

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Objective

To learn sustainable alternative methods of treatment of Soil and Liquid Waste

Rationale

Waste management and environmental hygiene is the need of the hour and needs to be addressed across all sectors and communities. The course on Waste Management and Environmental Hygiene gives the student an overview of waste management including collection, transfer, transport, and disposal along with methods of processing, basic disposal facilities, disposal options, recycling, project management and GIS applications, reclamation and remediation, entrepreneurship and job opportunities in waste sector. In addition, this course provides the student with relevant information about waste markets, recycling trends, cost and affordability of waste management practices, and incentive based concepts. This course is therefore essential for the students who wish to pursue a career in waste sector as moving ahead, waste management will become an infrastructural necessity.

Competency

The course will be taught and implemented with the objective to develop required skills sets in the students so that they are able to acquire following competencies: Plan segregation, collection, transportation, recycling and disposal of wastes, know recycling trends and available waste markets, acquire skill development and know the scope and entrepreneurship opportunities in the waste management sector.

Methodology

The theory will be taught and practicality of the course will be addressed through questionnaires, self-assessment and dissertation. The course will be through class room lectures, guest lectures, field visits, audio – video learning mode, brainstorming sessions, seminars and Q&A. A lecture series will strengthen students' understanding of waste management which will help in acquiring different learning outcomes in rational and theory to practice approach. Competency that will be gained as part of course outcome includes - understanding, learning, applying and implementing skills, knowing career prospects in waste management sector, and internship and placement opportunities in.

Topics Covered

- Availability of Local Choices
- Evolution of Technologies
- Eco-friendly Technologies
- Soil Restoration, Recovery
- Soil Remediation including Bioremediation

Reclamation and Remediation – An Introduction

Reclamation is returning disturbed land to a state where it is useful once again. This may involve reconstruction of land on a disturbed land area until approved for land reuse. Reclamation is a combination of natural and applied sciences that minimize the impacts of human activities on the ecosystem and natural resources. Reclamation intends to conserve, rebuild and repair the quality of the soil, vegetation and landscape in disturbed environments.

Remediation involves reducing, removing or destroying substances in soil, water or groundwater by applying physical, chemical or biological processes. Care needs to be taken as these substances may adversely affect human health and the environment if left at concentrations exceeding natural background concentrations.

Reclamation and remediation are fundamental to the goal of restoring land as a functioning unit within the ecosystem. Successful reclamation and remediation requires professional biologists who can work inter departmentally with other disciplines to restore human impacted sites so they no longer pose a risk to the life of all living organisms.

A typical reclamation and remediation practice includes developing reclamation plans to restore the land back to equivalent land capacity, including re-vegetation and ecosystem trajectory, through detailed site assessment; assessing migratory pathways and receptors, assessing ecological receptors and their influence by contamination in various media, assessing how that contamination will influence future ecological function, developing bioremediation/phytoremediation plans to remediate contaminated soils and groundwater, developing risk management plans to determine the risk of chemicals' exposure to fish and wildlife, and determining the extent of reclamation and assessing whether the land is back to original, or equivalent, capacity within the context of a healthy ecosystem.

Subject Competency and Outcome: The subject content will be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competencies:

- Know-how on contaminated sites
- Reclamation and Remediation
- Implementation of Landfill reclamation projects
- Soil remediation technologies
- Phytoremediation
- Electrokinetic, physical, chemical remediation
- Multi-criteria Decision Analysis

Chapter 1

Assessment of Contamination before Reclamation and Remediation

Objectives

- To learn details of characteristics of contamination, assessment of exposure, risk involved and resilience.
- To understand sample collection & analytical methods, and factors influencing risk assessment of contaminated site.

Structure

1.1. Characterization of contamination and assessment of exposure, risk, and resilience
1.2 Sample collection and analytical methods
1.3. Factors influencing risk assessment of contaminated site
1.4 Assessing exposure, risk and resilience

To Do Activities

- View film on soil testing.
- Explain the process of decision making when remediation or reclamation is required.
- Conduct practical exercise on PALS.
- Organise a seminar for students to share their findings.
- Find out about PALS with respect to five different toxins/ hazardous substances. This information should be collected either from reference books, hospital visits, research journals, or the internet.
- Organise a group discussion about how soil contamination due to each substance can affect its reclamation.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

1.1 Characterization of Contamination and Assessment of Exposure, Risk, and Resilience

Upon intimation of contamination, the primary tasks to be undertaken, ahead of any attempt at reclamation, remediation and capping plan are: characterization of contamination and assessment of exposure, risk and resilience. The initial efforts need to be directed at supporting clean-up following environmental contamination by providing field scientists with sampling protocols and laboratories with sample preparation and analytical methods for chemicals, biotoxins, pathogens (e.g., viruses and bacteria), and radiological agents, if any. This is important for emergency responders including local, state and central agencies, who need appropriate products and timely services to execute their tasks.

Once the authorities characterize contamination, the chance of exposure to humans is assessed, and the risk to human health and environment is determined. To accomplish this goal, environmental authorities develop risk models, exposure, and toxicity factors to determine possible human health effects.

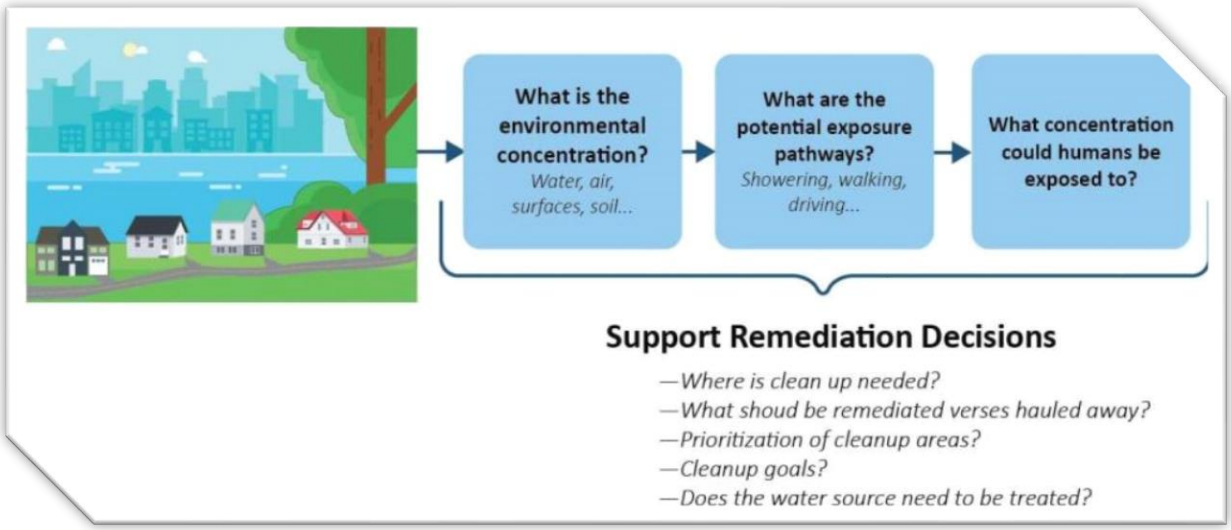


Fig 1.1 Characterization of Contamination and Assessment of Exposure, Risk, and Resilience

1.2 Sample Collection and Analytical Methods

Soon after being informed of a contamination incident, the environmental authorities must quickly determine the type and extent of contamination to limit its spread, and minimise exposure to public. This may require collection of thousands of environmental samples (air, water, soil and surfaces) to characterize the type and extent of contamination. Contamination by chemicals, bio-toxins, pathogens and radiological agents requires special sampling, handling and analytical procedures. The method detection limits determined by environmental authorities need to be at or below clean-up levels to give confidence to the decision makers that reoccupation of an affected area is possible. As a way to improve the nation's capability and capacity for analyzing large number of environmental samples, the networks of central, state and private laboratories should be fully used to support large-scale responses.

Focus areas

Given appropriate sample collection and analytical methods, following are the focus areas to determine the type and extent of contamination:

Chemicals: Accurately characterizing chemical contamination requires sampling protocols and analytical methods. Environmental authorities must quickly detect hazardous chemicals on common indoor and outdoor materials, including porous surfaces that can leach contaminants over time. Therefore, robust sampling and analysis methods are required to properly detect hazardous chemicals during both characterization and clean-up stages following an incident.

Biologicals (biotoxins and pathogens): Characterization of pathogens such as anthrax (Bacillus anthracis) in the environment is challenging. In addition to determining the presence and types of contaminants, scientists must also determine if the pathogens are alive or dead and only proven things become a protocol; Sample collection protocols, sampling strategies and analytical methods need to be employed for biological agents. Working directly with responders in the field, environmental researchers need to properly analyze, evaluate and interpret data to help lessen the impacts of, and kill pathogens in, environmental media.

Radio chemicals: Characterization of a radiologically contaminated site relies on proper collection and analysis of samples. There are proven sample collection procedures and strategies to support radiological clean-up. At times, the huge number of radiochemical samples that require analysis following contamination; can stretch the capability and capacity of radiochemistry laboratories beyond limits. To improve the capability of laboratories, rapid radiochemical methods could be employed for preliminary preparation and analysis of samples. Being faster than standard analytical methods, these methods can quickly determine if an area has been contaminated warranting actions to limit human exposure.

Standardized Methods Hold the Key

Proven analytical methods for environmental remediation and recovery need to be standardized. They include analytical methods for chemical, biological, radiological and nuclear samples. For easy comparison of results, labs should resort to similar analytical methods. Sometimes, an internal security incident may involve contaminants not previously encountered by the labs. Here, the environmental authorities need to quickly device new methods to detect unusual contaminants in environmental samples.

1.3 Factors Influencing Risk Assessment of Contaminated Site

There is a need to assess the hazard/ risk to decide the extent of contaminant remediation for a particular site. (Same word is used multiple times; e.g. required). The factors influencing risk assessment are given below

Toxicity: A material is considered toxic if it produces detrimental effects on biological tissues or associated process when organisms are exposed to concentration above the prescribed level.

Reactivity: It is the tendency to interact chemically with other substances. These interactions become hazardous when it results in explosive reaction with water and/or other substances and generate toxic gases.

Corrosivity: Corrosive contaminants degrade materials, such as, cells and tissues

Ignitability: It is the ease with which substance can burn. The temperature at which the mixture of chemicals, vapour and air ignite/burn is called the flash point of chemical substances.

1.4. Assessing Exposure, Risk and Resilience

Environmental authorities assess, compile and make available to partners information on exposure and toxicity of chemicals, biotoxins, microbial pathogens, and radiological agents (CBR) that might contaminate structures, outdoor areas, or water systems. Researchers provide scientific basis to assess exposure pathways and utilize exposure modeling for CBR contaminants to support risk assessment.

Exposure: Exposure is contact between a contaminant and a receptor of concern. It is important because the risk generally approximates to the amount of exposure. Exposure assessment is the critical link describing the transport and fate of a contaminant as it moves from its source of origin through the environment until reaching a receptor of concern.

Researchers have developed novel methods and models on use of field sampling data to inform risk decisions. For example, there are research findings (on advancing the understanding of likely human exposure concentrations, roundabout use; suggest ‘better understanding of human exposure to

concentrations) from water and wastewater systems by developing modeling tools and evaluations of potential exposure pathways. By increasing this understanding, decision-makers can take more informed remediation decisions during an incident of contamination.

Risk: Risk is defined as the likelihood of harm from an event. It is the product of the severity or consequence of the event and its probability of occurring. Understanding the risks to human health from the release (or threatened release) of contaminants is important to setting priorities, predicting and preventing terror attacks and responding quickly and effectively to save lives during and after an attack.

One of the most important points of risk assessment research is to develop Provisional Advisory Levels (PALs) that provide responders and leaders with critical information about dangerous chemical compounds – what harmful effects (ranging from skin rash to immediate death) one could see in people exposed to certain amounts of a dangerous chemical during relatively short periods of exposure. Scientists have developed over 3,000 PAL values for over 100 most dangerous chemical compounds.

Resilience: Resilience is the capacity to recover quickly from difficulties. Disasters affect community environments by damaging drinking water and wastewater infrastructure, producing debris and waste, exposing people to harmful substances, and destroying natural resources. Building resilience can help communities prepare for and recover from disasters.

Predictive Risk Assessment

PALs values are different from other risk values. Risk values like Oral Reference Dose (protective risk estimates) are mandated to ensure an adequate margin of protection to the entire population against unspecified adverse effects when assuming a continuous exposure over a lifetime.

PAL values (predictive risk estimates) are different for two reasons. First, PAL values identify specific types of toxicity (central nervous system toxicity, respiratory failure, blood toxicity, etc.) likely to occur in humans, and describe the changes in toxic effects as exposures increase. Second, PALs values are developed for specific less-than-lifetime exposures (24 hours, 30 days, 90 days and 2 years) similar to those that might accompany an unanticipated chemical release and clean-up efforts. These values describe the increase in toxic effects that occur with longer exposure durations. Predictive risk assessment method directly links hazard to exposure, to help first responders and emergency planners protect human health and identify the types of medical treatment needed if an exposure occurs.

Importance of Site Characterization or Contaminated Site Assessment (CSA)

a. Determining concentration and spatial distribution of harmful pollutants under consideration
b. Determining the extent of site remediation (zonation) based on which the suitable remediation technique is selected
c. Assessing environmental and human health risk due to contamination.

Summary

For reclamation and remediation of a contaminated area, the primary task is to assess contamination, its exposure, risk and resilience of the ecosystem to neutralize it. The right sampling protocols and procedures as well as emergency response protocol must be in place. The important decisions on whether to clean up or haul away the contaminated material, and the goals of clean-up must be specified, based on which priorities can be set. Sampling methods differ for chemical, biological and

radiological sampling. Predictive Risk Values (PALS) for specific toxins at different definite exposure period links hazard to exposure. Therefore, this chapter throws light on the importance of contaminated site assessment**.**

Film

- Soil Testing and Disposal Video: Duration 6 min https://www.youtube.com/watch?v=EtRIlHngvpQ
- The perfect soil- Vedic Way: Duration 7 min https://www.youtube.com/watch?v=oifWngdzwCg

Self Assessment Questions

- What is the source of contaminants?
- What is the type and physical form of contaminants?
- Spatial and depth-wise extent of contamination
- Whether the contaminants are stationary or movable?
- If they are movable, identify the significant pathways.
- Identify the potential receptors of contaminants

Further Reading

1. Guidelines for Risk Assessment of Contaminated Sites
http://www.miljodirektoratet.no/old/klif/publikasjoner/andre/1691/ta1691.pdf

2. Assessment of contaminated soils http://www.eolss.net/Sample-Chapters/C06/E6-13-05-05.pdf

3. Assessing soil contamination: A reference manual: FAO (Food and Agriculture Organization)
http://www.fao.org/docrep/003/X2570E/X2570E00.HTM

Chapter 2
Eco-Friendly Waste Management Technologies

Objective

- To gain insights into waste management technologies, reclamation and bioremediation
- To learn application of bioremediation in waste management technology, bioremediation of heavy metals and agricultural wastes, xenobiotics, degradation of xenobiotic compounds and different methods of degradation.

Structure

2.1. Eco Friendly Waste Management Technologies
2.2 Reclamation
2.3 Bioremediation
2.4 Bioremediation Techniques Overview, Xenobiotics and its Degradation

To Do Activities

- Discuss why and where alternative waste management solutions are required. Give a few examples.
- Conduct practical exercise- Use the videos to explain the harmful effects of oil spills over water bodies.
- Conduct a seminar on bio-venting, bio-sparging, bio-augmentation, bio-piling, land forming, etc.
- Read through the case studies and facilitate a discussion regarding bio-mining and land restoration.
- Sugar Spill: Create an experiment using sugar, yeast and water, which demonstrates how yeast breaks down oil spills.
- Visit a local landfill or dumping site – write an account on key challenges and methodological approaches being practiced.
- Have the students work in pairs to come up with a definition of bioremediation and its application.
- Group presentation / group work on decision-making process regarding landfill remediation.
- Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

[1]

2.1. Eco-Friendly Waste Management Technologies

Growing concern over the management of landfill sites and efficient disposal, coupled with the pressure on land availability has seen the development of technologies that convert waste into energy, or useful by-products. This technology is termed alternative waste treatment technology (AWT), designed to recover more resources from the waste while minimizing the impact on the environment. With this background, in lieu of growing recognition of material and energy resources that are engraved in residual wastes, alternative waste treatment technologies are classified into three categories:

- Alternative from conventional land filling
- Thermal treatment
- Biological treatment

[1] https://www.youtube.com/watch?time_continue=68&v=LhYkXVKL9Sw
https://www.teachengineering.org/activities/view/cub_lifescience_lesson04_activity1

Of the above three mentioned categories, biological treatment via sustainable option in the form of reclaiming waste lands, soil bioremediation are few noteworthy advancement for a more nature centric waste to resource and wasteland to utility value concepts. This subject as part of the curriculum shall address issues on waste lands, problems that arise to solid waste, leachate problems, how soil can be conditioned, reclaimed and remediated for better management. Before deciding on an alternative treatment technology, such as bioremediation, as much information as possible should be collected about the contaminated site. This is important because it appears that no single alternative treatment technology has completely eliminated the need to use a conventional treatment technology. Some example of technological approaches and its beneficial outcomes include:

Table 2.1 Technological Approaches

Technology	Feedstock	Beneficial outcomes	Environmental implications
Anaerobic digestion	Organic solid wastes, bio-solids	Bio-gas fuel for electricity and/or heat energy	Odour
Composting	Organic solid wastes, bio-solids	Compost (soil amendment)	Odour, solid residues
Direct combustion	Mixed solid wastes, bio-solids	Electricity and/or heat energy, recovered metals	Air emissions, solid residues
Gasification	Selected pre-processed waste	heat energy, recovered metals	Air emissions, solid residues
Mechanical biological treatment or processing (MBT/MBP)	Mixed solid wastes	Recovered recyclables, RDF or compost or biogas fuel for electricity, heat energy	Odour, solid residues

Before chapter wise detailing on reclamation and remediation in the subsequent chapters, an over view of alternative waste technologies which are available is discussed in this chapter and also why bioremediation is considered as the most promising alternative eco-friendly approach over other technologies.

Eco-friendly Technologies

Modifications to Conventional Landfill

They are categorized into two types:

1. Bioreactor landfills

Bioreactor Landfills are wet landfills and promote anaerobic degradation of organic components of waste within a realistic timeframe. Detailed protocols are implemented to speed up degradation, with the most important being the addition of water. Water ensures that decomposition process is increased, leachate is also re-circulated and in some cases sewage sludge is also added. The other protocols to assist in the process include waste shredding, pH adjustment, nutrient addition and temperature management. The flow rate of the liquid through the landfill must be monitored and controlled through hydraulic conductivity. Waste rearranges and settlement continues until finally biodegradation releases gas for energy and leachate for reuse in the system. The main challenges with bioreactor landfills are operational. Existing landfill practices results in barriers to water contacting and moving uniformly

through the waste. Furthermore infrastructure for the injection and drainage of fluid through the landfill is prone to biochemical fouling. Any excess leachate requires treatment prior to disposal.

2. Pre-treatment Landfill

In pre-treatment landfills the biodegradable or putrescible waste undergoes mechanical and biological pre-treatment to reduce pollution potential of the waste over the lifecycle of the landfill in which it is placed. Mechanical processes includes the shredding and sorting of materials with the extraction of ferrous metals. The shredding of waste is designed to increase surface area of materials so as to enhance biological processes. The screening process separates the high calorific materials such as plastic and paper from organic components.

Biological Conversion

This option includes

- Aerobic Decomposition
- Anaerobic Digestion

Aerobic Decomposition

Aerobic decomposition involves the decomposition of organic materials by microbial activity under aerobic conditions. The end product is dependent on waste systems and process arrangements achieving waste stabilization, fuel production or stable organic compost containing plant nutrients. The quality of material is determined by the quality of feedstock/input and suitable control in the form of aeration, moisture and temperature parameters. There are numerous different techniques used in aerobic decomposition which include:

Green Waste Composting in Open Windrows- the decomposition of green organics, garden waste and sewage sludge through microbial activity in moist rich aerobic conditions. The process takes 6-12 weeks. Different grades of material require different lengths of composting to ensure weeds or pathogens are destroyed.

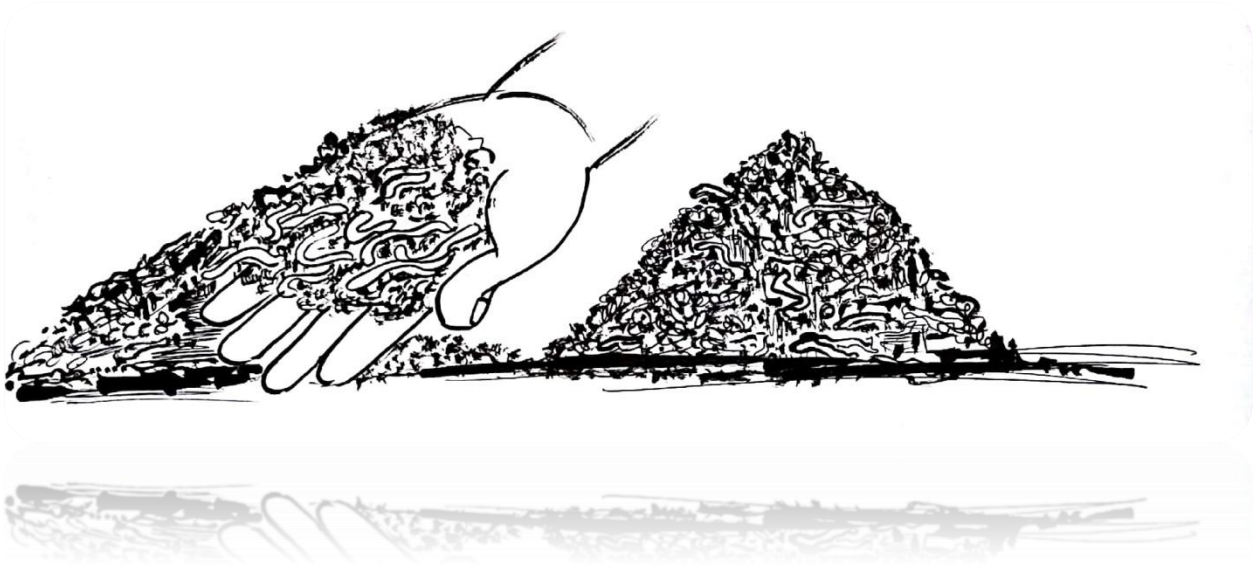
Aerated Static Pile – Vegetable and fruit waste and other food waste are piled on perforated concrete and covered by mature compost or wood chips with air drawn through the stationary pile. Material is cured for four to six weeks before being screened and processed to produce compost.

Drum Systems – Aerobic drums can process either source separated organics or mixed waste. Drums waste is mixed and homogenized within the rotating drums. Waste is loaded into the drums from the storage/tipping floor and bio-solids and water added to obtain the right moisture content. Material is processed in the drums for approximately 3-4 days at temperatures between 55 to 65^{o}C. Materials are then screened, with recyclables removed and large solid waste disposed of, the screened material is then placed into open on aerated static piles for a further 30 – 40 days. Material is then processed into a range of compost products. The cost of operating such as system is eapproximately$70 - $110 per tonne of waste input (EPA, 2003).

Vermi Composting

Vermi Composting uses worms to consume food waste, bio-solids, animal wastes and organic material to produce a high quality soil conditioner. Vermi Composting outcomes include:

- Earthworm biomass for worm farming purposes
- Produce vermicast for agricultural and environmental management
- Reduce organic waste volumes through vermi-stabilization



There are a variety of mechanisms, processes and strategies in the management of Vermi Composting. The general environmental conditions required for vermin composting include:

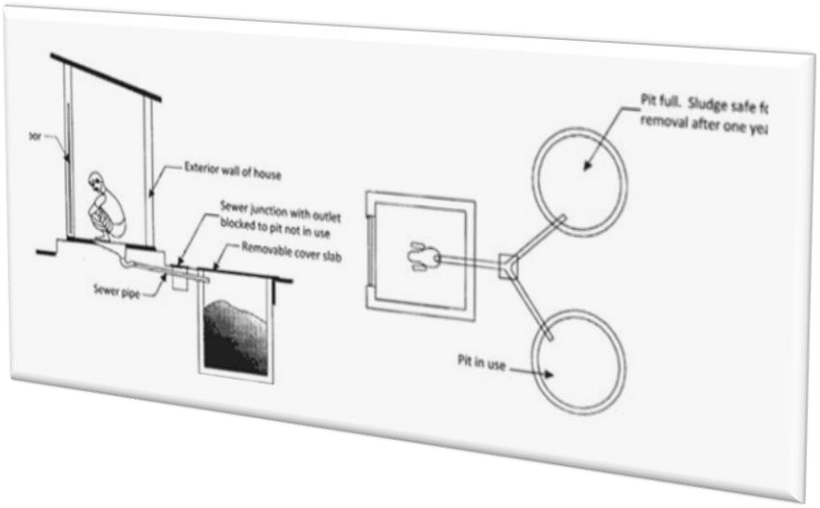
- Bedding - loosened and aerated, however. This process assists to maximize oxygen penetration and keep the system in an aerobic state.
- Temperature is one of the most important factors in Vermi Composting. Optimum temperature for bedding mass varies from 20°C-30°C depending on the species of worms.
- Moisture is an important consideration.
- pH of a system decreases and waste decomposes. The ideal pH range is between 4.5 – 9.
- Particle size of feedstock should be varied so as to maintain optimum aerobic conditions. The smaller the particles the greater the surface area and the easier it is for the worms to ingest and breakdown. If the particles are too small, there is a risk of compaction as system will move into an anaerobic state.
- Pre-treatment of feedstock may be necessary in some cases such as with problematic waste streams. Pre-treatment could take the form of primary decomposition or pre-composting to reduce feedstock toxicity.

Anaerobic Digestion

Bacterial decomposition of organic matter occurs in the absence of oxygen to produce methane and organic compost. Methane is used for energy production and the compost used for soil conditioning. This process is carried out in a controlled environment with pH and temperature monitored. This is usually a three stage process, including mechanical processing, one or two anaerobic decomposition phases and aerobic stabilizing process. There are two main types of biological treatment, 'mechanical biological treatment' and 'fermentation'.

Mechanical treatment is used for the treatment of source separated solid organic waste. Pre-treatment is necessary to remove non-organic materials which may inhibit the anaerobic process and/or produce unwanted metals or elements that may be harmful. By-products of the process include biogas in the form of methane and carbon dioxide as well as sludge. The biogas can be captured for energy production and the sludge used as a landfill cover or for agricultural purposes. It may also be further refined to

produce a soil conditioner or compost. Fermentation is an extension of the mechanical process and biogas produced is used to manufacture industrial feedstock such as ethanol. Fermentation technology mainly uses agricultural waste as the raw material; however recently using municipal solid waste as a feedstock is being looked up as a viable alternative.



2.2. Reclamation

Reclamation is considered as any action being taken to transform waste or abandoned land into a state fit for use. Just as recycling seeks to make the most effective use of scarce resources and raw materials, reclamation aims to make the best use of land. Reclamation is an important part of conceptualization of waste management and practices hierarchy. In order to reduce environmental risks associated with the accumulation and decomposition of wastes, reclamation of landfills and dumps of municipal solid wastes is an important measure (Guerriero, J.R. 1994). Environmental Protection Agency "Landfill Reclamation" (EPA, United States, Solid Waste and Emergency Response) notes that reclamation of landfills is an approach used to prevent the expansion of municipal landfills, which avoids additional tangible land acquisition costs for new objects. Reclamation costs are often offset by the sale or use of recovered materials, such as recyclables, soil, and waste, which can be burned as fuel. Other important benefits may include avoided liability through site remediation, reductions in closure costs, and reclamation of land for other uses. In spite of these benefits, some potential drawbacks exist to landfill reclamation as it may release methane and other gases. It may also unearth hazardous materials, which can be costly to manage. Also the excavation work involved in reclamation may cause adjacent landfill areas to sink or collapse. The tools used for reclamation projects are adapted mainly from technologies already in use in the mining industry, as well as in construction and other solid waste management operations.

The steps involved in reclamation include

- Excavation: An excavator removes the contents of the landfill cell and the excavated materials are organized into manageable stockpiles and the bulky materials are separated.
- Soil separation/screening: Vibrating screens separate soil from solid waste in the excavated material.
- Processing for Reclamation of Recyclable Material or Disposal: Based on the local conditions, either the soil or the waste may be reclaimed. The separated soil can be used as fill material or as daily cover in a sanitary landfill. The excavated waste can be processed at a materials recovery facility to remove valuable components (e.g., steel and aluminum) or burned in a municipal waste combustor (MWC) to produce energy

Basic steps in project planning before initiating landfill reclamation project includes:

- Site characterization study
- Assessing potential economic benefits
- Investigating regulatory requirements
- Environment, Health and Safety plan
- Assess projects costs

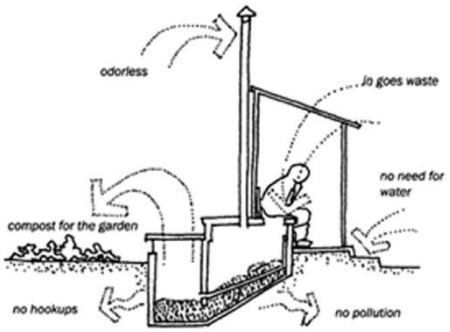
Table 2.2 Benefits and Drawbacks of Reclamation

Facility operators considering the establishment of a landfill reclamation program must weigh several benefits and drawbacks associated with this waste management approach.	
Benefits	**Drawbacks**
• Extending landfill capacity: **Landfill reclamation extends the life of the current facility by removing recoverable materials and reducing waste volume through combustion and compaction**	• **Hazardous waste materials management** Hazardous wastes that may be uncovered during reclamation operations, especially at older landfills, are subject to special handling and disposal requirements. Management costs for hazardous waste can be relatively high, but may reduce future liability
• Revenue generation from the sale of recyclable materials : **Recovered materials, such as metals, aluminum, plastic, and glass, can be sold if markets be present for these materials**	• **Controlling releases of landfill gases and odours:** Excavation raises a number of potential problems related to gases. Methane and other gases, generated by decomposing wastes, can cause explosions and fires. Hydrogen sulfide gas which is a highly flammable and odourous gas can be fatal when inhaled.
• Lowering operating costs : **Reclaimed soil can be used on site as daily cover material on other landfill cells, thus avoiding the cost of importing cover soil. Also, a market might exist for reclaimed soil used in other applications, such as construction fill.**	• **Controlling subsidence:** Excavation of one landfill area can undermine the integrity of adjacent cells, which can sink or collapse into the excavated area.
• Producing energy : **Combustible reclaimed waste can be mixed with**	• **Damage to equipments:** Reclamation activities reduce the useful

fresh waste and burned to produce energy	life of equipment, such as excavators and loaders, because of the high density of waste being handled. Also, the high particulate content and abrasive nature of reclaimed waste can increase pressure on other emission control devices, scrubbers etc.
• Reducing landfill closure costs and reclaiming land for other uses **By reducing the size of the landfill "footprint" through landfill cell reclamation, the operator may be able to either lower the cost of closing the landfill or make the land available for other uses.**	
• Retrofitting liners and removing hazardous materials **Liners and leachate collection systems can be installed at older landfills. These systems can be inspected and repaired. Also, hazardous waste can be removed and managed.**	

2.3. Bioremediation

Biodegradation is nature centric approach of recycling wastes, or in simple words we can say breaking down of organic matter into nutrients that can be used by other organisms. "Degradation" means decay, and "bio-" means decay carried out by huge range of bacteria, fungi, insects, worms, and other organisms that eat dead material and convert into a resource material/compost. If one foresees or looks from ecological standpoint, nothing is waste; a waste from one product can be a resource for recycling or for making a new product. Similarly waste products from one organism become a feedstock for others, providing nutrients and energy while breaking down the waste organic matter. Certain organic materials will break down much faster than others, but all will eventually decay. By harnessing these natural mechanisms of biodegradation, we can reduce wastes and clean up some types of environmental contaminants. The relative degradability is explained in figure: 1. Wastewater treatment also accelerates natural mechanism of biodegradation. In this case the purpose is to break down organic matter so that it will not cause pollution problems when the water is released into the environment. Through the concept of biodegradation comes bioremediation, which the degraded material brought into use.



Through bioremediation, microorganisms are used to clean up oil spills and other types of organic pollution. Composting and bioremediation provide many possibilities for student research. In a non-polluted environment, bacteria, fungi, protists, and other microorganisms are constantly at work breaking down organic matter, some of the microorganisms would die, while others capable of eating the organic pollutants would survive. Bioremediation works by providing these pollution-eating organisms with

fertilizer, oxygen, and other conditions that encourage their rapid growth. Depending on the site and its contaminants, bioremediation may be safer and less expensive than alternative solutions such as incineration or landfilling of the contaminated materials. It also has the advantage of treating the contamination in place so that large quantities of soil, sediment or water do not have to be pumped out of the ground for treatment.

Bacterial Bioremediation Applications

- Microbiologically influenced corrosion
- Bio-films and bio-fouling
- Biotransformation and biodegradation of hazardous compounds
- Bio-deterioration and biodegradation of wood and polymeric materials
- Recycling of nutrients, waste and pollution
- Biodegradation and bioremediation of persistent pollutants
- Biodiversity of organisms involved in bio-deterioration
- Bioremediation in environmental protection

2.4. Bioremediation Technologies – Overview

- Soil Composting – addition of moisture and nutrients, regular mixing for aeration
- Bio-piles – ex-situ aeration of soil
- Bio-venting – in-situ aeration of soil
- Land treatment – application of organic materials to natural soils followed by irrigation and tilling

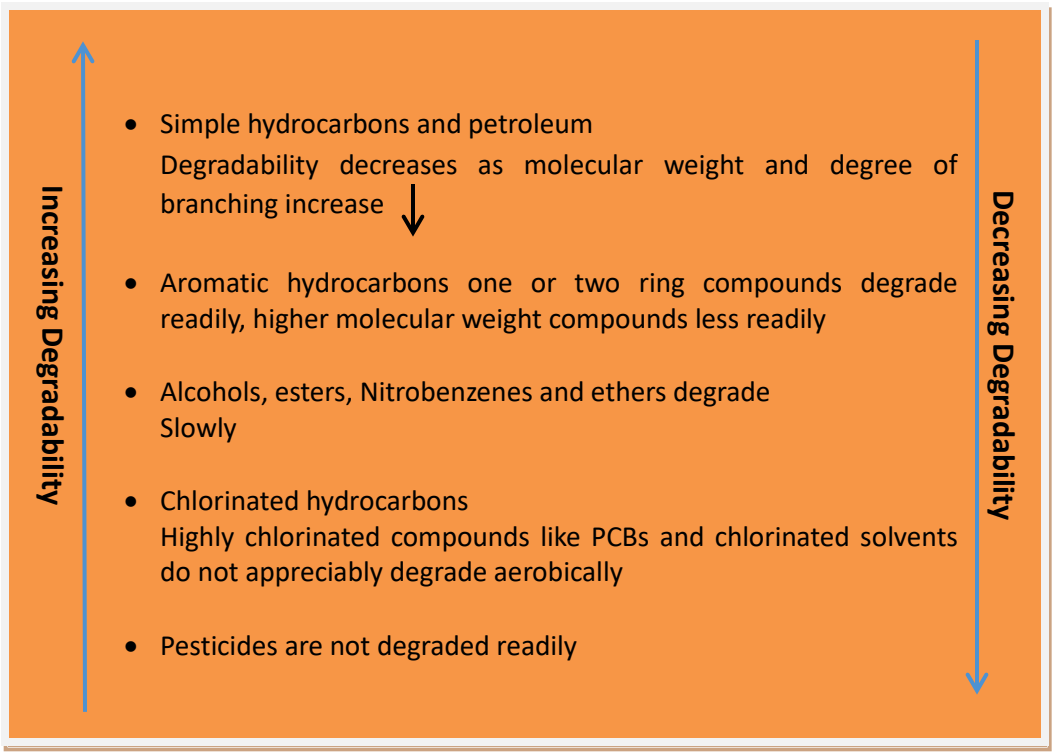


Fig 2.1 Increasing and Decreasing Relative Biodegradability of Varied Compounds

The first step before deciding on an alternative treatment technology, such as bioremediation, is collection of every possible details of the contaminated site (McNally, *etal,* EOLSS, 2007). This step has crucial role because no single alternative treatment technology has completely eliminated the need to use a conventional treatment, rather in most cases a combination of technological interventions are applied to resolve. For example – a combination of insitu bioremediation along with other treatment technologies if implemented strategically and sequentially shall assist in cleanup of contaminated site.

Insights into varied Bioremediation technologies include the following.

Bioventing

Bioventing is an in situ remediation technology involving the injection (and sometimes extraction) of air into the subsurface to enhance microbial activity and facilitate biodegradation of organic contaminants adsorbed to soils in the unsaturated zone. Bioventing is different from air sparring, which is typically conducted at higher flow rates to promote volatilization of VOCs rather than biodegradation.

Air is injected at low rates to increase the oxygen content in the sub surface and promote oxidation reactions. Other gases, such as methane or propane, can also be injected (at concentrations below the lower explosive limit) to promote the degradation of organic contamination under reducing conditions.

Where high concentrations of contaminants are present, it is possible that the soil pores can become clogged with additional biomass generated during bioventing, reducing the oxygen levels. Pulsed air injection can be useful to increase the oxygen levels under these conditions.

Enhanced Bio-Remediation

Aerobic Enhancement comprises the addition of oxygen (an electron acceptor) to the subsurface to increase the population of microbial organisms to assist with the biodegradation of contaminants in the soil or groundwater.

Although the introduction of oxygen releasing compounds (ORC) is more commonly used to enhance aerobic bioremediation of groundwater, ORC can also be applied to the unsaturated zone. The ORC can be a proprietary oxidant, or substances such as hydrogen peroxide or ozone

Anaerobic Enhancement comprises the addition of an electron donor (such as hydrogen or hydrocarbons) to the subsurface to increase the population of microbial organisms to assist with reductive dechlorination processes (anaerobic degradation) in groundwater. The direct addition of hydrogen is rare, as during anaerobic biodegradation hydrogen is normally indirectly generated via fermenting organic matter.

Other nutrients such as nitrate and sulphate can be added to groundwater to enhance anaerobic biodegradation of petroleum hydrocarbons.

Phytoremediation

Phytoremediation involves the use of plants to remove or stabilize contaminants in soil and, to a lesser extent, groundwater. An example of phytoremediation in the wastewater industry is the use of reed beds for on-site biological treatment of sewage effluent.

The following mechanisms are used in the process of phytoremediation:

- Enhanced rhizosphere biodegradation (the release of natural substances from plant roots to supply nutrients to microorganisms which increases biological activity).
- Phyto-accumulation (the uptake of contaminants by plant roots and transfer of the contaminants to the plants shoots and leaves).
- Phyto-degradation (metabolism of contaminants in plant tissues).
- Phyto-stabilisation (the production of chemical by the plant that immobilizes contaminants at the interface between the roots and soil).

Hardy species, such as eucalyptus, fern, rye and fescue grasses, are often selected for phytoremediation in Australia due to their fast growing and robust nature and ability to survive in saline and water-logged soils.

Myco-Remediation

Myco-remediation is a form of in situ bioremediation that uses fungal material (mycelium) to accumulate and degrade contaminants to remediate contaminated soils and groundwater. Mycelium is the dense network of branching white hyphae making up the fungi. The mycelia deliver the enzymes required to break down the contamination; as such, the reaction is extra-cellular (outside rather than within the fungi). Fungi can be effective in breaking down petroleum hydrocarbons and some chlorinated compounds, and are able to stimulate microbes and enzymes in situ. Heavy metals can also bio-accumulate in fungi and the contamination can be removed during harvesting.

The type of fungi used in myco-remediation is affected by the temperature, soil pH and the availability (or lack) of oxygen. Mycelium-treated substrate, including wood chips and straw, are spread over contaminated soils which produce enzymes capable of decomposing contaminants over time.

Some of the common fungi used in myco-remediation and the contaminants they can treat are outlined below[2]:

- Shaggy Mane: Arsenic, cadmium, and mercury
- Elm Oyster: Dioxins, wood preservatives
- Phoenix Oyster: TNT, cadmium, mercury, copper
- Pearl Oyster: PCBs, PAHs, cadmium, mercury, dioxins
- Shitake: PAHs, PCBs, PCPs
- Turkey Tail: PAHs, TNT, organophosphates, mercury
- Button Mushrooms: Cadmium
- King Stropharia: E-coli and other biological contaminants

Biopiles/Windrows

This is an ex situ application of bioremediation where petroleum hydrocarbon impacted soils are excavated and placed in a treatment area where agents are usually mixed into the contaminated soils to enhance the degradation process. The soil piles need to be aerated and moisture, temperature, oxygen and pH can be adjusted to make the process more effective. A leachate barrier and collection system is required to avoid contamination leaching into the soil and groundwater below the treatment area. Biopiles can also be engineered and contain ventilation piping and blower, irrigation piping and/or sump and pump systems to facilitate aeration and drainage to maximize degradation rates.

Composting

Composting involves the biological decomposition of wastes under controlled conditions to a state in which it can be handled, stored and / or applied to land without adversely affecting the environment. Contaminated soils are added to the compost process, and the contaminants are degraded together with the degradable waste material into humus and inert by-products (such as carbon dioxide, water and salts).

Composting is a special type of decomposition for which the conditions are set up to allow for optimal microbial activity. Conditions that are important include the correct proportions of carbon and minerals in the compost mix (e.g. carbon to nitrogen (C: N) ratio), good aeration and adequate moisture content. When the conditions are right, microbial (bacteria, including actinomycetes, and fungi) activity is very rapid and a large amount of heat is produced and the temperature rises.

When the material is grossly contaminated or odourous, different systems will be required, such as enclosed trenches or rotating drums where odours can be captured during the composting process, and treated. All systems require air to be drawn through the contaminated medium to provide suitable conditions for the microorganisms to survive.

Land Farming

Land farming involves spreading impacted soils in thin layers across a prepared surface and regularly turning the material to enable air flow through the soil matrix (introducing oxygen to facilitate degradation). The soil material is placed on a lined surface, with drainage control and bunding, to minimize the potential for leaching and run-off of contaminants. The soil conditions are controlled to maximize the degradation rate, including moisture content (via irrigation/spraying), aeration (by tilling) and pH (buffered to neutral by adding acid or alkali).

Where land farming is carried out in the open and volatile contaminants (such as petrol) are involved, volatilization can be a significant contributor to loss of contaminants. Where volatile emissions and odours are possible, the requirements for emission management must be addressed as part of such remediation works. If the process simply involves volatilization without degradation, some regulatory agencies will not accept land farming as an acceptable treatment option.

Land farming can also be conducted in situ to treat soils up to approximately 1mbgl. Soils are mechanically agitated to introduce oxygen to the subsurface and facilitate the addition of nutrients and lime to reduce the soil acidity.

Slurry Phase Biological Treatment

Slurry phase biological treatment is performed in a reactor to remediate a mixture of water and excavated soil. The soil is mixed with water to a concentration that is determined by the proportions of the contaminants in soils, the rate of biodegradation, and the physical nature of the soils. If the soil is prewashed, the contaminated fines and wash water are treated in the reactor. The slurry contains between 5% and 40% solids by weight depending on the nature of the biological reactor. The soil is suspended in a reactor vessel and mixed with nutrients and oxygen. Microorganisms, acid or alkali may be added depending on treatment requirements. When biodegradation is complete, the soil slurry is dewatered and the liquids filtered and clarified.

Treatable Contaminants

Bioremediation technologies are potentially able to treat a wide range of volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and petroleum hydrocarbons.

Bioremediation of PAHs is possible in engineered biopiles or windrows with the addition of compost, nutrients, and surfactants to release contaminants to the aqueous phase. High molecular weight PAHs and aged petroleum products are of low bioavailability and are not generally suitable for treatment by bioremediation, particularly phytoremediation, unless only minor reductions in concentration are required. Some higher-boiling-point halogenated compounds such as polychlorinated biphenyls (PCBs), dioxins and furans, and fluorinated compounds such as PFOS can be very difficult to degrade, and are unlikely to be suitable for treatment by bioremediation.

Application of Bioremediation in Waste Management Technology

Bioremediation is not only a process of removing the pollutant from the environment but also it an eco-friendly and more effective process (Singh and Tripathi, 2007). The pollutants can be removes or detoxify from the soil and water by the use of microorganism, known as bioremediation (Talley, 2005; Wasi *et al*, 2008). The purpose of bioremediation is to make environment free from pollution with help of environmental friendly microbes. Bioremediation is broadly divided in two categories:

- In-situ bioremediation
- Ex-situ bioremediation

In-situ Bioremediation provide the treatment at contaminated sites and avoiding excavation and transport of contaminants, means there is no need to excavate the water or contaminated soil for remediation. There is a biological treatment of cleaning the hazardous substances on the surface. Here the use of oxygen and nutrient to the contaminated site in the form of aqueous solution in which bacteria grow and help to degrade the organic matter. It can be used for soil and groundwater. Generally, this technique includes conditions such as the infiltration of water containing nutrients and oxygen or other electron acceptors for groundwater treatment [8]. Most often, in situ bioremediation is applied to the degradation of contaminants in saturated soils and groundwater. It is a superior method to cleaning contaminated environments since it is cheaper and uses harmless microbial organisms to degrade the chemicals. Chemotaxis is important to the study of in-situ bioremediation because microbial organisms with chemotactic abilities can move into an area containing contaminants. So by enhancing the cells' chemotactic abilities, in-situ bioremediation will become a safer method in degrading harmful compounds (Vidali M, 2001).

In-situ bioremediation is divided into following types:

Bioventing

It is a technique to degrade any aerobically degradable compound. In bioventing the oxygen and nutrient like nitrogen and phosphorus is injected to the contaminated site [9]. The distribution of these nutrient and oxygen in soil is dependent on soil texture. In bioventing enough oxygen is provided through low air flow rate for microbes. It is more effective if the water table is deep from the surface and the area having high temperature. It is mainly used for the removal of gasoline, oil, petroleum etc. The rate removal of these substances is varied from one site to another site. This is just because of the difference in soil texture and different composition of hydrocarbons (Rockne K, Reddy K, 2003).

Biosparging

In biosparging, air is injected below the ground water under pressure to increase the concentration of oxygen. The oxygen is injected for microbial degradation of pollutant. Biosparging increase the aerobic degradation and volatilization. There should be control of pressure while injecting the oxygen at the contaminated site to prevent the transfer of volatile matter into the atmosphere. In it the cost can be reduced by reducing the diameter of injection point. Before injecting the oxygen there should know about soil texture and permeability. This technology was applied to a known source of gasoline contamination in order to quantify the extent of remediation achieved in terms of both mass removed and reduction in mass discharge into groundwater. Biosparging is effective in reducing petroleum products at underground storage tank (UST) sites. Biosparging is most often used at sites with mid-weight petroleum products (e.g., diesel fuel, jet fuel); lighter petroleum products (e.g., gasoline) tend to volatilize readily and to be removed more rapidly using air sparging (Lambert, *etal*, 2009).

Bioaugmentation

Microorganisms having specific metabolic capability are introduced into the contaminated site for enhancing the degradation of waste. At sites where soil and groundwater are contaminated with chlorinated ethane's, such as tetrachloroethylene and trichloroethylene, bioaugmentation is used to ensure that the in situ microorganisms can completely degrade these contaminants to ethylene and chloride, which are non-toxic in nature.

Ex-situ Bioremediation

In ex situ, the contaminated soil excavated and is treated at another place.

Biopiling

It is a hybrid form of composting and land farming. The basic biopile system includes:

- a treatment bed
- an aeration system
- an irrigation/nutrient system and a leachate collection system

For proper degradation there should be control of moisture, heat, nutrients, oxygen, and pH. The irrigation system is buried under the soil and provides air and nutrients through vacuum. To prevent the run off the soil is covered with plastic and due to which evaporation and volatilization is also prevented and promote the solar heating. Biopile treatment takes 20 to 3 month to complete the procedure (Niu *etal*, 2009).

Landforming

In land forming, a sandwich layer is made of excavated soil between a clean soil and a clay and concrete. The clean soil at bottom and concrete layer is placed at the upper most layers. After this it is allowed for natural degradation. It is also provided with oxygen, nutrition and moisture and pH is to be maintained near the pH 7 by using lime. Land forming is useful mainly for pesticides.

Compositing

Compositing is a process in which microorganism degrades the waste at elevated temperature that is ranges from 55°- 65° c. During the process of degradation microbes release heat and increase the temperature which leads to the more solubility of waste and higher metabolic activity in composts. Windrow composting removes the rocks and other larger particles from excavated contaminated soil. The soil is transported to a composting pad with a temporary structure to provide containment and protection from weather extremes. Amendments (straw, alfalfa, manure, agricultural wastes and wood

chips) are used for bulking agents and as a supplemental carbon source. Soil and amendments are layered into long piles known as windrows (Blanca *etal*, 2007).

Bioremediation of Heavy Metals

Usually the atomic weight and density of heavy metal is high as compare to other elements. There is more than 20 heavy metals, only few of them such as Cadmium (Cd), Cupper (Cu), Argon (Ar), Silver (Ag), Chromium (Cr), Zinc (Zn), Lead (Pb), Uranium (Ur), Ra, Nickel (Ni) etc. is considered, due to their toxicity. The contaminations of soil through heavy metals become a major problem among all other environmental problems. These heavy metals contaminate not only the soil but also ground water through leaching. The removal of heavy metal is very important due to their potential of entering into the food chain causing adverse effect to human beings which accumulate into the body. These metals can also be removed by the use of various biological agents like yeast, fungi, bacteria, and algae etc. which act as bio sorbent for sequestering the metals. It can sequester dissolved metal ions out of dilute complex solutions very quickly and which is more effective and efficient. Hence it is an ideal candidate for the treatment of high volume and low concentration complex wastewaters. (Wang, 2006).The property of microorganism to absorb or sequester the metal is given consideration.

In this approach, biosorption is a reaction between the positive charged heavy metals and negative charged microbial cell membrane, in which metals are then transported to cell cytoplasm through cell membrane with the aid of transporter proteins and get bio accumulated. Biosorption of metal ions strongly depends on pH. The biosorption of Cr, Zn, Ni and Pb by p. chrysogenum was inhibited below pH 3.0. It was observed that biosorption of Cd by various fungal species is at very sensitive pH. It is observed that Cd2+ Cr6+ and Zn2+ removal activity ranged between 85% and 60%, with intracellular accumulation as predominant mechanisms in most of the cases. Pseudomonas aeruginosa and Aspergillus nigerare the species have the capacity of removing toxic heavy metals. (Volesky, 1990).

Table 2.3 Microbial Species and Elements Removed

S.No.	Name of the species	Removal of heavy metals
1.	Bacillus Species	Cd, Cu, Zn
2.	Cellulosmicrobium cellulans	Cr
3.	Pseudomonas aeruginosa	Cd, Pb, Fe, Cu, U, Ra, Ni, Ag
4.	Aspergillus fumigates	Ur
5.	Aspergillus niger	Cd, Zn, Th, Ur, Ag, Cu
6.	Beta Vulgaris	Cd, Ni, Cr, Hg
7.	Micrococus roseus	Cd
8.	Escherichia coli	Zn and V
9.	Oedogonium rivulare	Cr, Ni, Zn, Fe, Mn, Cu, Pb, Cd and CO
10.	Trichoderma viride and Humicola insolens	Hg

Bioremediation of Agricultural Wastes

Each year, agricultural produce approximately 38 billion metric tons of organic waste worldwide (Tiwari and Singh, 2014). The environmental friendly management of these wastes has become a global priority. Therefore, much attention has been paid in recent years to develop low-input and efficient technologies to convert such nutrient rich organic wastes into value-added products for sustainable land practices. However these can be managed through vermicomposting. A vermicomposting is nothing but a joint action between the earth warms and microorganisms. Here microorganism helps in degradation of organic matter and earth warm drives the process and conditioning to the substrate and altering the biological activity (Dominguez, 2004; Suthar, 2007). Several earthworms' species e.g., Eisenia fetida (Savigny), Perionyx excavatus (Perrier), Perionyx sansibaricus (Perrier), and Eudrilus eugeniae have been identified as detritus feeder and can be used potentially to minimize the anthropogenic waste from different source (Garg,etal,2006). In India, according to conservative estimation approximately 600 to 700 million tons of agricultural waste is available. This huge quantity of waste is being and converted to bio-fertilizer by vermicomposting. Vermicomposting often results in mass reduction, shorter time for processing, and high levels of humus with reduced phytotoxicity in ready material (Lorimor, *etal*, 2001). A variety of combinations of crop residues and cattle manure are used in vermicomposting trials to obtain a value-added product.

Xenobiotics

Xenobiotics are compounds that are foreign to an organism. Examples of xenobiotics includes: Pharmaceutical drugs, food additives, pesticides and other environmental pollutants.

Sources of Xenobiotics

1. Petrochemical industry: -oil/gas industry, refineries. - produces basic chemicals e.g. vinyl chloride and benzene
2. Plastic industry: - closely related to the petrochemical industry - uses a number of complex organic compounds -such as anti-oxidants, plasticizers, cross-linking agents
3. Pesticide industry: - most commonly found. -structures are benzene and benzene derivatives
4. Paint industry: - major ingredients are solvents, - xylene, toluene, methyl ethyl ketone, methyl
5. Others: - Electronic industry, Textile industry, Pulp and Paper industry, Cosmetics and Pharmaceutical industry, Wood preservation

Degradation of Xenobiotic Compounds

The degradation of xenobiotic compounds are depends upon microbial activity. Some example includes degradation of parathion. It is also dependent on the degradation pathway of xenobiotic compound when single substrate is available. In absence of oxygen there should be an alternative electron accepter nitrate, sulphate, selenite, carbonate etc. There are no microbes or group of microbes that degrade all compounds. There are a group of organisms, which are metabolically useful for the degradation of large number of compounds. For example, the degradation of xenobiotic compounds through white rot fungi can take place with certain enzymes. It has been reported that the degradation of TNT by non-ligninolytic strains of P.chrysosporium (Tiwari and Singh, 2014). Some examples of xenobiotic compounds include:

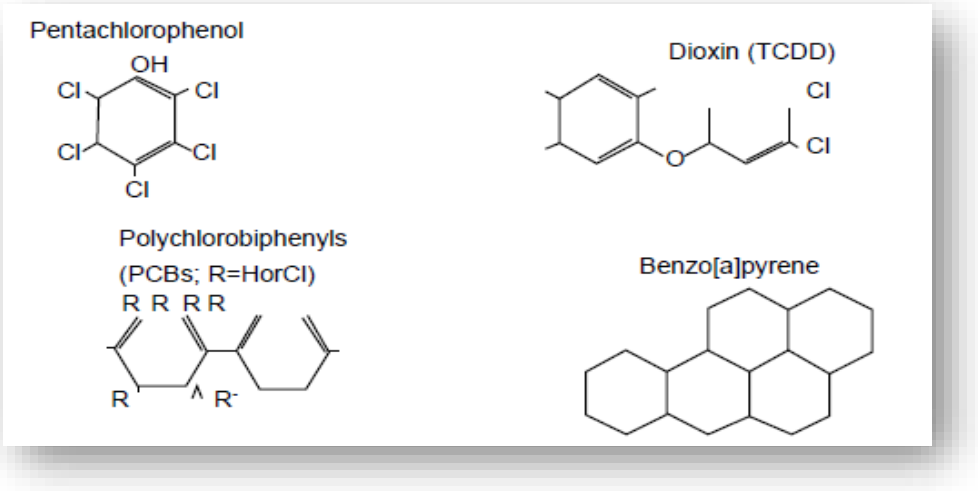


Fig 2.2 Some Examples of Xenobiotic compounds

Table 2.4 Xenobiotic Compounds and the Corresponding Microbial Species for Degradation

S.No.	Xenobiotic compounds	Microbes
1.	Endosulfan compounds	*Mycobacterium sp.*
2.	Endosulphate compounds	*Arthrobacter sp.*
3.	Vinylchloride	*Dehalococcoides sp.*
4.	Naphthalene	*Pseudomonas putida*
5.	Pyrene	*MycobacteriumPYR-1*
		Sphingomonas paucimobilis
6.	PCB	*RhodococcusRHA1*
7.	Benzene	*Dechloromonas sp.*

Different Methods (Sullia and Shantharam, 2017; Dubey and Maheshwari, 2009)

Detoxification

- Conversion of the pesticide molecule to a non-toxic compound.
- A single moiety in the side chain of a complex molecule is disturbed (removed), rendering the chemical non-toxic.

a) **Degradation**

- Breakdown or transformation of a complex substrate into simpler products leading to mineralization.
  E.g. Thirum (fungicide) is degraded by a strain of Pseudomonas and the degradation products are dimethylamine, proteins, sulpholipids, etc

c) **Conjugation (complex formation or addition reaction)**

- An organism makes the substrate more complex or combines the pesticide with cell metabolites.
- Conjugation or the formation of addition product is accomplished by those organisms catalyzing the reaction of addition of an amino acid, organic acid or methyl crown to the substrate thereby inactivating the pestcides

d) Changing the Spectrum of Toxicity

- Some pesticides are designed to control one particular group of pests, but are metabolized to yield products inhibitory to entirely dissimilar groups of organisms, for e.g. the fungicide PCNB is converted in soil to chlorinated benzoic acids that kill plants.

Biodegradation of Plastics

- Plastic is a broad name given to different polymers with high molecular weight, which can be degraded by various processes.
- The biodegradation of plastics by microorganisms and enzymes seems to be the most effective process.
- It consists of two steps - fragmentation and mineralization. But basically it involves, reactions occurring at molecular level are oxidation and hydrolysis.
- The decomposition of major condensation polymers (e.g. polyesters and polyamides) takes place through hydrolysis, while decomposition of polymers in which the main chain contains only carbon atoms (e.g. polyvinyl alcohol, lignin) includes oxidation which can be followed by hydrolysis of the products of oxidation.

Methods

Hydrolysis

- The process of breaking these chains and dissolving the polymers into smaller fragments is called hydrolysis. E.g. Pseudomonas sps
- Polymeric Chains is broken down into constituent parts for the energy potential by microorganisms. Monomers are readily available to other bacteria and are used.
- Acetate and hydrogen produced is used directly by methanogens. Other molecules, such as volatile fatty acids (VFAs) with a chain length greater than that of acetate is first catabolized into compounds that can be directly used by methanogens.

Acidogenesis

Further breakdown of the remaining components by acidogenic (fermentative) bacteria into ammonia, ethanol, carbon dioxide, and hydrogen sulfide. E.g Streptococcus acidophilus

Acetogenesis

Simple molecules created through the acidogenesis phase are further digested by Acetogens to produce largely acetic acid, as well as carbon dioxide and hydrogen.

Methanogenesis

- Here, methanogens use the intermediate products of the preceding stages and convert them into methane, carbon dioxide, and water.
- These components make up the majority of the biogas emitted.
- Methanogenesis is sensitive to both high and low pHs and occurs between pH 6.5 and pH 8. The remaining, indigestible material the microbes cannot use and any dead bacterial remains constitute the digestate.

Some of the microorganisms that can degrade plastics are:-

Aliphatic Polyesters

- PolyEthylene Adipate (PEA) - lipases from R. arrizus, R. delemar, Achromobacter sp. and Candida cylindracea
- Poly (β-Propiolactone) PPL - estereases from Acidovorax sp., Variovorax paradoxus, Sphingomonas paucimobilis.

Aromatic Polyesters

- Poly-3-Hydroxybutyrate (PHB) – estereases from Pseudomonas lemoigne, Comamonas sp. Acidovorax faecalis, Aspergillus fumigatus
- Poly Lactic Acid (PLA) - proteinase K from Tritirachium album, Amycolatopsis sp Strains of Actinimycetes has been reported to degrade polyamide (nylon), polystyrene, and polyethylene.

Aerobic Degradation

- Are metabolized by a variety of bacteria, with ring fission.
- Accomplished by mono- and dioxygenases.
- Catechol and protocatechuate are the intermediates.
- Mostly found in aromatic compound degradation pathway.

Other Mechanisms

1) Photometabolism: In bacteria, this light-induced "bound oxygen" (OH•) is used to oxidize substrates
2) Under nitrate-reducing condition: Nitrate-reducing bacteria couple the oxidation of organic compound with water to the exergonic reduction of nitrate via nitrite to N2.
3) Dissimilation through sulfate respiration: Sulfate- reducing bacteria couple the oxidation of organic compound with water to the exergonic reduction of sulfate via sulfite to sulfide.

Some microorganisms involved in the biodegradation of hydrocarbons, organic pollutants and other phenolic compounds include: Achromobacter, Alcaligenes, compound Acinetobacter, Arthrobacter, Azotobacter, Flavobacterium, Pseudomonas putida Candida tropicalis Trichosporon cutaneoum Aspergillus, Penicillium Benzoate & related Arthrobacter, Bacillus spp., compound Micrococcus, P. putida.

Another few organisms involved in degradation of organic pollutants include Aeruginosa, Candida Surfactants Alcaligenes, Achromobacter, Bacillus, Flavobacterium, Pseudomonas, Candida Pesticides P. Aeruginosa.

For DDT - B. sphaericu, Linurin Arthrobacter, P. cepacia

Genetic Regulation of xenobiotic degradation - plasmid-borne mostly in the genus Pseudomonas.

Polycyclic Aromatic Hydrocarbons (PAH)

- Bacteria, fungi, yeasts, and algae have the ability to metabolize both lower and higher molecular weight PAHs found in the natural environment.
- Most bacteria have been found to oxygenate the PAH initially to form dihydrodiol with a cis-configuration, which can be further oxidized to catechols.
- Most fungi oxidize PAHs via a cytochrome P450 catalyzed mono-oxygenase reaction to form reactive arene oxides that can isomerize to phenols.
- White-rot fungi oxidize PAHs via ligninases (lignin peroxidases and laccase) to form highly reactive quinones.

Compound Organisms Metabolite Naphthalene

Acinetobacter calcoaceticus , Alcaligenes denitrificans, Mycobacterium sp. , Pseudomonas sp., Pseudomonas putida

Naphthalene cis -1,2 – dihydrodiol, 1,2 – dihydroxynaphthalene, 2 - hydroxychromene - 2 – carboxylic acid, trans – o – hydroxybenzylidene pyruvic acid, salicylaldehyde, salicylic acid, catechol, gentisic acid, naphthalene trans – 1,2 – dihydrodiol.

Acenaphthene Beijerinckia sp., Pseudomonas putida, Pseudomonas fluorescens, Pseudomonas cepacia

Method for Removal of Polychlorinated Biphenyls (PCBs)

- **Natural Attenuation**: Microbes already in the soil are allowed to degrade as they can naturally and the site is closely monitored.
- **Biostimulation:** Microbes present in the soil are stimulated with nutrients such as oxygen, carbon sources like fertilizer to increase degradation.
- **Bioaugmentation:** Microbes that can naturally degrade PCB's are transplanted to the site and fed nutrients if necessary.

Pathways for PCB Removal Fungal Degradation

- Aspergillus niger: filamentous with cytochrome p450 that attacks lower chlorinated PCB's
- Phanerochaete chrysosporium: White rot fungi can attack lignin (PCB) at low concentration with the help of ligninases.

Bacterial degradation

- Soil bacteria breaks down PCBs via dioxygenase pathways.
- Most identified seem to be Pseudomonas species, Achromobacter, Acinetobacter, Alcaligenes, Arthrobacter, Corynebacterium, Rhodococcus, Burkholderia.

Drawbacks of Bioremediation

Some common environmental limitations to biodegradation are related to hazardous chemical wastes which posses' high waste concentrations and its toxicity. Because some time this toxicity either inhibits the growth of microorganism or some time kill them. For proper growth of microorganism it requires of favorable pH condition and sufficient amount of mineral nutrients and also requires temperature on which maximum microbes can survive i.e. 20°C to 30°C. Once the limitations by environmental conditions are corrected, the ubiquitous distribution of microorganisms, in most cases, allows for a spontaneous enrichment of the appropriate microorganisms. In the great majority of cases, an inoculation with specific microorganisms is neither necessary nor useful. Besides all these some other factors that also effect bioremediation include attributes such as solubility of waste, nature and chemical composition of waste, oxidation – reduction potential of waste and microbial interaction (Tiwari and Singh, 2014).

Case Studies

Case Study – Mines Afforestation in nutrient deficient inhospitable lands Jharia Coalfield, Dhanbad

Jharia coalfield of Bharat Coking Coal Ltd, Dhanbad, a subsidiary of Coal India Ltd

Improper management and unscientific manner of mining disturbs the ecosystem around the fields. Land degradation happens can be divided into 4 broad categories

- Abandoned/Active pits and queries of varying depths and extent with/without water accumulation.
- Overburdened dumps of varying sizes and heights comprising debris
- Land subsidence
- Fire affected area
  Source: http://dolr.nic.in/wasteland2010/India.pdf
  Department of Land Resources, Ministry of Rural Development , Govt of India Wasteland - Atlas of India - By National Remote Sensing Centre, ISRO, Hyderabad

Biomining Planned - Mumbai

In a suburb in northeast Mumbai lies a 60-acre dump site in the region of Mulund. The infamous garbage haven contains about 7,000 million tonnes of waste. Packed to the brim, the dump site was closed years ago. A planned to reclaim the dump site for better use is in offing.

The Brihan Mumbai Municipal Corporation (BMC) has finalized a five-year contract with Mumbai-based Prakash Constrowell Limited to reclaim the dumping ground at the cost of Rs 558 crore. The reclamation technique of bio-mining will be used and if exercised at this large scale, it would be the world's largest bio-mining project.

Source: https://www.thebetterindia.com/139308/worlds-largest-biomining-project-mumbai-free-up-60-acres-land-26-04-2018/

Table 2.3 Reclaimed Land Treated and it's Application for Beneficial Purpose (Almitra Patel, 2007)

Year	Location	Area cleared, hectares	Waste height, meters	Time taken, months	Total cost, Rs. millions	Cost / cubic meter	Remarks
2002-2003	Nasik	11.6	5	3	6.4	Rs. 110	Stadium construction
2003-2004	Madurai	12	2	1	0.75	Rs 3	Vegetable growing
2003-2004	Mumbai, Gorai	1	10	3	1	Rs. 110	Creation of extra landfill space
2003-2004	Hyderabad, Autonagar	3	20	24	NA	NA	Garbage overflow on forest land removed
2006	Pune, Demo	1	10	NA	NA	NA	Dumpsite rehabilitation
2007	Hyderabad,	19	0.2	<60	NA	NA	Agreement signed

Summary

Bioremediation is a nature-centric waste management technique. Alternative waste management technologies (AWT) are alternates to landfills and use thermal and biological treatment to clean up residual contamination. Soil conditioning, leachate management, and land reclamation are covered under this. Bioreactor landfills and pre-treatment landfills are two modifications to conventional landfills. Different forms of composting also fall under the purview of these technologies. Reclamation relies heavily on AWT. Basic steps as well as pros and cons of reclamation and bioremediation are explained in the chapter. Treatability of xenobiotics, heavy metals, different kinds of plastics as well as treatable contaminants has been discussed in this chapter.

Self Assessment Questions

- Discuss on advantages and disadvantages of insitu and ex situ bioremediation.

Further Reading

1. Land reclamation project for MSW dumping sites: https://www.youtube.com/watch?v=UE3oTugECdM2
2. Gurugram-Faridabad Dumpsite Bioremediationhttps://www.youtube.com/watch?v=yqT69-0CpkU
3. Almitra Patel presentation on city compost https://www.youtube.com/watch?v=kEtgoorOBoY
4. Water Supply, Sewerage, Waste Management Remediation Activities – Sewerage – National career service – India https://www.youtube.com/watch?v=vG1neW_yeGY
5. Talk on 'Revaluing Waste Land In Liberalizing India: The New Land Acquisition Act As a Polanyian Double Movement' by Dr. SaiBalkrishnan https://www.youtube.com/watch?v=555q9RBmtu4
6. Landfill remediation, MSW baling and wrapping with MAC 111 L in Asia Pacifichttps://www.youtube.com/watch?v=_Rttz_2BIGI

7. Biotransformation and Biodegradation
   https://www.youtube.com/watch?v=t5NrhKdXgwQ&list=PL1dLFV0gU8pUbU6gwoLdSR1jtqwmVT42S
8. Bioremediation webinar series
   https://www.youtube.com/watch?v=WkvtMEanJRg&list=PL1dLFV0gU8pUbU6gwoLdSR1jtqwmVT42S&index=6
9. Biodegradation and Bioremediation of Organic Compounds
   https://www.youtube.com/watch?v=H4PFpQLy1F8&list=PL1dLFV0gU8pUbU6gwoLdSR1jtqwmVT42S&index=2
10. Webinar series principles and practices of Bioremediation
    https://www.youtube.com/watch?v=aQ9O8X0JiL8
11. Bioremediation lecture series : https://nptel.ac.in/courses/105107173/35
12. Bioremediation methods and applications https://slideplayer.com/slide/695440/
13. Natural Attenuation of Groundwater Contaminants: New Paradigms, Technologies, and Applications https://www.coursera.org/lecture/natural-attenuation-of-groundwater-contaminants/requirements-for-biodegradation-5sOmO
14. Biodegradation of xenobiotic compounds https://www.powershow.com/view/3b1d35-NzdlY/Biodegradation_of_Xenobiotic_Compounds_Xenobiotics_powerpoint_ppt_presentation
15. Studies on heavy metal concentration and eutrophication through polluted Lakes and mitigation through Bioremediation – a case study on Byramangala lake, ramanagram district, Karnataka
    http://www.kscst.iisc.ernet.in/spp/37_series/spp37s/synopsis_seminar/028_37S1386.pdf
16. Oil spill project:
    https://www.youtube.com/watch?v=l1qOuDa-8LQ,
    https://www.youtube.com/watch?v=RhXwJtm4Jg0
    https://www.youtube.com/watch?v=kQl5YFDteEI

Chapter 3
Eco-Friendly Technologies
(Landfill Reclamation Projects)

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Objectives

- To provide detailed insights on Landfill reclamation projects, approach and criteria based framework, classification of wastelands.
- To understand how wastes can be used as fill material.

Structure

3.1 Landfill Reclamation Projects
3.2 Waste Lands-Classification and Reclamation
3.3 Use of Waste as Fill Material in Land Reclamation
3.4 Criteria Approach

To Do Activities

4 Explain about reclaimed land to the students. Let students share their knowledge and experience, especially from the locality.
5 Teach students that pollution and malpractices in agriculture have left much of the fertile land barren- saline or eroded. Teach the students how to revive the fertility of soil using the techniques mentioned in this chapter.
6 Using map of locality, identify a piece of land which has the potential to be restored. Teach students about the use of GIS tools for this process.
7 Take the necessary permission (from the private/ government land owner) to experiment with a small patch of degraded land. Make a field visit to the area and conduct the stepwise plan for land restoration.
8 Visit a site of a land reclamation site near you. This could be barren land, marshy area, old landfill or locality. Study use of waste material as fillers. Find out the precautions and measures being taken to conduct this activity.
9 Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

3.1 Landfill Reclamation Projects

Reclamation term is sometimes referred to as land reclamation or as land fill, is the method of making new or simulated land from waste lands, riverbeds, lake beds, or oceans. The freshly created or rescued land is considered as reclamation ground. Any landfill reclamation project should first assess and plan the following aspects for an effective approach based framework:

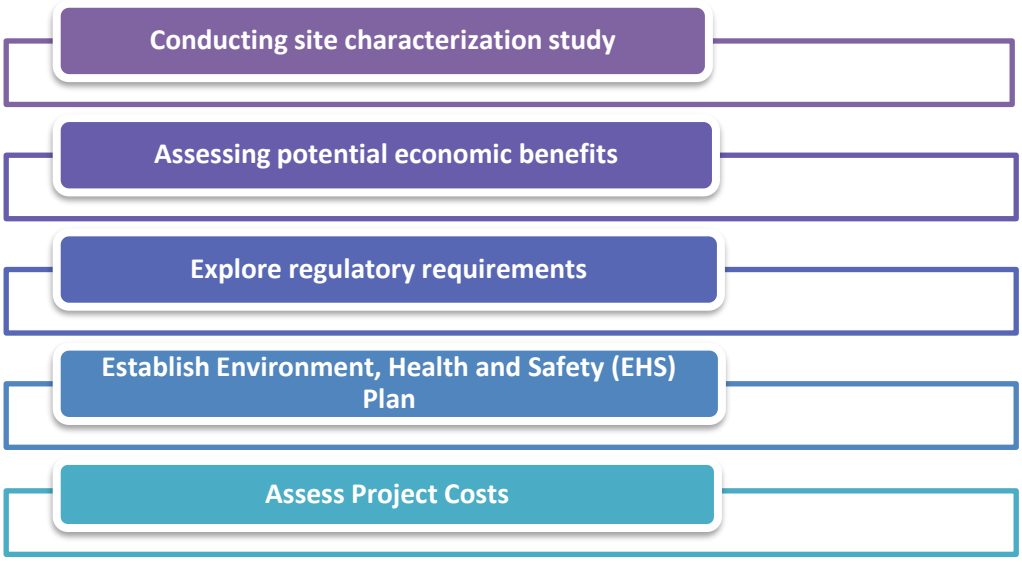

Fig 3.1 Step- Wise Planning Approach

Planning step sequence is undertaken so that during the subsequent project planning, interim assessment of project feasibility after each planning step is taken care of. Once these five steps are done, a feasibility study providing costs as well as benefits is done and a complete final assessment with review of the project, objectives and considerations in undertaking waste reclamation projects is prepared. The following is the detailed step wise planning approach:

1. Conducting Site Characterization Study

The first step in landfill reclamation project is site assessment to establish which portion of landfill that will undergo reclamation and estimate a material processing rate. The site characterization should assess capacity aspects, such as geological features, stability of the adjoining area, and proximity of ground water, and should determine the fractions of usable soil, recyclable material, combustible waste, and hazardous waste at the site.

2. Assess Potential Economic Benefits

The facts collected in site characterization study provide project with a basis for assessing the potential economic benefits of undertaking a reclamation project. If the planners identify possible financial benefits, then the assessment will provide support for further investing in project planning. Although economics are likely to serve as the major incentive for any reclamation project, other deliberations such as a communitywide commitment to recycling and environmental management is also given consideration.

Most of the potential economic benefits associated with landfill reclamation are indirect; however, a project can generate revenues if markets exist for recovered materials and also based on facility specific projects. The key points to look into are: 1. Increased disposal capacity 2. Reduced costs of:

- Landfill closure
- Post-closure care and monitoring
- Purchase of additional capacity or sophisticated systems
- Liability for remediation of surrounding areas.

Revenues from:

- Recyclable and reusable materials (e.g., ferrous metals, aluminum, plastic, and glass)
- Combustible waste sold as fuel
- Reclaimed soil used as cover material, sold as construction fill, or sold for other uses.
- Land value of sites reclaimed for other additional uses

3. Explore Regulatory Requirements

Landfill reclamation operations are expected to foresee all the regulatory requirements before undertaking any reclamation project.

4. Establish Environment, Health and Safety (EHS) Plan

After project planning stage, establishing a general framework for the landfill reclamation project in terms of environment, health and safety risks which the facility workers shall pose and damage to environment is required. Once potential risks are identified from the site characterization study and all the facts about facility operations, methods to mitigate or eliminate them are developed, a comprehensive EHS program charter is prepared. At the beginning of reclamation projects operations, all the facility workers who will be involved in the project should be provided with training and emergency response procedures. Environment, safety and health plan can be particularly challenging given the difficulty of accurately characterizing the nature of material buried in a landfill. Project workers are also likely to encounter some hazardous materials; therefore, the health and safety program should account for a variety of materials handling and response scenarios.

Although the environment, health and safety program should be based on site-specific conditions and waste types, as well as project objectives, a typical program should include:

- Communication kit: to inform personnel of potential risks.
- Personal Protective equipments: hard hats, steel-toed shoes, safety glasses and/or face shields, protective gloves, and hearing protection, respiratory/breathing apparatus, gas monitoring equipment /oxygen analyzer to alarm during emergencies
- Standard operating procedures and manual at the site
- Confined workspace safety procedures
- Dust and noise control.
- Medical surveillance
- Safety training that includes accident prevention and response procedures regarding hazardous materials.
- Recordkeeping

5. Assess Project Costs

The facts collected from the preceding steps are used to evaluate the estimated capital and operational costs of a landfill reclamation operation. Along with the expenses incurred in project planning, project costs should also include following:

Capital Costs

- Site preparation
- Rental or purchase of reclamation equipment
- Rental or purchase of personnel safety equipment

- Construction or expansion of materials handling facilities
- Rental or purchase of hauling equipment

Operational Costs

- Labour / workforce (for equipment operation and materials handling).
- Equipment fuel and maintenance costs
- Landfilling non-reclaimed waste or noncombustible fly and bottom ash if waste material is sent off site for final disposal
- Administrative and regulatory compliance expenses (e.g., recordkeeping)
- Worker training in safety procedures costs

Part of the cost analysis /cost –benefit involves determining whether the various aspects of the reclamation projects will result in reasonable costs relative to the anticipated economic benefits. It needs to consider whether capital costs can be minimized by renting or borrowing heavy equipment or machinery, such as excavating machinery, as such measures results in cost savings.

3.2 Waste Lands-Classification and Reclamation

Wastelands are lands which are unproductive, unfit for cultivation and other economic uses due to erosion of soils. The lands which are waterlogged and saline are also termed as wastelands. The loss of fertility followed by erosion also leads to the conversion of marginal forest lands into wastelands. In case of proper land management policy, geomorphic processes become active due to which soil layers are eroded and transported, making these lands infertile and useless. Therefore conservation of soil, protecting the existing cultivable lands and reclaiming the already depleted wastelands is a priority concern for land management.

Classification

1. Barren and uncultivable wastelands
2. Cultivable reclaimed wastelands
3. Salt-affected lands have been grouped into two main categories:
    - Saline soils-containing excess neutral soluble salts
    - Alkali soils having excess exchangeable sodium.
4. Mining Dump is also wasteland class
5. Sand dunes are a dominant wasteland class. This land could be made fertile by putting one or two cm thick layer of bio-compost and then mixing that with soil by plugging (Manoj and Sunil Kumar, 2017).

Reclamation of Wastelands

The different methods used for the reclamation of wastelands are:

1. These lands can be brought under cultivation by using water and fertilizers
2. Contour bunds are constructed which afford safe disposal of water of the catchment areas.
3. Application of remote sensing and GIS for wastelands reclamation.
4. Reclamation of saline soils involves leaching of soluble salts and providing adequate surface and sub-surface drainage.
5. Akali soils could be reclaimed by replacing by exchangeable sodium with calcium and its subsequent leaching beyond the root zone.

Strategies with Significant Mitigation Potential in Landfill Reclamation

- Direct reduction of greenhouse gas emissions :

    - Landfill methane recovery and utilization
    - Optimizing methane oxidation in landfill cover soils
    - Escalating sanitation practices and wastewater treatment
    - Recovery and utilization of biogas from anaerobic digestion
    - Reducing fossil fuel use during transport and processing
- Averting greenhouse gases generation
    - Composting
    - Incineration and other thermal processes
    - Mechanical and Biological Treatment (MBT)
- Averting waste generation, fossil fuel offsets
    - Recycling
    - Reuse
    - Waste minimization

Strategies of landfill gas utilization include

- Direct use as boiler fuel
- Onsite generation of electricity
- Conversion of landfill gas to synthetic natural gas by removal of CO_2 and trace components, however it is most expensive

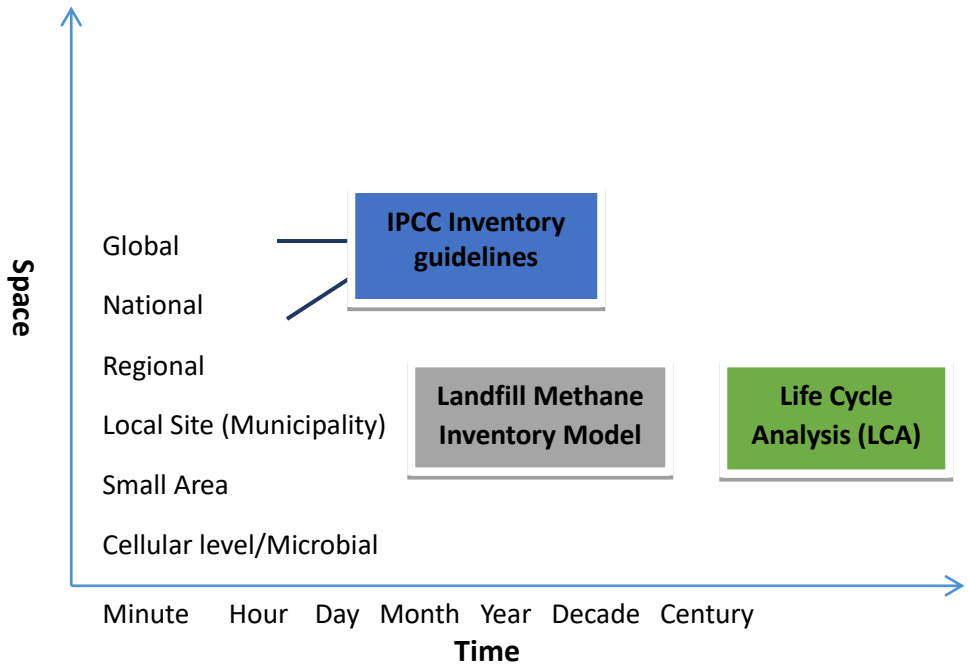

Fig 3.2 Scale of Method/Model/Calculations for GHG Accounting (Jean Bogner, 2009)

3.3. Use of Waste as Filling Material in Land Reclamation

Waste can be a good substitute for soil in the land reclamation. The use of waste as substitute for soil could solve a lot of problems due to lack of dumping grounds, if they exist and also the serious environmental and health hazard that it poses. The following questions arise when land reclamation projects consider use of waste as fill material.

1. How could waste be an interesting substitute for sand as fill material in land reclamation?
2. What are the alternative ways and also the types of material as fill material within the land reclamation?

Impact

The activity of dredging can result in the degradation and loss of coastal resources including foreshores, wetlands and wader bird habitats. Reclamation can also adversely affect coastal processes and scenic landscape values (Groot, 1979).

- Dredging involves the removal of seabed material or naturally accreted shoals. The footprint can be large, but ultimately depends upon the volume of material dredged.
- Removal of material from the seabed can significantly modify waves and currents reaching the shoreline.
- Sediment volume available for transport to the shoreline could be reduced due to sediment trapping in the dredged pit.
- There is potential for nutrients and pollutants to be released from sediment extracted from the seabed and released into the water column.

Therefore, the need for any reclamation work, as well as the extent and nature of any potential adverse impacts of this activity on coastal processes/resources and their values must be examined wisely.

In the case of waste water resulting from reclamation and contaminated water exuded through the landfill undergo surface aeration through floating aerators and biological oxidation treatment in a high-efficiency oxidation pond divided by permeable partitions. Concerning landfill layers above sea level, each layer is provided with a guide zone to which landfill gas is led for combustion at the end of the zone, to promote waste decomposition. In addition to the these efforts, all possible environmental monitoring measures are considered, including water examinations in the area surrounding the disposal site to check COD (chemical oxygen demand), BOD (biochemical oxygen demand), suspended solids and other values, and ensure that there is no environmental impact.

1. **Traditional Land Reclamation (Sand Filling Approach)**

The traditional land reclamation under tidal water involves filling land (mostly sand) under tidal water to a level above the high water mark to make the land suitable for a particular purpose. One of the most applied land reclamation methods is the Polder model. A polder is a reclamation area, surrounded by a closed loop of flood protection elements (sea defenses, dikes, water management system) to separate the water regime inside the polder areas from the water regime outside and to control the water table inside the area. A partial landfill is applied to improve the accessibility in the polder area. Hardened shores (seawalls, revetments, etc.) are an important part of land reclamation. A hardened shoreline refers to any coastal defense structure, generally constructed of concrete or rock, that is located along the shoreline within (or above) the intertidal zone. These structures are designed to protect the backing upland areas from flooding and/or coastal erosion. Depending upon the presence of fronting beach deposits, these structures can be exposed to wave action for some or all of the tidal cycle (Nene F. Barry, 2013).

Marine dredging is characterized as large-scale "capital" dredging for the creation of new projects. Capital dredging works generally describe a solitary process of excavation to enable development at a site, or to extract resources for use in a development at a remote location (e.g., building aggregate or sand). Dredging methods are divided into two primary categories, hydraulic and mechanical, with each consisting of a variety of equipment types. The impacts will vary between the individual extraction methods, with many involving some form of disturbance or excavation of the seabed while others simply involving suction of unconsolidated material from the seabed (Nene F. Barry, 2013).

2. The Use of Waste within Land Reclamation

In this type of land reclamation, waste is used as fill material instead of sand. Land reclamation is selected for different purposes.

- **Creating waste disposal sites:** This refers typically to offshore waste disposal landfills which are turned into natural areas (green zones, parks, golf courses etc.) after reclamation. In this case the reclaimed land is not stable and strong enough and therefore cannot be used for other urban development purposes, but issued for greenery or recreational purposes.
- **Creating new land for urban development plan:** These may range from residential and cultivation purposes to major development projects such as tourism, individual/commercial business ventures, and other infrastructural improvement. Here, the use of waste is only chosen when proven to be able to replace the use of sand and the traditional way of land reclamation and also when proven to be economically more attractive.

Land Reclamation Method with the Use of Plasma Gasification Slag as Fill Material

In this method, the land is covered by using slag residue of the plasma gasification and being able to use sheet piles as there is no geo-membrane in the way. Also, the quality and availability of the slag will determine whether the alternative of plasma gasification is suitable or not.

Land Reclamation Method with the Use of the Strengthened Sediment Technology

In this method, the land is covered by using strengthened sludge, where eventual contaminants are immobilized. Strengthened sediment is of good use as a substitute of sand and rubble within land reclamation projects. With this technique, dredged or excavated sludge or soft material is strengthened on-site using secondary building materials and could be directly used as fill material. There is no segregation of the mixture, when being applied. The mixture hardens within a sufficiently short time preventing any flow out.

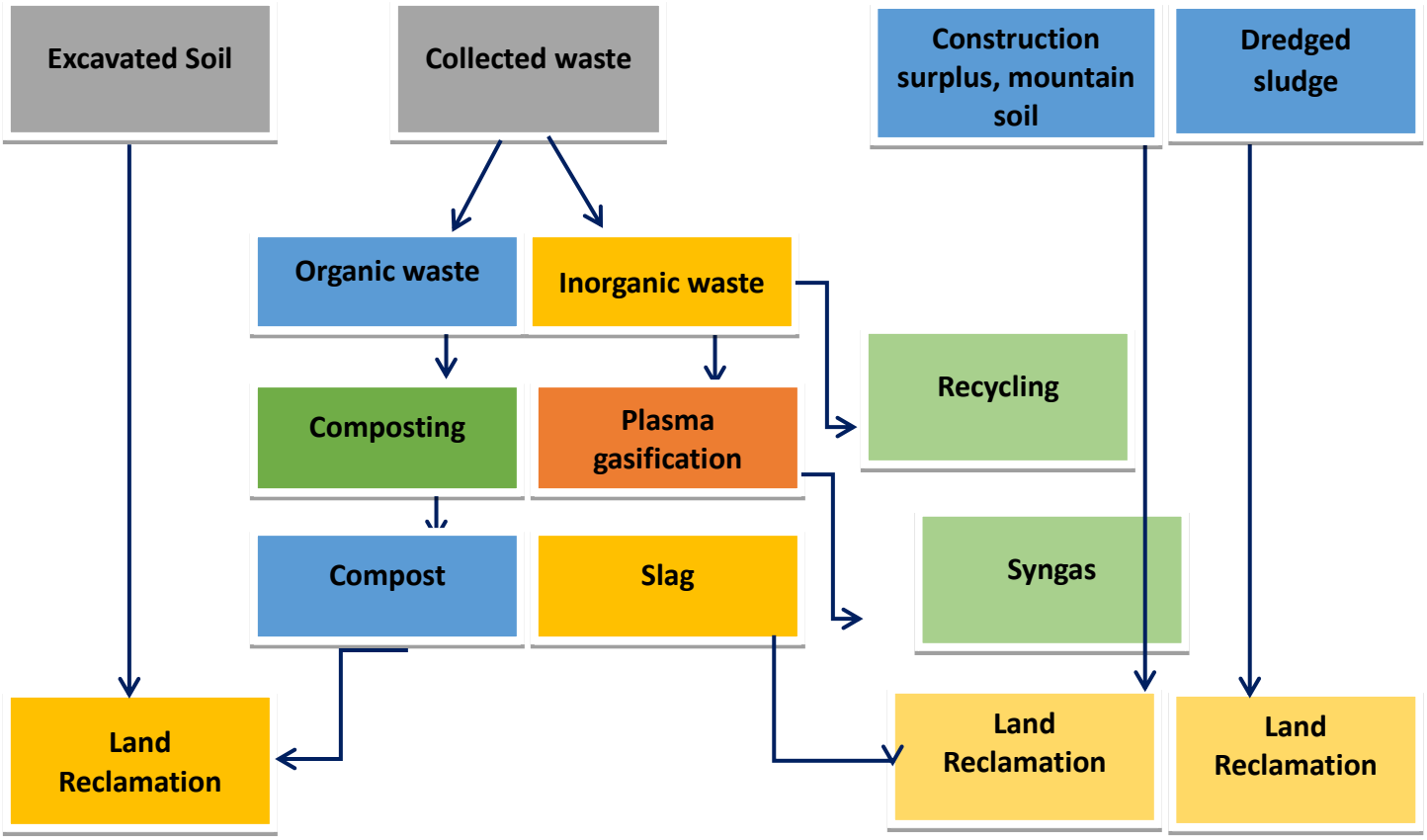

Fig 3.3 Overall Structured Framework of Land Reclamation

3.4 Criteria Approach

Alternative or a combination of alternative methods of using waste within landfill reclamation can be based on Triple Bottom Line (people, planet ad profit) principle having a conjunctive approach of Multi Criteria Analysis (MCA).The conjunctive approach is about minimizing risks, making sure the most favourable alternative is determined.

The Triple Bottom Line is an accounting framework that incorporates three dimensions of performance: Environmental, Social and Economic. MCA is a structured approach used to determine overall preferences among alternative options allows including a full range of social, environmental, technical, economic, and financial criteria.

Criteria of the MCA of the Alternatives

- The final product in this case is the reclaimed land
- The process is the approach of land reclamation; the use of waste and the way waste is used.

Table 3.1 Triple Bottom Line Approach

Planet : Environment Aspects	
Pollution	This aspect refers to any environmental pollution created or avoided by each alternative method of land reclamation and its corresponding waste management; air pollution through waste transportation, possible pollution through waste treatment methods etc.
Waste	The impact of each alternative land reclamation method on the waste management system, leachate or any pollution of waste within the site's surrounding water
Energy	The impact of each alternative land reclamation method on existing energy production methods and energy consumption
Water	The impact of each alternative land reclamation method on the water quality and flood risks.
Materials	The impact of each alternative land reclamation method on the use of exhaustible materials, recycled materials and sustainable materials
Biodiversity	The impact of each alternative land reclamation method on the conservation and creation of landscapes and greening
People: Social Aspects	
Health	The impact of the new reclaimed land on the general health and the impact of the used reclamation and waste management methods and techniques on the general health.
Safety	Safety across the site and within the land reclamation and corresponding waste management process
Participation	Involving participation of the dwellers in decision making processes and implementation
Comfort	The impact of each alternative land reclamation method on the comfort ofthe stakeholders and inhabitants, during and after reclamation
Cohesion	The impact of each alternative land reclamation method on the social cohesion of the inhabitants
Profit: Economic Aspects	
Prosperity	The impact of each alternative land reclamation method on the wellbeing of all involved stakeholders

Affordability	Affordability of each alternative land reclamation method compared to the land reclamation method where sand is used as fill material
Transparency	The impact of each alternative land reclamation method on transparency between stakeholders
Employment	The impact of land reclamation method on employment, and creation of (new) employment
Accessibility	The impact of land reclamation method on the accessibility around the site, during land reclamation
Manageability	Management aspects and impact of land reclamation

Coarse Rejects Must Not be Wasted[3]

Coarse fractions of stabilized waste have a wonderful healing effect on saline or alkaline soils, especially fields which have become less fertile over time or have developed a full white crust of salt on the ground, where nothing grows. This has been proven in small field trials in Kutch and Maharashtra. In Karnataka alone, 42 lakh hectares or 22% of arable (cultivable) land suffered from alkalinity or nutrient imbalance in 1990 and recent surveys report an alarming increase in such infertile acreage.

Karnataka's Director CADA (Command Area Development Authority) has agreed in principle to conduct demonstration field trials in two irrigation basins suffering salinity. In the Cauvery Basin, rejects from the Mysore or Bangalore compost plants will be tried in Maddur Taluk. A fine mixture of organics and soil called bio earth is produced in the prices of 'Bio-mining' of old open waste dumps to reclaim materials and space. Old mixed waste is unmixed, by sieving and sorting, into plastics, cloth, stones and sand, etc. Bio earth fortified with soil microbes can improve saline and alkaline soils.

Coarser organic fractions can easily break down over time in the soil and add good humus as well as essential microbes to improve soils and plant growth. They can be mixed with soil and usefully added into tree pits for horticulture (mango, guava, grape etc) or for agro-forestry or forestry. When ploughed into crop fields, coarse organic matter makes the soil porous and water-holding and promotes strong root systems for healthy and productive plants.

Almost half of the incoming waste ends up as such coarse rejects, returning to a landfill where it contributes to volume, bio-methane and leaching. FCO standards for compost require it to be finer than 4mm before enrichment and sale, so as to keep out broken glass and plastic fragments and make it easy for spreading. For this multiple levels of sieving are done. The rejects from the sieveing, such as lignin-rich twigs that take longer to compost become coarse rejects. Cement industries do not want them due to their high moisture content.

The cost of transporting coarse rejects from compost plant to barren fields cannot be borne by farmers But the benefit to the nation is enormous, especially when so much good land is lost to growing cities. So such application will need to be subsidized just as gypsum application is subsidized.

[3] http://www.almitrapatel.com/composting.htm#

Summary

This chapter discusses landfill reclamation projects, beginning with a stepwise approach. Reclamation of wastelands discusses their classification and strategies to reclaim soil from excess salinity, alkalinity and proper drainage in waterlogged areas. GIS is an effective tool to map the extent of wasteland. Different strategies are employed where methane production is observed. By recovering methane we avert greenhouse gas generation. Using waste as fill material has to be taken up very carefully. Improper planning can lead to irreparable damage. Traditional approach, triple bottomline approaches are both explained here. Case studies on Mumbai land reclamation, application of coarse rejects of compost and plasma are explained.

Self Assessment Questions

1. What are the different wastes that are being used as fill material in land reclamation project in your city?

Further Readings

- Developing a strategic approach to construction waste: Interim report: Waste reclamation survey http://www.wrap.org.uk/sites/files/wrap/Developing%20a%20Strategic%20Approach%20to%20Construction%20Waste%20-%20Interim%20Report%20-%20Reclamation%20Survey.pdf
- Mumbai Land Reclamation : https://www.downtoearth.org.in/news/haphazard-land-reclamation-fuelled-mumbais-maximum--dreams-40745
- Garbage to Gold , C. Srinivasan VIT Vellore https://www.youtube.com/watch?v=6357WexayZU
- How Plasma can fix our waste problem : Tom Whitton : TEDx Montreal https://www.youtube.com/watch?v=VquomoGn4zk

Chapter 4
Soil Restoration
(Implementation Analysis – Land Reclamation)

Objectives

- To understand land reclamation projects implementation approach through SWOT analysis, various check points while during implementation, scenario development on land reclamation.
- To understand how to conduct implementation analysis – SWOT and MCA (Multi-Criteria Analysis) approach, also through questionnaire

Structure

4.1. Implementation Analysis – Land Reclamation
4.2. How to do a SWOT Analysis
4.3. Implementation of Land Reclamation sample checkpoints
4.4 Land Reclamation – Scenario development

To Do Activities

1. Do a SWOT Analysis for lifepath, or career choice; or, a simple exercise like choosing to ride a bicycle to college instead of public transport.
2. After understanding the SWOT methodology, conduct this exercise for a reclamation project in your area, or a project you have read about in the news.
3. Conduct practical activity and explain implementation checkpoints.
4. Study a population vs. economy scenario development. Apply the methodology to land reclamation.
5. Examine the five case studies mentioned in the chapter.
6. Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

4.1 Implementation Analysis – Land Reclamation

SWOT Analysis

For the implementation analysis, firstly the application of alternative method of land reclamation will be evaluated followed by process steps of system dynamic models and methods. Then a SWOT analysis is conducted to evaluate the strengths, weaknesses, opportunities and threats of the method leading to the establishment of implementation conditions, which are then checked against the governmental, social, environmental and economic aspects.

The system dynamics model below shows the process steps of the fill materials (compost, slag, excavated soil, mountain soil and dredged sludge) from the origin towards land reclamation.

Table 4.1 SWOT Analysis

Strengths		Weakness	
S1	Reuse of waste and sludge in an environmental friendly manner	**W1**	Manageability issues due to the combination of several technologies and the differences with conventional method (use of sand)
S2	Improvement of the water quality and creation of better public health	**W2**	Irregularity due to technologies as it consumes time to adapt and implement to the new technology
S3	Efficient Waste Management system	**W3**	Costly plasma gasification investment
S4	Societal participation	**W4**	Limited flexibility of use of the reclaimed land
S5	Economically feasible alternatives	**W5**	More stakeholders participation and engagement is required for better implementation and outcomes
S6	Facilitating the creation of more Green spaces due to soft soil		
S7	Practice of using waste instead of sand		
Opportunities		**Threats**	
O1	Significant reduction in environmental pollution	**T1**	Unavailability of enough fill material (Construction debris, excavated earth etc.)
O2	Application of varied technologies and advancement	**T2**	Changes within governmental policy
O3	Integration of waste management and energy production	**T3**	Inadequate functioning of the waste management system (collection, sorting, composting, gasification)
O4	Creation of employment opportunities	**T4**	Lack of support to regulatory enforcements ; example plastic ban, recycling, source segregation
		T5	Changes within the existing social structure of waste management system

How to Do a SWOT Analysis

- **Determine the objective.** Decide on a key project or strategy to analyze and place it at the top of the page.
- **Create a grid.** Draw a large square and then divide it into four smaller squares.
- **Label each box.** Write the word "Strengths" inside the top left box, "Weaknesses" inside the top right box, "Opportunities" within the bottom left box, and "Threats" inside the bottom right box. These are titles, so they should be distinguished from the rest of the text using either color or font size.
- **Add strengths and weaknesses.** Add factors that affect the project to the applicable boxes. Components of a SWOT analysis may be qualitative and anecdotal as well as quantitative and empirical in nature. Factors are typically listed in a bullet form.

- **Draw conclusions.** Analyze the finished SWOT diagram. Be sure to note if the positive outcomes outweigh the negative. If they do, it may be a good decision to carry out the objective. If they do not, adjustments may need to be made, or else the plan should simply be abandoned.

4.2. Implementation of Land Reclamation sample checkpoints

Table 4.2 Implementation Sample Checkpoints

Basics	Answer Yes/No	Explanation	Possible suggestive and Measures
Commitment of the stakeholders		It is yet not clear whether all involved parties are willing to commit to the plan	An all stakeholder forum for acceptance or rejection of whole plan
Role and responsibility of all stakeholders		No single authority is charged with the development and implementation of solid waste management goals and policies. Instead, policy development is divided among several authorities and ministries, and implementation is the responsibility of each municipality There is no public participation in decision making	
Waste Sorting (at source level)		Most of the people do not usually conduct waste sorting	Public consultation and public participation as an integral part of waste sorting capacity building
Maximized waste Collection rate		Handling waste is perceived as a voluntary activity, though of late mandatory collection of wet and dry waste is being done. There is lack of seriousness for the concept of producers' responsibility and on polluters pay strict enforcement	Awareness and capacity building, strict enforcement of rules and regulations
Landfill sites		Abandon landfills which are not working	The willingness of the government and those involved parties to close the landfill sites that needs to be abandoned.
Waste sorting facilities		No space being provided for waste	Waste sorting facilities should be part of the

Before treatment		sorting after collection	waste treatment system.
Waste composting		If appropriate mechanisms, incentives, space/infrastructure and technical information or know-how is provided public participation and other stakeholder involvement in composting shall increase. Lack of space is a key hindrance	Training and capacity building in composting which is already in place since many years at few cities and villages. A further strategic community level composting can further strengthen the cause.
Waste gasification (gasification plant)		The willingness to invest in a plasma gasification plant as priority - Is it possible?	R & D on investment opportunities for plasma gasification plants
Energy resale to energy company		Are the investors and projectors keen on /or show willingness to invest in sustainable energy procurement /waste to energy /resale to energy starved companies	Design a suitable plan for its participation
Investing in waste treatment and transport or buying the fill material		Investment in alternative fill material	The societal acceptance of the whole plan
Relocation /Resettlement/Rehabilitation		The relocation of the people who live in the vicinity of the channels	The societal acceptance of the whole plan
Channel dredging		Necessary for the safety and defense against floods	An EIA need to be done before starting with dredging. Safeguards need to be taken to minimize environmental impacts
Sludge dredging from seabed		Dredging the sludge	An EIA need to be done before starting with dredging. Safeguards need to be taken to minimize environmental impacts

Application of strengthened sediment technology		Irregularity due to technologies as it consumes time to adapt and implement to the new technology	Implementation as well as the stakeholders' willingness to opt for the technology needs to be evaluated
Availability of sufficient fill material		The availability of sufficient fill material (construction waste, mountain soil, excavated soil and sludge)	The availability of sufficient fill material in future scenario needs to be evaluated

4.3. Land Reclamation – Scenario Development

Scenarios are stimulating and possible outcomes about how the future might unfold; diverse ways in which relevant issues might evolve. Because scenarios are hypotheses, they are created and used in sets of multiple scenarios that capture a range of future possibilities. The below figure shows most favourable simulated scenario for implementation of land reclamation in a place /regions based on the place's demography and economy.

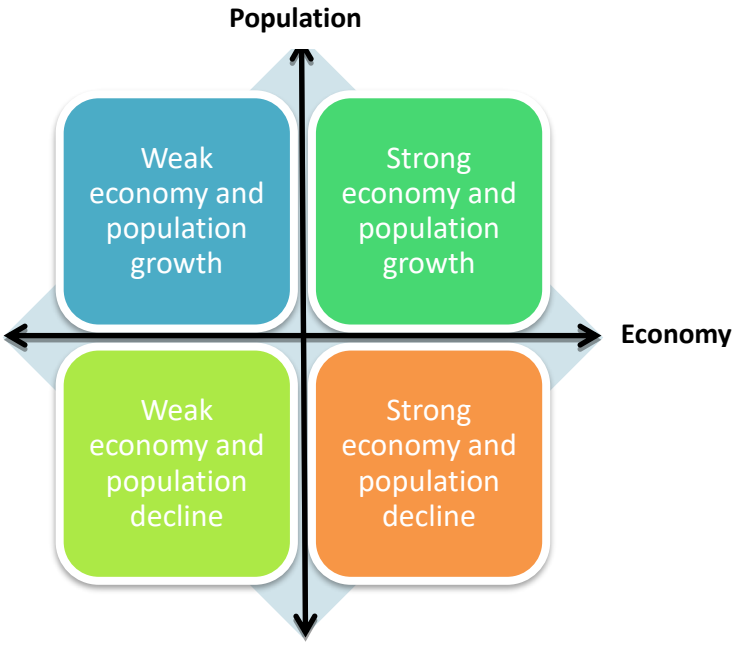

Fig 4.1 Scenario development

Strong Economy and Population Growth

More manufacture leads to more excavated soil from manufacturing work sites and therefore more alternative fill material for land reclamation. Population growth combined with wellbeing leads to more consumption and more waste production. There is more money available for technological innovations. The higher life standards demands adequate waste management system and more environmental responsibility, leading to more processed waste and dredged sludge due to the widening of the place's channels and resulting in the production of more alternative fill material for

land reclamation. This scenario is the most favourable for the use of waste as alternative fill material within land reclamation projects.

Weak Economy and Population Growth

The difference amongst the different strata's of society is eminent as the wealth gap shows increasing trend. Investors abandoning the land reclamation area, limiting its possibility are an example. The methods for excavation, dredging and other such practices are not really sustainable as moving ahead waste open dumping and in case of manufacturing products, wastes are burnt onsite.

Weak Economy and Population Decline

This scenario is more realistic as it is more common to see how people migrate away from declining economies. Here it is intended that revenues from land sales would be used for financing the land reclamation project moving ahead. However, if there were a population decline, that would be detrimental for the project, the economy shall affect both public and private parties and there is no easy way of investing into neither an adequate waste management system nor innovative technologies for land reclamation or even the conventional way of land reclamation.

Strong Economy and Population Decline

Irrespective of populations living in the area or not, this project could still be carried on. The developers and investors have enough money to develop the area and at least generate employment within the waste management system, for the land reclamation projects during the development process and the spatial development program. Economic and other drivers are sometimes all that is required to undertake a project that could look somewhat non-profitable. However because of the population decline, leading to low waste production and low construction demand, the availability of alternative fill material for land reclamation could be very low.

Summary

Land reclamation is an expensive, tedious, long duration process. To ensure its success, SWOT analysis is an important pre-requisite for the implementation analysis of any land reclamation project. A sample checklist is explained for the implementation. Next, a scenario is developed. Scenarios are hypothesis to be simulated. The most favorable scenario is selected for implementation.

Self Assessment Questions

1. Prepare a checklist of different wastes which are used as fill material in reclamation projects.

S.No.	Purpose – which project	Type of waste	Whether used as fill material (Yes/No), if yes specify the reasons for its use

Further Reading

1. Land Reclamation Using Waste as Fill Material: A Case Study in Jakartahttps://waset.org/publications/15500/land-reclamation-using-waste-as-fill-material-a-case-study-in-jakarta
2. Mumbai Case Study - Land Reclamation : BKC - http://www.ramboll.com/-/media/files/rgr/lcl/bgi_final-report_mit_mumbai_20160403.pdf?la=en
3. Use of wastes as fill material in land reclamation https://www.ofcoursecme.nl/?mdocs-file=2826
4. SWOT Analysis - Zero wastehttp://www.medzerowaste.eu/deliverables/SWOT%20Analysis.pdf
5. SWOT analysis and sustainable business planning. An IKEA case studyhttps://businesscasestudies.co.uk/ikea/swot-analysis-and-sustainable-business-planning/strengths.html
6. SWOT Analysis: https://www.youtube.com/watch?v=I_6AVRGLXGA

Chapter 5
Phytoremediation

Objectives

- To provide details on different phyto-remediation techniques and how through plant processes uptake and removal of contaminants is done.
- To provide details on what design considerations are needed for phytoremediation.

Structure

5.1 Introduction to Phytoremediation
5.2 Plant Processes
5.3 Different Phytoremediation Methods
5.4 Phytoremediation - Design Considerations

To Do Activities

1. View videos on toxic realities and phytoremediation.
2. Conduct practical exercise, visit to a riparian habitat.
3. Organise a seminar on plants used for phytoremediation
4. Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

5.1 Introduction to Phytoremediation

Phytoremediation is a technique which uses plants to partially or substantially remediate contaminants in contaminated soils, sludge, sediment, groundwater, surface water and waste water. It involves utilization of varied plant processes and physical characteristics of plants to aid site remediation. It is a continuous process with each process occurring at differing degrees or variations for different situations, media, contaminants and plants. Phytoremediation enees number of different methods that can lead to contaminant degradation, removal (through accumulation or dissipation), or immobilization:

1. Degradation (for destruction or alteration of organic contaminants).
    - Rhizodegradation: enhancement of biodegradation in the below-ground root zone by microorganisms.
    - Phytodegradation: contaminant uptake and metabolism above or below ground, within the root, stem, or leaves.

2. Accumulation (for containment or removal of organic and/ or metal contaminants)
    - Phytoextraction: contaminant uptake and accumulation for removal.
    - Rhizofiltration: contaminant adsorption on roots for containment and/or removal.

3. Dissipation (for removal of organic and/or inorganic contaminants into the atmosphere).
    - Phytovolatilization: contaminant uptake and volatilization

4. Immobilization (for containment of organic and/or inorganic contaminants).
    - Hydraulic Control: control of ground-water flow by plant uptake of water.
    - Phytostabilization: contaminant immobilization in the soil.

Vegetated caps, buffer strips, and riparian corridors are applications that combine a variety of these methods for contaminant containment, removal, and/or destruction. The different forms of phytoremediation are discussed individually below. With each phytoremediation method, it is necessary to ensure that unwanted transfer of contaminant to other media does not occur.

Phytoremediation is applicable to a variety of contaminants, which includes petroleum hydrocarbons, chlorinated solvents, metals, radionuclides, nutrients, pentachlorophenol (PCP), and polycyclic aromatic hydrocarbons (PAHs). Phytoremediation requires commitment of resources and time, but has the potential to provide a low cost, environmentally acceptable alternative to conventional remedial technologies at appropriate sites.

5.2 Plant Processes

Phytoremediation takes advantage of the natural processes of plants. These processes include water and chemical uptake, metabolism within the plant, exudate release into the soil that leads to contaminant loss, and the physical and biochemical impacts of plant roots. Growth of plants depends on photosynthesis, in which water and carbon dioxide are converted into carbohydrates and oxygen, using the energy from sunlight. Roots are effective in extracting water held in soil, even water held at relatively high matric and osmotic negative water potentials; extraction is followed by upward transport through the xylem. Transpiration (water vapor loss from plants to the atmosphere) occurs primarily at the stomata (openings in leaves and stems where gas exchange occurs), with additional transpiration at the lenticels (gas exchange sites on stem and root surfaces). Carbon dioxide uptake from the atmosphere occurs through the stomata, along with release of oxygen. Respiration of the carbohydrates produced during photosynthesis, and production of ATP, necessary for the active transport of nutrients by roots, requires oxygen. Plants require macronutrients (N, P, K, Ca, Mg, S) and micronutrients (B, Cl, Cu, Fe, Mn, Mo, Zn and possibly Co, Ni, Se, Si, V, and maybe others). Lack of chlorophyll due to stresses on the plant, such as lack of nutrients, can result in chlorosis (the yellowing of normally green plant leaves). Nutrient uptake pathways can take up contaminants that are similar in chemical form or behavior to the nutrients. Cadmium can be subject to plant uptake due to its similarity to the plant nutrients calcium and zinc, although poplar leaves in a field study did not accumulate significant amounts of cadmium (Pierzynski *et al.*, 1994). Arsenic (as arsenate) might be taken up by plants due to similarities to the plant nutrient phosphate; selenium replaces the nutrient sulfur in compounds taken up by a plant, but does not serve the same physiological functions (Brooks, 1998b). For uptake into a plant, a chemical must be in solution, either in ground water or in the soil solution (i.e., the water in the unsaturated soil zone). Water is absorbed from the soil solution into the outer tissue of the root. Contaminants in the water can move through the epidermis to and through the Casparian strip, and then through the endodermis, where they can be sorbed, bound, or metabolized. Chemicals or metabolites passing through the endodermis and reaching the xylem are then transported in the transpiration stream or sap. The compounds might react with or partition into plant tissue, be metabolized, or be released to the atmosphere through stomatal pores (Paterson et al., 1990; Shimp *et al*., 1993).

Ryan *et al*. (1988) provide more discussion of plant uptake of organic compounds. Plant uptake of organic compounds can also depend on the type of plant, age of the contaminant, and many other physical and chemical characteristics of the soil. Roots can form large openings (macropores) in the soil, especially as the roots decay, which can contribute to water, gas, and contaminant transport through the soil and change the aeration and water status of the soil. The increased 'workability' of soil due to the incorporation of organic matter by plants might make the soil conditions more amenable to various types of soil treatment. Plant materials and plant roots can have chemical and biological impacts in the soil. Exudates such as simple phenolics and other organic acids can be released from living cells or from

the entire cell contents during root decay. These exudates can change metals speciation (i.e., form of the metal), and the uptake of metal ions and simultaneous release of protons, which acidifies the soil and promotes metal transport and bioavailability (Ernst, 1996). In some cases, the changed metals speciation can lead to increased precipitation of the metals. The organic compounds in the root exudates can stimulate microbial growth in the rhizosphere (the region immediately surrounding plant roots). Fungi associated with some plant roots (i.e., mycorrhizae) can also influence the chemical conditions within the soil.

5.3 Different Phytoremediation Methods

Phytoextraction

Phytoextraction is contaminant uptake by roots with subsequent accumulation in the aboveground portion of a plant, generally to be followed by harvest and ultimate disposal of the plant biomass. It is a contaminant removal process. Phytoextraction applies to metals (e.g., Ag, Cd, Co, Cr, Cu, Hg, Mn, Mo, Ni, Pb, Zn), metalloids (e.g., As, Se), radionuclides (e.g., 90Sr, 137Cs, 234U, 238U), and non-metals (e.g., B) (Salt *et al*., 1995; Kumar *et al*., 1995; Cornish et al., 1995; Bañuelos *etal*., 1999), as these are generally not further degraded or changed in form within the plant. Phytoextraction has generally not been considered for organic or nutrient contaminants taken up by a plant, as these can be metabolized, changed, or volatilized by the plant, thus preventing accumulation of the contaminant. However, some studies have shown accumulation of unaltered organic contaminants within the aboveground portion of a plant. The target medium is generally soil, although contaminants in sediments and sludges can also undergo phytoextraction. Soluble metals in surface water or extracted ground water could conceivably be cleaned using phytoextraction, perhaps in conjunction with rhizofiltration.

Phytoextraction has also been referred to as phytomining or biomining. A narrower definition of phytomining is the use of plants to obtain an economic return from metals extracted by a plant, whether from contaminated soils or from soils having naturally high concentrations of metals (Brooks, 1998a);
Plant roots generally contain higher metal concentrations than the shoots despite the translocation mechanisms. An upper limit to the metal concentration within the root can occur. Root uptake of lead by hydroponically-grown plants reached a maximum concentration and did not increase further as the lead concentration of the solution increased (Kumar *et al*., 1995).

The effectiveness of phytoextraction can be limited by the sorption of metals to soil particles and the low solubility of the metals; however, the metals can be solubilized by addition of chelating agents to allow uptake of the contaminant by the plant The chelating agent EDTA was used in a growth chamber study to solubilize lead to achieve relatively high lead concentrations in Indian mustard (Blaylock *et al*., 1997) and EDTA solubilized lead for uptake by corn under greenhouse conditions (Wu *et al*., 1999). Potential adverse impacts of chelating agent addition, such as high water solubility leading to negative impacts on ground water, or impacts on plant growth, have to be considered (Wu *et al.,* 1999). In addition, increased uptake might be specific for one metal, such as lead, while decreasing uptake of other metals;

Phytostabilization

Phytostabilization is the use of vegetation to contain soil contaminants in situ, through modification of the chemical, biological, and physical conditions in the soil. Contaminant transport in soil, sediments, or sludges can be reduced through absorption and accumulation by roots; adsorption onto roots; precipitation, complexation, or metal valence reduction in soil within the root zone; or binding into humic (organic) matter through the process of humification. In addition, vegetation can reduce wind and

water erosion of the soil, thus preventing dispersal of the contaminant in runoff or fugitive dust emissions, and may reduce or prevent leachate generation.

Effective phytostabilization requires a thorough understanding of the chemistry of the root zone, root exudates, contaminants, and fertilizers or soil amendments, to prevent unintended effects that might increase contaminant solubility and leaching. Cunningham *et al*. (1995) indicate that phytostabilization might be most appropriate for heavy-textured soils and soils with high organic matter contents. Advantages of phytostabilization are that soil removal is unnecessary, disposal of hazardous materials or biomass is not required, the cost and degree of disruption to site activities may be less than with other more vigorous soil remedial technologies, and ecosystem restoration is enhanced by the vegetation. Disadvantages of phytostabilization include the necessity for long-term maintenance of the vegetation or verification that the vegetation will be self-sustaining. This is necessary since the contaminants remain in place and future re-releases of the contaminants and leaching must be prevented.

Some hazardous waste sites are former mining or mining-waste sites that can have large areal expanses of contaminated and severely degraded soil. Saline-affected soils can also cover large areas. Reclamation and revegetation of these soils will reduce wind and water erosion and subsequent dispersal of contaminated soil, as well as promote restoration of the local ecosystem. Phytostabilization is the primary strategy to be used at these sites, but if appropriate for the contaminant, extractive phytoremediation methods, such as phytoextraction, could be used.

Rhizofiltration

Rhizofiltration (also known as phytofiltration) is the removal by plant roots of contaminants in surface water, waste water, or extracted ground water, through adsorption or precipitation onto the roots, or absorption into the roots. The root environment or root exudates may produce biogeochemical conditions that result in precipitation of contaminants onto the roots or into the water body. The contaminant may remain on the root, within the root, or be taken up and translocated into other portions of the plant, depending on the contaminant, its concentration, and the plant species. Rhizofiltration and phytoextraction are similar in that they each result in accumulation of the contaminant in or on the plant. However, in rhizofiltration this accumulation can occur in the roots or in the portion of the plant above water, whereas for effective phytoextraction the accumulation occurs aboveground, not in the roots. In addition, rhizofiltration differs from phytoextraction in that the contaminant is initially in water, rather than in soil.

Rhizodegradation

Rhizodegradation is the enhancement of naturally-occurring biodegradation in soil through the influence of plant roots, leading to destruction or detoxification of organic contaminant. Organic contaminants in soil can often be broken down into secondary products or completely mineralized to inorganic products such as carbon dioxide and water by naturally occurring bacteria, fungi, and actinomycetes. A wide range of organic contaminants are contenders for rhizodegradation, such as petroleum hydrocarbons, PAHs, pesticides, chlorinated solvents, PCP, polychlorinated biphenyls (PCBs), and surfactants. Higher populations of benzene-, toluene-, and o-xylene-degrading bacteria were found in soil from the rhizosphere of poplar trees than in non-rhizosphere soil, although it was not clear that the populations were truly statistically different. Root exudates contained readily biodegradable organic macromolecules (Jordahl *et al.,* 1997). Schwab and Banks (1999) investigated total petroleum hydrocarbon (TPH) disappearance at several field sites contaminated with crude oil, diesel fuel, or petroleum refinery wastes, at initial petroleum hydrocarbon contents of 1,700 to 16,000 mg/kg TPH.

Phytodegradation

Phytodegradation is the uptake, metabolizing, and degradation of contaminants within the plant, or the degradation of contaminants in the soil, sediments, sludges, ground water, or surface water by enzymes produced and released by the plant. Phytodegradation is not dependent on microorganisms associated with the rhizosphere. Contaminants subject to phytodegradation include organic compounds such as munitions, chlorinated solvents, herbicides, and insecticides, and inorganic nutrients.

Phytovolatilization

Phytovolatilization is the uptake of a contaminant by a plant, and the subsequent release of a volatile contaminant, a volatile degradation product of a contaminant, or a volatile form of an initially non-volatile contaminant. For effective phytoremediation, the degradation product or modified volatile form should be less toxic than the initial contaminant. Phytovolatilization is primarily a contaminant removal process, transferring the contaminant from the original medium (ground water or soil water) to the atmosphere. However, metabolic processes within the plant might alter the form of the contaminant, and in some cases transform it to less toxic forms. Examples include the reduction of highly toxic mercury species to less toxic elemental mercury, or transformation of toxic selenium (as selenate) to the less toxic dimethyl selenide gas (Adler, 1996). In some cases, contaminant transfer to the atmosphere allows much more effective or rapid natural degradation processes to occur, such as photo degradation.

Vegetated Caps

A vegetated cap (or cover) is a long-term, self-sustaining cap of plants growing in and/or over contaminated materials, designed to minimize exposure pathways and risk. The primary purpose of the vegetation is to provide hydraulic control and prevent or minimize infiltration of precipitation and snowmelt into the contaminated subsurface, thus preventing or minimizing leachate formation. This is done by maximizing evapotranspiration and maximizing the storage capacity of the soil. A cap designed for this purpose is called an evapotranspiration cap or water balance cover. The vegetation can also increase stability of the soil, thus preventing erosion, and could potentially destroy or remove contaminants through rhizodegradation, phytodegradation, or phytovolatilization. A cap designed to incorporate contaminant destruction or removal in addition to the prevention of infiltration is called a phytoremediation cap. A vegetated cap can be constructed over landfills, or over contaminated soil or ground water. Long-term maintenance of the cap might be required, or the cap vegetation may be designed to allow an appropriate plant succession that will maintain the cap integrity.

Buffer Strips

Buffer strips are areas of vegetation placed down gradient of a contaminant source or plume, or along a waterway (i.e., riparian corridor). The vegetation contains, extracts, and/or destroys contaminants in soil, surface water, and ground water passing underneath the buffer through hydraulic control, phytodegradation, phytostabilization, rhizodegradation, phyto-volatilization, and perhaps phytoextraction. The use of buffer strips might be limited to easily assimilated and metabolized compounds. Relatively soluble contaminants, such as nutrients and some organics (especially pesticides), have been addressed using buffer strips and riparian corridors. Agricultural runoff has been a target of buffer strips and riparian corridors.

Constructed Wetlands

Constructed wetlands or treatment wetlands are artificial wetlands that are used for treating organic, inorganic, and nutrient contaminants in contaminated surface water, municipal waste water, domestic sewage; refinery effluents, acid mine drainage, or landfill leachate. Constructed wetlands might become

an option for treatment of water extracted from hazardous waste sites, using rhizofiltration and phytodegradation.

Advantages

1. Phytoremediation has been perceived to be a more environmentally-friendly “green” and low-tech alternative to more active and intrusive remedial methods.
2. Phytoremediation can be applied in situ to remediate shallow soil and ground water, and can be used in surface water bodies.
3. Phytoremediation does not have the negative impact on soil fertility and structure that some more vigorous conventional technologies may have, such as acid extraction and soil washing (Greger and Landberg, 1999).
4. Vegetation can also reduce or prevent erosion and fugitive dust emissions.

Disadvantages

1. A significant disadvantage of phytoremediation is the depth limitation due to the generally shallow distribution of plant roots.
2. Longer time frame is likely to be required for phytoremediation, as this technology is dependent on plant growth rates for establishment of extensive root system or significant above-ground biomass.
3. A phytoremediation system can lose its effectiveness during winter (when plant growth slows or stops) or when damage occurs to the vegetation from weather, disease, or pests. A back-up remedial technology might be necessary.
4. Potential transfer of contaminants to another medium, the environment, and/or the food chain should be prevented, especially if there is transformation of the contaminant into a more toxic, mobile, or bioavailable form. Bioconcentration of toxic contaminants in plants and ingestion of those contaminants by ecosystem consumers is a concern.
5. Phytoremediation might require use of a greater land area than other remedial methods. This might interfere with other remediation or site activities.

5.4 Phytoremediation - Design Considerations

Phytoremediation is a promising technology that can be applied for remediating a hazardous waste site. If initially proposed for a site, the phytoremediation alternative will need to be compared to other remedial technologies to determine which best suits the remedial goals. It is possible that other technologies will be able to remediate the site more effectively, that several technologies will be used, or that phytoremediation can fit into a treatment train. Successful vegetation growth depends strongly on the proper climatic conditions. The correct amount and timing of precipitation, sunlight, shade, and wind, and the proper air temperature and growing season length are necessary to ensure growth. Problem considerations include mobilization of contaminants through changes in soil chemistry, immobilization of contaminants through sorption onto organic matter or through humification, changes in microbial populations, or reduction of phytoremediation efficiency through competitive uptake of nutrients rather than contaminants. Vegetation growth should be optimized through monitoring and maintenance of proper soil or water pH, nutrient levels, and soil water content. Due to the role of plant roots in phytoremediation, the location of the roots will be important in planning sample collection and in assessing sampling results. Sampling and analysis of plant tissues may be necessary to measure accumulation of contaminants within the plant and formation of metabolites. Information on methods for sampling and analyzing plant matter and transpiration gases will need to become available to phytoremediation practitioners and to laboratories, and development of new analytical methods may be necessary.

Summary

Using plants to rejuvenate land, surface water, sludge, etc is phytoremediation. Certain plants have the ability to absorb organic contaminants. Phytoextraction, rhizofiltration, phyostabilization, hydraulic control are explained. The natural processes in plants are explained for better understanding of phytoremediation. Capping of landfills and mining sites also require a vegetated cap for early stabilization. Tolerant, fast growing species are chosen for this, which will maintain integrity of the cap and expedite natural succession. The advantages of buffers (riparian corridors) and constructed wetlands are described.

Films

Toxic Realities and Radical Remedies. Duration 3 min https://www.indiegogo.com/projects/toxic-realities-and-radical-remedies-a-grassroots-bioremediation-intensive#/

Modelling Phytoremediation of heavy metal contaminated mine spoil dumps Parikshit Verma, NEERI. https://slideplayer.com/slide/4741635/

Self Assessment Questions

1. Write a detailed account on phytoremediation.
2. Write a case study on phytoremediation.
3. Discuss how heavy metals can be extracted from plants. Discuss chelating agents- their advantages and disadvantatges.
4. Explain calling of landfills and vegetated capping.

Further Reading

1. Implementation of phytoremediation to remediate heavy metals from tannery waste: A review http://www.imedpub.com/articles/implementation-of-phytoremediation-to-remediate-heavy-metals-from-tannerywaste-a-review.pdf
2. Phytoremediation of industrial mines wastewater using water hyacinth https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5152555/

Chapter 6
Soil Remediation II –

Electrokinetic, Chemical, Thermal Remediation including Waste to Energy and Capping

Objectives

- To provide key insights into soil remediation technologies and attribute factors like risk assessment, sustainable development, stakeholder engagement, cost-benefit ratio and technical feasibility - requisites in selecting an effective remediation solution.
- To know about soil remediation technologies, biomining, capping and gas recovery, power generation or waste to energy and landfill flaming.

Structure

6.1 Soil resources and Bioremediation
6.2 Soil remediation technologies
6.3 Classification of soil remediation technologies - Electrokinetic, Chemical, physical and thermal Remediation
6.4 Biomining, capping, gas recovery, power generation and landfilling

To Do Activities

1. View videos on bioremediation
2. Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities**.**

6.1 Soil Resources and Bioremediation

Soil Restoration

Soil restoration is the technique of enhancing compacted soils to improve their porosity and nutrient retention. It includes worms and mechanical aeration, mechanical loosening (tilling), planting dense vegetation, and applying soil amendments. Soil amendments involve spreading and mixing of mature compost into disturbed and compacted soils.

The intent of soil restoration is to improve soil structure by increasing porosity for root growth and microbial activity, and to provide a source of organic substrate to retain more water and nutrients for plant uptake. Compost, the most common soil amendment, contains a mixture of organic matter that enhances soil structure, infiltration, root growth, and water-holding capacity and reduces soil compaction.

Some methods of soil restoration include aeration, mechanical loosening (tilling), and planting dense vegetation. Mechanical processes work to physically aerate the soil and return it to its predevelopment porosity.

The reasons for soil contamination include:

- Industrial activities (petrol, chemicals, metallurgy, varnish, tannery, electronics
- Emissions and discharge (power plants, motor vehicles, fossil fuels
- Composting; urban solid residues and waste; landfills
- Agriculture (fertilizers, pesticides, sewage sludge)

The main organic contaminants are:

- Mineral oil (fossil fuel, gasoline, diesel, lubricants)
- Aromatic compounds (PAH, PCB)
- Combustion products (dioxins)
- Agrochemicals

Inorganic contaminants are:

- Heavy metals (Cd, Cr, Ni, Cu, Zn, Pb)
- Light metals (Al, Be, Tl, F, Br)
- Volatiles (As, Hg, Se)
- Radionuclides (Cs, U, Ra)
- Nitrates, nitrites, phosphates

Some methods used to restore saline soils are:

- Installing drainage systems to wash salts down the soil profile (this method is expensive and complicated).
- Leaching out saline soils by applying water to contaminated soils to wash salts beyond the root zone.
- Use of salt tolerant plants (halophytes) as bioremediants. Halophytes accumulate salts in their shoots and other aerial plant parts. Examples include Allenrolfea occidentalis (iodine bush), Panicum virgatum (switch grass)
- Application of gypsum (calcium sulphate dehydrate) to sodic soils. Sodic soils have high content of sodium chloride. Gypsum mixed into the layers of sodic soils replaces sodium with calcium, reducing the sodium level.

Restoration of oil contaminated soils using biochar (charcoal produced from plant matter and is used as a soil amendment. Biochars possess a number of remarkable properties that make them suitable for the remediation of contaminated soils, including a high internal surface area, negative charge, and resistance to degradation

Another example is restoration of hydrocarbon contaminated soils using thermal technology. Thermal treatment technologies hold an important niche in the remediation of hydrocarbon-contaminated soils and sediments due to their ability to quickly and reliably meet cleanup regulatory requirement. It involves application of heat to contaminated soils with the intention of volatilizing/desorbing hydrocarbons, which are then carried away by a sweep gas or vacuum and eventually destroyed via incineration or carbon adsorption

Carbonation technology can be applied to solidify or stabilize solid combustion residues from municipal solid wastes, paper mill wastes, etc. and contaminated soils, and to manufacture precipitated calcium carbonate (PCC). Here the carbonated products can be utilized as aggregates in the concrete industry and as alkaline fillers in the paper (or recycled paper) making industry.

6.2 Soil Remediation Technologies

There are two factors that impact the cost-effectiveness of remediation technologies. The first is the impact of waste legislation and regulation that determines the fate of contaminated soil, and the potential for its treatment, disposal, recovery, recycling and reuse. The second is the designated land-use of a remediated site; this has an insightful effect on site values and thus the viable options available for remediation. The remedial categories are as follows:

1. **Excavation and Containment**
   - The disposal of material to an engineered commercial void space
   - Deposition within an on-site engineered cell, generally with a view to combining the disposal of waste with the reclamation of land area from the void space
   - Engineered land-raising and land forming, where materials are deposited on the land surface to make a hill or mound above the natural surface level suitably contained.

2. **Engineered Systems**
   - Designed to prevent or limit the migration of contaminants left in place or confined to a specific storage area, into the wider environment. Approaches include in-ground barriers, capping and cover systems; Hydraulic containment and pump-to-contain approaches.

3. **Site Rehabilitation** measures includes: bringing back some measure of utility to a site whose contamination cannot be treated or contained for technical or economic reasons. Examples include growth of grass cover tolerant of contaminants, covering with soil or soil substitute, liming and other cultivation measures.

4. **Treatment Based Approaches** remove or detoxify the contaminants contained in the polluted material (e.g. soil, groundwater etc.). Using treatment technologies in contaminated land remediation are perceived as having added environmental value compared with other approaches to remediation such as excavation and removal, containment or covering / re-vegetation. The "added “environmental value is associated with the removal or transformation of contaminants into less toxic forms.

Treatment based approaches include

- Biological Processes : depending on the use of living organisms
- Chemical processes : destroy, fix or concentrate toxic compounds by using one or more types of chemical reaction
- Physical processes: separate contaminants from the soil matrix by exploiting physical differences between the soil and contaminant (e.g. volatility) or between contaminated and uncontaminated soil particles (e.g. density).
- Solidification and stabilization (S/S): processes immobilize contaminants through physical and chemical processes (Solidification processes are those which convert materials into a consolidated mass. Stabilization processes are those in which the chemical form of substances of interest is converted to a form which is less available).
- Thermal processes: exploit physical and chemical processes occurring at elevated temperatures.
- Ex situ approaches are applied to excavated soil and/or extracted groundwater.

- In situ approaches use processes occurring in unexcavated soil, which remains relatively undisturbed. On site techniques are those that take place on the contaminated site. Offsite processes treat materials that have been removed from the excavated site (ex situ).

There are a number of factors that are requisite in selecting an effective remediation solution and to fulfill its goals. These factors or considerations include:

- Risk management
- Sustainable development
- Stakeholder engagement
- Technical feasibility
- Cost/benefit ratio and wider environmental, social and economic impacts.

All the above considerations should be on the basis of balanced and systematic process founded on the principles of transparency and inclusive decision-making. Remediation solutions are needed for the following reasons:

- To protect human health and environment
- To enable redevelopment and regeneration of contaminated areas
- Retrofitting /repair
- Restricting potential liabilities

Risk Management

A risk-based approach has been adopted for the management of contaminated land in many countries (Clarinet and Nicole, 1998). The assessment and management of land contamination risks involves three main components:

- The source of contamination (e.g. metal polluted soils, a leaking oil drum)
- The receptor (i.e. the entity that could be adversely affected by the contamination e.g. humans, groundwater, biodiversity, ecosystems etc.); and
- The pathway (the route by which a receptor could come into contact with the contaminating substances).

A pollutant linkage exists when all the above three elemental components exists. Risk assessment involves the characterization of such relationship, which typically includes: delineation of the source, measurement and modeling of fate and transport processes along the pathway, and assessment of the potential effect on the receptor

Sustainable Development

The concept of sustainable development gained international governmental recognition at the United Nation’s Earth Summit conference in Rio de Janeiro in 1992. Sustainable development is - “Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Brundtland, 1987). At a strategic level, the remediation of contaminated sites supports the goals of sustainable development by helping to conserve land as a resource, preventing air, water and soil pollution and also mitigating its impact.

Stakeholder Engagement

The principal stakeholders in remediation are generally considered to be the

- Land owners

- Regulatory authorities
- Planning authorities
- Site users, workers, visitors
- Financial community (banks, founders, lenders, insurers)
- Site neighbours (tenants, dwellers, visitors)
- Campaigning organizations and NGOs
- Consultants, contractors, and researchers

Seeking consensus between the different stakeholders is important to achieve sustainable development. Risk communication and risk perception issues need special consideration. Opinions and decisions need to be communicated in a balanced form to all stakeholders.

Cost/Benefit Ratio or Cost Effectiveness

Costs of remediation depend on many factors and may be broken down into mobilization, operation (per unit volume or area treated), demobilization, monitoring and verification of performance. It includes the future use of land, and the finances available for developing this use. Cost benefit ratio is not just a product of reducing remediation costs, but it also includes finding remediation approaches that provide an additional enhancement to the value of the land.

Technical Feasibility

A suitable technology is one that meets the technical and environmental criteria for dealing with a particular remediation problem.

- Previous performance of the technology in dealing with a particular risk management problem (in the countries);
- Ability to offer validated performance information from previous projects
- Ability to verify the effectiveness of the solution when it is applied;
- Confidence of stakeholders in the solution
- Cost and acceptability of the solution to stakeholders

6.3 Classification of Soil Remediation

Soil remediation technologies involved in the contaminant removal or treatment process include:

1. Mass Transfer Technologies

This group includes technologies that remove contaminant mass from the soil matrix by physical or chemical means, and subsequently treat them in other process step. These technologies can be applied either insitu or ex situ, such as soil vapour extraction, low temperature thermal desorption and solvent extraction.

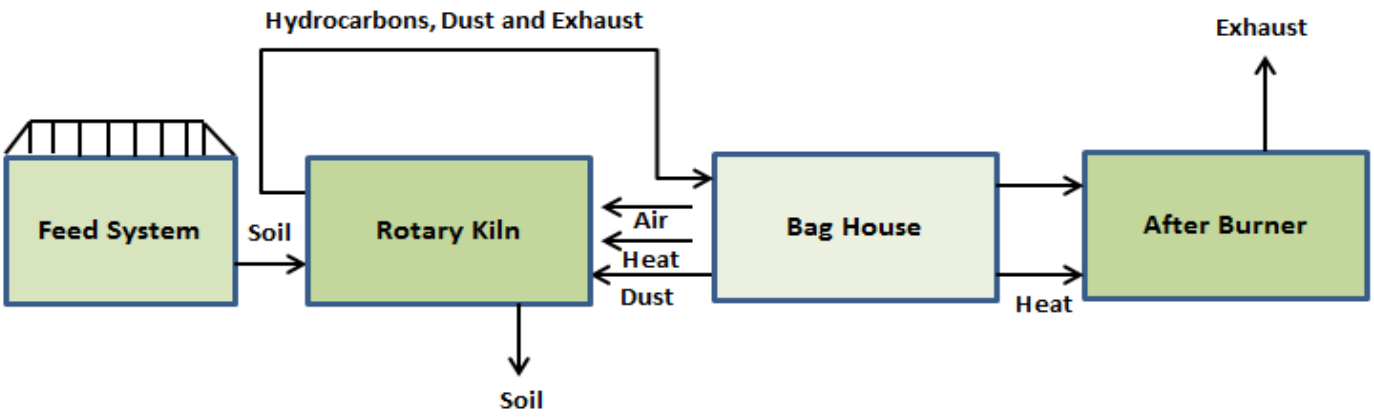

Fig 6.1 Thermal Desorption Unit - A Mass Transfer Technology

2. **Transformation technologies**
   These technologies transform the contaminant mass into products of different chemical compositions by various chemical or biochemical means. The purpose of these technologies is to transform the contaminant into harmless by-products or into a new form that is easier to treat or dispose. Such technologies include bioremediation and thermal destruction.

3. **Stabilization technologies**
   These technologies incorporate the contaminants into a solid matrix so that leaching into the environment is reduced to levels below those required by regulatory agencies. The incorporation of the contaminant into a monolithic structure can be accomplishes by physical or chemical means or by a combination of both. Such technologies include cement or lime stabilization, vitrification and other macro or microencapsulation techniques

Phase wise preliminary test or options plan for implementation of remediation technology

1. Technology screening and selection
2. Testing the technologies that are selected for the project
3. Pilot study
4. Implementation technology

Technology Screening and Selection

The objective of this phase is to identify potentially effective technologies as contenders for bench scale testing. The first step requires site and soil characterization. The site hydrogeological characteristic and soil properties must be determined and the extent and level of contamination defined. The second step involves information studies and data collection related to the contaminant type, site characteristics, and various treatment technologies. In step three, laboratory level or research/analytical level scale testing is conducted as part of the information collection. These tests are inexpensive and provide valuable guidance for technology selection. It can be a part of the initial technology screening and evaluation to determine key parameters such as biodegradability of contaminants and sorption characteristics of the soil. Step four includes assessing the need for pre-treatment and or post treatment of soil and other pollutant streams. For instance soil pre-treatment may be required to remove debris and other large

particles moving ahead. So basically all these four emerge as attesting protocol for application of technology.

Testing the technologies that are selected for the project

Testing the technologies or bench-scale testing is to assess the effectiveness of a remedial technology and generate data that will allow estimation of pertinent design parameters like physio-chemical characteristics of soil, soil washing, and solvent extraction

The protocol for testing the technologies should have the following key instructions and details

- Materials and supplies
- Construction and equipment needed
- Sample handling and preparation
- Preparation of required solutions
- Experimental QA/QC plan (duplicates, control..)
- Scheduling and execution of the experimental procedures
- Sampling complete project evaluation
- Development of analytical methods and analytical QA/QC
- Evaluation of technology effectiveness
- Estimation of scale-up parameters

Electro Kinetic Remediation

As mentioned in the earlier chapters, soil remediation can be conducted in two ways: in-situ and ex-situ. Electro kinetic remediation is performed as an in-situ remediation technique, where in the soil is not excavated for the purpose of decontamination (De Battisti and Ferro. 2007). This method encompasses application of direct current of low density to the contaminated sites. Here the electric field is created by inserting electrodes in the contaminated site and by passing low density DC, the contaminant particles are made mobile in the soil media. The contaminants get transported towards the electrodes and then they get pumped out**.** This technique is usually used for removing organic and inorganic pollutants including heavy metals, radionuclides and hydrocarbons from soils with low permeability.

Figure 6.2 shows how the electrodes with their casings are inserted in the soil which is contaminated. There should be a minimum of two electrodes to carry out the process, which includes anode and the cathode. The anode is positively charged and it attracts the negatively charged contaminants and the cathode is negatively charged and it attracts the positively charged contaminants when the current is passed (Sharma and Reddy. 2004). The contaminated water from the electrode casings are removed by pumps. The removal sometimes is improved by using surfactants or weak acids at the reservoirs. The electrode arrangement depends on the extent of contamination. In areas of extensive contamination of soils the electrodes may even be arranged in a grid with alternating cathode and anode layers. Electrokinetic remediation may also be referred to as electrokinetics, electromigration, electrorestoration, electroremediation and electroosmosis.

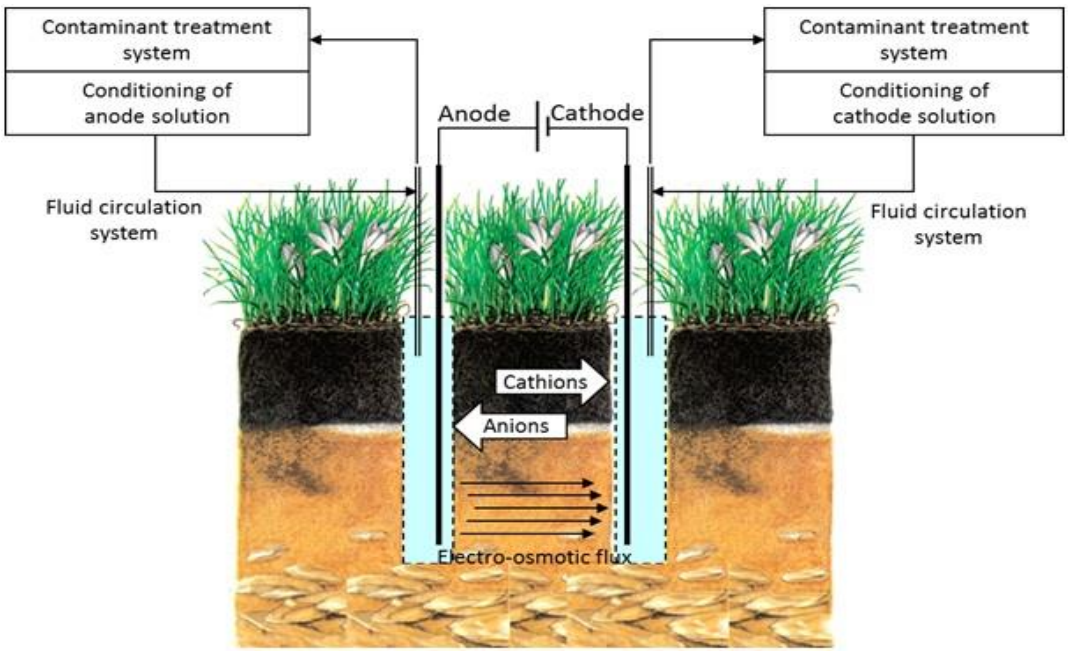

Fig 6.2 Principle of Electrokinetic Remediation (Cameselle *et al*., 2013)

Types of Contaminants Mechanism in Electro Kinetic Remediation

$$qe = \frac{ED\zeta R^2}{4\eta L}$$

E – electrode potential

D – dielectric constant

ζ – Zeta potential

η – viscosity

L – length of the specimen

Electrokinetic Remediation will lead to the transport of the contaminants through four main mechanisms. The following are the mechanisms:

Electroosmosis

Electroosmosis occurs due to Columbic forces which are induced by the applied electric field in the soil. The soil particles are usually negatively charged and the positively charged cations in pore water align along the negative soil surfaces (Virkutyt, 2002). The water molecules in turn align around the cations till there are no excess cations left. The remaining water molecules end up around the negatively charged soil surface forming the boundary layer. The closest molecules are held by electrical attraction though they are free to move in the double layer (Sharma and Reddy, 2004).

When we apply electric field during remediation, the positively charged water molecules will move towards the negatively charged cathode. As the cations move toward the negatively charged electrode, a shearing action takes place. The cations move through the pore water at high velocities and pull the water molecules along with them. This results in the large transfer of water from anode to cathode (Jane E. Apatoczky, 1992). In electroosmosis, flow depends on temperature, ion concentration, and viscosity of pore water, dielectric constant and ion mobility. It is denoted as:

Electromigration

$$v = \frac{I v_i P_w}{A \tau \theta}$$

This transport mechanism is comparatively faster than electroosmosis and is the dominant transport mechanism during remediation. The rate of movement of ions is a function of ionic mobility, valency numbers and electrolyte concentration (Virkutyt., 2002; Sharma and Reddy., 2004). The ions travel with a velocity given by:

Where,

I – Applied current

v_i – ion velocity

A – Cross sectional area

P_w – Pore water resistivity

τ – Tortuosity

θ – Volumetric moisture content

Electrophoresis

This is the movement of colloids towards electrodes and is similar to electromigration (Virkutyt., 2002). This type of movement is insignificant if the soil is tightly packed which would physically restrict the colloids from moving.

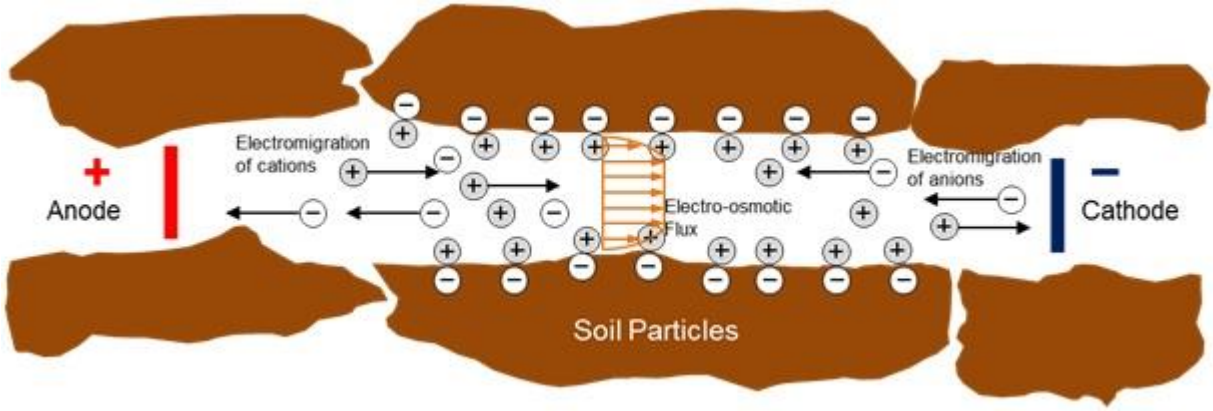

Fig 6.3 Transportation of ions in the soil (Cameselle *et al.*, 2013)

Physical and Chemical Processes Involved

The physical and chemical processes involved are electrolysis, diffusion, adsorption-desorption, precipitation-dissolution and oxidation-reduction.

Electrolysis

This is the reaction that occurs at the anode and cathode when an electric field is applied. In the case of electrokinetic remediation, water decomposition occurs at the electrodes. Oxidation takes place at the

anode and hydrogen ions H^+ and oxygen gas are generated. Reduction reaction takes place near cathode and hydroxyl ions OH^- and hydrogen gas are generated. These are shown by the following equations (Cameselle et al., 2013; Sharma and Reddy, 2004).

$$2H_2O \longrightarrow 4e^- + O_2 + 4H^+ \quad E_0 = -1.229\ V$$

$$4H_2O + 4e^- \longrightarrow 2H_2 + 4OH^- \quad E_0 = -0.828\ V$$

The process of electrolysis leads to changes in the soil pH near the electrodes. The region near anode develops a low pH of about 2 whereas near the cathode it increases up to 11 or 12. The hydrogen and hydroxyl ions move both due to electromigration and diffusion. The hydrogen ions being smaller than the hydroxyl ions tend to travel faster leading to rapid acid front migration at almost twice the speed of the base front migration. The acid front migration is even easier in low buffering capacity soils compared to high buffering capacity soils since the hydrogen ions get consumed to neutralize soil constituents (Sharma and Reddy, 2004). The acid dissolves the usual cations in the soil or precipitates and helps cation removal. If the contaminants are anionic, the acid front would increase adsorption and reduce contaminant removal. Both the acid and base front will in turn have an effect on the zeta potential of the soil influencing the flow.

Diffusion

Diffusion is the process where the contaminants move due to difference in concentration gradient. This usually does not contribute to a significant amount of contaminant transport in remediation. This depends on the tortuosity and porosity of the medium and the concentration of the species (Sharma and Reddy, 2004). The rate of diffusion is given by:

$$U_{diff} = \frac{vRT\nabla c}{c}$$

Where,

v - mobility

R - Gas Constant

T – Temperature

∇c - concentration gradient

c – concentration of contaminants

Adsorption-Desorption

Adsorption involves the movement of contaminants from pore water to the soil particles. Generally soils are negatively charged but it would depend on the pH of the soil (Reddy, 2011). The net charge in soil will be zero for a particular value of pH and that is called the point of zero charge (PZC). If the pore water falls to a pH less than PZC then adsorption of anions will be predominant and when pH rises above PZC the adsorption of cations are significant. Thus adsorption is dependent on factors including soil type, soil charge, contaminant, organic matter and pore water characteristics.

Desorption is the reverse of adsorption and involves the transport of contaminants from soil to pore water. When pH falls below PZC desorption of cations are significant and vice versa. Due to extreme pH differences between the regions near the electrodes, the cationic absorption and anionic desorption occurs near cathode. The anionic adsorption and cationic desorption occurs near anode. The area of the PZC is known as the slippage plane and beyond this; free pore water is present in the soil.

Precipitation-Dissolution

Precipitation is the formation of solid that results when the concentration of compound exceeds its solubility. Dissolution is the reverse where compound forms a solution. Both processes are highly pH dependent and would occur depending on their location. The contaminants could be precipitated or dissolved during remediation. The dissolved contaminants would be easier to remove than the precipitated contaminants in soil.

Oxidation-Reduction

Redox reactions take place during the remediation process. Area near Anode experiences oxidation since electrons are lost and the cathode area experiences reduction since there is addition of electrons. Some metal cations precipitate near cathode. The valence of the metal ions decides on their solubility and thus might impact removal (Sharma and Reddy, 2004).

Applicability of Electrokinetic Remediation

Electrokinetic Remediation can be implemented for the remediation of soils, sediments and any porous material. This technique is used on both saturated and unsaturated soils though it works better on saturated soils. It can also be implemented on heterogeneous soils and used to treat a wide range of contaminants (Acar *et al*., 1995). The method is very effective in removal of strontium and cesium from high water content soil (Jane E. Apatoczky, 1992). pH control at the electrodes and the use of enhancement agents would broaden the range of contaminants that can be treated with this process such as lead, mercury and cobalt (Kornilovich *et al.,* 2005). Thus, Electrokinetic remediation is a developing technology which intends to separate and extract radionuclides, heavy metals and organic contaminants from saturated or unsaturated soils, sludges, sediments and groundwater.

Advantages

- The process can target a specific area since the remediation will take place only between the electrodes.
- The fact that the soil need not be removed indicates that the amount of energy needed for this process would be comparatively lower than ex-situ procedures.
- The technique is applicable for a wide range of contaminants since metal contaminants can be moved because they have charge and the non-charged contaminants are moved due to induced flow.
- It is flexible to be used as both in-situ and ex-situ method (Sharma and Reddy, 2004) and it can be tailored to site specific conditions.

Disadvantages

- Electrokinetic Remediation could prove to be a time consuming process.
- The electrolysis reactions near the electrodes change the soil pH. Acidic conditions near anode will cause decay and degradation of the electrolyte. There could be stagnant zones between electrodes where the migration is very slow (Sharma and Reddy, 2004).

Chemical Remediation

In situ chemical oxidation (ISCO), a form of advanced oxidation processes and advanced oxidation technology, is an environmental remediation technique used for soil and/or groundwater remediation to reduce the concentrations of targeted environmental contaminants to acceptable levels. Example: The hydrogen peroxide treatment was able to remediate chlorophenols, polycyclic aromatic hydrocarbons, diesel and transformer oil contaminated soil.

Soil Washing

Contaminants observed onto fine soil particles are separated from bulk soil in an aqueous-based system on the basis of particle size. The wash water may be augmented with a basic leaching agent, surfactant, pH adjustment, or chelating agent to help remove organics and heavy metals. Ex situ soil separation processes (often referred to as "soil washing"), mostly based on mineral processing techniques, are widely used in Northern Europe and America for the treatment of contaminated soil. Soil washing is a water-based process for scrubbing soils ex situ to remove contaminants.

Chemical Extraction

Chemical extraction does not destroy wastes but is a means of separating hazardous contaminants from soils, sludges, and sediments, thereby reducing the volume of the hazardous waste that must be treated. The technology uses an Extracting chemical and differs from soil washing, which generally uses water or water with wash-improving additives.

Solvent Extraction

Solvent extraction is a common form of chemical extraction using organic solvent as the extractant. It is commonly used in combination with other technologies, such as solidification/stabilization, incineration, or soil washing, depending upon site-specific conditions. Organically bound metals can be extracted along with target organic contaminants, thereby creating trace residuals. Traces of solvent may remain within the treated soil matrix, so the toxicity of the solvent is an important consideration. The treated media are usually returned to the site after having met Best Demonstrated Available Technology (BDAT) and other standards

Stabilization Technologies

In stabilization and solidification technology involve processing of the waste or contaminated soil through different processes:

(1) Bituminization
(2) Emulsified asphalt
(3) Modified sulfur cement
(4) Polyethylene extrusion
(5) Pozzolan/Portland cement
(6) Radioactive waste solidification
(7) Sludge stabilization
(8) Soluble phosphates
(9) Vitrification/molten glass

Circulating Bed Combustor (CBC)

Circulating bed combustor (CBC) uses high velocity air to entrain circulating solids and create highly turbulent combustion zone that destroys toxic hydrocarbons. The CBC operates at lower temperatures than conventional incinerators (1,450 to 1,600 °F). The CBC's high turbulence produces a uniform

temperature around the combustion chamber and hot cyclone. The CBC also completely mixes the waste material during combustion.

Infrared Combustion

The infrared combustion technology is a mobile thermal processing system that uses electrically-powered silicon carbide rods to heat organic wastes to combustion temperatures. Waste is fed into the primary chamber and exposed to infrared radiant heat (up to 1,850 °F) provided by silicon carbide rods above the conveyor belt. A blower delivers air to selected locations along the belt to control the oxidation rate of the waste feed.

Permeable Reactive Barriers (PRB)

Permeable reaction walls are an emerging technology for the treatment of contaminated groundwater. Successful treatment of contaminated groundwater using this technique requires that the contaminant be rendered immobile during transport through the in-situ treatment zone. The extent of treatment and the success of the permeable barrier system depends on the nature of the contaminant, the selection of the reactive material, the physical design of the treatment system, and natural site conditions.

In simple terms, we can say a permeable reactive barrier is an engineered treatment zone of reactive material(s) that is placed in the subsurface in order to remediate contaminated fluids as they flow through it.

The most common of the permeable barrier walls is the iron treatment wall. It is made up of zero-valent iron or iron-bearing minerals that reduce chlorinated contaminants such as perchloroethylene (PCE). As the iron is oxidized, a chlorine atom is removed from the compound using electrons supplied by the oxidation of iron. The chlorinated compounds are reduced to nontoxic by-products.

Fe^0Fe ⇾ + 2e - Anodic Reaction
RCl + 2e⇾ H +® RH + Cl - Cathodic Reaction
Fe^0 + RCl + H +Fe 2+ + RH + Cl - Net Reaction

Sorption and Bioavailability

Chemical transport, reactivity, and toxicity can be strongly influenced by the compound's interactions with solid surfaces that exist in the environment. Sorption is defined as the “uptake of a solute by a sorbent”. Natural sorbents include soils, sediments, and microorganisms. Sorption includes the processes of adsorption of the solute onto surface or interior voids and the partitioning of the solute into an organic medium, usually organic coatings found on soils, sediments, and clays. Because these organic coatings tend to accumulate on charged surfaces, solids such as clays (or the “fines”) typically contain a disproportional amount of these coatings. A chemical’s partition coefficient (Kp) is commonly used to determine the movement of an organic chemical in the subsurface (the retardation factor used widely in hydrogeology requires input of Kp). For natural systems, the extent of sorption is primarily determined by the magnitude of the soil water partition coefficient that is normalized to organic carbon (Koc) and the fraction of organic carbon that is present in the soil-sediment system (ocf). Koc has been found to be linearly related to the degree of hydrophobicity that is usually determined by the magnitude of a chemical’s octanol-water partition coefficient, which is typically reported in log units (common notation is either ow log or log PK).Chemicals that strongly sorb to soil may not transport to a great extent in the unsaturated zone. Therefore, they are more likely to accumulate in surface soils and sediments. Examples of such contaminants include polychlorinated biphenyls (PCBs) and polycyclic aromatic hydrocarbons (PAHs) (Dan McNally, 2009).

Because sorption strongly influences the bioavailability of an organic chemical, the sorption intensity influences whether the chemical is readily accessible to microorganisms for biodegradation. In addition, chemicals that have partitioned into a separate phase or are present themselves as a separate phase, such as oil, non-aqueous phased liquids (NAPLs), or dense non-aqueous phase liquids (DNAPLs) may also not be bioavailable. However, some microorganisms have developed the ability to change the hydrophobicity of their outer membrane so they can directly contact the separate phase, or they secrete chemicals with surfactant-like properties (i.e., bio-surfactants) that can solubilize separate phase chemicals, which can increase bioavailability(Dan McNally, 2009).

6.4 Biomining, Capping, Gas Recovery and Flaming

"Biomining" is the process of using microorganisms to extract metals of economic interest from rock ores or mine waste. Biomining techniques may also be used to clean up sites that have been polluted with metals. Approach wise both biomining and bioremediation are same, except biomining involves application in mining waste.

Bioremediation and Biomining

*"*Bioremediation*"* is a waste management technique that uses naturally occurring organism to breakdown hazardous substances into less toxic or non-toxic substances. Some bio-remediation techniques are bio-leaching, bio-reactor, composting etc. whereas "Biomining*"* is a technique of extracting metal from ores and other solid material typically using micro-organism especially fungi.

Key Points

- Bio remediation and bio mining both works for new waste as well as old waste and are found to be most effective and eco-friendly waste management technique.
- It can be used to clear oil spills in sea and pollution from soil, ground water, surface water and air.
- It can be used for hydrocarbon contamination (PCB, Pentachlorophenol, and Trichloroethylene etc.).

The treatment of mine waste is one of the most important issues created by mining companies around the world (Garcia, et al., 2001). These mine wastes containing metals are a significant toxic factor to biota in the environment i.e. microbes and ecosystem processes (Giller, *etal*. 2009). There are several remediation approaches which have been developed as excavation, land fill, thermal treatment, electro reclamation and soil capping but all these are more expensive and environmentally destructive (Ritcey, 1989). Bioremediation technology provides an alternative to conventional methods for remediating the metal-polluted soils (Khan, 2009). The microbiological processes are significant in determining metal mobility and have actual potential application in bioremediation of metal pollution (Gadd, 2004).

According to Ge, etal. (2009) several approaches have been followed for the reclamation of metal contaminated soil by bioremediation/biosorption process. Biosorption technique appears to be suitable as secondary or polishing applications for metal removal from metal polluted environment, which would be competitive with ion-exchange resin, based on final cost-beneficial analysis and the greatest use for biosorption may be in modular system for small companies. Worldwide several researchers have been using microbes (bacteria, fungi etc.) as an ideal agent for bioremediation process, due to their small size, their ubiquity, their ability to grow under controlled condition and their resilience to a wide range of environmental situations (Urrutia, 1997). The Acidothio bacillussp were found most abundantly in acid

and metal containing environment. The most well-known species is Thiobacillus ferrooxidans, for treating heavy metal contaminated tailing and soils, which are industrially, exploited in bio-leaching of metal sulfide and uraninite ores (Straube, etal., 2003). P. aeruginosa and P. putidaare previously reported as effective bacterial species for the reclamation of oil/metal contaminated soils by producing surfactants and tolerant to certain heavy metals (Wong, et al., 1993; Mathiyazhagan and Natarajan, 2011b). Garcia, et al., (2001), had used Sulfate Reducing Bacteria (SRB) for bioremediation of mine effluents. Among the microbes, fungi also play an important role in the biosorption of metals. The biomass of fungi (both live and dead form) has been used as suitable biosorbent for metal biosorption (Sayed and Morsey, 2004). The biomass from Rhizopusarrhizus has been extensively used for the sorption of salts and complexes of different metals such as iron, nickel, copper etc., present individually or in multi-component systems and polluted soils (Aksu, *et al*., 1999; Yesim, *et al*., 2000 a, b; Subudhi and Kar, 2008). Harma, *et al*., (2009) had used rumen fluid microorganisms for the bioremediation of sulphate rich mine effluents.

Currently biomining processes target valuable metals like copper, uranium, nickel, and gold and in commonly found sulfides' (sulfur-bearing) minerals. Microbes are especially good at oxidizing sulfidic minerals, converting metals like iron and copper into forms that can dissolve more easily. Other metals, like gold, are not directly dissolved by microbial process, but are made more accessible to traditional mining techniques because the minerals surrounding these metals are dissolved and removed by microbial processes. When the metal of interest is directly dissolved, the biomining process is called **"**bioleaching," and when the metal of interest is made more accessible or "enriched" in the material left behind, it is called **"**bio-oxidation." Both processes involve microbial reactions.

The most common processes used in biomining as per Barrie Johnson, 2014 study on extracting and recovering metals from ores and waste materials are:

- **Heap leaching:** freshly mined material is moved directly into heaps that are then bioleached.
- **Dump leaching:** low-value ore or waste rock is placed in a sealed pit and then bioleached to remove more of the valuable metals from the waste pile.
- **Agitated leaching:** crushed rocks are placed into a large vat that is shaken to distribute the microbes and material evenly and speed up the bioleaching process

Leaching times vary from days to months, making this process slower than conventional mineral extraction techniques (Barrie Johnson, 2014). Dump and heap leaching are the oldest and most established biomining techniques, but the use of agitated leaching is becoming more common for minerals that are resistant to leaching, including some copper sulfides like chalcopyrite.

The abilities of acidophilic chemolithotrophic bacteria and archaea to accelerate the oxidative dissolution of sulfide minerals have been harnessed in the development and application of a biotechnology for extracting metals from sulfidic ores and concentrates. Biomining is currently used primarily to leach copper sulfides and as an oxidative pretreatment for refractory gold ores, though it is also used to recover other base metals, such as cobalt, nickel and zinc. Recent developments have included using acidophiles to process electronic wastes, to extract metals from oxidized ores, and to selectively recover metals from process waters and waste streams (Barrie Johnson, 2014).

Also Biomining entails the use of acidophilic microbes to facilitate the recovery process of metals from sulfide minerals in the processes of bioleaching and bio-oxidation. Bio-oxidation is the enrichment of metals, particularly gold, by mobilization and thus removal of interfering metal sulfides from ores bearing the precious metals (Rohwerderetal, 2003). Sulphurlayers can be oxidized to soluble sulphate by

sulphur-oxidizing bacteria such as Acidithiobacilluscaldus or Acidithiobacillusthiooxidans (Dopson and Lindstrom, 1999; Sand etal, 2001; Mangoldetal, 2011).

Capping

According to United States, Environmental Protection Agency, capping involves placing a cover over contaminated material such as landfill waste or contaminated soil. Such covers are called “caps.” Caps do not destroy or remove contaminants. Instead, they isolate them and keep them in place to avoid the spread of contamination. Caps prevent people and wildlife from coming in contact with contaminants.

What does capping do?

- Stops rain water from seeping through the material and carrying contaminants to the groundwater.
- Keeps storm water runoff from carrying contaminated material offsite or into lakes and streams.
- Prevents winds blowing contaminated material offsite.
- Control releases of gas from wastes containing or producing “volatile” chemicals

Design Dependency Factors

The cap design selected for a site will depend on several factors, which includes:

- the types and concentration of contaminants present
- the size of the site
- the amount of rainfall the area receives
- the future use

Construction of a “cap” can be as simple as placing a single layer of a material over lightly contaminated soil to placing several layers of different materials to isolate more highly contaminated wastes. Also A cap for a hazardous waste landfill, however, might require several layers, including a vegetative layer, drainage layer, geo-membrane, and clay layer.

Some of the possibilities for caps according to EPA include:

- Asphalt or concrete
- Vegetative layer: A top layer of soil planted with grass or other vegetation can help prevent soil erosion and make the area look more natural
- Drainage layer: A layer of sand and gravel, often containing rows of slotted pipes, is built to collect and drain any water that makes it through the top layers of a cap.
- Geo-membrane: A sheet of strong plastic-like material is used to prevent downward drainage of water and upward escape of gases.
- Clay: A layer of compacted clay also can help prevent the downward drainage of water.

As mentioned in the EPA Capping guide[4]:

Landfill covers, such as those for municipal landfills, may also include collection and venting systems for methane and other gases that could build up underground.

Why opt for capping?

- Capping isolates landfill wastes and contaminants.
- It occasionally is used to address large volumes of soil or waste with low-levels of contamination.

- If made of asphalt or concrete, or even a layer of soil planted with grass, can allow some sites to be reused.

How safe is capping?

When properly built and maintained, a cap can safely keep contaminated material in place. A cap will continue to isolate contamination as long as it does not erode or develop cracks or holes that allow water to reach the contaminated material. And for that to happen, regular inspections are needed to check for damage, leakages, methane gas emission.

Several alternative Best Available Technologies (BAT) designs for capping systems are available. A distinctive capping system includes:

- 12 inches of intermediate cover soils
- 12 to 24 inches recompacted clay
- 40-mil HDPE liner or a geo-synthetic clay liner
- 40-mil HDPE liner
- A Drainage layer
- (12 inches of sand or geo-composite)
- 18 to 24 inches of protective cover soils
- 6 inches of vegetative soils

All final slope surfaces are re-vegetated for long-term protection. Areas are revegetated for long-term erosion protection in order to:

1. Provide adequate soil-seed contact to enhance seed germination.
2. Enhance plant root penetration and development.
3. Retard soil erosion.
4. Improve water availability within the root zone.

Other components of the final capping system include installation of downslope channels, final diversion berms, rock channels and other surface management ancillary components in accordance with American Landfill's engineering design.

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Product Liners for Capping

- GCL/Bentonite, Geo-membranes as a substitute for clay layers in bottom lining as well as in capping.
- Geo-membranes of the following types - HDPE, LDPE, RPP and the like.
- Drainage mats and Geonet for collecting biogas, leachate and water drainage.
- Geotechnical fabrics, Geocells and Geogrids for stabilizing and strengthening waste sites slopes.
- Pipeline for collecting gas and leachate, including leakage control and monitoring.

Gas Recovery: Waste to Energy

Energy recovery from waste is defined as conversion of non-recyclable waste materials into useable heat, electricity, or fuel through a variety of processes, including combustion, gasification, pyrolization, anaerobic digestion, and landfill gas (LFG) recovery. This process is also often called waste-to-energy (WTE). Energy recovery from waste is part of the non-hazardous waste management hierarchy. Non-recyclable waste materials are converted into electricity and the generated heat, a renewable energy source reduces carbon emissions by offsetting and reducing methane generation from landfills. According to the Ministry of New and Renewable Energy (MNRE), there exists a potential of about 1700 MW from urban waste (1500 from MSW and 225 MW from sewage) and about 1300 MW from industrial waste. The ministry is also actively promoting the generation of energy from waste, by providing subsidies and incentives for the projects. Indian Renewable Energy Development Agency (IREDA) estimates indicate that India has so far realized only about 2% of its waste-to-energy potential.

The Indian Government has over a decade had recognized waste to energy as a renewable technology and supports it through various subsidies and incentives. The Ministry of New and Renewable Energy (MNRE) actively promotes all the technology options available for energy recovery from urban and industrial wastes. MNRE also promotes research on waste to energy by providing financial support for R&D projects on cost sharing basis in accordance with the R&D Policy of the MNRE and for studies on resource assessment, technology up-gradation and performance evaluation.

Technologies for the Generation of Energy from Waste

Energy can be recovered from the biodegradable as well as non-biodegradable waste through thermal, thermo-chemical, biochemical and electrochemical methods.

- **Thermal Conversion**: The process involves thermal degradation of waste under high temperature. In this technique complete oxidation of the waste occurs under high temperature. The major technological option under this category is incineration. End products include steam, flue gas and ash.

- **Thermo-chemical Conversion**: This process entails high temperature driven decomposition of organic matter to produce either heat energy or fuel oil or gas. They are useful for wastes containing high percentage of organic non-biodegradable matter and low moisture content. The main technological options under this category include pyrolysis and gasification. The products of these processes (producer gas, exhaust gases etc) can be used purely as heat energy or further processed chemically, to produce a range of end products.

- **Bio-chemical Conversion**: This process is based on enzymatic decomposition of organic matter by microbial action to produce methane gas, and alcohol etc. This processes preferred for wastes having high percentage of organic, bio-degradable (putrescible) matter and high level of moisture/ water content, which aids microbial activity. The major technological options under this category are anaerobic digestion (bio-methanation) and fermentation. Of the two options, anaerobic digestion is the most frequently used method for waste to energy conversion, and fermentation too has evolved and emerged as an effective technology option.

- **Electrochemical Conversion**: Electrochemical conversion in the context of waste to energy is referred as microbial fuel cells (MFC). MFCs are biochemical-catalyzed systems in which electricity is produced by oxidizing biodegradable organic matters in the presence of either bacteria or enzyme (Rahimnejad*et al*.2011). Bacteria are more likely to be used in MFCs for electricity production, which also accomplish the biodegradation of organic matters and wastes. Good sources of microorganisms include marine sediment, soil, wastewater, fresh water sediment and activated sludge. MFCs consist of anodic and cathodic chambers separated by a proton exchange membrane. The anodic part is usually maintained in the absence of oxygen, while the cathodic can be exposed to air or submerged in aerobic solutions. However this methodology according to Energy Alternatives India agency mentions need for extensive evaluation studies on bulk scale liquid waste treatments and stands at a nascent level in India as well as worldwide.

- **Landfill with Gas Capture:** Landfills are significant source of greenhouse gas emissions, and methane in particular can be captured and utilized as an energy source. Organic materials that decompose in landfills produce a gas which is comprised of roughly 50% methane and 50% carbon dioxide and iscalled Landfill Gas (LFG). Methane is a potent greenhouse gas with a global warming potential that is 25 times greater than CO_2 so capturing methane emissions from landfills is not only beneficial for the environment as it helps mitigate climate change, but also for the energy sector and the community.

  As per World Energy Council, the applications for LFG include
  - Direct use in boilers, thermal uses in kilns (cement, pottery, bricks), sludge dryers, infrared heaters, blacksmithing forges, leachate evaporation and electricity generation to name a few.
  - LFG is also increasingly being used for heating of processes that create fuels such as biodiesel or ethanol, or directly applied as feedstock for alternative fuels such as compressed natural gas (CNG), liquefied natural gas or methanol. Also, the projects that use cogeneration (with Combined Heat and Power Unit) to generate electricity and capture the thermal energy are more efficient.

The process of capturing LFG involves partially covering the landfill and inserting collection systems with either vertical or horizontal trenches. Both systems of gas collection are effective, and the choice of design will depend on the site-specific conditions and the timing of installation. They can also be employed in combination and an example is the utilization of a vertical well and a horizontal collector. As gas travels through the collection system, the condensate (water) formed needs to be accumulated and treated. The gas will be pulled from the collection wells into the collection header and sent to downstream treatment with the aid of a blower. Depending on the gas flow rate and distance to downstream processes, the blowers will vary in number, size or type. The excess gas will be flared in open or enclosed conditions to control LFG emissions during start up or downtime of the energy

recovery system, or to control the excess gas, when the capacity for energy conversion is surpassed (US EPA, 2014).

LFG is considered as a good source of renewable energy, and has a heating value of about 500 British thermal units (Btu) per standard cubic foot (US EPA). Benefits of using this Waste to Energy process go beyond abatement of GHG emissions and offset the use of non-renewable resources, to include other economic advantages such as revenue for landfills, energy costs reduction for LFG energy users, sustainable management of landfills, local air quality improvement and job creation. The below table 6.1 show some of the prominent companies in Waste to Energy sector in India.

Table 6.1 Treatment Facilities in India Based on Waste[5]

Company	Headquarters	Highlights
Bio-methanation		
M/S Asia Bio- energy Pvt Ltd (ABIL)	Chennai	Follows "Biogas induced mixing arrangement-(BIMA)" technology for a 5.1 MW MSW to energy project
Cicon Environment Technologies	Bhopal	Upflow Anaerobic Sludge Blanket (UASB) technology and activated sludge process are followed in installations
Bermaco/WM Power Ltd	Navi Mumbai	Completed 11 MW biogas plant in Mumbai using WABIO process.
Sound craft Industries	Mumbai	Installing 12.8 MW plant at Mumbai with technology from Ericsons, USA
Hydroair Tectonics Limited	Navi Mumbai	Adopting aerated and UASB technologies for the treatment of waste sludge and biogas generation respectively.
RamkyEnviro Engineers Ltd	Hyderabad	Undertaking comprehensive biomethanation projects coupled to secure composting and landfills. Also involved in incineration and presently operating India's largest waste incinerator at Taloja, Maharashtra.
Mailhem Engineers	Pune	Has adopted modified UASB technology. Has installed about

[5] **Energy Alternatives India:** http://www.eai.in/ref/ae/wte/comp/companies.html

Pvt Ltd.		250 waste-to-energy plants.
Combustion /Incineration		
A2Z Group of Companies	Gurgaon	RDF based combustion technology with scope for cogeneration of heat and power.
Hanjer Biotech Energies	Mumbai	Developing 15 MW combustion power plants in Surat District with MSW based RDF pellets as fuel.
SELCO International Limited	Hyderabad	SELCO setup the first commercial Municipal Solid Waste-processing unit in India in 1999. Have installed 6.6 MW using RDF pellets as energy source.
East Delhi Waste Processing Company Pvt Ltd	New Delhi	Implementing 10 MW incineration power plants with MSW derived RDF pellets as fuel.
Gasification		
Zanders Engineers Limited	Mohali	Has a collaborative gasification technology to process multiple feedstock's including MSW for power
UPL Environmental Engineers Pvt Ltd	Vadodara	Advanced gasification technology with destruction efficiency of 99.9% and emissions well below threshold

Table 6.2 Waste to Energy Value Creation: Business Opportunities

Waste to Energy Value Chain	Business Opportunities
Primary collection and segregation of inerts, dry organics and others.	• Collection of reusable plastics and metals etc. for sale in local market. • Waste Processing and sell RDF pellets to biomass power plants. • Mobilizing construction debris to make tiles and bricks
Separation of wet organic wastes	• Production and sale compost to bio fertilizer firms. • Biogas based power generation from sludge for selling it to the grid.
Secondary collection and storage	• Maintenance of transfer stations • High throughput screening of materials for recycling, energy recovery and land fill disposals.
Recycling of wastes	• Recyclable commodity transactions from transfer stations • Sale of recycled plastic or metal granules • Conversion of processed wastes to industrial commodities
Transportation and logistics	• Transporting solid waste from the source to the landfill or to the processing centers for energy recovery. • Revenues from automobile manufacturing and sales to corporate bodies and contract holders etc
Waste to energy recovery	• Production of machineries and equipment's for energy recovery technologies • Decentralized technology installations. • Power generation and sale of power • Production and sale of processed organic feed stocks from MSW • Income from Certified Emission Reductions(CER's)
Management of wastes at dumpsite	• Design and construction of secured landfills • Urban landscape development at abandoned landfills
Organization/financing for service and value chain enterprises	• Debt and equity financing

Which companies can leverage benefit from waste to energy sector in value chain?
The companies in the domain of renewable energy, engineering services, procurement and construction, transportation and logistics, sanitation and environment, power plant sector, facility management and many such sectors suitable for waste to energy business.

Category wise details of which type of companies can leverage benefit for each section of waste to energy value chain as per Energy Alternatives India:

1. Segregation of dry wastes, reusable and inerts, etc. :
    - Recycling companies
    - Informal recyclers
    - Rag pickers

2. Segregation of wet wastes and processing
    - Farmers
    - Fertilizer companies, agro-market enterprises
    - Informal waste collectors and recyclers
3. Transport and logistics
    - Transport agencies
    - Locomotive manufacturing companies
    - Private vehicles
    - Part time workers under contract
4. Recycling of wastes
    - Material recovery facility operators
    - Intermediate material processing units
    - Small and medium junk shop owners
    - Environmental engineering companies
5. Waste to energy recovery
    - Technology providers
    - Service technicians
    - Producers and dealers of waste derived RDF pellets
6. Management of wastes at landfill
    - Civil infrastructure developers
    - Site inspectors and verifiers

Flaming – Landfill Fires

Flaming or landfill fires occur when air infiltrates a landfill. Landfill fires fall into one of two categories, surface and underground fires. Depending on the type of landfill and type of fire, landfill fires can pose unique challenges to the landfill/ waste management industry and fire services.

Surface Fires: Surface fires involve recently buried or uncompacted refuse, situated on or close to the landfill surface in the aerobic decomposition layer, generally 1 to 4 feet in depth (EPA, 2003). These fires can be intensified by landfill gas (methane), which may cause the fire to spread throughout the landfill.

Surface fires include the following:

- Dumping of undetected smoldering materials into the landfill. Hot load fires are caused by the disposal of refuse that is still burning on arrival to the landfill (e.g., cleared brush).
- Fires associated with landfill gas control or venting systems. Landfill gas control systems can themselves pose a fire hazard. Landfill gas (predominantly methane) can be ignited as it escapes from the vents or from leaks in the collection pipe network. Excessive gas extraction can also be a fire cause. The vacuum created by excessive extraction can increase the airflow and thereby increase the oxygen level in the landfill, which can cause underground fires.
- Fires caused by human error on the part of the landfill operators or users. Landfill operators and users can cause fires through careless smoking on the landfill, which can ignite waste or landfill gas.
- Fires caused by construction or maintenance work. Fires can occur while construction and maintenance takes place, including fires caused by sparks from vehicles used in the landfill (dump trucks, bulldozers, backhoes, etc.). A surface fire could also be ignited when drilling or

while driving metal pipes through layers of buried waste if a hard object buried in the landfill is struck.

- Spontaneous combustion of materials in the landfill. The mixing of certain materials in a landfill can result in spontaneous combustion. Even in small quantities, some chemicals can ignite if exposed to one another. Also, some materials, such as oily rags, can spontaneously combust under certain conditions

Underground Fires

Underground fires in landfills occur deep below the landfill surface and involve materials that are months or years old. These fires are generally more difficult to extinguish than surface fires. Underground fires also have the potential to create large voids in the landfill, which can cause cave-ins of the landfill surface. Further, they produce flammable and toxic gases (such as carbon monoxide) and can damage leachate containment liners and landfill gas collection systems.

The most common cause of underground landfill fires is an increase in the oxygen content of the landfill, which increases bacterial activity and raises temperatures (aerobic decomposition). These so-called "hot spots" can come into contact with pockets of methane gas and result in a fire.

Summary

Soil remediation for ex situ practices would require excavation, containment, engineering systems, and a treatment based approach.

Stakeholder engagement, risk management, cost effectiveness and technical feasibility are important criteria to bear in mind. Transformation technologies, stabilizing technologies have to be screened and selected. The components in the protocol for selecting technologies are explained. Electrokinetic remediation involves application of electric current directly into the soil, thereby mobilizing the contaminant and forcing it to collect in one zone. Electro-osmosis, electromigration, electrophoresis and electrolysis are explained. Diffusion, dissolution, oxidation-reduction are all different chemical interactions that take place during the process. The advantages and disadvantages of electrokinetic remediations are addressed. Soil washing, extraction by chemicals or solvents is explained. Stabilization technology, such as circulating bed combustor, infrared combustion, permeable reactive barriers and sorption are important. Flaming, gas recovery and biomining with the use of fungi, heap leaching, dump leaching and agitated leaching are important. Treatment facilities in India as well as business opportunities in W2E are enumerated. The risk associated with fires has also been touched upon.

Self Assessment Questions

1. How can bioremediation clean up polluted soil?
2. Discuss xenobiotics
3. Which is the successful technique in treating petroleum hydrocarbon?

Further Reading

1. Environmental remediation and conversion of carbon dioxide (CO_2) into useful green products by accelerated carbonation technologyhttps://pdfs.semanticscholar.org/11b0/91e8f5ccf4a1b7eb4b74f89409415235a195.pdf
2. Electrokinetic Remediation and Its Combined Technologies for Removal of Organic Pollutants from Contaminated Soils http://www.electrochemsci.org/papers/vol7/7054528.pdf

3. Contaminated Soil Remediation with Hydrogen Peroxide Oxidation https://waset.org/publications/6980/contaminated-soil-remediation-with-hydrogen-peroxide-oxidation
4. Capping Jawaharnagar, Hyderabad, Telanganahttps://www.thehindu.com/news/cities/Hyderabad/jawahar-nagar-dump-yard-capping-by-april/article24374885.ece
5. Bio-Mining at Kumbakonam - A path-breaking bio-mining concept has helped Kumbakonam Municipality reclaim a vast area that was used as a garbage dump on the outskirts of the temple town. https://www.youtube.com/watch?v=X9GANY9mqxo
6. Municipal solid waste biomining dumpyardhttps://www.youtube.com/watch?v=STes-Zda0m0
7. Bioremediation of Dumped Waste– Indorehttps://www.youtube.com/watch?v=4pTqFd5upFA
8. Municipal Waste to Energy and Power 24 MW Plant by RamkyEnviro Engineershttps://www.youtube.com/watch?v=gcTKQnnYzAU
9. MSW to Power - Waste to Energyhttps://www.youtube.com/watch?v=Am1yjwG4BKo
10. In-Situ Biological Treatment of Contaminated Soi lhttps://www.youtube.com/watch?v=bAwAFu7Mrk4
11. Soil bioremediation by biopileshttps://www.youtube.com/watch?v=h6FNr7S9BE8
12. Waste to energy process https://www.youtube.com/watch?v=DROZUstnsnw
13. How San Francisco Is Becoming A Zero Waste Cityhttps://www.youtube.com/watch?v=DROZUstnsnw

Chapter 7
Multi-Criteria Decision Analysis

Objective

- To gain insights into why selection of particular technology based on availability, economy, time and environmental conditions helps in taking environmental and economically feasible decisions

Structure

7.1 Multi-criteria Decision Analysis (MCDA) or Multi-criteria Decision Making (MCDM)
7.2 Methodological process and Criteria Options
7.3 Identification and implementation of Waste Options/Alternatives

To Do Activities

1. Explain processes of electrokinetic remediation.
2. Organise a seminar on types of leaching, biomining and gas recovery methods
3. Discuss on what topics each student is interested in, scope out possibilities of career development, research or internship opportunities.

Assessment methods are common tools to support decisions, regarding waste management. The primary goal of sustainable waste management is to protect environment and human health and to conserve resources. To reach these goals, decision makers apply integrated strategies that include multitude of associated processes, such as collection, transportation, treatment, recycling, and disposal. Also care is taken during decision making to have a practicable waste management approach with due consideration given to acceptable costs, balancing environmental, social and economic factors. Also regulatory, technical and other required parameters are duly considered during decision analysis.

Key elements of any waste management assessment methodology:

Goal Assessment

1. Defining the scope and goal of the assessment : It includes –
   - Aspects : Environmental, social and economic aspects
   - Objectives : Waste prevention, collection, recycling, treatment, disposal
   - Receiving entities or groups : Government, municipalities, operators, citizens and service providers

2. Assessment Methodologies :
   - Life cycle assessment
   - Benchmarking
   - Environmental impact assessment
   - Cost-Benefit Analysis
   - Strategic environmental assessment
   - Risk Assessment

- Multi-Criteria Decision Analysis (MCDA)
- Eco-efficiency analysis

3. Applying the mass and balance principle

$$\sum_{Input} = \sum_{Output} \pm \Delta Stocks$$

4. Ensuring better implementation and transparency

7.1. Multi-Criteria Decision Analysis (MCDA) or Multi-Criteria Decision-Making (MCDM)

Multi-criteria decision analysis (MCDA) is a decision making tool that facilitates choosing the best alternative among several alternatives. This tool evaluates a problem by comparing and ranking different options and by evaluating their consequences according to the criteria established (Hermann *et al.,* 2007; Hung *et al.,* 2007; Karmperis *et al.,* 2013). It is used to describe a group of formal multi criteria approaches which in turn help individuals and varied stakeholders in decision making. For example waste management involving public participation or stakeholder engagement can be facilitated by MCDA, through the structuring and articulation of the public opinion and stakeholder's opinion.

When dealing with for example large scale biodegradable wastes, often many logistical problems and environmental and public health impacts arises. And if the segregation step fails to deliver results, it leads to hindrance in integration of efficient waste management. Extra precaution is required to plan and facilitate decision making. Also decision making with regard to use of sustainable facilities, will involve tradeoffs between other conflicting objectives- say for example if we opt for incineration, the waste gets disposed quickly but the emissions become the issue, so one benefit comes with a drawback, so decision making with regard to different wastes is needed. Multi-criteria Decision Analysis can be applied in such cases to evaluate different waste management options and its applicability.

Another example that can be given is decision making involving waste recycling and the development of new facilities for waste disposal. Making decisions for such facilities has an impact on diverse domains and entities starting from individuals to authorities and organizations or to the society as a whole. So multi criteria analysis oversees these together.

7.2 Methodological process and Criteria Options

1. **Selecting the best plus or most suitable options or alternative for biodegradable wastes:**
   MCDA framework can be applied here, which helps to assess the suitability of different wastes treatment options and or alternatives applicable to handling biodegradable wastes. The purpose of selecting is improving public health through restriction of wastes discharge, using appropriate sorting, storage, collection, transport, recycling or disposal of wastes.

2. **Problem definition and goal determination**
   The selection of proper and right treatment and disposal will reduce excess incurring of costs and saves time. It also helps to know the problem statement early in time so that goals can be set accordingly. Problem defining and at right time, right methodology protects public health, conserves resource and reduces the risk to water, air and soil systems.

3. **Hierarchy Identification of Criteria and Options**
   The criteria has to be clearly defines in order develop a proper hierarchy of waste management model through MCDA approach.

Defining Criteria

- **Environmental Criteria**
  This criteria aims to specify changes be it positive or negative to air, water or land and to human health, ecosystem at large due to actions taken while undertaking waste management. The way waste is treated, disposed, reused and recycled does reflect the environmental impacts that it creates. As a result, all the criteria options are judged against the environmental implications before selecting any best available waste management technology. The environmental options that are given consideration during decision making include the following:
  - Air and Water Pollution
  - Exposure to Pathogens
  - Land Use, Requirement, and Contamination
  - Material Recovery
  - Waste Coverage and Elimination
  - Energy Recovery
  - Noise and Dust

- **Socio-cultural Criteria**
  Waste generation is usually determined by socioeconomic characteristics and people's attitudes towards wastes. It is well known fact that campaigns and positively influences people's approach to wastes and their way of discarding. This criterion supports the aim to improve working conditions, earnings, and access to social services, and also evaluates each option based on the following list:
  - Acceptance
  - Lifestyle habits
  - Consumption pattern
  - Perception and Complexity
  - Usability and Compatibility
  - Flexibility of Administration Principles
  - Policy
  - Implementation and Adoptability
  - Vulnerability of the Area

- **Technical Criteria**
  Technical criteria are particularly given consideration when selecting waste disposal options. Their importance is usually in view of the possibility of subsequent increases in the daily tonnage of waste that the facility will be required to manage, for added processing capabilities. These criteria also determine what equipment, skills and training will be required to perform waste management responsibilities. The following criteria points that are given consideration include: Possibility and Robustness
  - Local Labour, workforce – skilled and informal
  - Working Experience
  - Adaptability to existing systems
  - Handling capacity and continuous Process (materials)
  - Prospective Future Improvement

- **Economic Criteria**

An economic criterion is an important part of strategic planning and investment decision making for any waste disposal or for any waste management facility. Estimating the preliminary investment capital requires long-term operating and maintenance costs in relation to the different waste management activities. It will also include an appraisal of public's willingness and capability to pay for the service. The criteria points include:

- Capital and Construction Cost
- Operating and Maintenance Cost
- Revenue Generation and Marketability
- Financial Planning
- Employment and Job Creation
- Waste Volume and Composition, *i.e.*, Wet and Dry Waste
- Resource Recovery, *i.e.*, Nutrient Reuse and Energy Recovery

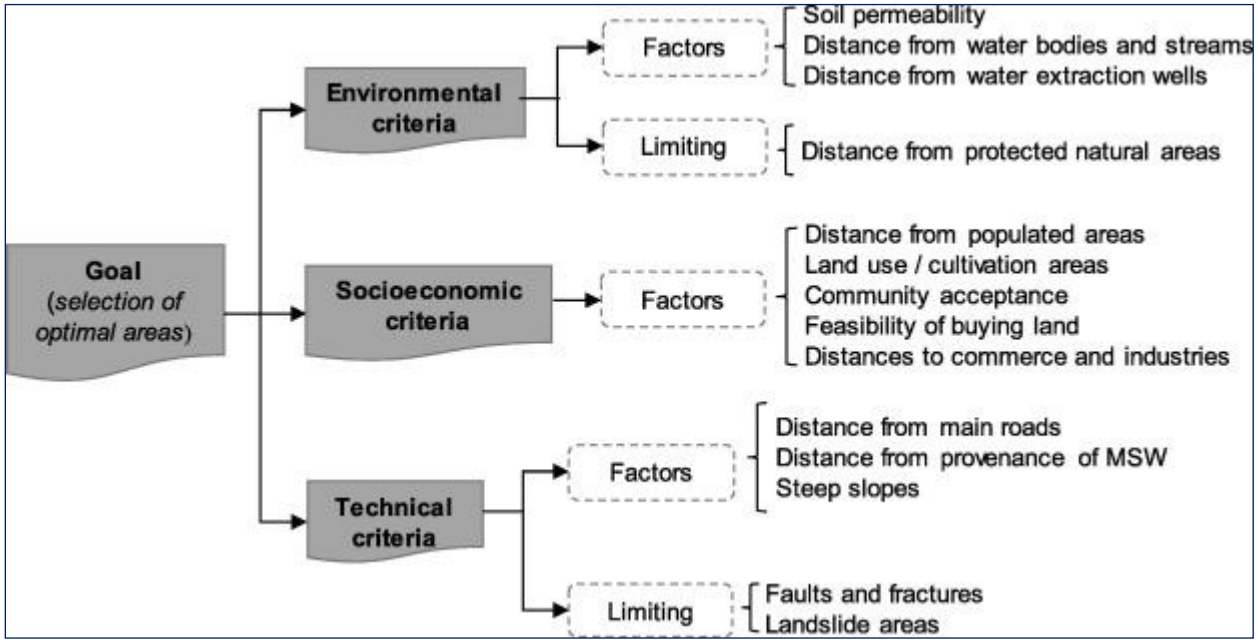

Fig 7.1 Hierarchy Structure for the Emplacement of MSW Management Infrastructure (Aguilar *etal*, 2018)

7.2 Identification and Implementation Results of Waste Options/Alternatives

Various disposal methods have been adopted to treat wastes, say for example if it is a biodegradable wastes, the known methods include open dumping, sanitary landfilling, incineration, and composting However it was necessary to identify the options and criteria that could fulfill the aims and objectives while applying MCDA. The figure 7.1 depict the goal, criteria and options to carry out MCDA and its applicability to waste management.

- Anaerobic Digestion
- Incineration
- Compost
- Landfill

The goal, criteria, and options identified and are represented appropriately in a hierarchical structure implementation can be done which helps to facilitate the procedure for assigning weights and scores and accordingly bring about a successful waste management technology accepted with all the criteria viz; environmental, social-cultural, economic, technical criteria duly considered.

Weighting of criteria and sub-criteria

Weights and scores are assigned and accordingly comparison of each waste management practice, landfill reclamation or for that matter any waste management is done to develop the best plus model for implementation.

- Pairwise comparison for the general criteria
- Pairwise comparison for the environmental criteria
- Pairwise comparison for the socioeconomic criteria.
- Pairwise comparison for the technical criteria

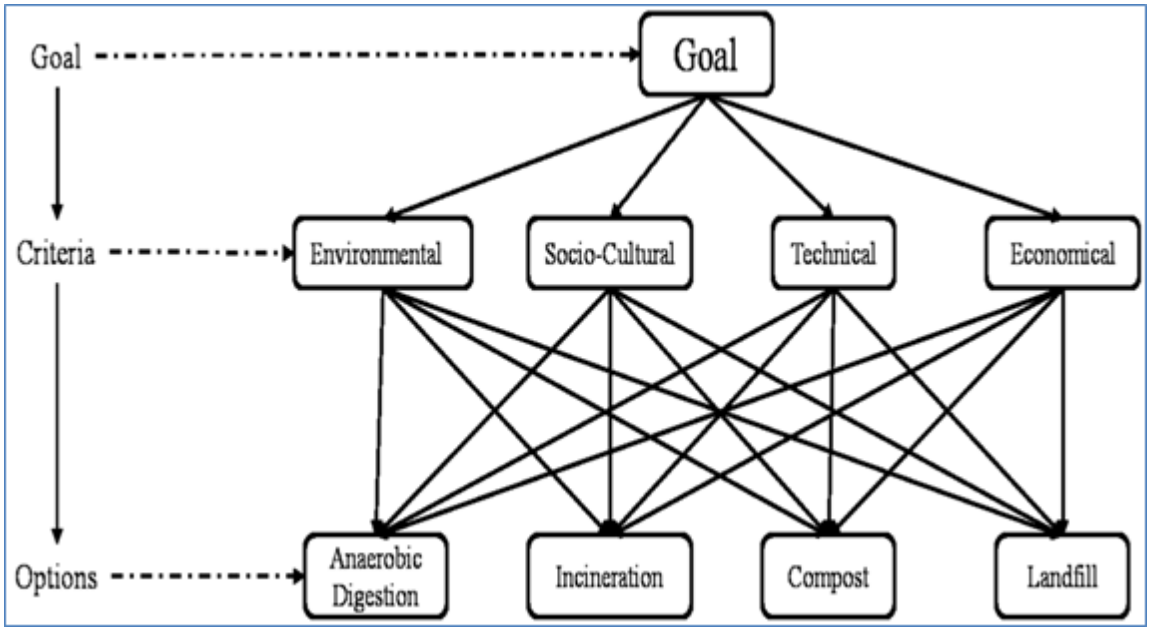

Figure: 7.2. MCDA Hierarchy Model Showing the Criteria and Options (Allesch and Brunner, 2014)

Summary

Multicriteria decision making involves assessment of goals. The methods involved are LCA, benchmarking, EIA, CBA, SEA, risk assessment, which we have learnt in other courses as well**.**

MCDM is explained in detail, along with eco-efficiency analysis and mass and balance principle. Besides the hierarchy criteria, it is equally important to consider environmental criteria such as Air and water pollution, exposure to pathogens, land use, requirement and contamination, material recovery, waste coverage and elimination, energy recovery, noise and dust. Socio- cultural criteria include the evaluation of Acceptance, lifestyle habits, consumption pattern, perception and Complexity, flexibility of administration principles, vulnerability, etc. Technical criteria give consideration to local labour, working

experience, continuous process, handling capacity, and prospective future improvement, and finally, economic criteria.

Self Assessment Questions

1. Apply multi-criteria decision analysis to waste management and write a concept note on it.
2. Write different steps involved in multi-criteria decision analysis.
3. Explain stabilizing technologies.

Further Reading

1. Evaluating plastic waste disposal options in Delhi using Multi Criteria Decision Analysis https://www.iioab.org/articles/IIOABJ_7.11_25-35.pdf
2. Location allocation for urban waste disposal site using multi-criteria analysis: A study on Nabadwip Municipality, West Bengal, India http://www.ipublishing.co.in/jggsvol1no12010/volthree/EIJGGS3107.pdf
3. Sustainable and smart city project: an overview of the application of multiple criteria decision making techniques and approaches for Indian context http://iraj.in/journal/journal_file/journal_pdf/14-391-15064030681-6.pdf
4. The use of multi-criteria decision analysis in Environmental Impact Assessment https://jyx.jyu.fi/bitstream/handle/123456789/49480/1/Annex7.2.5ReportontheuseofMCDAinEIAandSEA.pdf
5. A Multi-Criteria Decision Analysis of Waste Treatment Options for Food and Biodegradable Waste Management in Japan https://www.mdpi.com/2076-3298/2/4/471/htm

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Annexure – I

1. Waste to Energy Report – World Energy Council
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2. Practical Bioremediation Course – Laboratory Exercises on Biodegradation of Cationic Surfactant
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4416508/

Annexure – II Student Take Away – Knowledge tool kit

1. Guidelines for Reclamation of Problem Soils
   http://agricoop.nic.in/sites/default/files/rps_guidelines%20%282%29.pdf
2. Harnessing the Fourth Industrial Revolution for Life on Land - Towards an inclusive Bio-Economy : World Economic Forum, 2018
   http://www3.weforum.org/docs/WEF_Harnessing_4IR_Life_on_Land.pdf
3. Financing Soil Remediation Exploring the use of financing instruments to blend public and private capitalhttps://www.iisd.org/sites/default/files/publications/financing-soil-remediation

Course 10 Legal Aspects and Mandatory Regulations

PG Diploma in Waste Management & Environmental Hygiene

Mahatma Gandhi National Council of Rural Education
Hyderabad - 500004

Foreword

Waste management disposal in a safe and scientific method is a pressing issue in India. This affects public health and the environment and highlights the need for waste management. Waste management refers to a process, which includes collection, transport, processing, recycling or disposal, and monitoring of waste materials. The term usually relates to materials produced by human activityincluding human waste. Legally, the framework for waste management mainly consists of the Environment (Protection) Act, 1986. Rules have been framed under the Act to deal with various wastes such as municipal solid waste, hazardous waste, electronic waste and bio-medical waste. Statutes relating to local bodies in the urban as well as rural areas are also pertinent in the waste management context.Local bodies are the key agencies responsible for general sanitation duties. Waste management is a part of their statutory duties. SwachhBharat Abhiyan and the Jawaharlal Nehru National Urban Renewal Mission in urban areas), which arefunded by the Central government, also lay down norms and standards on waste management.

Waste management laws in India are multi-scalar in nature. The existing laws consist of different legal instruments at different levels, at central and state levels. The existing law in India on waste management has different instruments for different kinds of waste such as municipal waste, hazardous waste and electronic waste. Different regulatory and institutional mechanisms have been studied under these laws according to the waste type. Local bodies are mainly responsible for municipal solid waste management and producers are responsible to ensure environmentally sound management of electronic waste. There are many rules defining waste, however, the implementation of these laws continues to be a major challenge.

This course on Legal Aspects and Mandatory Regulations in Waste Management is suitable for students of all streams - Commerce, Humanities, Science, Management, Journalism, Mass Media, Healthcare services (B Pharm, Social Work), Education, and Engineering. The extent of environmental damage and the innovations in combating the issues require scientific understanding of the subject.

The subject has vast possibilities and several interlinking themes. There is extensive scope to explore and experience different aspects of sanitation, pollution, environmental hygiene and waste management during classroom learning, practical experiments in field and laboratory, internship and dissertation. There is a sea of opportunity in this field of waste management and environmental hygiene, and an urgent need of skilled as well as dedicated workers to make our country clean and green.

Nature has interlinked realms. Similarly, subjects dealt in this course cannot be compartmentalized. They necessarily have to merge with one another. It is therefore important that students try to make these linkages in their minds rather than treating subjects in isolation. Students can make the most of this learning opportunity as they prepare to launch their careers in a field that holds great premise.

Dr. W G Prasanna Kumar

Chairman, MGNCRE

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The sincerity with which the course curriculum was completed and published can be assessed from the fact that a prior National Consultation Workshop was held with several subject matter experts and academicians across the country, to review the contents of the course material.

The workshop was held to familiarize Central, State and Private Universities, local and social bodies with the contents of the curriculum and to discuss and share feedback on ways to improve the course curriculum. Theworkshop also focused on building industry–academia partnerships in Waste Management and Environmental Hygiene through an intellectual interaction. The findings and inputs of the consultation were subsequently incorporated in the course material.

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Objective

To promote eco - responsible behavior and practice compliance to regulatory requirements

Rationale

Waste management and environmental hygiene is the need of the hour and needs to be addressed across all sectors and communities. The course on Waste Management and Environmental Hygiene gives the student an overview of waste management including collection, transfer, transport, and disposal along with methods of processing, basic disposal facilities, disposal options, recycling, project management and GIS applications, reclamation and remediation, entrepreneurship and job opportunities in waste sector. In addition, this course provides the student with relevant information about waste markets, recycling trends, cost and affordability of waste management practices, and incentive based concepts. This course is therefore essential for the students who wish to pursue a career in waste sector as moving ahead, waste management will become an infrastructural necessity.

Competency

The course will be taught and implemented with the objective to develop required skills sets in the students so that they are able to acquire following competencies: Know plan segregation, collection, transportation, recycling and disposal of wastes, know recycling trends and available waste markets, acquire skill development and know the scope and entrepreneurship opportunities in the waste management sector.

Methodology

The theory will be taught and practicality of the course will be addressed through questionnaires, self-assessment and dissertation. The course will be through class room lectures, guest lectures, field visits, audio – video learning mode, brainstorming sessions, seminars and Q&A. A lecture series will strengthen students' understanding of waste management which will help in acquiring different learning outcomes in rational and theory to practice approach. Competency that will be gained as part of course outcome includes - understanding, learning, applying and implementing skills, knowing career prospects in waste management sector, and internship and placement opportunities. Also included will be field Interaction with litigants, lawyers and other CSO experts,Caselets and study of PILs.

Topics Covered

- Environmental laws regarding pollution and waste management Air Act 1981
- Water Act 1974, EP Act 1986 and rules thereof including Hazardous Waste Management Rules1989, BMW Rules MSW Rules 2016
- Plastic Waste, C&D and e-Waste Management Rules and updates thereof
- NGT and Courts

Introduction

The need for protection and conservation of environment and sustainable use of natural resources is reflected in the framework of the Constitutionof India and in the country's international commitments. The history of legislative measures started with Indian Penal Code 1860. Section 268 defined what is public nuisance. Abatement of public nuisance is also a subject of Section 133 to 144 of I.P.C. These are only prohibitive provisions. Sections 269 to 278 of the Indian Penal Code are penal provisions which means that a person guilty of violating any of the provisions is liable to prosecution and punishment.

Several pieces of environmental protection legislation existed even before Independence. However, the thrust for putting in force a well-developed framework came only after the UN Conference on the Human Environment (Stockholm, 1972). After the Stockholm Declaration, the National Council for Environmental Policy and Planning was set up in India in the same year (1972) within the Dept. of Science and Technology. The Constitution, under Part IVA (Art 51A-Fundamental Duties) casts a duty on every citizen of India to protect and improve the natural environment, including forests, lakes, rivers and wildlife, and to have compassion for living creatures. Further, the Constitution,through the 42ndAmendment in 1976, under Part IV (Art 48A-Directive Principles of State Policy and Fundamental Rights and Duties), stipulates that the State shall endeavor to protect and improve the environment and to safeguard the forests and wildlife of the country.

The Dept. of Environment wasestablished in 1980to ensure a healthy environment for the country. This Council later evolved into a full-fledged Ministry of Environment and Forests (MoEF) in 1985. Today, it is the apex administrative body in the country for regulating and ensuring environmental protection. Also, it lays down the legal and regulatory framework for the same. Since the 1970s, a number of environment laws have enacted. The MoEF and the pollution control boards ("CPCB" i.e., Central Pollution Control Board and "SPCBs" i.e., State Pollution Control Boards) together form the regulatory and administrative core of the sector.

Over the years, apart from rising environmental consciousness, there has been a change in the traditionally-held perception that there is a trade-off between environmental quality and economic growth as people have come to believe that the two are necessarily complementary. The current focus on environment is not new; environmental considerations have been an integral part of the Indian culture.

A policy framework has also been developed to complement the legislative provisions. The Policy Statement for Abatement of Pollution and the National Conservation Strategy and Policy Statement on Environment and Development were brought out by the MoEF in 1992 to develop and promote initiatives for the protection and improvement of the environment. The EAP (Environmental Action Programme) was formulated in 1993 with the objective of improving environmental services and integrating environmental considerations into development programmes.

The Government of India has launched various programmes and made use of audiovisual media to educate the people and arouse their consciousness for the protection of environment. In February 1971, the University Grants Commission (India), in collaboration with other organizations, launched a symposium on the development of environmental studies in the Indian Universities. The consensus that emerged at the symposium was that ecology and environmental issues should form part of the courses of study at all levels.

Some of the important measurestaken by the government through legislation to protect and preserve the environment are as follows:

1. Forest Act
2. Wildlife Act

3. The Water (Prevention and Control of Pollution) Act, 1974
4. The Air (Prevention and Control of Pollution) Act, 1981
5. The Environment Protection Act, 1986
6. The National Green Tribunal Act, 2010
7. The Hazardous Waste Management Regulations and others.

Some of these Acts have been amended from time to time. Other important pieces of legislation concerning environment have been explained in the succeeding chapters, which deal with environmental Hygiene, Water and Solid Waste Management issues.

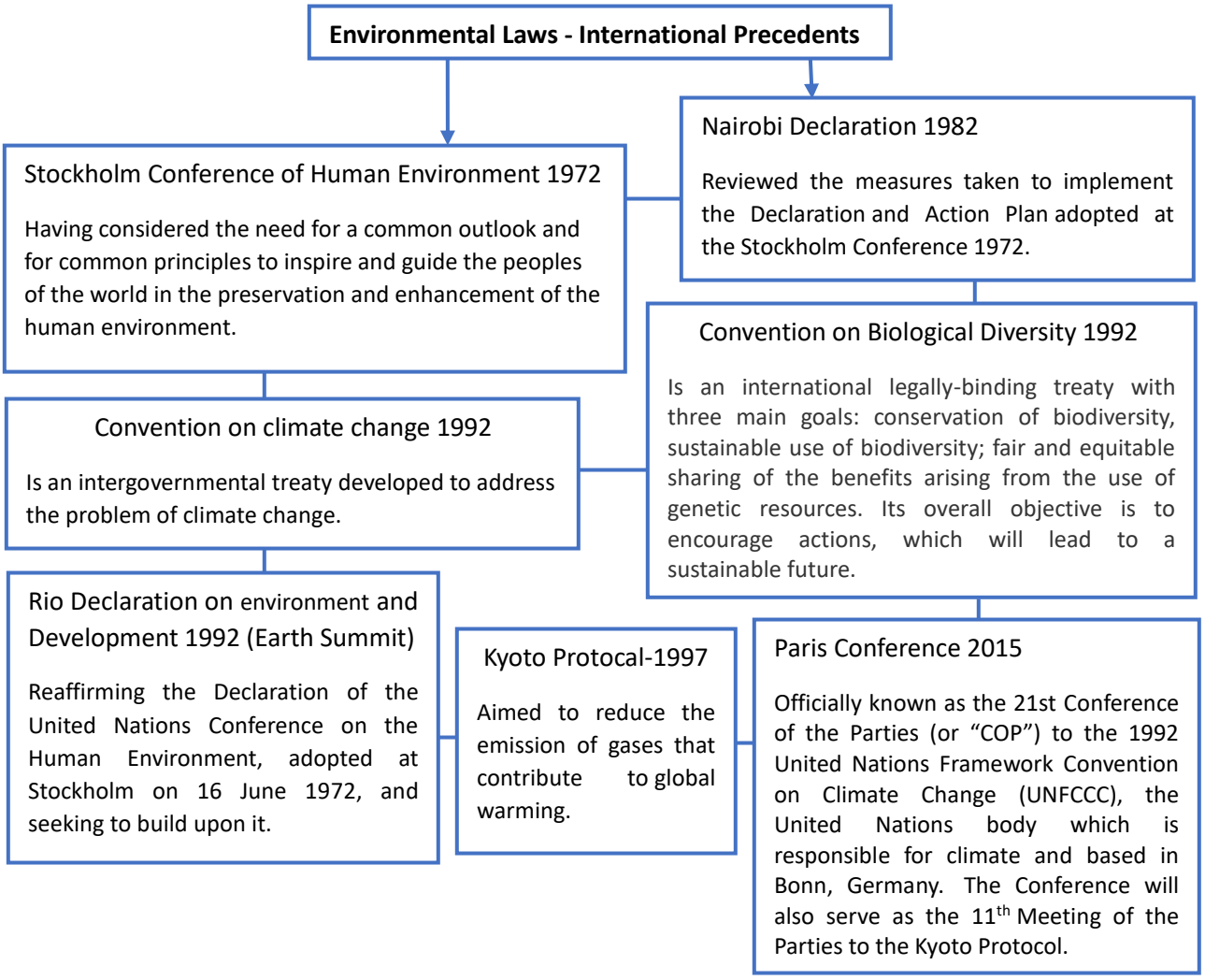
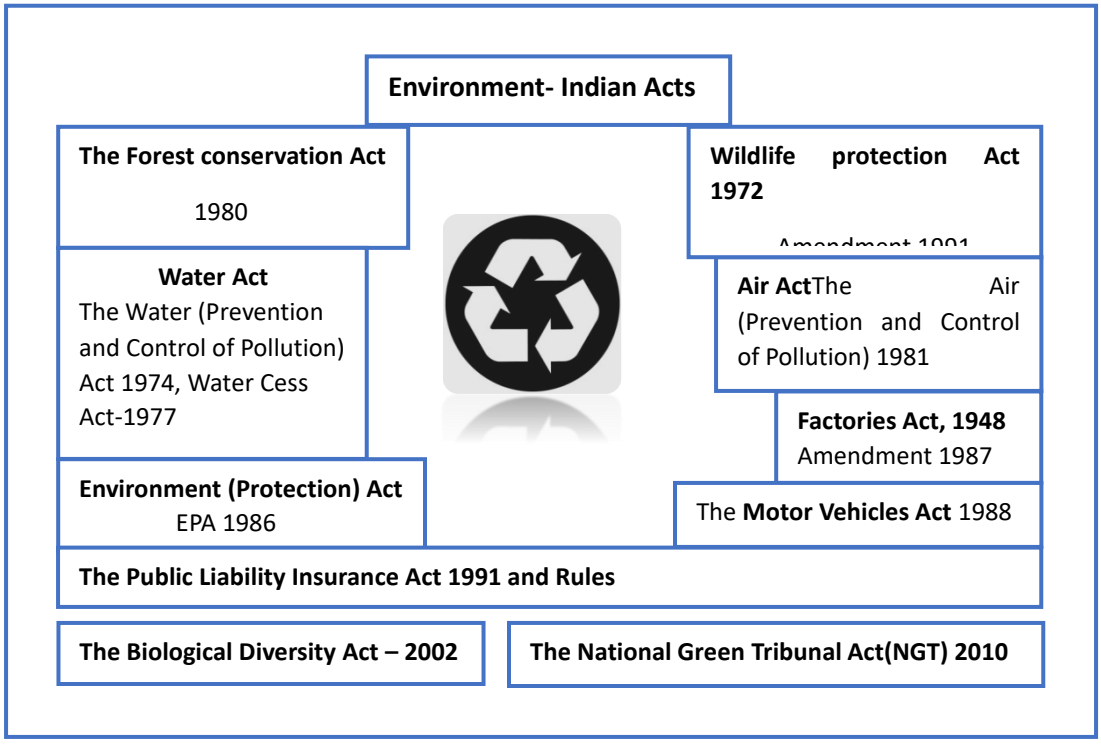
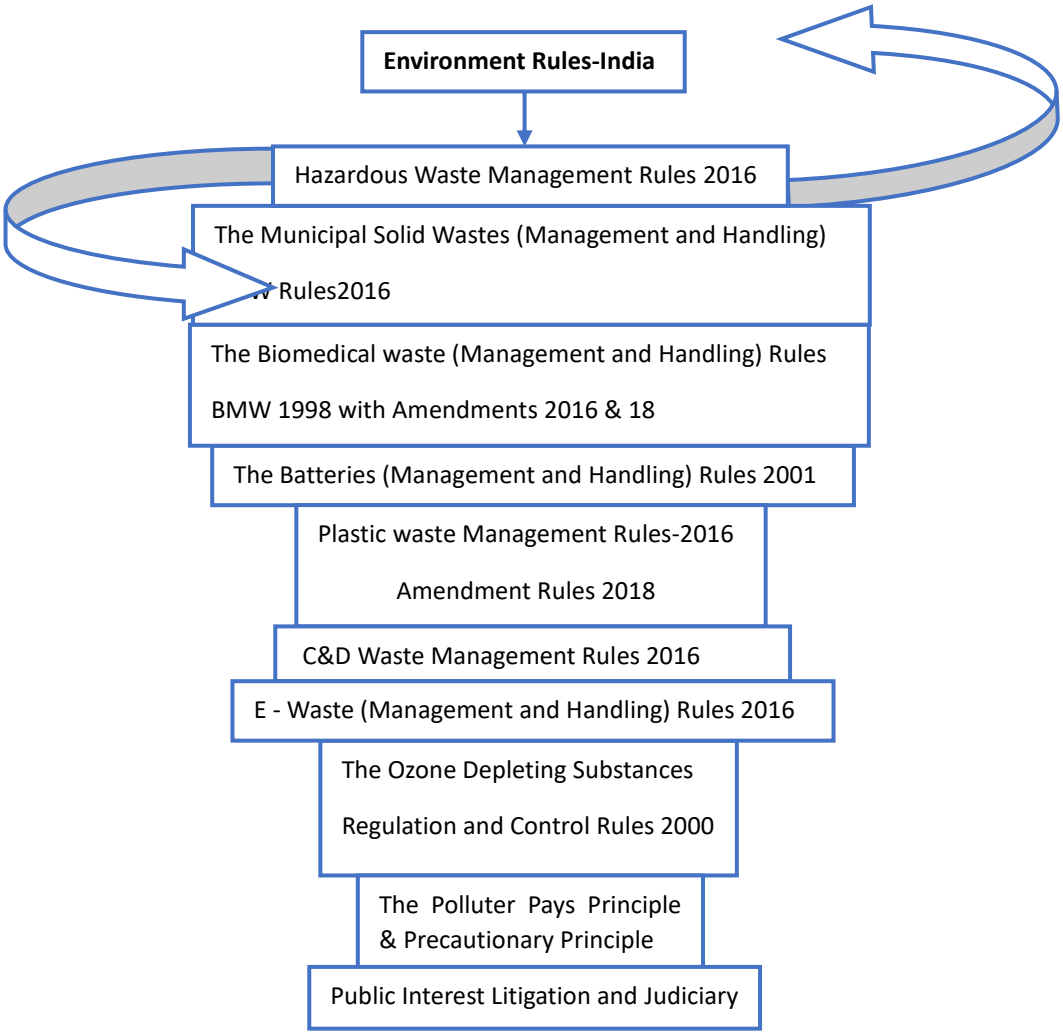


Fig 1.1 Environmental Laws- International Precedents


Environment- Indian Acts
The Forest conservation Act
1980
Wildlife protection Act 1972
Water Act
The Water (Prevention and Control of Pollution) Act 1974, Water Cess Act-1977
Air ActThe Air (Prevention and Control of Pollution) 1981
Factories Act, 1948
Amendment 1987
Environment (Protection) Act
EPA 1986
The Motor Vehicles Act 1988
The Public Liability Insurance Act 1991 and Rules
The Biological Diversity Act – 2002
The National Green Tribunal Act(NGT) 2010



Constitutional Provisions for the Protection of Environment

Chapter 1

Constitutional Provisions for the Protection of Environment

Objectives

- To understand fundamental rights and duties
- To realize fundamental rights and human rights of the vulnerable and disadvantaged sections of society
- To understand conservation and survey of flora, fauna, forests and wildlife
- To understand NGT Act

Structure

1.1 Fundamental Rights and Fundamental Duties
1.2 Directive Principles of State Policy and Other Constitutional Mandates
1.3 Public Interest Litigation and Doctrine of Trust
1.4 National Green Tribunal
1.5 The Ministry of Environment, Forest and Climate Change

To Do Activities

- Visit a nearby court to understand how some of these acts are dealt with
- Conduct a survey to understand how far these Acts have been implemented in the respective arenas.
- Discuss caselets on various Acts
- Provide topics for group or individual presentation
- Organize debate on the Acts which are important andcheck forpractical implementation

1.1 Fundamental Rights and Fundamental Duties

The concern for environmental protection in India is not only been about the status of fundamental law of the land, but also about human rights. It is now well-established that it is the basic human right of every individual to live in pollution-free environment with full human dignity. Central to these laws are the Fundamental Rights and Fundamental Duties concerning environment.

Fundamental Rights

Part III of the Constitution of India contains fundamental rights. These rights were included in the Constitution after long debates in the Constituent assembly. Under this, Article 21 deals with protection of life and personal liberty. It says: No person shall be deprived of his life or personal liberty except according to procedure established by law. Article 32 provides remedies for enforcement of rights conferred by this Part.

Courts have recognized several unarticulated liberties that were implied by Article 21 and it is now established that the right to life and personal liberty includes the right to wholesome environment. For instance, life cannot be possible without clean drinking water; therefore, right to clean water has been held to be one of the attributes of the right to life in Article 21 of the Constitution. The courts have been enthusiastic and active in accepting and declaring that ‘right to life’ in Article 21 includes ‘right to environment’.

Right to Livelihood vis-à-vis Environment

The Supreme Court has recognised another aspect of the right to life enshrined under Article 21 of the Constitution, viz. the right to livelihood. For, there is a real chance of clash of these rights, i.e. right to

environment and right to livelihood as government's action to close down industrial units for protection of environment may result in loss of job, dislocation of poor workers and might disrupt badly the lifestyles of people heavily dependent on such industries. For instance, it is to secure this right that courts have issued directions to Municipal Corporations to provide alternative sites or accommodation to slum and pavement dwellers near to their original sites; and to provide amenities to slum-dwellers if they are displaced. In many cases the Supreme Court passed orders requiring State agencies and concerned person to resettle and rehabilitate the workers or other persons who were being displaced by the decision of the Court or of the Government displaced by the Decision of the Court or of the Government to close down an industry or to relocate at a suitable place.

Right to Equality

Article 14 of the Constitution guarantees to every person the right not to be denied equality before the law or the equal protection of the laws. The possibility of infringement of this Article by a government decision having impact on the environment cannot be ruled out. Article 14 strikes at arbitrariness because an action that is arbitrary must necessarily involve a negation of equality.Thus, permission for contractions that is contrary to town planning regulation by the municipal authority may be challenged. Similarly, Article 14 may be invoked to challenge governmental sanction of projects having adverse impact on the natural environment and where such sanctions involve arbitrary considerations.

Freedom of Trade

Article 19(1) (g) of the Constitution guarantees to all citizens of India, the right to practice any profession or to carry on any occupation or trade or business. The freedom however, is not uncontrolled.The aggrieved industrialist may resort to Article 19 in case his trade and business interests are affected by the action of governmental agencies in the name of the environmental protection. It is now settled that courts will need to balance environmental interests with the fundamental right to carry on any occupation, trade or business guaranteed in Article 19(1) (g). Various standards have been prescribed by the Government for the discharge of different pollutants. An industry may challenge a very stringent standard which cannot be complied with, despite best efforts by available technology or if it is otherwise unreasonable.

Role of Panchayat and Municipalities

The Constitution (Seventy-third Amendment) Act 1992 and the Constitution (Seventy –fourth Amendment) Act 1992 have given a Constitutional status to the panchayats and the Municipalities respectively. Article 243-B provides or the establishment of intermediate and district levels. Article 243-G authorises the legislature of State to endow the panchayats with such powers and authority as may be necessary to enable them to function as institution of self-government.

The Eleventh Schedule, along with other matters, contains following maters which are directly or indirectly related to environment like, agriculture, soil conservation, water management and watershed development; fisheries; social forestry and farm forestry; minor forest produce; drinking water; health and sanitation; and maintenance of community assets.

The matters which are related to environment in the Twelfth Schedule may be enumerated as follows:Urban planning including town planning regulation of land use water supply; public health, sanitation, conservancy and solid waste management, urban forestry, protection of the environment and promotion of ecological aspects; provision of urban amenities such as park grounds; cremation grounds and electric crematoriums; prevention of cruelty to animals regulation slaughter houses and tanneries.Thus, it is evident that the Constitution imposes the duty to protect and preserve the environment in all the three tiers of the Government i.e. Central, state and local.

Prior to the Forty-Second Amendment, the Fundamental Law of the land attached greater more importance to rights. The makers of the Constitution were concerned about the moral and natural rights. For, the intention was that the citizens and the State would shoulder the responsibility for protecting the constitutional order as their moral duty. Over time, most citizens became conscious of their rights, but neglected their duties. Rights and duties are very important elements of law. They correlate to each other in such a way that one cannot be conceived without the other. A right is always against someone upon whom they correlative duty is imposed.

Fundamental Duties

Therefore, the Constitution (Forty-Second Amendment) Act, 1976 added a new part IV-A dealing with "Fundamental Duties" in the Constitution of India. Article51-A (g) specially deals with fundamental duty with respect to environment that: "It shall be the duty of every citizen of India to protect and improve the natural environment, including forests, lakes, rivers and wildlife and to have compassion for living creatures". Besides, Article 51-A (g) refers to the fundamental duty of every citizen to protect and improve "natural environment". Thus, the fundamental duty impose done very citizen is not only to "protect" the environment from any kind of pollution but also to "improve" the environment quality if it has been polluted. So, it is the duty of every citizen to preserve the environment in the same way as nature has gifted it to all of us.

Courts have held time and again that preservation of environment and keeping the ecological balance unaffected is a task which not only Government but also very citizen must undertake. It is a social obligation. Every citizen should do his fundamental duty as enshrined in Article 51-A (g) of the Constitution. Thus, there is both a Constitutional pointer to the State and a Constitutional duty of the citizens not only to protect but also to improve the environment and to preserve and safeguard the forests, the flora and fauna, the rivers and lakes and all the other water resources of the country. The neglect or failure to abide by the pointer or to perform the duty is nothing short of a betrayal of the fundamental law which the State and, indeed, every Indian, high or low, is bound to uphold and maintain. The Courts have reminded time and again to both State as well as citizens about their duties towards environment while deciding environmental issues by referring to Article 48-A and 51- A(g) of the Constitution.

1.2 Directive Principles of State Policy and Other Constitutional Mandates

Under Part IV of the Directive Principles of State Policy, Article 48A deals with protection and improvement of environment and safeguarding of forests and wildlife. It says that the State shall endeavour to protect and improve the environment and to safeguard the forests and wild life of the country. Article 48-A reflects an increasing awareness of people all over the word of the need to preserve the environment from pollution, especially in urban areas. Smoke, industrial waste, deleterious exhaust fumes from motor cars and other combustion engines are injurious to the health and well-being of the people and foul the atmosphere. The preservation of forests and their renewal by afforestation has long been recognised in India is of great importance both with reference to rainfall and to prevent soil erosion by depriving it of forests which protect it. The preservation of wild life is looked upon as necessary for the 'preservation of ecological balance'. Article 48-A rightly emphasise the fact that the State should try not only to protect but to improve the environment.

Article 39(e), 47 and 48-A of the Directive Principles of State Policy have a definite bearing of environmental problems. They, by themselves and collectively impose a duty on the State to secure the health of the people, improve public health and protect and improve the environment.

Environmental pollution may damage the monuments of national importance, the protection of which is a duty of the State under Article 49 of the Constitution. Article 49 of the Directive Principles of State Policy provides for the obligation of the State to protect monuments, places and objects of national importance. In the Taj

case9, the Supreme Court of India seems to have got inspiration from Article 49 while protecting the Taj Mahal, a monument protected under the Ancient Monuments and Archaeological Sites and Remains Act, 1958, from harmful Industrial emissions originating in and around Agra.

Article 51(c) directs the State to foster respect for international law and treaty obligations in the dealings of organised peoples with one another. Therefore, in view of the range of international treaties law and treaty obligations in Article 51 (c), read to conjunction with the specific treaty provision, may also serve to strengthen the hands of pro-conservation judge.

Duties of the State towards environmental protection: On this, Article 47 of the Constitution states: "The State shall regard the raising of the level of nutrition and the standard of living of its people and the improvement of public health as among its primary duties and, in particular, the State shall endeavor to bring about prohibition of the consumption except for medical purposes of intoxicating drinks and drugs which are injurious to health". It is clear that Article 47 calls upon the State to perform the basic duty to look after the health of the citizen and also take necessary and effective steps to improve their standard of living and also raise the level of nutrition. Improvement of public health forms the core of environment because due to various environmental hazards it is the health of the general people which comes under severe threat. In order to protect the health, the framers of the Constitution gave emphasis on the improvement of public health which is more vital for the existence of the mankind. Thus, the Constitution recognizes the right to health and casts a responsibility upon the State, making it obligatory to work for improving the health of the citizens.

Apart from various constitutional provisions and other statutory provisions contained in various laws relating to environment protection, the Supreme Court has held that the essential feature of "sustainable development" such as the "precautionary principle" and the "polluter pays principle" a reports of the environmental law of the country.

Preamble and Environment

The Preamble to the Constitution provides that our country is based on "socialistic" pattern of society, where the State pays more attention to the social problems than on any individual problems. Environmental pollution, which has emerged as one of the biggest social problems, is being regarded as a real problem affecting the society at large and thus state is under an obligation to fulfill the basic aim of socialism, that is, to provide decent standard of living to all which can be possible from a pollution-free environment. The preamble further declares that, the great rights and freedoms which the people of India intended to secure all citizens include justice, social, economic and political. Justice also includes environmental justice.

Parliament Empowered

Further, despite division of legislative powers in environmental matters, the parliament is empowered to legislate in the 'national interest' on matters enumerated in the State List. In addition, Parliament may enact laws on State subjects, for States whose legislatures have consented to central legislatures. Thus, the Water (Prevention and Control of Pollution) Act of 1974 was enacted by Parliament pursuant to consent resolution passed by the State Legislatures.

1.3 Public Interest Litigation and Doctrine of Trust

Public Interest Litigation

Definitions

- Public Interest Litigation means Litigation for the protection of the public interest
- Litigation means legal action

Object and Purpose

Public Interest Litigation is a means of constitutional litigation evolved in India under the writ jurisdiction of courts designed to

- Realize Fundamental Rights and Human Rights of the vulnerable and disadvantaged sections of society.

Supreme Court has evolved this instrument to make the constitutional mandate under article 32, more meaningful by allowing the demand for the rights of the poor to be voiced through any public-spirited person. PIL is absolutely necessary for maintaining the rule of law:

- Vindication of rule of law
- Facilitating effective access to justice to the socially and economically weaker sections of the society
- Meaningful realization of Fundamental Rights

The Indian judiciary has always welcomed public interest litigation petitions for furthering the cause of environmental protection in many cases. Quite often courts have taken suo motu cognizance of cases that impinge on environmental protection. The basic ideology behind adopting PIL petition is that access to justice ought not to be denied to the needy for the lack of knowledge or finances. In the case of a PIL petition, a public spirited individual or organization can maintain petition on behalf of poor & ignorant individuals.

In the area of environmental protection, thanks to PIL, courts have prohibited continuance of mining operations, terming it to be adversely affecting the environment. Courts have cautioned the industries discharging inherently dangerous chemicals and effluents. The courts have held that such type of pollution infringes right to wholesome environment and ultimately right to life. It was held recently that air pollution in Delhi caused by vehicular emissions violates right to life under Art. 21 and directed all commercial vehicles operating in Delhi to switch to CNG fuel mode for safeguarding health of the people. It has been held that noise pollution violates Art.21 of the Constitution. Tanneries discharging toxic chemicals in the river have been asked to close their business.

History

PIL originated and developed in the USA in 1960s to provide legal representation to previously unrepresented groups and interests. PIL is a product of the judicial activism role of Supreme Court. The seeds of the concept of public interest litigation were initially sown in India by V.R. Krishna Iyer, P.N. Bhagwati, were the pioneers.

In 1976 in Mumbai Kamagar Sabha vs. Abdul Thai (AIR 1976 SC 1455; 1976 (3) SCC 832) and was initiated in Akhil I3/taratiyaSos/ail Karnuu: hari Sangh (Raihvaiy vs, Union of India, wherein an unregistered association of workers was permitted to institute a writ petition under Art.32 of the Constitution for the redressal of common grievances. Krishna lyer J., enunciated the reasons for liberalization of the rule of Locus Standi in Fertilizer Corporation Kamgar vs. Union of India (AIR 1981 SC 149; 1981 (2) SCR 52) and the ideal of 'Public Interest Litigation' was blossomed in S.F. Gupta and others vs. Union of India, (AIR 1982 SC 149).

Approach

Public interest litigation or social interest litigation today has great significance and drew the attention of all concerned. Any public-spirited citizen can move/approach the court for the public cause (in the interests of the public or public welfare) by filing a petition:

1. In Supreme Court under Art.32 of the Constitution;
2. In High Court under Art.226 of the Constitution; and
3. In the Court of Magistrate under Sec.133, Cr. P.C.

In Public Interest Litigation (PIL) vigilant citizens of the country can find an inexpensive legal remedy because there is only a nominal fixed court fee involved in this. Further, through the PIL, the litigants can focus attention on and achieve results pertaining to larger public issues, especially in the fields of human rights, consumer welfare and environment.

The area in which Public Interest Litigation has been significant is environmental law. M.C. Mehta pioneered in bringing a large number of issues to the Court concerning environmental and ecological degradation. These included the issues emerging from the lead of oleum gas from a factory in Delhi, pollution in Delhi, the danger of the Taj Mahal from a refinery nearby it (Mathura Refinery), traffic regulation in Delhi, degradation of the Ridge area in Delhi.

The extent of judicial activity in the Taj Trapezium case is matchless. The Court supervised the installation of pollution control equipment and devices, closed violators, directed Gas Authority of India Limited to pipe gas to the industries, urged development of a green belt around the monument, relocated industries, carved out a labor compensation and entitlement scheme, expedited the construction of a highway to divert traffic away from Agra (place of the monument), asked the government to speed up work on barrages that would revive the flow in Yamuna and generally monitored development activity in the Trapezium. Here, apart from the judicial pronouncement, the Court has stepped out to execute and supervise the resultant actions too. This is the magnificent result of public interest litigation.

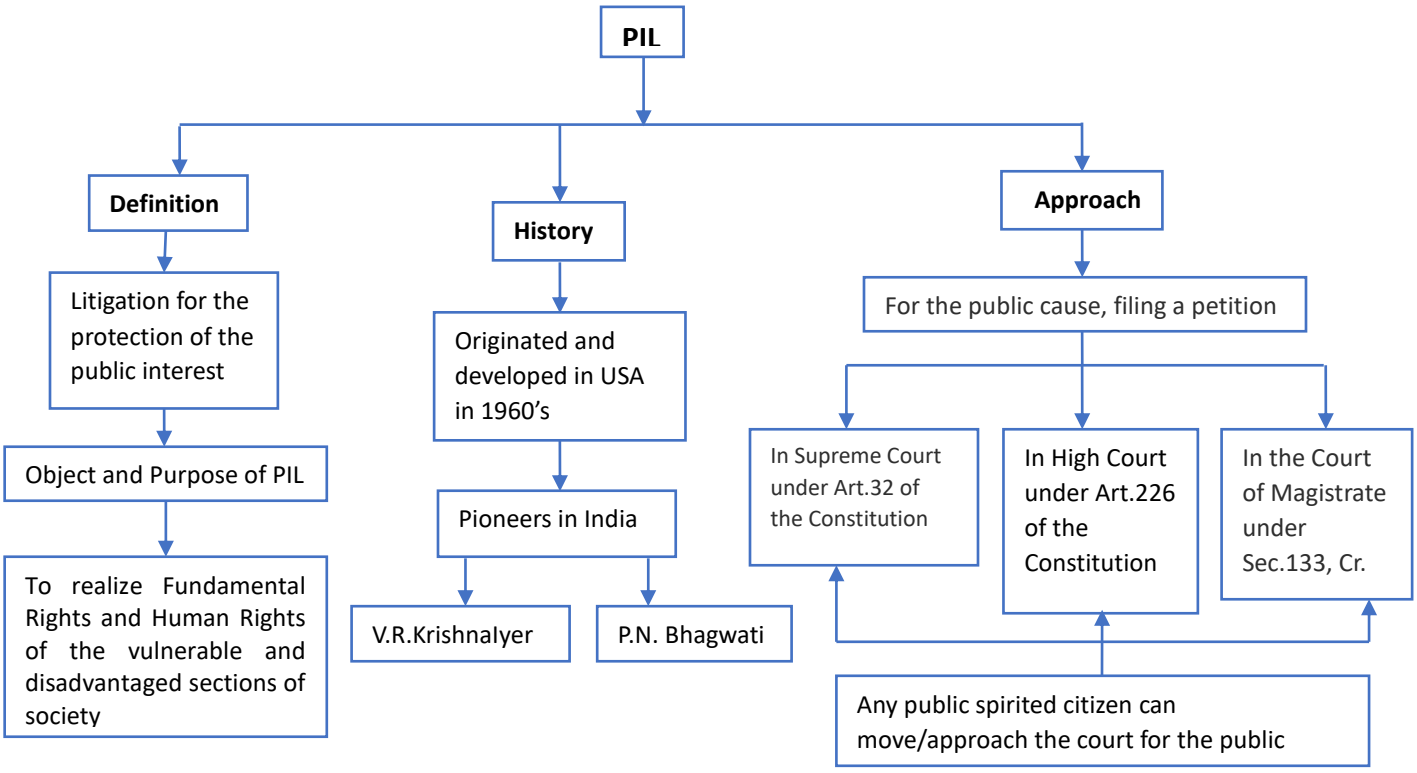


Fig 1.1 Public Interest Litigation

As regards the vehicular pollution in Delhi, on a petition filed by M.C. Mehta the Central Government was compelled to constitute an authority called Environment Pollution (Prevention and Control) Authority for the National Capital Region (EPPCA). Monitoring of pollution level came into being. With the introduction of CNG,

the pollution level came drastically down. Commercial vehicles now use only CNG in Delhi.

In the 1990s the Supreme Court set the national environmental agenda on a range of ecological issues. It did so through judicial orders in public interest litigations filed by citizens, non-governmental organizations and environmental groups. Dissatisfied at the poor enforcement profile of government agencies, the apex court set apart large amounts of judicial time and resources to address public grievances. This lead provided by the Supreme Court was followed by a number of State High Courts in various matters and adopted similar strategies to improve enforcement.

On the orders of the Supreme Court, arising out of public interest litigation, many areas in Delhi have been retrieved from encroachments. The Forest Dept. has been instructed to do a habitat development through natural regeneration cum enrichment planting combined with soil and moisture conservation measures.

The above are only some illustrative examples and do not forms an exhaustive list. The list will go endless and for fear of space and time, the list is restricted to the above examples/cases.

The Court's engagement with these matters resulted in the activation of the machinery and mechanisms under various environmental laws. The Court's activism in this area, however, drew flak too. The dangers of unchecked industrialization have compelled the Court to come down heavily on industry and developing the ‘polluter pays' principle. This principle was applied in the cases of shrimp farms, tanneries, chemical industries and distillery units. With the monitoring mechanism stipulated by the Court, the Court has ensured that a polluting unit is reopened only after it has satisfactorily installed pollution control devices. The Court also directed reparations at the cost of the polluter.

The Court also evolved ‘precautionary principle' which enjoins the State to anticipate dangers from the use of hazardous technology. The case of Tamil Nadu tanneries is a good example in this regard. Despite the foreign exchange earning capacity of these tanneries, the Court pointed out that the leather industry has no right to destroy the ecology, degrade the environment and pose a health hazard.

The Supreme Court has incorporated the 'Public Trust Doctrine' into the Indian environmental jurisprudence. According to the Supreme Court, the state is the trustee of the natural resources which are by nature meant for public use and enjoyment. The public at large is the beneficiary of the seas, rivers, air, forests and other ecologically fragile lands and these resources cannot be converted into private ownership. The Supreme Court has further recognized the principle of intergenerational equity wherein the present generation has an obligation to preserve natural resources or to exploit them in a manner so as to pass on to future generations an environment as intact as the one we inherited from the previous generation.

Thus, public interest litigation has become an essential tool to remedy injustice. We have to sharpen this weapon so that it becomes more effective as a vehicle for delivery of justice. As we go along, new problems are encountered and new challenges are met. We try to overcome the problems and to protect this new tool invented by the judiciary, for law must not only speak justice but also deliver justice.

International Agreements on Environmental Issues and Adoption by India

The Precautionary Principle & the Polluter Pays Principle

In order to link law and sustainable development we split Sustainable Development into two components: -

- Environmental Justice
- Social Justice

The two principles of Environment justice are

- Precautionary Principle (PP)
- Polluter Pays Principle (PPP)

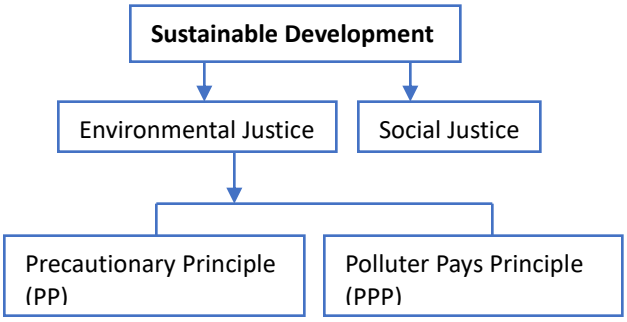


Fig 4.8 Sustainable Development

The Precautionary Principle (PP)

The Precautionary Principle states that when an activity causes some threat or harm to the public or the environment, general precautionary measures should be taken. When a scientific investigation proves that there is a possible risk in doing some activity, then this principle should be applied to anticipate and avert environmental harm.

Background

The origins of the Precautionary Principle can be traced to Swedish and German environmental law and policy at national level. Subsequently it was mentioned in the:

- World charter of a Nature of 1982
- The North Sea Conference of 1984
- The Bergen ministerial declaration on Sustainable Development (Regional European Community level) of 1990
- 1991- EU Proposed a text
- 1992 UNCED-In the cause of the Rio declaration PP was specifically taken note of in Principle 15

Internationally, one of the most important expressions of the Precautionary principle is the Rio Declaration from the United Nations Conference on Environment and Development.

Principle 15 of the Rio Declaration reads:
"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."
This principle is applied in the context of human activities on the environment and human health.

The 'Precautionary Principle' in the context of the municipal law means:

- Environmental measures – by the State Government and the statutory authorities – must anticipate, prevent and attack the causes of environmental degradation.
- Where there are threats of serious and irreversible damage, lack of scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.
- The 'Onus of proof' is on the actor or the developer/industrialist to show that his action is environmentally benign".

The Supreme Court held that "the precautionary principle and the polluter pays principle are part of the environmental law of the country. SC affirmed the decision especially in Vellore Citizens' Welfare Forum Union on India. In this case, the petitioners filed a petition in the public interest under Article 32 of the Constitution of India, directed against the pollution caused by enormous discharge of untreated effluent by the tanneries and other industries in the State of Tamil Nadu. The Supreme Court of India noted that:

"Though the leather industry is of vital importance to the country as it generates foreign exchange and provides employment avenues it has no right to destroy the ecology, degrade the environment and pose as a health hazard". The Court recognized that a balance must be struck between the economy and the environment:

"The traditional concept that development and ecology are opposed to each other, is no longer acceptable; 'Sustainable Development' is the answer The Indian courts have particularly embraced the precautionary principle.

The Precautionary Principle and the Onus Proofs

In Narmada BachaoAndolan, Union of India, the Court was called upon to decide various legal questions arising from the Sardar Sarovar Project involving the construction of a dam on the Narmada River. An environmental clearance had been given for the project. At the time it was granted there was no obligation to obtain any statutory clearance and hence the environmental clearance granted was essentially administrative in character. Nevertheless, the environmental clearance was challenged. It was alleged the necessary particulars in regard to the environmental impact of the Project were not available when the environmental clearance was given and it therefore could not have been given. It was further alleged that the execution of the Project, having diverse and far reaching environmental impact, without proper study and understanding of the environmental impacts and without proper planning of mitigative measures, was a violation of fundamental rights of life of the affected people guaranteed under Article 21 of the Constitution of India[1]. In the course of judgment, the majority noted the submission of the petitioners that "in cases pertaining to the environment, the onus of proof is on the person who wants to change the status quo and, therefore, it is for the respondents to satisfy the Court that there will be no environmental degradation". The majority dealt with this argument of shifting the burden of proof and the precautionary principle stating:

"That the 'precautionary principle' and the corresponding burden of proof on the person who wants to change the status quo will ordinarily apply in a case of polluting or other project or industry where the extent of damage likely to be inflicted is not known. When there is a state of uncertainty due to lack of data or material about the extent of damage or pollution likely to be caused then, in order to maintain the ecology balance, the burden of proof that the said balance will be maintained must necessarily be on the industry or the unit which is likely to cause pollution. On the other hand, where the effect on ecology of environment of setting up of an

[1]https://www.lawctopus.com/academike/precautionary-principle/ -
_edn62https://www.lawctopus.com/academike/precautionary-principle/ - _edn52

industry is known, what has to be seen is that if the environment is likely to suffer, then what mitigative steps can be taken to offset the same. Merely because there will be a change is no reason to presume that there will be ecological disaster. It is when the effect of the project is known then the principle of sustainable development would come into play which will ensure that mitigative steps are and can be taken to preserve the ecological balance. Sustainable development means what type or extent of development can take place which can be sustained by nature/ecology with or without mitigation

Caselet 1

In AP Pollution Control Board Prof. M V Nayudu, 1999, the Supreme Court comprehensively reviewed the precautionary principle. An application was submitted by a company to the Pollution Control Board for permission to set up an industry for production on "BSS Castor Oil Derivatives". Although a letter of intent had later been received by the company, the Pollution Control Board did not give its No Objection Certificate to the location of the industry on the site proposed by it. The Pollution Control Board, while rejecting the application for consent, *inter alia*, stated that the factory fell under the red category of polluting industry and it would not be desirable to locate such an industry in the catchment area of Himayat Sagar, a lake (in erstwhile Andhra Pradesh State) now in Telangana State. The appeal filed by the company against the decision of the Pollution Control Board was accepted by the appellate authority. A writ petition was filed in the nature of public interest litigation and also by the Gram Panchayat challenging the order of the appellate authority but the writ petition was dismissed by the High Court. On the other hand, the writ petition filed by the company was allowed and the High Court directed the Pollution Board to grant consent subject to such conditions as may be imposed by it. The decision of the High Court was the subject matter of challenge in the Supreme Court of India. The Supreme Court referred to the difficulty courts face in dealing with highly technological or scientific data. The Court noted that uncertainty in science in the environmental context has led international conferences to formulate new legal theories and rules of evidence. One of these is the precautionary principle.

Another example is TN GodavarmanThirumalpadUoI and others 2002 decision where the Court reference the Principle of proportionality it requires a balancing priorities of development and environmental protection. In 2006 decision, the principle was used to advocate general precautionary measures by the Supreme Court of India.

The polluter pays principle (PPP) States that whoever is responsible for damage to the environment should bear the cost Assoc. d with it." to compensate for the damage caused and return the environment to its original state regardless of the intent.

The Polluter Pays Principle (PPP) is one of the internationally recognized principles that influence the shaping of environmental policy at both the national and international level. As one of the environmental principles that have developed 'from political slogans to legal rules,' it is also increasingly reflected in national and international law.

History

The Polluter Pays Principle was first introduced in 1972 by the Organization for Economic Cooperation and Development (OECD) Guiding Principles concerning International Economic Aspects of Environmental policies where under the polluter was held responsible for the environmental damage and pollution. Subsequently, the Rio Declaration laid down the guidelines for sustainable development meaning thereby a strategy to cater the needs of the present generation without compromising the needs of the future generation. In furtherance of the aim of sustainable development Rio Declaration Principle 16 of the Rio Declaration enshrined the Polluter Pays principle stating that the polluter should bear the cost of pollution.

India & Polluter Pays Principle

The principle essentially implies that polluters must bear the costs of restoring the environment of that pollution. In India, the Supreme Court has used the PPP in several landmark environmental decisions. In 2010, the National Green Tribunal Act (NGT Act), codified the application of the PPP by the National Green Tribunal (NGT) when deciding civil cases involving a substantial question of the environment. Section 20 of the NGT Act states that the NGT shall apply the principles of Sustainable Development, the Precautionary Principle and the Polluter Pays Principle when rendering a decision, order or an award.

The Supreme Court of India inexplicitly, applied the principle in the case of M.C. Mehta v. Union of India in the year 1986. It was declared by the court that 'we have to evolve new principles and lay down new norms, which would adequately deal with the new problems which arise in a highly industrialized economy'. The significance of this judgement lies in the court's formulation of the principle of the measure of liability of industry engaged in 'hazardous or inherently dangerous activities'. Such measure must be correlated to the magnitude and capacity of the enterprise. Secondly, the court directed the industry either to shift from the present location or evolve a green belt around it as a condition precedent to restart the industry. Further, the industry was asked to deposit a sum of Rs. 3500000/- in a bank and a guarantee of rupees 1500000/- with the court for compensation to be paid to one who can prove before the court of law that he suffered because of the Oleum gas leakage from the Sri Ram Food and Fertilizer Corporation. Thus an innovative remedy was evolved by the Supreme Court of India in this case which was indirect recognition and application of the 'polluter pays principle'.

Caselet 2

1. Indian Council for Enviro-Legal Action vs. Union of India 1996(3) SCC 212. (Bichhri Case)The 'polluter pays principle' was for the first time, applied and defined in the case of Indian Council for Enviro-Legal Action v. Union of India. It was declared by the court that redemption of the damaged environment is a part of the process of sustainable development and as such polluter is liable to pay the cost of the individual sufferers as well as the cost of reversing the damaged ecology.

In this case, five chemical industries were producing H-acid (l-napthol-8-amino, 6-disciphonic acid). An azo dye and untreated toxic sludge was discharged into the open compound which, in due course of time, flowed through a canal across entire area and the rain water washed the sludge deep into the bowels of earth. It caused pollution of river water and underground water up to 70 feet below the ground within a radius of seven miles of the village Bichhri. It further left the fields of this area infertile. As a result of which residents of Bichhri and of nearby villages had to migrate to other places. The case was taken up by the Supreme Court of India on a petition from the Indian Council for Enviro-legal Action of Udaipur as a public interest petition.

National Environmental & Engineering Research Institute (NEERI) in the year 1994 be made a basis to compute it. NEERI in its report, had stated that rupees 4,00,00,000/- would be needed to reverse the power of soil and water contamination.

It was pronounced that the Ministry of Environment and Forest must recover the money from the units and the recovered money be used to repair the damage caused to the land and water in the area. As a result of which the plant and factories have been sold by the State Government. The collector of the area has started assessing the damage caused to the twenty affected villages. With the help of the NGO and research institutes the work of reversing the ecology of the area has commenced. The court, however, offered no compensation to the victims *of Bichhari* village. Applications are still pending with the Supreme Court for compensation.

2. Vellore Citizens' Welfare Forum UoI and others (1996 SC) (Vellore Case)

In Vellore Citizens Forum case, more than 550 tannery units were discharging untreated effluent, thereby, causing water pollution and land pollution in 59 villages of three districts. 467 wells of two districts, which were used for drinking and irrigation purposes, were polluted. This created acute shortage of potable water. Looking to such a grave state of affairs the court ordered for the closure of industries involved in the tannery business. It was suggested by the court that the Central Government should constitute an 'authority' under section 3(3) of the Environment (Protection) Act, 1986 and such authority, shall, with the help of the expert opinion assess the loss to the ecology/environment in the affected area. After making proper assessment, such an authority shall further determine the compensation to be recovered from the polluters as cost of reversing the damaged environment, after giving the polluter an opportunity of being heard.

The environment protection funds:
In this same case the court also ordered for imposing a fine of Rs. 10,000/- on each tannery of the area. The fine had to be paid to the collector of the district. The court proposed the fine plus the compensation amount so recovered from the polluters be deposited under the head 'Environment Protection Fund'. This fund could be utilized for compensating the affected persons identified by the 'authority' and also for 'restoring the damaged environment' [AIR 1996 SC2715 at 2726]

The 'authority' created by the government was directed by the court to frame a scheme for reversing the damage caused to the ecology and environment by pollution in the state of Tamil Nadu. Such scheme is proposed to be implemented by the state governments with the assistance of the central government. The expenditure for such schemes shall be met out of the 'Environment Protection Fund' and if needed finances could be provided by the state and the central government. To monitor the implementation of comprehensive directions by the authority and the government, the Supreme Court suggested the constituting of a special bench 'Green Bench', which in future will deal with environmental issues. Thus, it was really a landmark judgement in the history of environmental management in India.

3. Taj trapezium - M.C. Mehta Union of India

The Supreme Court reiterated the 'polluter pays principle' and re-emphasised the need to apply it in the case of 'yellowing and decaying of the Taj Mahal'. The NEERI (1993) and Vardhrajan Committee (1995), Reports says the foundries, chemicals or hazardous industries and the Mathura refinery were the major sources of damage to Taj Mahal, a priceless national monument. The court ordered the industries to shift away from the Taj Trapezium or to switch over to gas as fuel. The industries, which did not switch over to gas, were ordered to be closed down unconditionally by December 31, 1997.

Justice Kuldeep Singh gave a new dimension to the 'polluter pays principle'. The court has ordered that the various kinds of industries, numbering 292, if they opt to shift to other states/sites, would have to give 'compensatory benefits' to their workers.

The court directed that the rights and benefits which a worker of such an industry is entitled to includes

a. Continuity of employment from closure to restart of the industry, for which they will get full wags;
b. One year wages as 'shifting bonus'.
c. Workers not interested in shifting with the industry will get compensation as per section 25-F (b) of the Industrial Disputes Act, and six years' wages as additional compensation.
d. gratuity shall be paid in addition to all this

They are also entitled to certain rights and benefits from the erring industries. Therefore, it was suggested that sufficient compensation or guarantee of livelihood should always be a part of the entire order leading to the closure/shifting of an industry. Such a package must be a precondition to the closure of an industry.

Other examples are

1. The Oleum Gas Leak case (M.C. Mehta vs. Union of India) AIR 1987 SC 1086.
2. M. C. Mehta vs Kamal Nath &Ors (1997)1SCC388.

Caselet 3

Indian Council for Enviro Legal Action Vs. Union of India and ors. - Supreme Court Judgment , 2011[2].

An environmentalist organization brought to light the sufferings and woes of people living in the vicinity of chemical industrial plants in India. This petition relates to the suffering of people of village Bichhri in Udaipur District of Rajasthan. In the Writ Petition No.967 of 1989, it was demonstrated how the conditions of a peaceful, nice and small village of Rajasthan were dramatically changed after respondent no. 4 Hindustan Agro Chemicals Limited started producing certain chemicals like Oleum (concentrated form of sulphuric acid) and Single Super Phosphate. Respondent numbers 4 to 8 are controlled by the groupof chemical industries. The entire chemical industrial complex is located within the limits of Bichhri village, Udaipur, Rajasthan. Pursuit of profit of entrepreneurs has absolutely drained them of any feeling for fellow human beings living in that village.

Caselet 4

The Delhi High Court on the Inaction of the East Delhi Municipal Corporations

Improper waste disposal has a huge environmental and public health impact. Open dumps release methane from decomposition of biodegradable waste leading to fires and explosions. Discarded recyclable materials such as tyres collect water which is a breeding ground for mosquitoes. Leeching of untreated garbage leads to groundwater and river pollution with magnified health impact. Lack of proper waste disposal leads to increased incidences of infections, allergies, inflammations and health epidemics. Unscientifically dumped C&D waste can also clog rivers leading to floods.

In 2015, a PIL was filed in the Delhi High Court on the inaction of the East Delhi municipal corporations in effective removal of garbage leading to health implications in the area. Two years later, the High Court in its judgment recommended the formation of an expert committee to form and implement a long-term action plan regarding collection, removal and disposal of all the waste in Delhi. The Court accepted the recommendations presented by the committee headed by Sanjeev Jain, Member Secretary, Delhi State Legal Services Authority, on August 2, 2017. The draft bylaws for solid waste management for Delhi were also presented to the Court that was finally notified on January 15, 2018 by the state government under the Environmental Protection Act.

Doctrine of Public Trust

The public trust doctrine primarily rests on the principle that certain resources like air, sea, water and the forests have such a great importance to the people as a whole that it would be wholly unjustified to make them a subject of private ownership. The said resources being a gift of nature, they should be made freely available to everyone irrespective of the status in life. The doctrine enjoins upon the Government to protect the resources for the enjoyment of the general public rather than to permit their use for private ownership or commercial purposes. For example, under this doctrine, the government holds title to all submerged land under navigable waters. Thus, any use or sale of such land must be in the public interest.

1.4 National Green Tribunal

The National Green Tribunal (NGT) was established on October 18, 2010 under the National Green Tribunal Act 2010 for effective and expeditious disposal of cases relating to environmental protection and conservation of forests and other natural resources, including enforcement of any legal right relating to environment and giving relief and compensation for damages to persons and property. It is a specialized body equipped with the

[2]https://www.legalcrystal.com/case/919935/indian-council-enviro-legal-action-vs-union-india

necessary expertise to handle environmental disputes involving multi-disciplinary issues. The Tribunal is not expected to be bound by the procedure laid down under the Code of Civil Procedure, 1908. It is to be guided solely by principles of natural justice. The Principal Bench of the NGT has been established in the National Capital – New Delhi, with regional benches in Pune (Western Zone Bench), Bhopal (Central Zone Bench), Chennai (Southern Bench) and Kolkata (Eastern Bench). Each Bench has a specified geographical jurisdiction covering several States in a region. There is also a mechanism for circuit benches. For example, the Southern Zone bench, which is based in Chennai, can decide to have sittings in other places like Bangalore or Hyderabad.

The Tribunal's dedicated jurisdiction in environmental matters is intended to provide speedy environmental justice and help reduce the burden of litigation in the higher courts. The Tribunal is mandated to make and endeavour for disposal of applications or appeals finally within 6 months of filing of the same. New Delhi is the principal place of sitting of the Tribunal and Bhopal, Pune, Kolkata and Chennai are the other 4 places of sitting of the Tribunal.

Object and Purpose of the Act

The National Green Tribunal Act, 2010 (No. 19 of 2010) (NGT Act) has been enacted to

- The effective and expeditious disposal of cases relating to environment protection and conservation of forests and other natural resources including enforcement of any legal right relating to environment
- To deal with environmental disputes involving multi-disciplinary issues.
- Giving relief and compensation for damages to persons and property and for matters connected therewith or incidental thereto.

Salient Features

The salient features of National Green Tribunal:

- The NGT is not bound by the procedure laid down under the Code of Civil Procedure, 1908, but shall be guided by principles of natural justice.
- NGT is also not bound by the rules of evidence as enshrined in the Indian Evidence Act, 1872.
- It will be relatively easier for conservation groups to present facts and issues before the NGT, including pointing out technical flaws in a project, or proposing alternatives that could minimize environmental damage but which have not been considered.
- While passing Orders, decisions, awards, the NGT will apply the principles of sustainable development, the precautionary principle and the polluter pays principles. However, it must be noted that if the NGT holds that a claim is false, it can impose costs including lost benefits due to any interim injunction.

Powers of NGT

- The Act mandates enforcement of any legal right relating to environment
- Giving relief and compensation for damages (Person or property)
- Powers equivalent to that of a Civil Court

Jurisdiction

As per Section 14 (1) The National Green Tribunal has jurisdiction over all civil cases where a substantial question relating to environment (including enforcement of any legal right relating to environment), is involved and such question arises out of the implementation of the enactments specified in Schedule I of the National Green Tribunal Act 2010. The acts listed in Schedule 1 are:

- The Water (Prevention and Control of Pollution) Act, 1974;
- The Water (Prevention and Control o[Pollution) Cess Act, 1977;
- The Forest (Conservation) Act;
- The Air (Prevention and Control of Pollution) Act, 1981;

- The Environment (Protection) Act, 1986;
- The Public Liability Insurance Act, 1991;
- The Biological Diversity Act, 2002.

The Tribunal shall hear the disputes arising from the questions referred to in sub- section (I) and settle such disputes and pass orders thereon. Appellate jurisdiction under section 16 of the Act- As per Section 15 (1) of the Act, the Tribunal may, by an order, provide:

a) Relief and compensation to the victims of pollution and other environmental damage arising under the enactments specified in the Schedule 1 (including accident occurring while handling any hazardous substance)
b) For restitution of property damaged
c) For restitution of the environment for such area or areas, as the Tribunal may think fit.

Review and Appeal

- Under Rule 22 of the NGT Rules, there is a provision for seeking a Review of a decision or Order of the NGT.
- Orders can be appealed to the Supreme Court within 90 days.

Why NGT (Specialized Environmental Court)

- By definition tribunals are court with specialization
- They deal in the field of their expertise
- Ordinary courts may find it difficult to handle those issues without any sufficient expertise
- The jurisdiction will provide speedy environmental justice
- Go long way for ensuring sustainable development
- Help remove arbitrary environmental destruction

Members and Structure

Members

- Full time Chairperson, retired judge of the supreme court Head Quartered in Delhi
- Judicial members -minimum 10-Maximum-20 retired judges of High Court
- Expert members- minimum 10-Maximum-20

Chairperson can invite any person having specialized knowledge to assist the tribunal.

Structure

With principal bench in New Delhi and regional benches (Pune, Bhopal, Kolkata & Chennai) in western, central, eastern and southeastern, thus there is geographical jurisdiction.

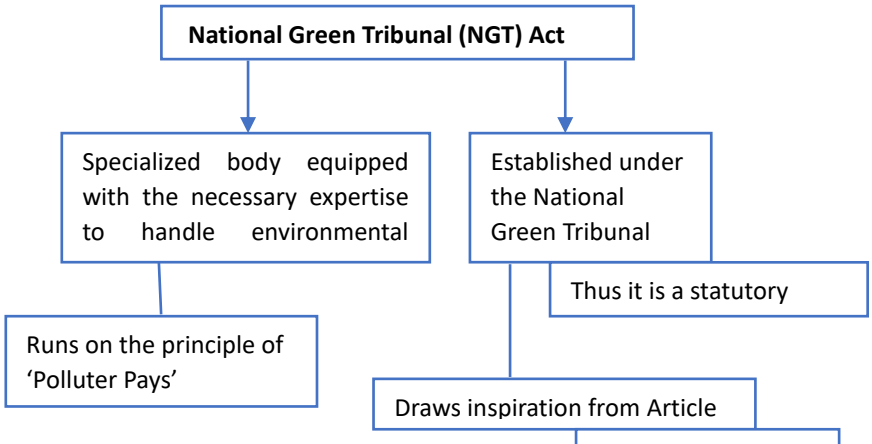


Fig 1.2 National Green Tribunal (NGT) Act 2010

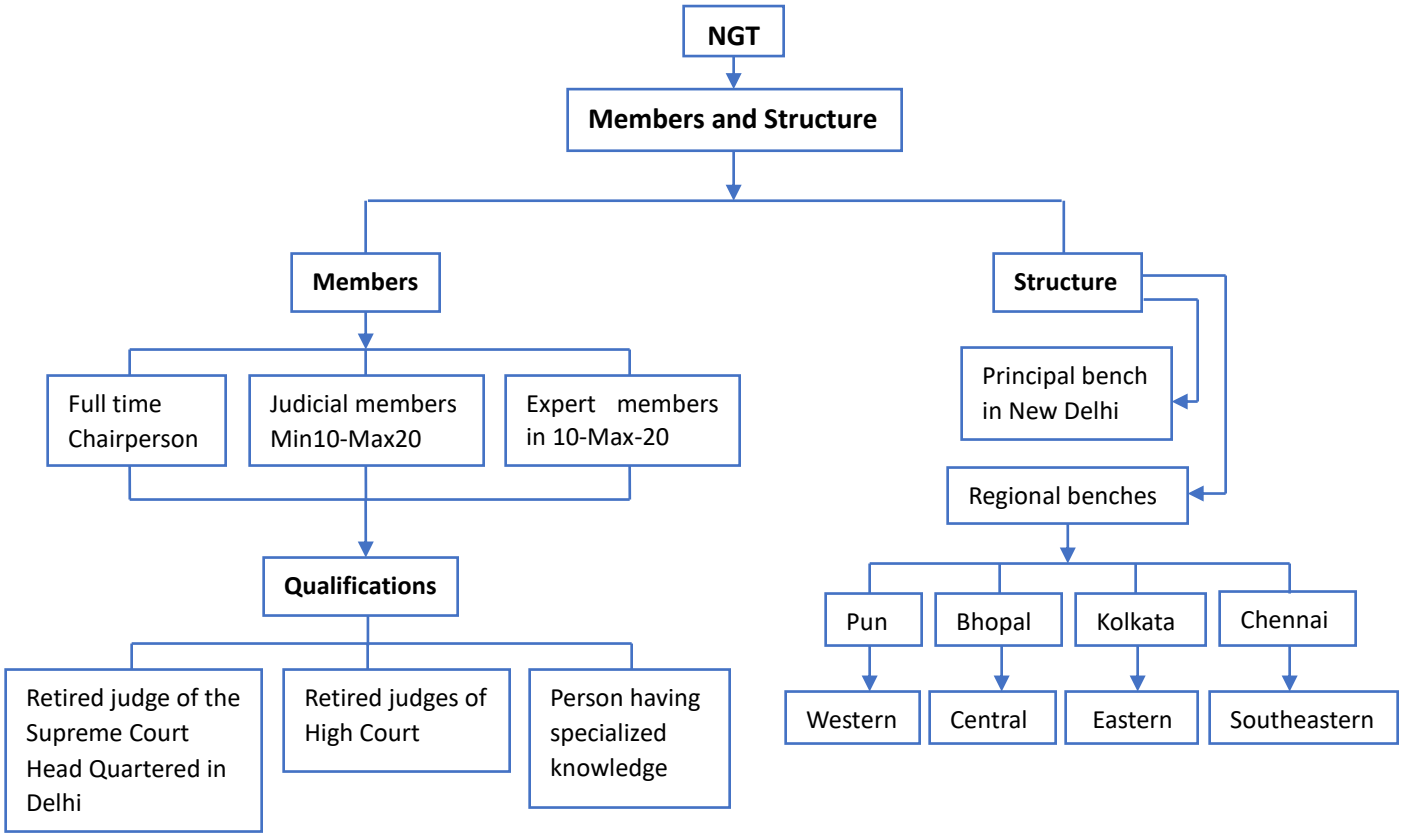


Fig 1.3 Structure of NGT

Caselet 5

Landmark NGT Judgments

- Srinagar Bandh Aapda Sangarsh Samiti &Anr v. Alaknanda Hydro Power Co.Ltd&Ors- NGT has directly relied on the principle of 'polluter pays' and made a private entity liable to pay a compensation, making them subject to a code of environmental jurisprudence.
- Samit Mehta vs. Union of India and Ors- This case was held to involve questions of public importance and significance of environmental jurisprudence and 'Polluter Pays' principle was invoked.
- Save Mon Region Federation and Ors. Vs. Union of India and Ors-The Tribunal very proactively suspended the Environmental Clearance granted to the Project and Directed the EAC to make a fresh appraisal of the proposal for environmental clearance grant and asked the Ministry of Environment and Forest to make a separate study on the protection of the said bird.
- Rural Litigation and Entitlement Kendra, Dehradun and Ors v State of U.P. and Ors- Article 21 of the Indian Constitution has been interpreted to mean several things. One of such interpretations laid down by the court was that people do have a right to live in a healthy environment; right to have the enjoyment of quality of life and living and right of enjoyment of pollution free water and air for full enjoyment of life.

- Ms. Betty C Alvares vs. The State of Goa and Ors- Even a Foreign National Can Approach the NGT. National Green Tribunal Act, 2010 (No. 19 of 2010) http://www.moef.nic.in/downloads/public-information/NGT-fin.pdf

Other Caselets

- Recently in December 2017, The National Green Tribunal held Sri Sri Ravi Shankar's Art of Living (AoL) "responsible" for causing damage to the Yamuna floodplains by conducting the World Culture Festival there and directed that the Rs 5 crore paid by the organization in fine be utilized by the Delhi Development Authority (DDA) for restoration of the affected area.
- The southern bench of the National Green Tribunal has suspended the environmental clearance of the India-based Neutrino Observatory project for research on high energy and nuclear physics, being set up in Tamil Nadu. The INO Project is a multi-institutional effort aimed at building a world-class underground laboratory with a rock cover of approximately 1200 metre for non-accelerator based high energy and nuclear physics research in India.
- The illegal and improper activities at the camping sites led to the pollution of Ganga, forest areas and there was violation of the norms and guidelines with impunity thus the National Green Tribunal has prohibited all camping activity on beaches along the Ganga which fall within 100 meters from the middle of the river during lean season flow from Shivpuri to Rishikesh, a hub for eco-tourism and river rafting.
- Biomedical waste plants in Delhi shall be subjected to inspection by joint inspection team of CPCB and DPCC. A complete and comprehensive report be submitted about their performances, capacity and results of treating such para-medical wastes. The NGT also directed the team to report about the manner in which bio-medical waste was being handled by hospitals and the situation prevailing in medical institutions adversely affecting human health and environment.
- The National Green Tribunal (NGT) ordered a complete ban on burning of any kind of garbage, leaves, plastic waste and rubber in the open in Delhi-National Capital Region (NCR) to control air pollution. As per NGT, burning of garbage and other material like plastic is responsible for nearly 30 percent of the air pollution in the capital and its suburbs. The person who is found burning or responsible for burning would be liable to pay compensation in terms of Section 15 of the National Green Tribunal Act, 2010. It also directed authorities to levy a fine of 5000 rupees on anyone found burning such material in the open. *Almitra H. Patel &Ors. vs. Union of India and Ors*-A complete prohibition on open burning of waste on lands. Absolute segregation has been made mandatory in waste to energy plants and landfills should be used for depositing inert waste only and are subject to bio-stabilization within 6 months.
- Order of the National Green Tribunal regarding uprooting of trees while laying of underground optic fiber line from Nannoor to Veldurthy Village in Andhra Pradesh. Order of the National Green Tribunal in the matter of C. Janardana Reddy Vs. Jio Reliance Company dated 01/10/2018 regarding uprooting of trees by Jio-Reliance while laying of underground optic fiber line from Nannoor to Veldurthy Village, Andhra Pradesh. NGT directs the Divisional Forest Officer, Kurnool District to verify the facts and send a report to this Tribunal[3].

[3]http://www.indiaenvironmentportal.org.in/content/459015/order-of-the-national-green-tribunal-regarding-uprooting-of-trees-while-laying-of-underground-optic-fibre-line-from-nannoor-to-veldurthy-village-andhra-pradesh-01102018/
http://www.indiaenvironmentportal.org.in/files/file/Jio_Reliance_Tree_Uprooted_Nanoor_NGT_Order.pdf

1.5 The Ministry of Environment, Forest and Climate Change

The Ministry of Environment, Forest and Climate Change (MoEFCC) is the nodal agency in the administrative structure of the Central Government for the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes.

The primary concerns of the Ministry are implementation of policies and programmes relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programmes, the Ministry is guided by the principle of sustainable development and enhancement of human well-being.

The Ministry also serves as the nodal agency in the country for the United Nations Environment Programme (UNEP), South Asia Co-operative Environment Programme (SACEP), International Centre for Integrated Mountain Development (ICIMOD) and for the follow-up of the United Nations Conference on Environment and Development (UNCED). The Ministry is also entrusted with issues relating to multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environment Facility (GEF) and of regional bodies like Economic and Social Council for Asia and Pacific (ESCAP) and South Asian Association for Regional Co-operation (SAARC) on matters pertaining to the environment.

Object and purpose of the Ministry

The broad objectives of the Ministry are:

- Conservation and survey of flora, fauna, forests and wildlife
- Prevention and control of pollution
- Afforestation and regeneration of degraded areas
- Protection of the environment and
- Ensuring the welfare of animals

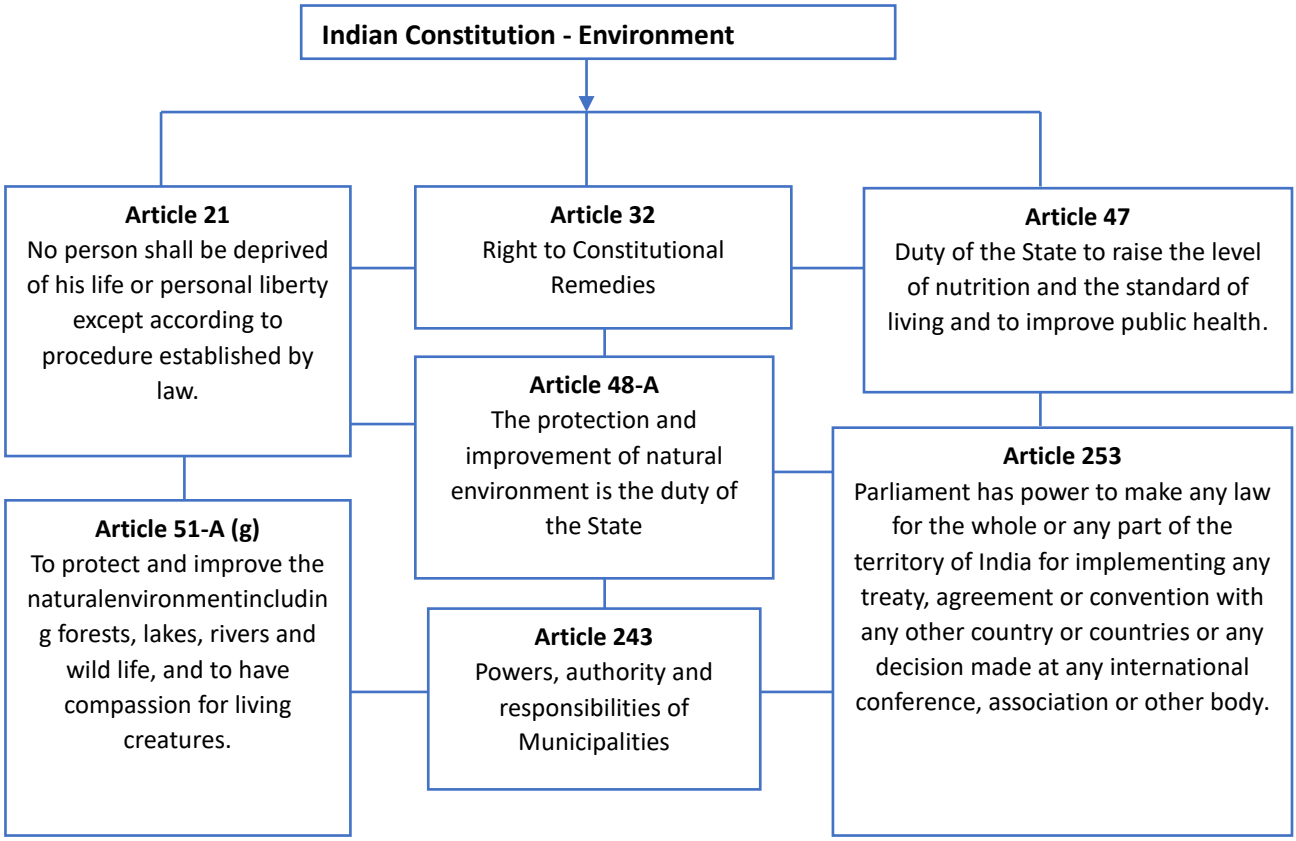


Fig 1.4 Indian Constituent- Environment

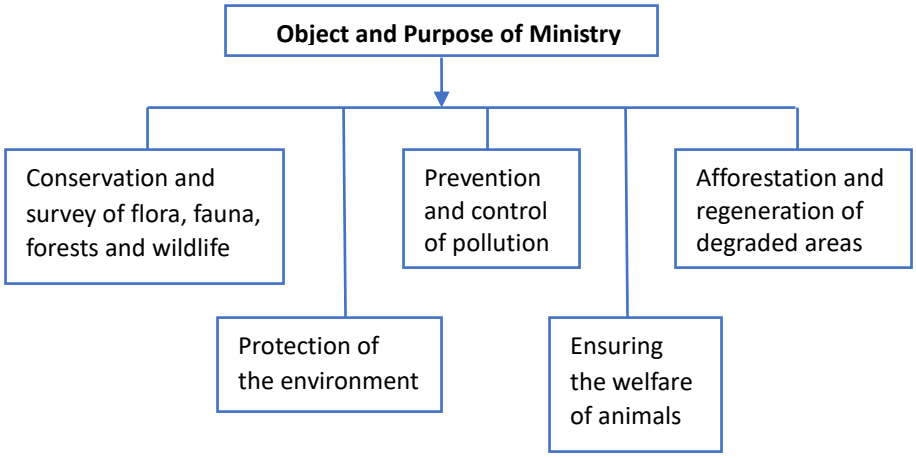


Fig 1.5 Object and Purpose of the Ministry

These objectives are well supported by a set of legislative and regulatory measures, aimed at the preservation, conservation and protection of the environment. Besides the legislative measures, the National Conservation Strategy and Policy Statement on Environment and Development, 1992; National Forest Policy, 1988**;** Policy Statement on Abatement of Pollution, 1992; and the National Environment Policy, 2006 also guide the Ministry's work.

Summary

The Judiciary in India has laid down that the "Precautionary Principle" and the "Polluter Pays Principle" as essential features of "sustainable development". These concepts are part of Environment Law of the country. The courts are the guardian of the Constitution of India. In the absence of any “treaty regulating legislation” in India, it mainly has to play the following roles.

The suggestions made by the Supreme Court in A.P. Pollution Control Board M.V.Nayudu, for the improvement of the adjudicatory machinery under the various environmental laws should be implemented by the Government. The main burden of these suggestions is that in all environmental courts, tribunals and appellate authorities, there should be a judge of the rank of a High Court or a Supreme Court, sitting or retired, and a scientist or a group of scientists of high ranking and experience so as to help a proper and fair adjudication of disputes relating to environment and protection. If implemented, this would go a long way in securing justice to the needy. Any law is as good as the implementation. There must be an effective monitoring mechanism.

Self Assessment Questions

1. What is the difference between a Court and a Tribunal?
2. To protect a National Park/Sanctuary from various pressures including a dam proposal and widening of a highway. Is the case to be approached to the NGT?
3. Can anyone personally argue a matter before the NGT or do they need a lawyer?
4. What is the penalty for non-compliance of an NGT order?
5. Is there a bar on civil courts to hear /take up cases under the seven specified laws in Schedule I of the NGT Act?
6. Who is a Polluter?
7. What does the polluter have to pay for?

Video Lessons

1. https://youtu.be/GM3285TzEbo - Public interest litigation (Law)- English
2. https://youtu.be/RhwiVqWgm1Y - - L-153- PIL - What is Public Interest Litigation in India- Polity- Hindi
3. https://youtu.be/jCyw_6N3zo8 public interest litigation | Indian polity by laxmikant in Hindi UPSC IAS PCS SSC UPPSC
4. https://youtu.be/GUbtL1j_3cw - Vidya-Mitra
5. https://youtu.be/NM8Q7cXPu1g - Know everything about National Green Tribunal(NGT) -Hindi

Chapter 2
Environmental Laws for Pollution Control and Waste Management-I

Objectives

- To understand environmental laws for pollution such as Forest and Wild life Protection laws
- To understand air and water pollution laws
- To understand vehicular pollution laws

Structure

2.1 Forest & Wildlife Protection Laws
2.2 Air and Water Pollution Control Laws
2.3 TheFactories Act
2.4 TheMotor Vehicles Act
2.5 Public Liability Insurance Act 1991

To Do Activities

- Visit a nearby court to understand how some of these acts are dealt with
- Conduct a survey to understand how far these Acts have been implemented in the respective arenas
- Discuss caselets on various Acts
- Provide topics for group or individual presentation
- Organize debates on the important Acts and discuss their monitoring and practical implementation

2.1 Forest & Wildlife Protection Laws

The Indian Forest Act, 1927 consolidates the law relating to forests, the transit of forest-produce and the duty leviable on timber and other forest-produce. Forest (Conservation) Act and Rules, 1981, provides for the protection of and the conservation of the forests, and Amendment, 1984, is one of the many surviving colonial statutes. The Wildlife Protection Act, Rules 1973 and Amendment 1991 provides for the protection of birds and animals and for all matters that are connected to it whether it be their habitat or the waterhole or the forests that sustain them.

The Forest Conservation Act, 1980

Object and Purpose of the Act

The Forest Conservation Act, 1980 was enacted to help

1. Protect and conserve the country's forests.
2. It strictly restricts and regulates the de-reservation of forests or
3. Use of forest land for non-forest purposes without the prior approval of Central Government.
4. To this end the Act lays down the pre-requisites for the diversion of forest land for non-forest purposes.

1988 Amendment of Forest Conservation Act

The Amendment which took place in 1988 emphasized upon that forest Departments are not allowed to assign any forest land by way of lease or otherwise to any private person or non-government body for reforestation.Clearance of any forest land of naturally grown treesfor the purpose of afforestation is also not allowed. A period of 15 days imprisonment punishment has to be given if any one contravenes this law.

Definitions

Non-forest purpose includes clearing of any forestland for cultivation of cash crops, plantation crops, horticulture or any purpose other than re-afforestation.

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006, recognizes the rights of forest-dwelling Scheduled Tribes and other traditional forest dwellers over the forest areas inhabited by them and provides a framework for according the same.

The Wildlife Protection Act 1972 (Amendment 1991)

Object and Purpose of the Act

The Wild Life (Protection) Act WPA, 1972 was enacted with the objective of

1. Effectively protecting the wild life of this country and
2. To control poaching, smuggling and illegal trade in wildlife and its derivatives.
3. This Act provides protection to listed endangered species of flora and fauna and
4. Establishes a network of ecologically-important protected areas.

Definitions

Animal: An animal means amphibians, birds, mammals and reptiles and their young, and also includes, in the cases of birds and reptiles, their eggs.

Habitat: includes land, water or vegetation which is the natural home of any wild animal.

Hunting means

1. Killing or poisoning of any wild animal or captive animal.
2. Capturing, coursing, snaring, trapping, driving or baiting any wild.
3. Injuring or destroying or taking any part of the body of any such animal.

The Wild Life (Protection) Act was the first umbrella act which established schedules of protected plant and animal species.The WPA empowers the central and state governments to declare any area a wildlife sanctuary, national park or closed area. There is a blanket ban on carrying out any industrial activity inside these protected areas. It provides for authorities to administer and implement the Act; regulate the hunting of wild animals; protect specified plants, sanctuaries, national parks and closed areas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The Act prohibits hunting of animals except with permission of authorized officer when an animal has become dangerous to human life or property or so disabled or diseased as to be beyond recovery (WWF-India, 1999). The near-total prohibition on hunting was made more effective by the Amendment Act of 1991. The Ministry has proposed further amendments in the law by introducing more rigid measures to strengthen the Act In January 2003, with this thepunishment and penalty for offences under the Act have been made more stringent.

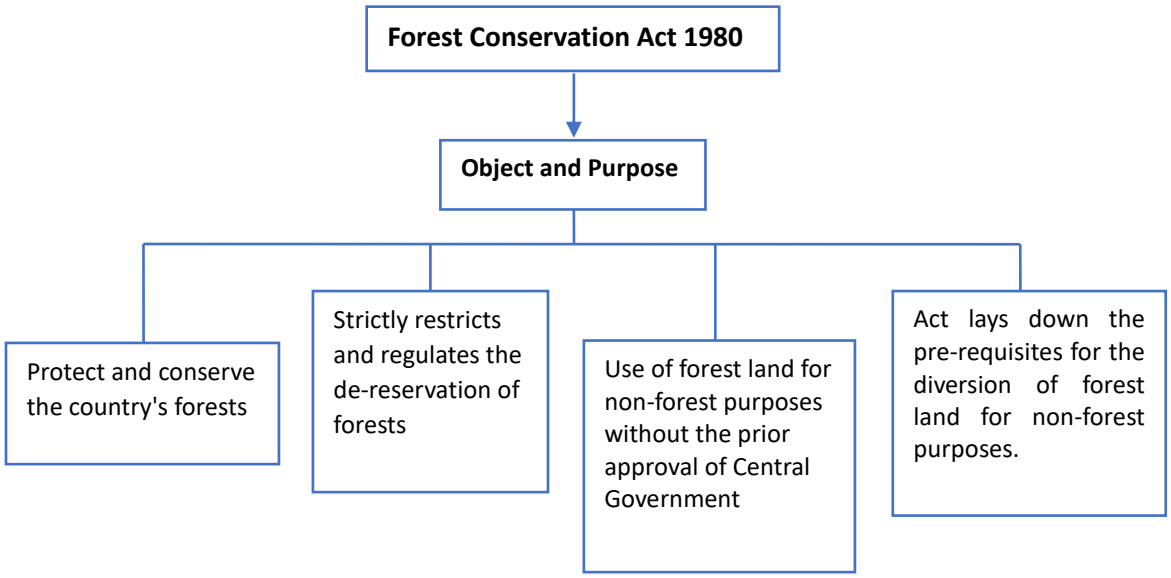


Fig 2.1 Forest Conservation Act 1980

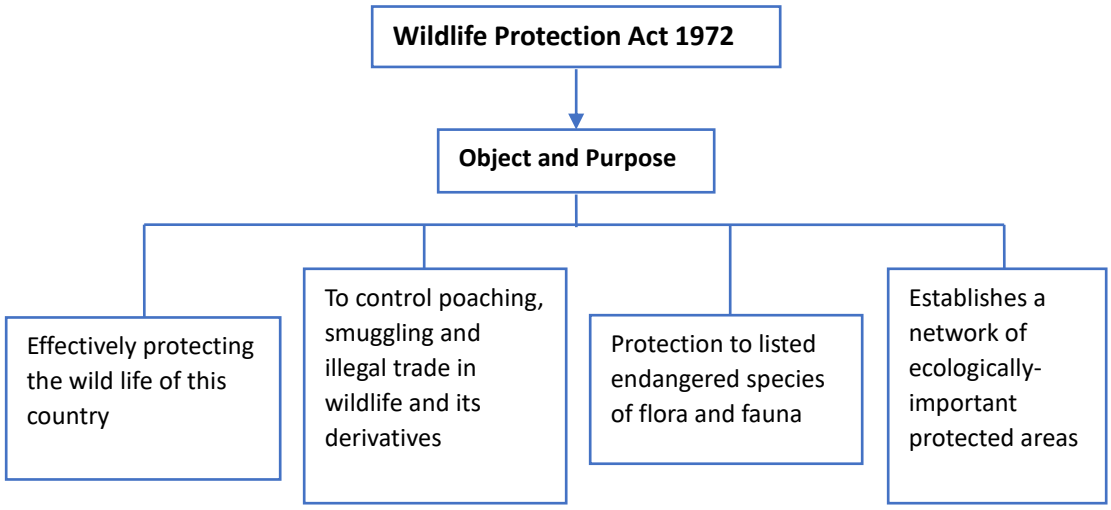


Fig 2.2 Wildlife Protection Act 1972

Caselet 1Encroachment of Forest Land

Kamal Nath Case: In the State of Himachal Pradesh, Span motel, owned by the family members of Shri Kamal Nath, Minister for Environment and Forests, Govt. of India diverted the Course of river Beas to beautify the motel and also encroached upon some forest land. The apex court ordered the management of the Span motel to hand over forest land to the Govt. of Himachal Pradesh and remove all sorts of encroachments. The Court delivered a land mark judgment and established principle of exemplary damages for the first time in India. The Court said that polluter must pay to reverse the damage caused by his act and imposed a fine of Rs Ten Lakhs (Rs 10,00,000) on the Span motel as exemplary damages. The Supreme Court of India recognized Polluter Pays Principle and Public Trust Doctrine.[4]

[4]https://www.indianbarassociation.org/wp-content/uploads/2013/02/environmental-law-article.pdf

Otherexamples of cases like in Shri Krishna v. Union of India, allocation of forest land for rehabilitation of Gujjars after obtaining permission from the Central Government was upheld by the Court, under Section 2 of the Forest (Conservation) Act, in 1980. In Seven City Developers Pvt. Ltd., Mumbai v. State of Meghalaya, the High Court however held that the deemed sanction for transfer of tribal land to a non-tribal company under Section 4(1) of the Meghalaya Transfer of Land (Regulation) Act, 1972 which was under an unregistered document, would not be tenable as the state is governed by Schedule-VI of the Constitution and also in view of Section 2 of the Forest (Conservation) Act, 1980.

Protection of Wild Life

Order of the Supreme Court of India in the matter of Centre for Environment Law Vs Union of India & Others dated 03/10/2018 Item no-3, Court no-2, Section PIL-W, IA 192/2017 in Writ Petition(s) (Civil) No(s).337/1995, regarding translocation of cheetah from Namibia. Upon hearing the council, the court made the following order: Learned Counsel appearing for the National Tiger Conservation Authority (NTCA)would like to take instructions whether the consent of IUCN has been taken for translocation of cheetah from Namibia.[5]

Principal Chief Conservator of Forests, Thiruvananthapuram Secretary, ParamekkavuDevaswom, the Kerala High Court dealt with four Writ Appeals and one Writ Petition raising an important issue pertaining to transfer, sale, transaction and transportation of elephants of Kerala. A division bench held that prior permission of the Chief Wildlife Warden is required for transferring an elephant from other States to Kerala or within Kerala in view of Sections 40 and 43 of the Wildlife Protection Act, 1972.This judgment assumes importance as it emphasizes that under Sec.40 (2) of the Act, not mere reporting of transfer but prior permission of CWLW is required- 2015(5) FLT 878 (Kerala HC)

2.2 Air and Water Pollution Control Laws

The Air (Prevention and Control of Pollution) Act 1981

To counter the problems Assoc. d with air pollution, ambient air quality standards were established under the 'Air Act', the Air (Prevention and Control of Pollution) Act, 1981.

Object and Purpose of the Act

This Act is to provide for:

1. The prevention, control and abatement of air pollution and
2. The establishment of Boards the Central and State levels with a view to carrying out the aforesaid purposes.

Definitions

Air Pollutant [Sec.2 (a)]

- Any solid, liquid or gaseous substance including noise.
- Present in atmosphere in such concentration
- As may tend to be injurious to
    - Human beings
    - Living creatures
    - Plants
    - Properties, or
    - Environment

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[5] http://www.indiaenvironmentportal.org.in/files/file/cheetah_translocation_Supreme_Court_Order.pdf

Air Pollution [Sec.2 (b)]: Presence of air pollution in atmosphere
Control Equipment [Sec. 2 (1)]:

- Any Apparatus, device, equipment or system
- To control
- The quality & manner of emission of any air pollutant

It includes any device used for securing the efficient operation of any industrial plant.

Air Pollution Control Area [Sec. 19]:

- State Government, after consultation with the State Board, can declare any area as the Air Pollution Control Area.
- Such area can be added, deleted or altered by notification.
- State Government can prohibit burning of any material (other than fuel) in such area if it is likely to cause air pollution.

The Air Act seeks to combat air pollution by prohibiting the use of polluting fuels and substances, as well as by regulating appliances that give rise to air pollution. The Air Act empowers the State Government, after consultation with the SPCBs, to declare any area or areas within the Sate as air pollution control area or areas. Under the Act, establishing or operating any industrial plant in the pollution control area requires consent from SPCBs. SPCBs are also expected to test the air in air pollution control areas, inspect pollution control equipment, and manufacturing processes.

National Ambient Air Quality Standards (NAAQS) for major pollutants were notified by the CPCB in April 1994. These are deemed to be levels of air quality necessary with an adequate margin of safety, to protect public health, vegetation and property (CPCB 1995 cited in Gupta, 1999). The NAAQS prescribe specific standards for industrial, residential, rural and other sensitive areas. Industry-specific emission standards have also been developed for iron and steel plants, cement plants, fertilizer plants, oil refineries and the aluminum industry. The ambient quality standards prescribed in India are similar to those prevailing in many developed and developing countries.

To empower the central and state pollution boards to meet grave emergencies, the Air (Prevention and Control of Pollution) Amendment Act, 1987, was enacted. The boards were authorized to take immediate measures to tackle such emergencies and recover the expenses incurred from the offenders. The power to cancel consent for non-fulfillment of the conditions prescribed has also been emphasized in the Air Act Amendment.

The Air (Prevention and Control of Pollution) Rules formulated in 1982, defined the procedures for conducting meetings of the boards, the powers of the presiding officers, decision-making, the quorum; manner in which the records of the meeting were to be set. They also prescribed the manner and the purpose of seeking assistance from specialists and the fee to be paid to them.

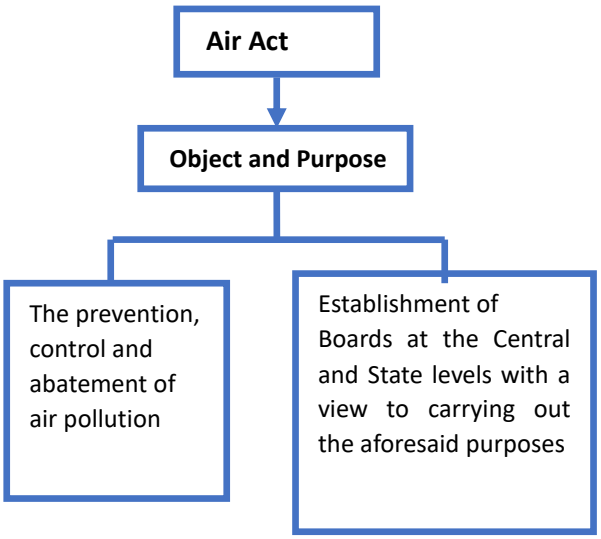

Fig 2.3 Air Act 1974

Functions of SPCB under Air Act

- To plan a comprehensive program for prevention control or abatement of air pollution.
- To advise the state government on prevention and control of air pollution.
- To collect &disseminate information to the public.
- Training and awareness program.
- To inspect the air polluting areas & industries.
- To lay down stringent standards in consultation with CPCB.
- Recognize the laboratories outside.
- Furnish information under section 2.
- Power of entry/inspection
- Air sample collection
- Results declaration.
- Appeal under 31 (A)- power to direction clauses/restriction (Similar to Water Act).

Caselets

- Order of the National Green Tribunal in the matter of Sanju Monica Vs. State of Tamil Nadu & Others dated 19/09/2018. The applicant seeks to assail construction of a Decentralized Micro Composting Centre under a Special Solid Waste Management Project in the city of Salem. It is alleged that the land on which the project is being set up on a site which is in the heart of the city surrounded by schools, hospitals, etc. It is further contended that the Corporation has not obtained necessary Consent to Establish and Consent to Operate under the Air (Prevention and Control of Pollution) Act, 1981 and the Water (Prevention and Control of Pollution) Act, 1974. That apart, it is alleged that no Environmental Clearance has been obtained for the purpose.
- The respondents, more particularly the Municipal Corporation Salem City, shall show cause before the next date as to why order for interim stay of the project is not granted.[6]
- Rajiv Narayan &Anr. V. Union of India &Ors., and Rathi Steel & Power Ltd., Ghaziabad, U.P. the NGT dealt with a case of air pollution. In this case, the applicant, a public spirited person, working in the field of environment conservation, filed an Original Application under the provisions of the National Green

[6] http://www.indiaenvironmentportal.org.in/content/458735/order-of-the-national-green-tribunal-regarding-construction-of-a-decentralized-micro-composting-centre-salem-tamil-nadu-19092018/
http://www.indiaenvironmentportal.org.in/files/file/Micro_composting_Centre_NGT_Order_Salem.pdf

Tribunal Act, 2010. According to the applicant, who resides two kms, from the National Highway and near an industrial area, it was noticed that small and big industries which are emitting black smoke in the area, were causing serious air pollution and health hazards to the local residents. According to him, the Central Pollution Control Board (for short 'CPCB') in 2009, came up with a Comprehensive Environmental Pollution Index (CEPI), by looking at four prime parameters, i.e. pollutant, pathway, receptor and additional high risk element to arrive at a score for water, air and land pollution. This index showed Ghaziabad as third most polluted city in the country. The Ministry of Environment, Forest and Climate Change (for short 'MoEF'), vide its order dated 31st August, 2010, had imposed a moratorium on consideration of projects for Environmental Clearance, which were located in a critically polluted area/ industrial cluster, identified by the CPCB. One of the polluted areas identified by the CPCB was Ghaziabad and consequently this moratorium became applicable to that city. The World Bank in 'Project Appraisal Document of 2010' has also referred to a finding by CPCB that the pollution in Ghaziabad is seriously affecting the quality of life of communities, particularly referring to industrial clusters. Applicant has referred to various Press Reports and subsequent reports prepared by different statutory authorities. On these facts, the applicant prayed for issuance of various orders, including closing of the polluting industries, strict implementation of prescribed standards and ensuring complete implementation of the action plan for improving air quality within the scope and ambit of the Acts specified in Schedule I of the NGT Act. The Bench, after perusing the facts, relevant notifications and judgments of various courts issued the following among other directions to curtail air pollution.

- Direction to the joint inspection team (a scientist from the MoEF, Sr. Environmental Engineer from Central Pollution Control Board and Sr. Environmental Engineer from the Uttar Pradesh Pollution Control Board) to inspect the unit and submit its final report to the Tribunal clearly stating whether the industry is complying all the directions issued by the Boards and is a non-polluting industry. The trade effluent, stack and ambient air quality samples would be collected and analyzed and the report should be submitted to the Tribunal. The samples would be tested at the laboratory of the Central Pollution Control Board. The joint inspection team should clearly report as to the quantum of extraction of ground water by the industry, the cess payable and amount of cess actually paid by the industry for all these years. It should also be placed on record whether the industry has obtained the permission from the Central Ground Water Authority for extraction of ground water, if so, with effect from which date. The joint inspection team shall also verify if the units have authorisation to deal with hazardous wastes, if the same is found in the premises of the unit.
- The industry is to show cause as to why it should not be directed to pay compensation for polluting the environment and its restitution for the period when it operated without consent of the Board and admittedly caused pollution as it had not installed proper antipollution devices to control and check air and water pollution.
- Direction to the Uttar Pradesh Pollution Control Board and the competent authority under the Water (Prevention and Control of Pollution) Cess Act, 1977 to issue notice to all the industries, particularly industries like M/s. Rathi Steel, wherever they were extracting ground water and were not paying appropriate cess in accordance with Water (Prevention and Control of Pollution) Cess Act, 1977. Further, if such industry is causing any pollution i.e. air and water by their activity, show cause notices shall be issued by the Board within two weeks from the date of this order and it should proceed with such industries in accordance with law.[7]

[7]Available at http://www.greentribunal.gov.in/Writereaddata/Downloads/762-2014(PB-I-Judg)MA-13-1-2015.pdf and judgment dated 13th January, 2015

Table 2.1 Air, Factories, and Motor Vehicles Act- Salient Features

S.No	Year	Act	Salient features
1.	1948	The Factories Act	The Factories Act and Amendment in 1987 was the first to express concern for the working environment of the workers. The amendment of 1987 has sharpened its environmental focus and expanded its application to hazardous processes.
2.	1981	The Air (Prevention and Control of Pollution) Act	The Air Act provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the CPCB .
3.	1982	The Air (Prevention and Control of Pollution) Rules	These Rules defines the procedures of the meetings of the Boards and the powers entrusted to them.
4.	1982	The Atomic Energy Act	The Atomic Energy Act deals with the radioactive waste.
5.	1987	The Air (Prevention and Control of Pollution) Amendment Act	The Air (Prevention and Control of Pollution) Amendment Act empowers the central and state pollution control boards to meet with grave emergencies of air pollution.
	1988	The Motor Vehicles Act	Act states that all hazardous waste is to be properly packaged, labeled, and transported.

TheWater(Prevention and Control of Pollution) Act 1974

Object and Purpose of the Act

This Act is to provide for

1. The prevention and control of Water Pollution
2. Maintaining and restoring the wholesomeness of water, and
3. The establishment of Boards for prevention and control of Water Pollution
4. To confer and assign such powers and functions on the Boards

Definitions

2 (e) Pollution (Water):

- Contamination of water or
- Alteration of physical, chemical or biological properties of water or
- Discharge of any sewage effluent or trade effluent or of any other liquid or solid substance into water

As may render such water harmful

- To Public health or
- To domestic, commercial, industrial, agricultural or other legitimate uses or
- To the life of animals and plants or of aquatic organisms

2(g) Sewage effluent means effluent from

- Any sewer system or disposal works and

- Includes sullage from open drains

2(k) Trade effluent includes
- Any liquid, solid or gaseous substance
- Which is discharged from any premises used for carrying on
- Any industry operations or process or treatment and disposal system,
- Other than domestic sewage.

2(d) Occupier: In relation to any factory or premises means
- The person who has control over the affairs of the factory or the premises, and includes in relation to any substance
- The person in possession of the substance

2(dd) Outlet includes
- Any conduit pipe or channel, open or closed
- Carrying sewage or trade effluent or any other holding arrangement
- Which causes or is likely to cause pollution

2(j) Stream includes
- River
- Water course (whether flowing or for the time-being dry)
- Inland water (whether natural or artificial)
- Subterranean waters
- Sea or tidal waters to such extent or as the case may be, to such point as the state government may, by notification in the official Gazette, specify in this behalf

The Water (Prevention and Control of Pollution) Act, 1974

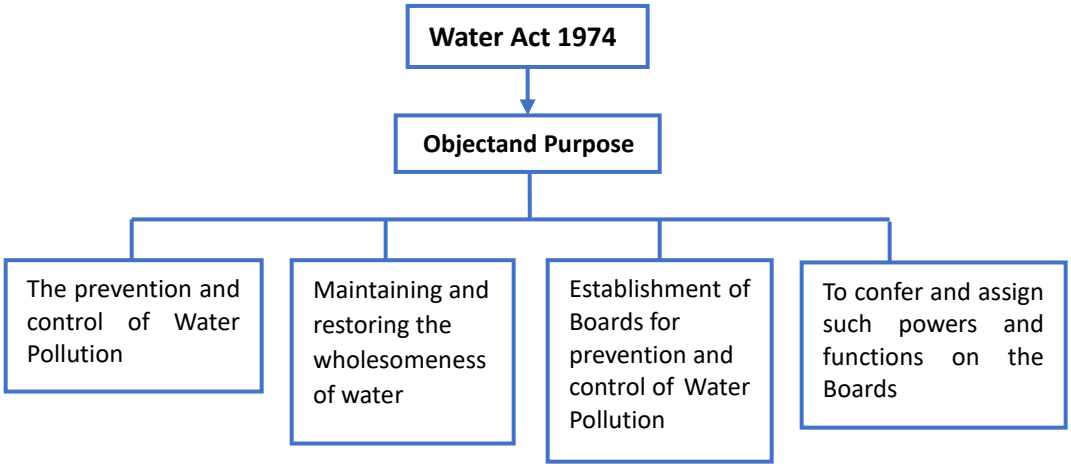

Fig 2.4 Water Act 1974

The Water Prevention and Control of Pollution Act, 1974 (the "Water Act") has been enacted to comprehensively deal with environmental issues, to provide for the prevention and control of water pollution and to maintain or restore wholesomeness of water in the country. It further provides for the establishment of Boards for the prevention and control of water pollution with a view to carry out the aforesaid purposes. The

Water Act prohibits the discharge of pollutants into water bodies beyond a given standard, and lays down penalties for non-compliance. The Act was amended in 1988 to conform closely to the provisions of the EPA, 1986. At the Centre, the Water Act has set up the CPCB (Central Pollution Control Board) which lays down standards for the prevention and control of water pollution. At the State level, SPCBs (State Pollution Control Board) function under the direction of the CPCB and the State Government to implement the standards stipulated.

Water quality standards especially those for drinking water are set by the Indian Council of Medical Research. These bear close resemblance to WHO standards. The discharge of industrial effluents is regulated by the Indian Standard Codes and recently, water quality standards for coastal water marine outfalls have also been specified. In addition to the general standards, certain specific standards have been developed for effluent discharges from industries such as, iron and steel, aluminum, pulp and paper, oil refineries, petrochemicals and thermal power plants.

Table 2.2 Powers and Functions of CPCB

Advise Central Government	**Collect, compile, publish statistics**
• **Coordinate the activities of State Boards** • **Technical Assistance and Guidance** • **Plan/Organize the Training of person** • **Mass media program**	• Standards for streams or well • Nationwide program (Prevention control and abatement) • Other functions • Laboratories

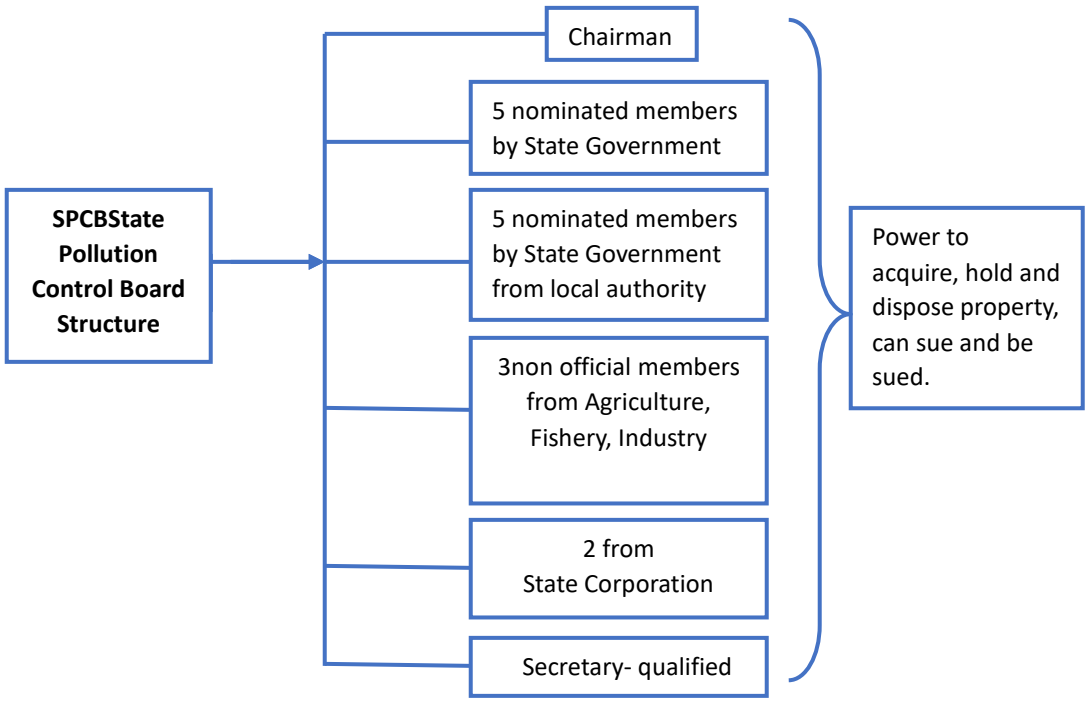

Fig 2.5 CPCB Structure

Functions of State Pollution Control Board

- Creating awareness
- The SPCB can make/verify stringent standards than the standards stipulated by CPCB depending on the real/local conditions.

Table 2.3 Functions of SPCB	
Plan comprehensive program	**Evolve economical methods for treatment**
To advice State government	Agricultural use
To collect and broadcast the information	Efficient method of disposal on land
Research encouragement	Standards in particular weather
Collaboration with CG for Training	Giving or revoke the orders
Inspect	Standards to be complied by person
Laying Standards	Other functions

Table 2.4 Powers of SPCB under Water Act[8]	
Penalties	**Punishments**
Section 20 (2)Power to obtain information (Person)	Section 21 3 months or Rs.10,000 or both, with additional fine of Rs.5000 per day.
Section 20 (3)Power to obtain information (Industry)	
Section 32 (1) (C)Emergency measure in case of pollution of stream or well	Section 411.5 years to 6 years, fine, Rs.5,ooo everyday
Section 33 (2)Power of Board to make application to Court	
Section 33 (A)Direction to person, authority, officer.Either the closure/prohibition/regulation of any industry, operation and process. Section 33 (B)Power to Stoppage or regulation of power supply, water or any other services to the polluting industry.	
Section 42Destruction of matter put up by board Obstructing person acting under board's direction Failing to furnish any information required by board officer Damaging property belonging to board Fails to intimate Giving false statement Related to Section 25/Section 26	Section 423 months or fine 10,000 Rupees or both
Section 25Restriction on new outlets (New, alter, Industry)	Section 441.5 years to 6 years
Section 26For existing outlets	
Section 45 Enhanced penalty after previous conviction	
Section 45A Any other punishment	

[8]*Source:https://www.youtube.com/watch?v=6y4ssnKZl3Y -Part-2 published by LegalFundaa, Aug 2017*

Section 43Section 24 (Of poisonous material - Prohibition of use of stream or well for further disposal of pollutants)
Section 21 Powers to take samples of the effluents and procedures to be followed in connection there with.
Section 22 Results to be declared of the samples taken under section 21.
Section 23 Powers of Inspection or entry in the industry premises.
Section 28 Aggrieved by the order of PCB, the aggrieved party can prefer an appeal within 30 days from the order of communication in NGT.

The Water (Prevention and Control of Pollution) Cess Act, 1977

The Water (Prevention and Control of Pollution) Cess Act was enacted in 1977 to provide for the levy and collection of a Cess on water consumed by persons operating and carrying on certain types of industrial activities ie, the Industries and the local authorities. This Cess is collected with a view to augment the resources of the Central and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974. Following this Act, the Water (Prevention and Control of Pollution) Cess Act was enacted in 1977 and the Rules were formulated in 1978 for defining standards and indications for the kind of and location of meters that every consumer of water is required to install. The Act was last amended in 2003. Further, after GST Act in 2017, the Water Cess act is merged in GST.Legislation to control water pollution is listed in the Table 2.5 below.

Table 2.5 Legislation to Control Water Pollution

S.No	Year	Act	Salient features
1	1882	The Easement Act	Allows private rights to use a resource that is, groundwater, by viewing it as an attachment to the land. It also states that all surface water belongs to the state and is a state property.
2	1897	The Indian Fisheries Act	Establishes two sets of penal offences whereby the government can sue any person who uses dynamite or other explosive substance in any way (whether coastal or inland) with intent to catch or destroy any fish or poisonous fish in order to kill.
3.	1956	The River Boards Act	Enables the states to enroll the central government in setting up an Advisory River Board to resolve issues in inter-state cooperation.
4.	1970	The Merchant Shipping Act	Aims to deal with waste arising from ships along the coastal areas within a specified radius.
5.	1974	The Water (Prevention and Control of Pollution) Act	Establishes an institutional structure for preventing and abating water pollution. It establishes standards for water quality and effluent. Polluting industries must seek permission to discharge waste into effluent bodies. The CPCB (Central Pollution Control Board) was constituted under this act.
6.	1977	The Water (Prevention	Cess Act provides for the levy and collection of cess or

		and Control of Pollution)Cess Act	fees on water consuming industries and local authorities.
7.	1978	The Water (Prevention and Control of Pollution)Cess Rules	Cess Rules contains the standard definitions and indicate the kind of and location of meters that every consumer of water is required to affix.
8.	1991	The Coastal Regulation Zone	The Coastal Regulation Zone Notification puts regulations on various activities, including construction, are regulated. It gives some protection to the backwaters and estuaries.

The Water (Prevention and Control of Pollution) CESS (Amendment) ACT 2003

Ministry of Law and Justice (Legislative Dept.) New Delhi, the 17th March, 2003 The following Act of Parliament received the assent of the President on the 13th March, 2003.An Act further to amend, the Water (Prevention and Control of Pollution) Cess Act, 1977. Be it enacted by parliament in the Fifty -fourth Year of the Republic of India as follows:

1. This Act is called the Water(Prevention and Control of Pollution) Cess (Amendment) Act, 2003.
2. Amendment of Section 2 In the Water (Prevention and Control of Pollution) Cess Act, 1977.(hereinafter referred to as the principal Act), in section 2, for clause(C) the following clause shall be substituted, namely:-
   Note: '(C) "industry" includes any operation or process, or treatment and disposal system, which consumes water or gives rise to sewage effluent or trade effluent, but does not include any hydel power unit'.
3. Substitution of Certain Expression In the principal Act, for the words "specified industry", wherever they occur and the word "industry" shall be substituted.
4. Substitution of New Section for Section 16
   For section 16 of the principal Act, the following section shall be substituted, namely:- Power of Central Government to Exempt the Levy of Water Cess "16.(1) Notwithstanding anything contained in section 3, the Central Government may, by notification in the Official Gazette, exempt any industry, consuming water below the quantity specified in the notification, from the levy of water cess. (2) In exempting an industry under sub-section (1), the Central Government shall take into consideration – (a) the nature of raw material used; (b) the nature of manufacturing process employed; (c) the nature of effluent generated; (d) the source of water extraction; (e) the nature of effluent receiving bodies; and (f) the production data, including water consumption per unit production, in the industry and the location of the industry."
5. Omission of Schedule I-Schedule I to the principal Act shall be omitted.
6. Substitution of New Schedule for Schedule II For Schedule II to the principal Act, the following Schedule shall be substituted , namely:-

Table 2.6 Water Act- Schedule II

Purpose for which water is consumed	Maximum rate under sub-section (2) of section 3	Maximum rate under Sub-section (2A) of Section 3
1. Industrial cooling, spraying in mine pits or boiler feeds	Five paise per kilolitre	Ten paise per kilolitre
2. Domestic purpose	Two paise per kilolitre	Three paise per kilolitre.
3. Processing whereby water gets polluted and the pollutants	Ten paise Per kilolitre.	Twenty paise per kilolitre.

are – a) easily biodegradable ; or b) non – toxic; or c) both non toxic and easily bio degradable. 4. Processing whereby water gets polluted and the pollutants are – a) not easily biodegradable; or b) toxic; or c) both toxic and not easily biodegradable.	Fifteen paise per kilolitre	Thirty paise per kilolitre."

Caselets

1. Vellore Citizens Case: In a landmark judgment where the principle of sustainable development has been adopted by the Supreme Court as a balancing concept, while rejecting the old notion that development and environmental protection cannot go together, the apex court held the view that sustainable development has now come to be accepted as "a viable concept to eradicate poverty and improve the quality of human life while living within the carrying capacity of the supporting eco system." Thus, pollution created as a consequence of development must be commensurate with the carrying capacity of our ecosystem.
   Facts - In this case, certain tanneries in the State of Tamil Nadu were discharging untreated effluent into agricultural fields, roadsides, waterways as open lands. The untreated effluent finally discharges in the river which has the main source of water supply to the residence of Vellore. The Supreme Court issued comprehensive directions for maintaining the standards stipulated by the Pollution Control Board.
2. Order of the National Green Tribunal in the matter of M. C. Mehta Vs Union of India & Others dated 06/08/2018 regarding pollution of river Ganga.National Green Tribunal directs the constitution of a Monitoring Committee to monitor and audit the compliance of the directions and also to issue directions in the nature of a Supervisory Committee. The National Mission for Clean Ganga will be the nodal agency to co-ordinate with the Committee. The Committee will focus its working on the segment from Gaumukh to Unnao (Segment A and B of Phase-I).Court also directs that the online mechanism for monitoring the sewage treatment plants should also be connected to the servers of CPCB and State Pollution Control Boards so that the CPCB can also monitor the data[9].
3. In M/s Pushp Sanitary Appliances Delhi Pollution Control Committee three appeals were filed under Sec.18 (1) of the NGT Act 2010 questioning the orders issued by the Delhi Pollution Control Committee (DPCC) ordering the closure of the industry as well as disconnections of essential supplies like water and electricity to the factories under Sec.33-A of the Water (Prevention and Control of Pollution) Act, 1974 (the Water Act).In the instant case,the NGT foundmerit in the contentions raised on behalf of the appellant though they did not express any opinion at that stage. The detailed reply as submitted by the industry taking up plea that it has consent of the Board, its ETPs are functioning properly, analysis reports have been taken. Furthermore the unit showed its willingness in using the latest and recent technology to ensure that they become a zero discharge unit. They had also specifically stated that they had permission/ authorization for storing of Hazardous waste.

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1. [9]http://www.indiaenvironmentportal.org.in/files/file/Ganga_pollution_Kanpur_Haridwar_NGT_Order.pdfhttp://www.indiaenvironmentportal.org.in/content/459127/order-of-the-national-green-tribunal-regarding-pollution-of-river-ganga-06082018/
2.

The NGT observed that passing a direction of closure under section 33-A of the Water Act is an order of very serious consequence. In fact, it amounts to civil death of a unit. The order has to be passed strictly in compliance with the procedure prescribed under section 33-A of the Water Act. The procedure prescribed under Rule 34 of the Water (Prevention and Control of Pollution) Rules, 1975 has to be adhered to. The procedure prescribed requires service of the copy of the proposed direction and an opportunity of not less than 15 days from the date of service of a notice to be provided from the date of the objection and these objections would be dealt with as per procedure provided under the sub-rules (3) and (5) of the Rules, Opportunity of being heard has to be provided even to occupier and after considering the objections,the order containing directions has to be passed. This is a mandatory procedure and in any case the Principles of Natural Justice are to be complied with. Person must be provided an opportunity before any adverse order could be passed against him, there should be application of mind, that is, the authority must deal with the objections raised by the affected party and then an order which is reasoned should be passed.2016(6) FLT 60 (NGT- PB-ND). See also Angrez Singh v.State of Punjab 2016(6) FLT 471(P&H HC) where the court directed the regular monitoring of a rice mill in a village to check pollution.

2.3 TheFactories Act 1948

The Factories Act, 1948 is a post-independence statute that explicitly showed concern for the environment.

Object and Purpose of the Act

To secure

- Health, safety, welfare
- Proper working hours
- Other benefits to workers

It provides that precaution should be taken for safety of workers and prevention of accidents.

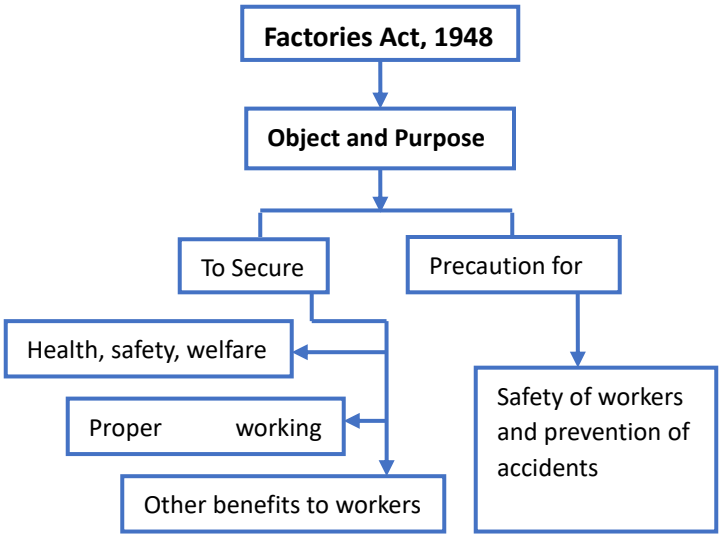


Fig 2.7 Factories Act

The primary aim of the 1948 Act has been to ensure the welfare of workers not only in their working conditions in the factories but also their employment benefits. While ensuring the safety and health of the workers, the Act contributes to environmental protection.

The Act contains a comprehensive list of 29 categories of industries involving hazardous processes, which are defined as a process or activity where unless special care is taken, raw materials used therein or the intermediate or the finished products, by-products, wastes or effluents would:

- Cause material impairment to health of the persons engaged
- Result in the pollution of the general environment

Provisions Relating To Hazardous Processes

The Site Appraisal Committee Section (41A)

Shall examine an application for the establishment of a factory involving hazardous process and make its recommendation to the State Government within a period of ninety days of the receipt of such application in the prescribed form.

1. Where any process relates to a factory owned or controlled by the Central Government or to a corporation or company owned or controlled by the Central Government, the State Government shall co-opt in the Site Appraisal Committee a representative nominated by the Central Government as a member of that Committee.
2. The Site Appraisal Committee shall have power to call for any information from the person making an application for the establishment or expansion of a factory involving a hazardous process.
3. Where the State Government has granted approval to an application for the establishment or expansion of a factory involving a hazardous process, it shall not be necessary for an applicant to obtain a further approval from the Central Board or the State Board established under the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981).

Permissions

State Government or a Chief Inspector refuses to grant permission to the site, construction or extension of a factory or to the registration and licensing of a factory, the applicant may within thirty days of the date of such refusal appeal to the Central Government if the decision appealed from was of the State Government and to the State Government in any other case.

Explanation.—A factory shall not be deemed to be extended within the meaning of this section by reason only of the replacement of any plant or machinery, or within such limits as may be prescribed, of the addition of any plant or machinery 1 [if such replacement or addition does not reduce the minimum clear space required for safe working around the plant or machinery or adversely affect the environmental conditions from the evolution or emission of steam, heat or dust or fumes injurious to health].

Guidelines, Instructions and Records- Rule 16A

1. Without prejudice to the general responsibility of the occupier to comply with the provisions of Section 7(A), the Chief Inspector may, from time to time, issue guidelines and instructions regarding the general duties of the occupier relating to health, safety and welfare of all workers while they are at work in the factory.
2. The occupier shall maintain such records, as may be prescribed by the Chief Inspector, in respect of monitoring of working environment in the factory

Disposal of Trade Wastes and Effluents

1. Rules prescribed under sub-section (2) of Section 12 -Disposal of Trade Wastes and Effluents.- The arrangements made in every factory for the treatment of wastes and effluents due to the manufacturing processes carried on therein shall be in accordance with those approved by the relevant Water and Air Pollution Boards appointed under the Water (Prevention & Control of Pollution) Act, 1974 and the Air (Prevention & Control Of Pollution) Act, 1981 and other appropriate authorities.

2. The State Government may make rules prescribing the arrangements to be made under sub-section (1) or requiring that the arrangements made in accordance with sub-section (1) shall be approved by such authority as may be prescribed.

Compulsory disclosure of information by the occupier (Section 41B)

(1) The occupier of every factory involving a hazardous process shall disclose in the manner prescribed all information regarding dangers, including health hazards and the measures to overcome such hazards arising from the exposure to or handling of the materials or substances in the manufacture, transportation, storage and other processes, to the workers employed in the factory, the Chief Inspector, the local authority within whose jurisdiction the factory is situate and the general public in the vicinity.

(2) The occupier shall, at the time of registering the factory involving a hazardous process, lay down a detailed policy with respect to the health and safety of the workers employed therein and intimate such policy to the Chief Inspector and the local authority and, thereafter, at such intervals as may be prescribed, inform the Chief Inspector and the local authority of any change made in the said policy.

(3) The information furnished under sub-section (1) shall include accurate information as to the quantity, specifications and other characteristics of wastes and the manner of their disposal.

(4) Every occupier shall, with the approval of the Chief Inspector, draw up an on-site emergency plan and detailed disaster control measures for his factory and make known to the workers employed therein and to the general public living in the vicinity of the factory the safety measures required to be taken in the event of an accident taking place.

(5) Every occupier of a factory shall, -

(a) if such factory engaged in a hazardous process on the commencement of the Factories (Amendment) Act, 1987, within a period of thirty days of such commencement; and

(b) if such factory proposes to engage in a hazardous process at any time after such commencement, within a period of thirty days before the commencement of such process, inform the Chief Inspector of the nature and details of the process in such form and in such manner as may be prescribed.

(6) Where any occupier of a factory contravenes the provisions of sub-section (5), the license issued under section 6 to such factory shall, notwithstanding any penalty to which the occupier of factory shall be subjected to under the provisions of this Act, be liable for cancellation.

(7) The occupier of a factory involving a hazardous process shall, with the previous approval of the Chief Inspector, lay down measures for the handling, usage, transportation and storage of hazardous substances inside the factory premises and the disposal of such substances outside the factory premises and publicize them in the manner prescribed among the workers and the general public living in the vicinity.

Specific responsibility of the occupier in relation to hazardous processes (Section 41C)
Every occupier of a factory involving any hazardous process shall:
(a) Maintain accurate and up-to-date health records or, as the case may be, medical records of the workers in the factory who are exposed to any chemical, toxic or any other harmful substances which are manufactured, stored, handled or transported and such records shall be accessible to the worker's subject to such conditions as may be prescribed

(b) Appoint persons who possess qualifications and experience in handling hazardous substances and are competent to supervise such handling within the factory and to provide at the working place all the necessary facilities for protecting the workers in the manner prescribed.Provided where any question arises as to the qualifications and experience of a person so appointed, the decision of the Chief Inspector shall be final.

(c) Provide for medical examination of every worker:

- Before such worker is assigned to a job involving the handling of, or working with, a hazardous substance, and
- While continuing in such job, and after he has ceased to work in such job, at intervals not exceeding twelve months, in such manner as may be prescribed.

Caselets
Baldev Singh And Ors. vs State Of H.P. and Ors. On 27 July, 2006
Himachal Pradesh High Court, Bench: V Gupta, D Gupta, Judgement: Deepak Gupta, J

This writ petition under Article 226 of the Constitution of India has been filed in the public interest by some residents of villages Batamandi and Ganguwala questioning the legality and propriety of the expansion of the existing fermentation plant at Ganguwala for manufacture of bulk drugs and setting up of a new formulation plant at Batamandi M/s. Ranbaxy Laboratories Limited. The challenge is on various grounds. According to the petitioners, the respondents have violated various provisions of law. It is also alleged that the respondent has not only violated the law but has started the construction without any legal and valid permission. According to the petitioners in case the plant is set up it shall cause huge amount of pollution leading to environmental degradation.

Violation of Factories Act
On the allegations made by the petitioners the Committee has reached a finding that the State Government was bound to comply with the mandatory provisions of the Factories Act and grant approval for the setting up of the factory after obtaining the recommendations of a Site Appraisal Committee in terms of Section 41 (A) of the Factories Act. There is no doubt that the bulk drug fermentation plant at Ganguwala is a plant which comes within the ambit of hazardous process as defined in Section 2 (CB) of the Factories Act. The Committee has made the following pertinent observations in this behalf.Therefore, M/s. Ranbaxy Laboratories Ltd. should have obtained approval of the State Government for site appraisal as required under Section 41-A of the Act ibid. Construction of this Plant without complying with this statutory requirement is a patent illegality.

It has further been observed that no Site Appraisal has been done as required under the said Act with regard to the plant at Ganguwala. It was only when the matter was pending before the Committee that respondent No. 4 filed an application for site appraisal. The Committee has comes to the conclusion that there is a clear violation of the provisions of the Factories Act. No action has been taken under the provisions of the Factories Act. The respondent No. 4 is clearly guilty of having started construction in total violation of the Factories Act without obtaining clearance from the Site Appraisal Committee. No such approval/ recommendation of the Site

Appraisal Committee has been obtained till date and, therefore, the further construction cannot be allowed to continue till requisite permission is obtained.

The respondent has violated the provisions of Section 41 A read with Sections 6 and 7 of the Factories Act especially with regard to the fermentation plant at Ganguwala. Therefore, the respondent be dealt with strictly in accordance with the provisions of the Factories Act.

2.4 The Motor Vehicles Act 1988

Object and Purpose of the Act

In 1988, the *Motor Vehicles Act,* was enacted to

- Regulate vehicular traffic, besides,
- Ensuring proper packaging, labeling and transportation of the hazardous wastes.

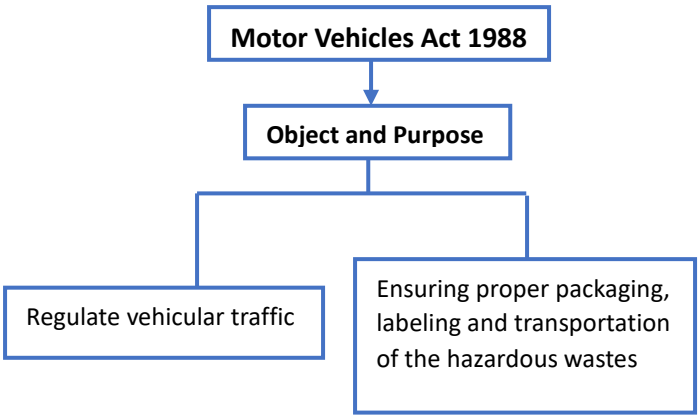


Fig 2.8 Motor Vehicles Act 1988

Vehicular Pollution

Various aspects of vehicular pollution have also been notified under the EPA of 1986. Mass emission standards were notified in 1990, which were made more stringent in 1996. In 2000 these standards were revised yet again and for the first time separate obligations for vehicle owners, manufacturers and enforcing agencies were stipulated. In addition, fairly stringent Euro I and II emission norms were notified by the Supreme Court on April 29, 1999 for the city of Delhi. The notification made it mandatory for car manufacturers to conform to the Euro I and Euro II norms by May 1999 and April 2000, respectively, for new non-commercial vehicles sold in Delhi.

Control of Transport Vehicles

Application for Goods Carriage Permit

An application for a permit to use a motor vehicle for the carriage of goods for hire or reward or for the carriage of goods for or in connection with a trade or business carried on by the applicant (in this Chapter referred to as a goods carriage permit) shall, as far as may be, contain the following particulars, namely:— (a) the area or the route or routes to which the application relates; (b) the type and capacity of the vehicle; (c) the nature of the goods it is proposed to carry; (d) the arrangements intended to be made for the housing, maintenance and repair of the vehicle and for the storage and safe custody of the goods; (e) such particulars as the Regional Transport Authority may require with respect to any business as a carrier of goods for hire or reward carried on by the applicant at any time before the making of the application, and of the rates charged by the applicant; (f) particulars of any agreement, or arrangement, affecting in any material respect the provision within the region of the Regional Transport Authority of facilities for the transport of goods for hire or reward, entered into by the

applicant with any other person by whom such facilities are provided, whether within or without the region; (g) any other particulars which may be prescribed.

Considerations of Application for Goods Carriage Permit

A Regional Transport Authority shall, in considering an application for a goods carriage permit, have regard to the following matters, namely:

(a) The nature of the goods to be carried with special reference to their dangerous or hazardous nature to human life

(b) The nature of the chemicals or explosives to be carried with special reference to the safety to human life.

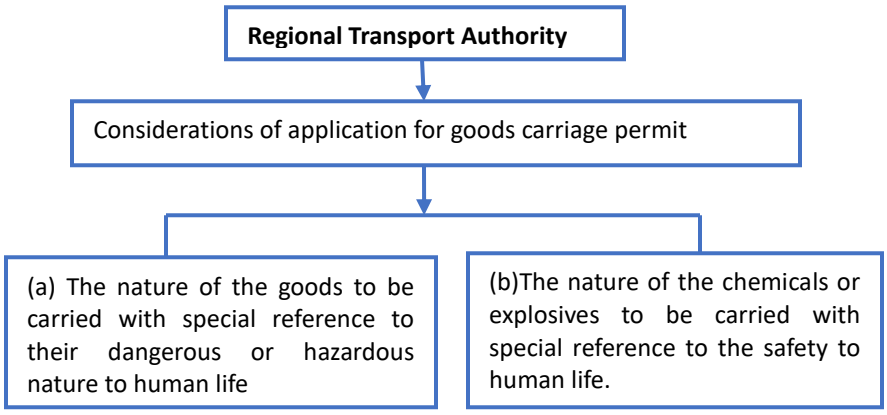


Fig 2.9 Regional Transport Authority

Grant of Goods Carriage Permit

(1) A Regional Transport Authority may, on an application made to it under section 77, grant a goods carriage permit to be valid throughout the State or in accordance with the application or with such modifications as it deems fit or refuse to grant such a permit: Provided that no such permit shall be granted in respect of any area or route not specified in the application.

(2) The Regional Transport Authority, if it decides to grant a goods carriage permit, may grant the permit and may, subject to any rules that may be made under this Act, attach to the permit any one or more of the following conditions, namely:— (i) that the vehicle shall be used only in a specified area or on a specified route or routes; (ii) that the gross vehicle weight of any vehicle used shall not exceed a specified maximum; (iii) that goods of a specified nature shall not be carried; (iv) that goods shall be carried at specified rates (v) that specified arrangement shall be made for the housing, maintenance and repair of the vehicle and the storage and safe custody of the goods carried; (vi) that the holder of the permit shall furnish to the Regional Transport Authority such periodical returns, statistics and other information as the State Government may, from time to time, prescribe; (vii) that the Regional Transport Authority may, after giving notice of not less than one month,— (a) vary the conditions of the permit; (b) attach to the permit further conditions; (viii) that the conditions of the permit shall not be departed from, save with the approval of the Regional Transport Authority; (ix) any other conditions which may be prescribed.

(3) The conditions referred to in sub-section (2) may include conditions relating to the packaging and carriage of goods of dangerous or hazardous nature to human life.

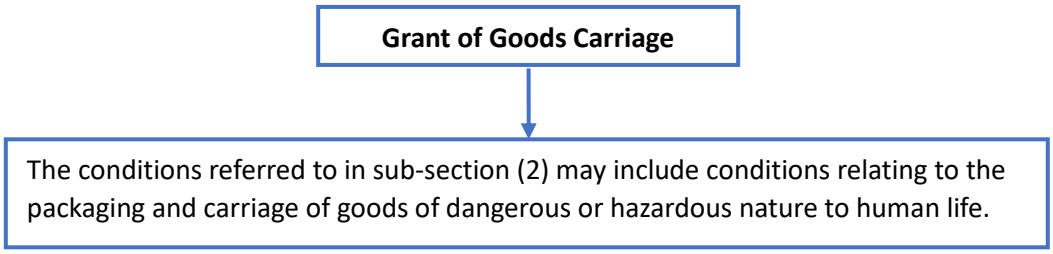


Fig 2.10 Grant of Goods Carriage Permit

Management of Hazardous Waste- Guidelines for Transportation of Hazardous Wastes

As per Hazardous Waste (Management & Handling) Rules, 1989, as amended, the requirements for hazardous waste management include proper packaging, labeling and transportation of hazardous wastes. It is the responsibility of the occupier or operator of a facility to ensure that the hazardous wastes are packaged, based on the composition in a manner suitable for handling, storage and transport. The labeling and packaging should be such that same is easily visible and able to withstand physical conditions and climate factors so that identity of waste is not lost and suitable measures can be taken up in case of spill etc. Provisions of the rules under Motor Vehicle Act, 1988 are required to be complied with regarding packaging, labeling and transportation of hazardous waste. The Central Pollution Control Board prepared draft guidelines on transportation of hazardous waste in October 2003 as a CPCB publication.

Definitions

Appropriate authority: In relation to a national permit, means the authority which is authorized under this Act to grant a goods carriage permit.National permit: means a permit granted by the appropriate authority to goods carriages to operate throughout the territory of India or in such contiguous States, not being less than four in number, including the State in which the permit is issued as may be specified in such permit in accordance with the choice indicated in the application

2.5 The Public Liability Insurance Act 1991

The Public Liability Insurance Act 1991 was enacted on January 22, 1991. This act was brought up mainly in response to the Bhopal gas tragedy that killed over 3,700 people and 16,000 others injured. The 1991 act was framed with provisions that required factory owners to insure against potential personal injury and property damage in the surrounding communities.

The purpose of the act is to provide immediate relief to persons (other than workmen) affected by accidents occurring while handling hazardous substances through the insurance amount paid by the owner of the hazardous substance.

Public liability insurance refers to the insurance covered against any hazardous substance / any other property by its owner and the same is paid as relief or compensation to the claimant who has been injured / any damage has been occurred due to that hazardous substance/property.

The specialty of this act is that it ensures `No Fault Liability' against the owners of hazardous substances. In other words, it could be said that the owner of a hazardous substance must have insured so that any person injured or died of any hazardous substance could claim compensation, without going into any question of fault on the part of the owner.

Under the act, every owner of any hazardous property, before handling that property, shall take one or more insurance policies providing contracts of insurance whereby he is insured against the liability to give relief claimed by the person injured or suffered any loss occurred due to that hazardous substance.

The persons who can apply for claim/relief under this act include the person who has sustained the injury; the owner of the property to which the damage has been caused, the legal representatives of the deceased, in case of death occurred as a result of the accident and the authorized agent of the above-mentioned.Under this act, the claim or relief is applied to the collector under whose jurisdiction the accident occurred/hazardous substance lies.

The time limit to apply under this act is five years from the date of occurrence of the accident. For this, the collector, after entertaining the application, shall issue notice to the parties and give opportunity of being heard. Then, the collector holds an inquiry regarding the amount claimed and determines a final amount to be settled as compensation. The copy of the award delivered should be delivered to the parties within 15 days from the date of delivery of the award. The award is binding on the parties and the insurer who is liable to pay the amount mentioned in the award, shall pay the amount within 30 days from the date of announcement of the award.

The penalties for non-compliance under this act included imprisonment which extends from 3 months to 7 years and fine which extends from Rs.1000 to Rs.1 lakh for non-compliance of a wide range of provisions of this act.

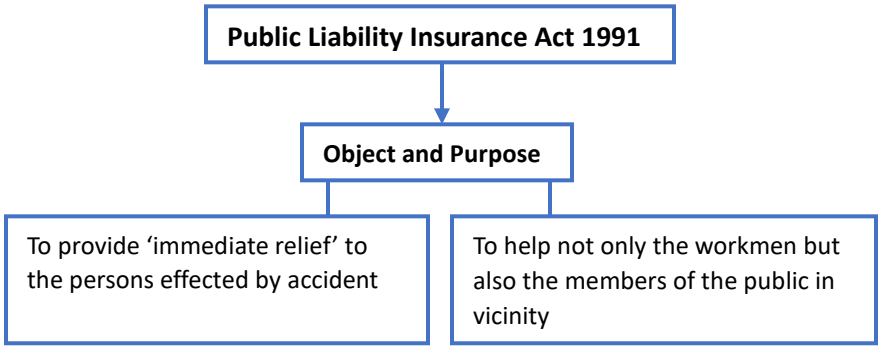


Fig 2.11 Public Liability Insurance Act 1991

Summary

The Indian Forest Act, 1927 is a comprehensive piece of legislation that consolidates the law relating to forests, the transit of forestproduce, and the duty leviable on timber and other forest-produce. Besides, the Forest (Conservation) Act and Rules, 1981, provide for the protection and conservation of forests, while the Amendmentmade in 1984 is one of the many surviving colonial statutes.

The Wildlife Protection Act, Rules 1973 and Amendment 1991 provide for the protection of birds and animals and for all matters related to it, be it their habitat or the waterhole or the forests that sustain them.The Wild Life (Protection) Act was the first umbrella act which established schedules of protected plant and animal species. The WPA empowers the central and state governments to declare any area a wildlife sanctuary,

national park or closed area. There is a blanket ban on carrying out any industrial activity inside these protected areas. It provides for authorities to administer and implement the Act; regulate the hunting of wild animals; protect specified plants, sanctuaries, national parks and closed areas; restrict trade or commerce in wild animals or animal articles; and miscellaneous matters. The Act prohibits hunting of animals except with permission of authorized officer when an animal has become dangerous to human life or property or so disabled or diseased as to be beyond recovery (WWF-India, 1999). The near-total prohibition on hunting was made more effective by the Amendment Act of 1991.

Self-Assessment Questions

- Discuss about the Act that provides for the protection of birds and animals
- Which Act provides protection to listed endangered species of flora and fauna?
- Which is the Act that provides for the levy and collection of a cess on water consumption by industries and other local authorities?
- What is the primary aim of the Factory's Act? Discuss its significance.

Video Lessons

1. Forest Conservation Act 1980https://youtu.be/3IDagwQcg00
2. Wildlife (Protection) Act 1972- https://youtu.be/B_Oeft3ZDek
3. https://youtu.be/nFETDQzhD8o - by Prof. CS Shantanu Pethe (CACSCMA Coach)
4. https://youtu.be/GW8G0UyjUII Part-1
5. https://www.youtube.com/watch?v=6y4ssnKZl3Y -Part-2
6. https://youtu.be/Gj87lXwwi9A -in Hindi
7. https://youtu.be/EdkJGPlePmM
8. ECL Air (Prevention & Control of Pollution) Act 1981- https://youtu.be/0Vszm8Pj1uY
9. A Video by Prof. Shantanu Pethe (CACSCMA Coach) www.cacscmacoach.com
10. https://youtu.be/AsPQmpiOJ3E
11. Part-1 https://youtu.be/8kZhBmtpVJ0 Part-2 https://youtu.be/9kQkVhcgA6w
12. Part 1 - https://youtu.be/aD5xAqx7ItM - video by Prof. Shantanu Pethe (CACSCMA Coach) -A fast track revision of Factories Act 19482.
13. Factories act 1948 lecture in 10 mins- CMA, CA, LLB And MBA- https://youtu.be/ORX4-q_Mzrw
14. Q & A- Part-1-ILGL MCQs (Video-1) Factories Act 1948- https://youtu.be/Ki_XyToLAbs - 2016.
15. Q & A- Part-2-ILGL MCQs (Video-2) Factories Act 1948- https://youtu.be/T_68WOREub0
16. Q & A- Part-3-ILGL MCQs (Video-3) Factories Act 1948-https://youtu.be/zairKJ-pF6s
17. Q & A- Part-4-ILGL MCQs (Video-3) Factories Act 1948- https://youtu.be/scyhuk0if0M

Chapter3
Environmental Laws for Pollution Control and Waste Management -II

Objectives

- To protect and improve environment and connected matters
- To create an authority with adequate powers to control pollution and protect environment
- To understand Hazardous, Biomedical and E-Waste Rules
- To understand proper and effective management and handling of lead acid of batteries waste

Structure

3.1 TheEnvironment Protection Act 1986
3.2 The Hazardous Waste Management Rules
3.3 Biomedical Wastes (Management and Handling) Rules
3.4 E-waste (Management and Handling) Rules 2016
3.5 Batteries (Management and Handling) Rules

To Do Activities

- Visit a nearby hospital to understand how far Biomedical Rules are followed
- Conduct a survey to understand how far these Acts have been implemented in the respective arenas
- Discuss caselets on various Acts
- Provide topics for group or individual presentation
- Organize debates on the important Acts and check for monitoring and practical implementation

It is interesting to note that natural resources had been stored virtually untouched in the Earth for millions of years. But since the start of the industrial revolution vast amounts of these resources had been exploited within a period of just a couple of hundreds of years at unimaginable rates, with all the waste from this exploitation going straight in the environment (air, water, land) and seriously damaging its natural processes. Although pollution had been known to exist for a very long time (at least since people started using five thousands of years ago), it had seen the growth of truly global proportions only since the onset of the industrial revolution during the 19th century.

In the Constitution of India, it is clearly stated that it is the duty of the state to 'protect and improve the environment and to safeguard the forests and wildlife of the country'. It imposes a duty on every citizen 'to protect and improve the natural environment including forests, lakes, rivers, and wildlife'. Reference to the environment has also been made in the Directive Principles of State Policy as well as the Fundamental Rights. The Dept. of Environment was established in India in 1980 to ensure a healthy environment for the country. This later became the Ministry of Environment and Forests in 1985.

The constitutional provisions are backed by a number of laws – acts, rules, and notifications. The EPA (Environment Protection Act), 1986 came into force soon after the Bhopal Gas Tragedy and is considered an umbrella legislation as it fills many gaps in the existing laws. Thereafter a large number of laws came into existence as the problems began arising, for example, Handling and Management of Hazardous Waste Rules in 1989.

Following is a list of the environmental laws regarding 'Pollution and waste management', which have come into effect. We will study some of these Acts and rules in this Chapter-2 and in the following chapters 3 and 4 as separate Units.

Table 3.1 EPA and other Acts & Rules- Salient Features

S.No.	Year	Act/Rules	Salient features
1.	1986	The Environment (Protection) Act EPA and the Rules	1. Authorizes the central government to protect and improve environmental quality, control and reduce pollution from all sources, and prohibit or restrict the setting and /or operation of any industrial facility on environmental grounds. 2. The Environment (Protection) Rules lay down procedures for setting standards of emission or discharge of environmental pollutants
2.	1989	Hazardous Waste (Management and Handling) Rules	1. The objective of Hazardous Waste (Management and Handling) Rules is to control the generation, collection, treatment, import, storage, and handling of hazardous waste. 2. The Manufacture, Storage, and Import of Hazardous Rules define the terms used in this context, and sets up an authority to inspect, once a year, the industrial activity connected with hazardous chemicals and isolated storage facilities. 3. The Manufacture, Use, Import, Export, and Storage of hazardous Micro-organisms/ Genetically Engineered Organisms or Cells Rules were introduced with a view to protect the environment, nature, and health, in connection with the application of gene technology and microorganisms.
3.	1991 - 92	The Public Liability Insurance Act and Rules and the Amendment	The Act was drawn up to provide for public liability insurance for the purpose of providing immediate relief to the persons affected by accident while handling any hazardous substance.
4.	1995	The National Environmental Tribunal Act	The Act has been created to award compensation for damages to persons, property, and the environment arising from any activity involving hazardous substances.
5.	1998	The Biomedical waste (Management and Handling) Rules	The Biomedical waste (Management and Handling) Rules is a legal binding on the health care institutions to streamline the process of proper handling of hospital waste such as segregation, disposal, collection, and treatment.
6.	1999	The Environment (citing for Industrial Projects) Rules	The Environment (Siting for Industrial Projects) Rules, 1999 lay down detailed provisions relating to areas to be avoided for siting of industries, precautionary measures to be taken for site selecting as also the aspects of environmental protection which should have been incorporated during the implementation of the industrial development projects.
7.	2000	The Municipal Solid Wastes (Management and Handling) Rules	These Rules, apply to every municipal authority responsible for the collection, segregation, storage, transportation, processing, and disposal of municipal solid wastes.

8.	2000	The Ozone Depleting Substances (Regulation and Control) Rules	These Rules have been laid down for the regulation of production and consumption of ozone depleting substances.
9.	2001	The Batteries (Management and Handling) Rules	These rules shall apply to every manufacturer, importer, re-conditioner, assembler, dealer, auctioneer, consumer, and bulk consumer involved in the manufacture, processing, sale, purchase, and use of batteries or components so as to regulate and ensure the environmentally safe disposal of used batteries.
10.	2002	The Biological Diversity Act	The Biological Diversity Act is an act to provide for the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the use of biological resources and knowledge Assoc. d with it.
11.	2011	E - Waste (Management and Handling) Rules	To reduce the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous material and to channelize the e-waste generated in the country for environmentally sound recycling.
12.	2016	Plastic	

3.1 The Environment Protection Act 1986

After the enactment of water (Prevention and control of pollution) Act, 1974 and Air (Prevention and control of pollution) Act 1981, it was felt to make a general legislation for environmental protection as well.

Object and Purpose of the Act

The Environment Protection Act, 1986 (The "EP-Act") enacted to

- To protect and improve environment and connected matters.
- To create an authority with adequate powers to control pollution and protect environment.

Aims

- Regulation of discharge
- Handling of Hazardous substances
- Speedy response to accidents threatening environment and
- Deterrent punishment to those who endanger human environment, safety and health

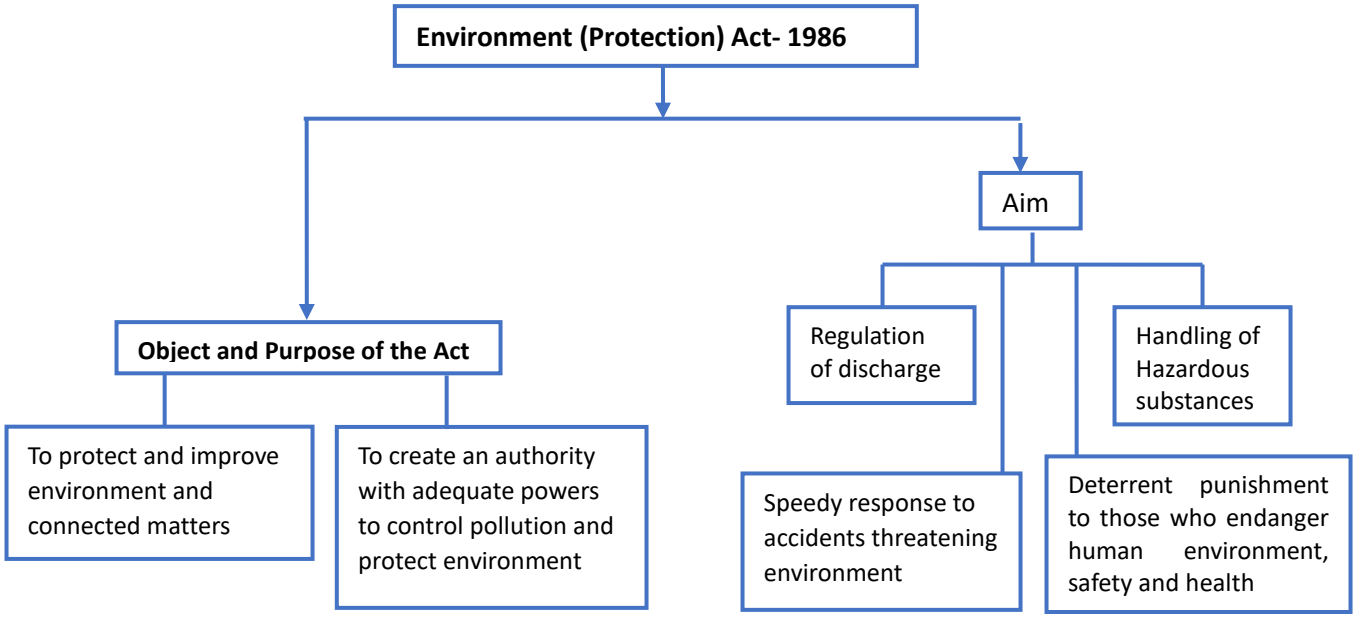


Fig 3.1 Environment Protection Act- 1986

Main Provisions of this Act

1. Laying down standards for
   - Quality of environment in its various aspects
   - Emission or discharge of environmental pollutants
2. Restriction of areas in which any industry
   - Shall not be carried out or
   - Shall be carried out, subject to certain conditions

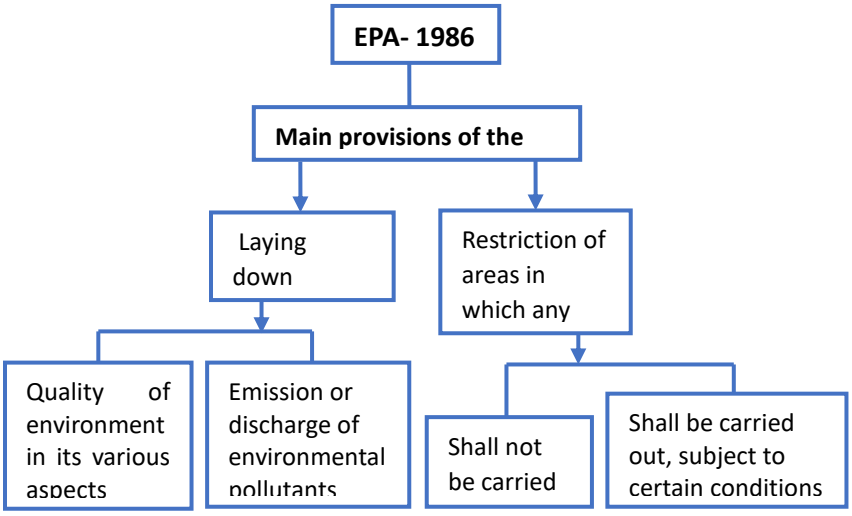


Fig 3.1 EPA 1986 Main Provisions of the Act

Definitions

Sec 2(a) - Environment

- Water
- Air
- Land
- The inter relationship exists among and between water, air and land, human beings, other living creatures, plants, micro-organism and property.

(b) – Environmental pollutant

means

- Any solid, liquid or gaseous substance
- Present in such concentration
- As may be or tend to be
- Injurious to environment

(c) Environmental Pollution

- Means the presence in the environment of any environmental pollutant

(d) Handling

- In relation to any substance, means the
- Manufacture, processing, treatment, package, storage, transportation, use, collection, destruction, conversion, offering for sale, transfer or the like.
- Of such substance

(e) Hazardous Substance means any substance or preparation which, by reason of its,

- Chemical or
- Physico chemical properties or
- Handling

Is liable to cause harm to

- Human beings, other living creatures, microorganism,
- Plants property or
- The environment

Powers of Central Government under this Act

Power to issue directions [Sec. 5]

Central government has got powers to issue directions and guidelines to any person, officer or any authority and such person, officer or authority shall be bound to comply with such directions:

The directions issued by the Central Government may include the following:

- Direction for closure, prohibition or regulation of any industry, operation or process
- Stoppage or regulation of supply of electricity or water or any other service

Power to issue directions [Sec. 6]

The Central Government can make Rules pertaining to the following aspects

a) Standards of quality of air, water or soil for various areas and purposes
b) Maximum allowable concentration of various environmental pollutants for different areas
c) Procedures and safeguards for handling of hazardous substances
d) Prohibitions and restrictions on handling the hazardous substances in different areas
e) Prohibitions and restriction on location of industries and carrying on operations or process in different areas
f) Procedures and safeguards for prevention of accidents which may cause environmental pollution and for providing remedial measures

The Environment Protection Act establishes the framework for studying, planning and implementing long-term requirements of environmental safety and laying down a system of speedy and adequate response to situations threatening the environment. It is an umbrella legislation designed to provide a framework for the coordination of central and state authorities established under the Water Act (Prevention and Control), 1974 and the Air Act(Prevention and Control) 1981. The term "environment" is understood in a very wide term under s 2(a) of the Environment Act. It includes water, air and land as well as the interrelationship which exists between water, air and land, and human beings, other living creatures, plants, micro-organisms and property.

Under the Environment Act, the Central Government is empowered to take measures necessary to protect and improve the quality of environment by setting standards for emissions and discharges of pollution in the atmosphere by any person carrying on an industry or activity; regulating the location of industries; management of hazardous wastes, and protection of public health and welfare. From time to time, the Central Government issues notifications under the Environment Act for the protection of ecologically-sensitive areas or issues guidelines for matters under the Environment Protection Act.

In case of any non-compliance or contravention of the Environment Act, or of the rules or directions under the said Act, the violator will be punishable with imprisonment up to five years or with fine up to Rs 1,00,000, or with both. In case of continuation of such violation, an additional fine of up to Rs 5,000 for every day during which such failure or contravention continues after the conviction for the first such failure or contravention will be levied. Further, if the violation continues beyond a period of one year after the date of conviction, the offender shall be punishable with imprisonment for a term which may extend to seven years.

Some notifications issued under this Act are

- Doon Valley Notification (1989), which prohibits the setting up of an industry in which the daily consumption of coal/fuel is more than 24 MT (million tons) per day in the Doon Valley.
- Coastal Regulation Zone Notification (1991), which regulates activities along coastal stretches. As per this notification, dumping ash or any other waste in the CRZ is prohibited. The thermal power plants (only foreshore facilities for transport of raw materials, facilities for intake of cooling water and outfall for discharge of treated waste water/cooling water) require clearance from the MoEF.
- Dhanu Taluka Notification (1991), under which the district of Dhanu Taluka has been declared an ecologically fragile region and setting up power plants in its vicinity is prohibited.
- Revdanda Creek Notification (1989), which prohibits setting up industries in the belt around the Revdanda Creek as per the rules laid down in the notification.
- The Environmental Impact Assessment of Development Projects Notification, (1994 and as amended in 1997). As per this notification:
- All projects listed under Schedule I require environmental clearance from the MoEF.
- Projects under the de-licensed category of the New Industrial Policy also require clearance from the MoEF.
- All developmental projects whether or not under the Schedule I, if located in fragile regions must obtain MoEF clearance.
- Industrial projects with investments above Rs 500 million must obtain MoEF clearance and are further required to obtain a LOI (Letter Of Intent) from the Ministry of Industry, and an NOC (No Objection Certificate) from the SPCB and the State Forest Dept. if the location involves forestland. Once the NOC is obtained, the LOI is converted into an industrial license by the state authority.
- The notification also stipulated procedural requirements for the establishment and operation of new power plants. As per this notification, two-stage clearance for site-specific projects such as pithead thermal power plants and valley projects is required. Site clearance is given in the first stage and final environmental clearance in the second. A public hearing has been made mandatory for projects

covered by this notification. This is an important step in providing transparency and a greater role to local communities.

- Ash Content Notification (1997), required the use of beneficiated coal with ash content not exceeding 34% with effect from June 2001, (the date later was extended to June 2002). This applies to all thermal plants located beyond one thousand kilometers from the pithead and any thermal plant located in an urban area or, sensitive area irrespective of the distance from the pithead except any pithead power plant.
- Taj Trapezium Notification (1998), provided that no power plant could be set up within the geographical limit of the Taj Trapezium assigned by the Taj Trapezium Zone Pollution (Prevention and Control) Authority.
- Disposal of Fly Ash Notification (1999) the main objective of which is to conserve the topsoil, protect the environment and prevent the dumping and disposal of fly ash discharged from lignite-based power plants. The salient feature of this notification is that no person within a radius of 50 km from a coal-or lignite-based power plant shall manufacture clay bricks or tiles without mixing at least 25% of ash with soil on a weight-to-weight basis. For the thermal power plants the utilization of the fly ash would be as follows:
- Every coal-or lignite-based power plant shall make available ash for at least ten years from the date of publication of the above notification without any payment or any other consideration, for the purpose of manufacturing ash-based products such as cement, concrete blocks, bricks, panels or any other material or for construction of roads, embankments, dams, dykes or for any other construction activity.
- Every coal or lignite based thermal power plant commissioned subject to environmental clearance conditions stipulating the submission of an action plan for full utilization of fly ash shall, within a period of nine years from the publication of this notification, phase out the dumping and disposal of fly ash on land in accordance with the plan.[1]

Rules for the Manufacture, Use, Import, Export and Storage of Hazardous Micro-organisms/Genetically Engineered Organisms or Cell were introduced in 1989 with the view to protect the environment, nature and health in connection with gene technology and micro-organisms, under the Environmental Protection Act, 1986. The government in 1991, further decided to institute a national label scheme for environmentally-friendly products called the ECOMARK. The scheme attempts to provide incentives to manufactures and importers to reduce adverse environmental impacts, reward genuine initiatives by companies, and improve the quality of the environment and sustainability of available resources. Besides the above attempts, notifications pertaining to Recycled Plastics Manufacture and Usage Rules, 1999 were also incorporated under the Environment (Protection) Act of 1986.

The Environment (Protection) Rules, 1986

These rules lay down the procedures for setting standards of emission or discharge of environmental pollutants. The Rules prescribe the parameters for the Central Government, under which it can issue orders of prohibition and restrictions on the location and operation of industries in different areas. The Rules lay down the procedure for taking samples, serving notice, submitting samples for analysis and laboratory reports. The functions of the laboratories are also described under the Rules along with the qualifications of the concerned analysts.

Caselets

Bhopal Gas Tragedy and Legal Issues

The Environment Protection Act, 1986 came into force soon after the Bhopal Gas Tragedy which was a major leak of toxic chemical gases occurred from the Union Carbide chemical plant in the city of Bhopal in 1984 and is considered an umbrella legislation as it fills many gaps in the existing laws. Therefore a large number of laws came into existence as the problem began arising. The Bhopal disaster underlines the problem governments

confront in formulating a response to disaster situations when poverty levels are high and health infrastructures and government resources are severely limited. This brings into focus the need for private multinational (or public) industries to take some responsibility towards the environments and populations they are located in.

Industrial disaster, the Bhopal gas tragedy is, till date, the world's worst industrial disaster. In the February of 1985, the Government of India filed a case in the U.S Court for a claim of $3.3 billons against the Union Carbide Corporation (UCC). But by 1986 all of these litigations in the U.S District were transferred to India on the grounds of forum non-convenience. It means that the case should be transferred to a more convenient forum so that the trial proceeds smoothly. Meanwhile in March 1985, the Bhopal Gas Leak Disaster (Processing of Claims) Act was passed which empowered the Central Government to become the sole representative of all the victims in all kinds of litigations so that interests of the victims of the disaster are fully protected and the claims for compensation are pursued speedily. In the year 1987, cases were filed in the Bhopal District Court which ordered the Union Carbide Corporation to pay 350 crores as interim compensation. But the interim order could not be decreed and therefore the UCC refused to pay the amount. Later on, at the High Court, this interim compensation amount was reduced to 250 crores. Both the Union of India and the UCC preferred appeals by special leave against this High Court's order. One of the main issues which the Bhopal Gas tragedy raises is the issue of absolute liability. This issue was elaborately discussed in the case of M.C. Mehta v Union of India (http://indiankanoon.org /doc/59060/). The principle of absolute liability states that when an enterprise is engaged in hazardous or inherently dangerous industry and if any harm results in account of such activity then the enterprise is absolutely liable to compensate for such harm and that it should be no answer to the enterprise to say that it had taken all reasonable care and that the harm occurred without any negligence on its part.

This principle of absolute liability in India evolved primarily because of the awakening that the Bhopal Gas Disaster and the Oleum Gas Leak case gave. The Bhopal Gas Tragedy is also in a way responsible for the passing of the Public Liability Insurance Act, 1991 which provides for compulsory insurance of any unit or factory undertaking a hazardous activity. Apart from all of this, the tragedy has recently been much discussed in the light of the Nuclear Liability Bill. This bill has a lot of controversial provisions which aim at capping the total liability in case of a nuclear accident. The bill also prohibits the victims from suing the suppliers directly and allows them to recover only from the operators. The bill also lays a cap on the amount that an operator can recover from the suppliers.

3.2 The Hazardous Waste Management Rules

Hazardous waste

Means any waste which, by reason of any of its physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive characteristics, causes danger or is likely to cause danger to health or environment, whether alone or when in contact with other wastes or substances. It comprises the waste generated during the manufacturing processes of the commercial products such as industries involved in petroleum refining, production ofpharmaceuticals, petroleum, paint,aluminum,electronic products etc. As per the information furnished by Central Pollution Control Board (CPCB) in the year 2015, the total hazardous waste generation in the country is 7.46 million metric tons per annum from about 44,000 industries.

Importance of Proper Hazardous Waste Management

Scientific disposal of hazardous waste through collection, storage, packaging, transportation and treatment, in an environmentally sound manner minimizes the adverse impact on human health and on the environment. The hazardous waste can be disposed at captive treatment facility installed by the individual waste generators or at Common Hazardous Waste Treatment, Storage and Disposal Facilities (TSDFs). There are 40 Common

Hazardous Waste Treatment, Storage and Disposal Facilities (TSDFs) available in 17 States/UTs. Hazardous waste such as lead acid battery scraps, used oil, waste oil, spent catalyst etc. and other waste such as waste tyres, paper waste, metal scrap etc. are used as raw material by the industries involved in recycling of such waste and as supplementary resource for material and energy recovery. Accordingly, it is always preferable to utilize such waste through recycling, or for resource recovery to avoid disposal through landfill or incineration. There are about 1080 registered recyclers; 47 cement plants permitted for co-processingand about 108 industries permitted for utilization of hazardous waste.

Problems of Unscientific Disposal of Hazardous and Other Waste

Unscientific disposal of hazardous and other waste through burning or incineration leads to emission of toxic fumes comprising of Dioxins & Furans, Mercury, heavy metals, causing air pollution and Assoc. d health-related problems. Disposal in water-bodies or in municipal dumps leads to toxic releases due to leaching in land and water entailing into degradation of soil and waterquality. The workers employed in such unscientific practices suffer from neurological disorders, skin diseases, genetic defects, cancer etc. Hence, there is a need for systematic management of hazardous and other waste in an environmentally sound manner by way of prevention, minimization, re-use, recycling, recovery, utilization including co-processing and safe disposal of waste.

Policies and Regulations

The Ministry of Environment and Forests (MoEF& CC) and the pollution control boards: Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) together form the regulatory and administrative core of the waste management sector in India. At the state level, the management of solid waste is the responsibility of Urban Local bodies. Industries generating hazardous wastes must seek permission from the respective SPCB. A key issue is that municipal authorities do not possess the budgets to adequately cover the costs Assoc. d with developing effective waste management systems. The lack of strategic plans, as well as systems for governance (particularly waste collection/segregation), and regulation are major barriers to achieving effective Solid Waste Management (SWM) in India.

Table 3.2 The Responsibilities of Agencies for the Hazardous Waste Rules in India

Activity	Authority			
	MoEF& CC	SG	SPCB	CPCB
Survey and inventorisation of hazardous waste generators and processors			x	
Grant authorization for handling hazardous waste to sites and operators			x	
Inspect facilities/infrastructure/technical capabilities in hazardous waste units			x	
Suspend/refuse/can authorization for handling hazardous waste			x	
Identify and notify sites for hazardous waste treatment/disposal facilities		x	x	
Facilitate environmental impact assessment studies before identifying sites		x	x	
Collect, collate and publish list of abandoned hazardous waste dump sites		x		
Establish a system for filing annual returns and reporting accidents by hazardous waste facilities and operators			x	
Process and grant permits for the import of hazardous waste to sites in India			x	
Examine and permit/refuse exporters' requests for the importation of hazardous waste into India	x			

Issue instructions to hazardous waste importers			x	
Inform port authorities to take appropriate steps for the safe handling of hazardous waste at ports	x		x	
Inspect records of imports	x		x	X
Process appeals		x		
Source: CPCB (Central Pollution Control Board); MoEF& CC (Ministry of Environment, Forests and Climate Change); SG (State Government); and SPCB (State Pollution Control Board). Adapted from [Case Study 3: Hazardous Waste Issues in India. Available online: http://www.eolss.net/sample-chapters/ c09/e1-08-06.pdf (accessed on 29 June 2018)].				

The Hazardous Waste (Management, Handling & Transboundary Movement) Rules 2008

Is for manufacture and import of hazardous chemicals and for management of hazardous wastes. To ensure safe handling, generation, processing, treatment, package, storage, transportation, use reprocessing, collection, conversion, and offering for sale, destruction and disposal of Hazardous Waste. These Rules came into effect in the year 1989 and have been amended later in the years 2000, 2003 and with final notification of the Hazardous Waste (Management, Handling and Transboundary Movement) Rules, 2008 in supersession of former notification. The Rules lay down corresponding duties of various authorities such as MoEF, CPCB, State/UT Govts., SPCBs/PCCs, DGFT, Port Authority and Custom Authority while State Pollution Control Boards/ Pollution Control Committees have been designated with wider responsibilities touching across almost every aspect of Hazardous wastes generation, handing and their disposal. There are several legislations that directly or indirectly deal with hazardous waste management. The relevant legislations are the Factories Act, 1948, the Public Liability Insurance Act, 1991, the National Environment Tribunal Act, 1995 and rules and notifications under the Environmental Act of 1986. The MoEF has issued several notifications to deal with the problem of hazardous waste management.

The Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016

In exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, except as respects things done or omitted to be done before such supersession, the Central Government made theHazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016. For the first time, Rules have been made to distinguish between Hazardous Waste and other wastes. Other wastes include: Waste tyre, paper waste, and metal scrap, used electronic items, etc. and are recognized as a resource for recycling and reuse. These resources supplement the industrial processes and reduce the load on the virgin resource of the country.

The salient features of Hazardous and Other Wastes (Management & Trans boundary Movement) Rules, 2016 include the following

- The ambit of the Rules has been expanded by including 'Other Waste'.
- Waste Management hierarchy in the sequence of priority of prevention, minimization, reuse, recycling, recovery, co-processing; and safe disposal has been incorporated.
- All the forms under the rules for permission, import/export, filing of annual returns, transportation, etc. have been revised significantly, indicating the stringent approach for management of such hazardous and other wastes with simultaneous simplification of procedure.
- The basic necessity of infrastructure to safeguard the health and environment from waste processing industry has been prescribed as Standard Operating Procedure (SOPs), specific to waste type, which has to be complied by the stakeholders and ensured by SPCB/PCC while granting such authorization.
- Procedure has been simplified to merge all the approvals as a single window clearance for setting up of hazardous waste disposal facility and import of other wastes.

- Co-processing as preferential mechanism over disposal for use of waste as supplementary resource, or for recovery of energy has been provided.
- The approval process for co-processing of hazardous waste to recover energy has been streamlined and put on emission norms basis rather than on trial basis.
- The process of import/export of waste under the Rules has been streamlined by simplifying the document-based procedure and by revising the list of waste regulated for import/export.
- The import of metal scrap, paper waste and various categories of electrical and electronic equipment's for re-use purpose has been exempted from the need of obtaining Ministry's permission.
- The basic necessity of infrastructure to safeguard the health and environment from waste processing industry has been prescribed as Standard Operating Procedure (SOPs) specific to waste type.
- Responsibilities of State Government for environmentally sound management of hazardous and other wastes have been introduced as follows:
- To set up/ allot industrial space or sheds for recycling, pre-processing and other utilization of hazardous or other waste.
- To register the workers involved in recycling, pre-processing and other utilization activities.
- To form groups of workers to facilitate setting up such facilities.
- To undertake industrial skill development activities and ensure safety and health of workers.
- List of processes generating hazardous wastes has been reviewed taking into account technological evolution in the industries.
- List of Waste Constituents with Concentration Limits has been revised as per international standard and drinking water standard.

The following items have been prohibited for import:

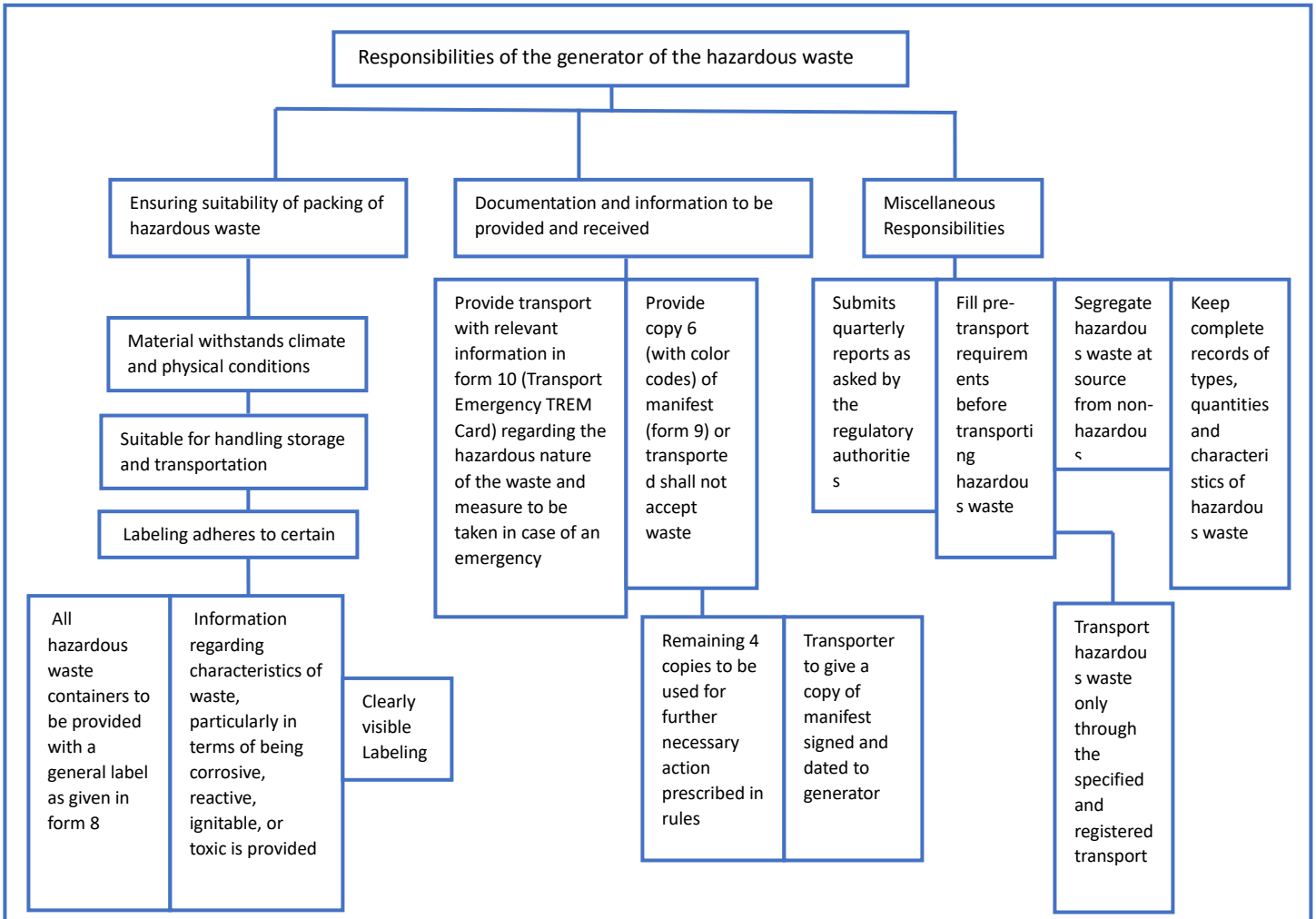
- Waste edible fats and oil of animals, or vegetable origin;
- Household waste
- Critical Care Medical equipment
- Tyres for direct re-use purpose
- Solid Plastic wastes including Pet bottles
- Waste electrical and electronic assemblies scrap
- Other chemical wastes especially in solvent form
- State Government is authorized to prepare integrated plan for effective implementation of these provisions, and have to submit annual report to Ministry of Environment, Forest and Climate Change.
- State Pollution Control Board (SPCB) is mandated to prepare an annual inventory of the waste generated; waste recycled, recovered, utilized including co-processed; waste re-exported and waste disposed and submit to the Central Pollution Control Board by the 30th day of September every year.

Schedules[10]

Schedule I- List of processes generating hazardous wastes
Schedule II- List of waste constituents with concentration limits
Schedule III- Part-A & B- List of hazardous wastes applicable for import and export with or without Prior Informed Consent [Annexure VIII & IX of the Basel Convention*], Part C-List of Hazardous Characteristics, Part D-List of other wastes applicable for import and export without permission from Ministry of Environment, Forest and Climate Change [Annex IX of the Basel Convention*]
Schedule IV- List of commonly recyclable hazardous wastes

[10] For more information on Schedules, please click the below link.
http://cpcb.nic.in/displaypdf.php?id=aHdtZC9IV01fUnVsZXNfMjAxNi5wZGY=

Schedule V- PART A- Specifications of Used Oil Suitable for recycling, Part B-Specification of fuel derived from waste oil
Schedule VI- Hazardous and Other wastes prohibited for import
Schedule VII- List of authorities and corresponding duties
Schedule VIII- List of documents for verification by Customs for import of other wastes specified in Part D of Schedule III



Source: ELI (Environmental Law Institute). Enforcing Hazardous Waste Rules in India: Strategies and Techniques for Achieving Increased Compliance; ELI: Washington, DC, USA, 2014. file:///C:/Users/PC/Downloads/environments-05-00103.pdf

Fig 3.3 Responsibilities of the Generator of the Hazardous Waste

Caselet

Oleum Gas Leak Case, 1986

Environmental lawyer Mahesh Chander Mehta relives what he told the Chief Justice of India P.N. Bhagwati on December 4th, 1985. Oleum gas had just leaked from the Shriram Chlorine plant in Najafgarh, and Delhi had panicked. By a strange coincidence, M.C. Mehta had filed a public interest litigation against the Chlorine plant a month earlier (before the gas leak), and was scheduled to argue another case before the Chief Justice of India

on December 4th. When the matter came up, Mehta referred to the Oleum gas that had leaked just three hours earlier. “The gas leaked at 11 am; the case was listed and heard at 2 pm; the court immediately issued a notice” said Mehta. “No case has been heard this quickly”. Nor perhaps judged so decisively like this case. The Supreme Court has punished the company heavily and the entire complex has eventually shut down. Further the Supreme Court created the `absolute liability principle’ where companies engaged in inherently hazardous activities had absolutely no excuse when an accident occurred.The Bhopal Gas Tragedy is considered as one of the worst manmade disasters.

3.3 The Biomedical Waste (Management and Handling) Rules (Amendment) 2016 & 2018

Definition

Biomedical waste: comprises human & animal anatomical waste, treatment apparatus like needles, syringes and other materials used in health care facilities in the process of treatment and research.

This waste is generated during diagnosis, treatment or immunization in hospitals, nursing homes, pathological laboratories, blood bank, etc.

Object and Purpose

Scientific disposal of Biomedical Waste through segregation, collection, transportation and treatment in an environmentally sound manner.

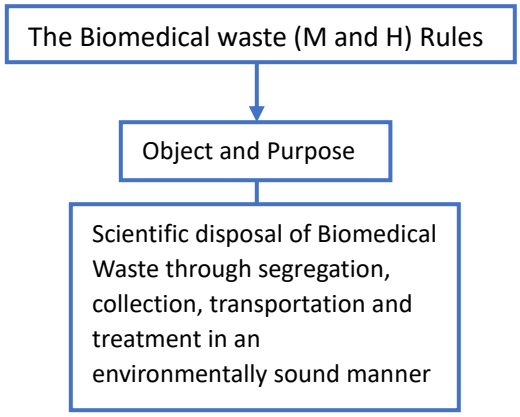


Fig 3.4Biomedical waste (M & H) Rules

Importance of the Rules

Biomedical waste contains infectious or potentially infectious materials.Management of Biomedical waste minimizes the adverse impact on health workers and on the environment. The hospitals are required to put in place the mechanisms for effective disposal either directly or through common biomedical waste treatment and disposal facilities. The hospitals servicing 1000 patients or more per month are required to obtain authorization and segregate biomedical waste into 10 categories, pack five color backs for disposal. There are 198 common bio-medical waste treatment facilities (CBMWF) in operation and 28 are under construction. 21,870 HCFs have their own treatment facilities and 1, 31,837 HCFs are using the CBMWFs.

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Total biomedical waste generation in the country is 484 TPD from 1,68,869 healthcare facilities (HCF), out of which 447 TPD is treated. The quantum of waste generated in India is estimated to be 1-2 kg per bed per day in a hospital and 600 gm per day per bed in a clinic. 85% of the hospital waste is non-hazardous, 15% is infectious/hazardous. Mixing of hazardous results in to contamination and makes the entire waste hazardous.

Hence there is necessity to segregate and treat. Improper disposal increases risk of infection; encourages recycling of prohibited disposables and disposed drugs; and develops resistant microorganisms.

BMW Rules 1998 & (Amendment) 2016

Biomedical Waste (Management and Handling) Rules, 1998, were formulated along parallel lines, for proper disposal, segregation, transport, etc, of infectious wastes. In view of the short-comings and overlapping of some categories causing inconvenience in implementation of the Biomedical Waste (Management and Handling) Rules, 1998 the Ministry of Environment, Forest and Climate Change has formulated the draft BMW Rules, 2015. Hence the 2016 bio-medical waste management rules have been notified to efficiently manage the generated bio-waste for its proper treatment and disposal and to ensure environmentally sound management of these wastes in the country.Further the BMW Management Rules, 2016 have been amended to improve compliance and strengthen the implementation of environmentally sound management of biomedical waste in India.

The amended rules stipulate that generators of bio-medical waste such as hospitals, nursing homes, clinics, and dispensaries etc will not use chlorinated plastic bags and gloves beyond March 27, 2019 in medical applications to save the environment. Blood bags have been exempted for phase-out, as per the amended BMW rules, 2018.

Biomedical waste (Management and Handling) Rules 2016- The Salient features

- The ambit of the rules has been expanded to include vaccination camps, blood donation camps, surgical camps or any other healthcare activity;
- Phase-out the use of chlorinated plastic bags, gloves and blood bags within two years;
- Pre-treatment of the laboratory waste, microbiological waste, blood samples and blood bags through disinfection or sterilization on-site in the manner as prescribed by WHO or NACO;
- Provide training to all its health care workers and immunize all health workers regularly;
- Establish a Bar-Code System for bags or containers containing bio-medical waste for disposal;
- Report major accidents; (g) Existing incinerators to achieve the standards for retention time in secondary chamber and Dioxin and Furans within two years;
- Bio-medical waste has been classified in to 4 categories instead 10 to improve the segregation of waste at source;
- Procedure to get authorization simplified. Automatic authorization for bedded hospitals. The validity of authorization synchronized with validity of consent orders for Bedded HCFs. One time Authorization for Non-bedded HCFs;
- The new rules prescribe more stringent standards for incinerator to reduce the emission of pollutants in environment;
- Inclusion of emissions limits for Dioxin and furans;
- State Government to provide land for setting up common bio-medical waste treatment and disposal facility;
- No occupier shall establish on-site treatment and disposal facility, if a service of `common bio-medical waste treatment facility is available at a distance of seventy-five kilometer.
- Operator of a common bio-medical waste treatment and disposal facility to ensure the timely collection of bio-medical waste from the HCFs and assist the HCFs in conduct of training.

Biomedical Waste (Management and Handling) (Amendment) Rules 2018- The Salient Features

1 Bio-medical waste generators including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological laboratories, blood banks, health care facilities, and clinical

establishments will have to phase out chlorinated plastic bags (excluding blood bags) and gloves by March 27, 2019.

2 All healthcare facilities shall make available the annual report on its website within a period of two years from the date of publication of the Biomedical Waste Management (Amendment) Rules, 2018.

3 Operators of common bio-medical waste treatment and disposal facilities shall establish bar coding and global positioning system for handling of bio-medical waste in accordance with guidelines issued by the Central Pollution Control Board by March 27, 2019.

4 The State Pollution Control Boards/ Pollution Control Committees have to compile, review and analyze the information received and send this information to the Central Pollution Control Board in a new Form (Form IV A), which seeks detailed information regarding district-wise bio-medical waste generation, information on Health Care Facilities having captive treatment facilities, information on common bio-medical waste treatment and disposal facilities.

5 Every occupier, i.e. a person having administrative control over the institution and the premises generating biomedical waste shall pre-treat the laboratory waste, microbiological waste, blood samples, and blood bags through disinfection or sterilization on-site in the manner as prescribed by the World Health Organization (WHO) or guidelines on safe management of wastes from health care activities and WHO Blue Book 2014 and then sent to the Common bio-medical waste treatment facility for final disposal.

6 These amendments have been made vide Notification G.S.R. 234(E) dated March 16, 2018.

Caselet

Indira Nagar Jan Vikas Samiti vs State Of Uttarakhand And Others on 10 July, 2018[11]

Court: High Court of Uttarakhand at Nainital
Reserved on: April 11, 2018, Pronounced on: July 10, 2018.
Writ Petition (PIL) No.40 of 2017

Petitioner- Indira Nagar Jan Vikas Samiti – Versus- Respondents -State of Uttarakhand & others
A question of grave public importance has been raised in this petition. According to the averments made in the petition, the respondents are permitting dumping of solid waste (garbage) including bio-medical waste near Gola River. The place where the solid waste is being dumped is barely 200 meters away from Indira Nagar, Ward No.21. 25,000 people are residing in Indira Nagar. Gola River is the lifeline of Haldwani city. The Members of petitioner Society have made various representations to the respondents to dispose of all the garbage in a scientific manner. The entire Kathgodam and Haldwani towns are dependent on Gola's river's water.

The standards for Treatment and Disposal of Biomedical Wastes are provided under SCHEDULE II [See rule 4(t), 7(1) and 7(6)].It is a serious breach of the Biomedical Waste Management Rules, 2016. No bio-medical waste can be mixed up with the general solid waste. It is required to be disposed of as per the Biomedical Waste Management Rules, 2016.

Accordingly, this petition is disposed of by issuing mandatory directions stating, that the respondent no.5-Nagar Nigam, Haldwani is directed to set up Solid Waste Management Plant/ Dumping ground, landfill within six months from today on the land approved by the Ministry of Environment, Forests & Climate Change on 20.2.2018. Till the Solid Waste Management Plant is set up, the respondent no.5 is restrained from dumping the solid waste including bio-medical waste at the present place of dumping to avoid pollution of River Gola forthwith.

3.4 The E - Waste (Management and Handling) Rules 2016 (Amendment-2018)

[11]https://indiankanoon.org/doc/177422578/

The ‘E-Waste (Management) Rules, 2011 rules came with primary objective to reduce the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous material and to channelize the e-waste generated in the country for environmentally sound recycling.

Government of India in the Ministry of Environment, Forest and Climate Change in exercise of the powers conferred by sections 6, 8 and 25 of the Environment (Protection) Act, 1986 (29 of 1986), and in supersession of the e-waste (Management and Handling) Rules, 2011, makes the ‘E-Waste (Management) Rules, 2016’ and further amends the 2016 rules and makes 2018 rules.

Application

These rules shall apply to every manufacturer, producer, consumer, bulk consumer, collection centers, dealers, e-retailer, refurbisher, dismantler and recycler involved in manufacture, sale, transfer, purchase, collection, storage and processing of e-waste or electrical and electronic equipment listed in Schedule I, including their components, consumables, parts and spares which make the product operational.

Definitions

Bulk consumer means bulk users of electrical and electronic equipment such as Central Government or State Government Dept.s, public sector undertakings, banks, educational institutions, multinational organizations, international agencies, partnership and public or private companies that are registered under the Factories Act, 1948 (63 of 1948) and the Companies Act, 2013 (18 of 2013) and health care facilities which have turnover of more than one crore or have more than twenty employees.

Collection centremeans a centre or a collection point or both established by producer individually or as association jointly to collect e-waste for channelizing the e-waste to recycler and play such role as indicated in the authorization for Extended Producer Responsibility granted to the producer and having facilities as per the guidelines of Central Pollution Control Board, including the collection centre established by the dismantler or refurbisher or recycler which should be a part of their authorization issued by the State Pollution Control Board where the facility exists.

Refurbisher for the purpose of these rules, means any company or undertaking registered under the Factories Act, 1948 or the Companies Act, 1956 or both or district industries centre engaged in refurbishment of used electrical and electronic equipment.

E-Waste Management Rules 2016

1. Manufacturer, dealer, refurbisher and Producer Responsibility Organization (PRO) have been introduced as additional stakeholders in the rules.
2. The applicability of the rules has been extended to components, consumables, spares and parts of EEE in addition to equipment as listed in Schedule I.
3. Compact Fluorescent Lamp (CFL) and other mercury containing lamp brought under the purview of rules.
4. Collection mechanism based approach has been adopted to include collection centre, collection point, takeback system etc for collection of e - waste by Producers under Extended Producer Responsibility (EPR).
5. Option has been given for setting up of PRO, e - waste exchange , e - retailer, Deposit Refund Scheme as additional channel for implementation of EPR by Producers to ensure efficient channelization of e - waste.
6. Provision for Pan India EPR Authorization by CPCB has been introduced replacing the state wise EPR authorization.
7. Collection and channelisation of e - waste in Extended Producer Responsibility - Authorisation shall be i n linewith the targets prescribed in Schedule III of the Rules. The phase wise Collection Target for e - waste, which can be either in number or Weight shall be 30% of the quantity of waste generation as indicated

in EPR Plan during first two year of implementation of rules followed by 40% during third and fourth years, 50% during fifth and sixth years and 70% during seventh year onwards.

8. Deposit Refund Scheme has been introduced as an additional economic instrument wherein the producer charges an additional amount as a deposit at the time of sale of the electrical and electronic equipment and returns it to the consumer along with interest when the end - of - life electrical and electronic equipment is returned.
9. The e - waste exchange as an option has been provided in the rules as an independent market instrument offering assistance or independent electronic systems offering services for sale and purchase of e – wastegenerated from end - of - life electrical and electronic equipment between agencies or organizations authorised under these rules.
10. The manufacturer is also now responsible to collect e - waste generated during the manufacture of anyelectrical and electronic equipment and channelise it for recycling or disposal and seek authorization from SPCB.
11. The dealer, if has been given the responsibility of collection on behalf of the producer, need to collect the e - waste by providing the consumer a box and channelize it to Producer.
12. Dealer or retailer or e - retailer shall refund the amount as per take back system or De posit Refund Scheme of the producer to the depositor of e - waste.
13. Refurbisher need collect e - waste generatedduring the process of refurbishing and channelise the waste to authorised dismantler or recycler through its collection centre and seek one time authorization from SPCB.
14. The roles of the State Government has been also introduced in the Rules in order to ensure safety, health and skill development of the workers involved in the dismantling and recycling operations.
15. Dept. of Industry in State o r any other government agency authorised in this regard by the StateGovernment is to ensure earmarking or allocation of industrial space or shed for e - waste dismantling and recycling in the existing and upcoming industrial park, estate and industrial clusters.
16. Dept. of Labour in the State or any other government agency authorised in this regard by the StateGovernment need to ensure recognition and registration of workers involved in dismantling and recycling; assist formation of groups of such workers to facilitate setting up dismantling facilities; undertake industrial skill development activities for the workers involved in dismantling and recycling; and undertake annual monitoring and to ensure safety & health of workers involved in dismantling and recycling.
17. State Government to prepare integrated plan for effective implementation of these provisions, and to submit annual report to Ministry of Environment, Forest and Climate Change.
18. The transportation of e - waste shall be carried out as per the manifest system whereby the transporter shall berequired to carry a document (three copies) prepared by the sender, giving the details.
19. Liability for damages caused to the environment or third party due to improper management of e – wasteincluding provision for levying financial penalty for violation of provisions of the Rules has also been introduced.
20. Urban Local Bodies (Municipal Committee/Council/Corporation) has been assign the duty to collect and channelized the orphan products to authorized dismantler or recycler.

Amendment Rules 2018

The E-Waste Management Rules 2016 have been amended vide notification G.S.R. 261(E), dated March 22, 2018.The amendment in rules has been done with the objective of channelizing the E-waste generated in the country towards authorized dismantlers and recyclers in order to formalize the e-waste recycling sector. The collection targets under theprovision of Extended Producer Responsibility (EPR) in the Rules have been revised and targets have been introduced for new producers who have started their sales operations recently.

Some of the salient features of the E-waste (Management) Amendment Rules, 2018 are as follows:

1. The e-waste collection targets under EPR have been revised and will be applicable from 1 October 2017. Thephase-wise collection targets for e-waste in weight shall be 10% of the quantity of waste generation as indicated in the EPR Plan during 2017-18, with a 10% increase every year until 2023. After 2023 onwards, thetarget has been made 70% of the quantity of waste generation as indicated in the EPR Plan.
2. The quantity of e-waste collected by producers from the 1 October 2016 to 30 September 2017 shall beaccounted for in the revised EPR targets until March 2018.
3. Separate e-waste collection targets have been drafted for new producers, i.e. those producers whose number of years of sales operation is less than the average lives of their products. The average lives of the products will be as per the guidelines issued by CPCB from time to time.
4. Producer Responsibility Organizations (PROs) shall apply to the Central Pollution Control board (CPCB) for registration to undertake activities prescribed in the Rules.
5. Under the Reduction of Hazardous Substances (RoHS) provisions, cost for sampling and testing shall be borneby the government for conducting the RoHS test. If the product does not comply with RoHS provisions, then thecost of the test will be borne by the Producers.

Caselets

E-waste on Ramganga Banks[12]

NGT summons Uttar Pradesh Chief Secretary.The order came after the Central Pollution Control Board (CPCB) informed it that a number of sealed e-waste industries were operating illegally in densely populated residential areas. Irked over the non-compliance of its order, the National Green Tribunal Monday directed the Uttar Pradesh chief secretary to appear before it and apprise it of disposal of e-waste from the banks of the Ramganga river in Moradabad. Observing that disposal of e-waste is a serious environmental issue, a bench headed by NGT Chairperson Justice Adarsh Kumar Goel took exception to inaction of the district administration to remove the hazardous waste lying on the river bank. The tribunal directed the chief secretary to appear before it on October 10 2018.

The order came after the Central Pollution Control Board (CPCB) informed it that a number of sealed e-waste industries were operating illegally in densely populated residential areas. It also told the bench that the electricity Dept. failed to snap connection of 27 illegal units and the joint inspection team visited the areas in the vicinity of river Ramganga and found that “heaps of black powder stacked in the open” were found lying on the bank. The tribunal had earlier imposed an environment compensation of Rs 10 lakh on the Uttar Pradesh government for failing to take action on disposal of the e-waste lying on the banks of the Ramganga river in Moradabad.

Advocate Gaurav Bansal, appearing for the petitioner in the case, said a large number of people are involved in unscientific dismantling and washing of metal-rich residue on the banks of Ramganga and the authorities have failed to take action against them.Earlier, a committee comprising officials of the UP Pollution Control Board (UPPCB), Moradabad Nagar Nigam, UP Public Works Dept. and UP Rural Engineering Services, had told the tribunal in a report that the e-waste lying on the banks of the Ramganga river contains hazardous chemicals such as chromium and cadmium. The committee, formed by the NGT, had said the concentration of metals in the e-waste, which was in the form of black powder, was above the prescribed level.The tribunal had earlier asked the district magistrate to hold a meeting and submit a detailed report on the issue.

[12]E-waste on Ramganga banks.
https://indianexpress.com/article/india/e-waste-on-ramganga-banks-ngt-summons-up-chief-secretary-5349212/

The tribunal was hearing a petition filed by scientist Mahendra Pandey, seeking action against illegal processing of electronic waste in Moradabad, Bareilly and Shahjahanpur districts of Uttar Pradesh along the Ramganga river, an important tributary of the Ganga.The green panel had announced that anyone found dumping electronic waste (e-waste) on the banks of the Ramganga River in Moradabad would have to pay Rs 1 lakh as environment compensation. The bench, which had noted that Ramganga was highly polluted, had also made it clear that the environment compensation would vary from Rs 50,000 to Rs 1 lakh depending on the quantum of the waste dumped.The river, which spans a length of 596km, carries a BOD (biochemical oxygen demand) load of 128 tons per day and is polluted by heavy discharge from various industries such as sugar, distillery, pulp and paper, textile and dyeing, it had noted.

3.5The Batteries (Management and Handling) Rules 2001

Object and Purpose of the Rules

Batteries (Management & Handling) Rules, 2001 deal with

- The proper and effective management and handling of lead acid of batteries waste.
- All manufacturers, assemblers, re-conditioners, importers, dealers, auctioneers, bulk consumers, consumers, involved in manufacture, processing, sale, purchase and use of batteries or components thereof, to comply with the provisions of Batteries (Management & Handling) Rules, 2001.

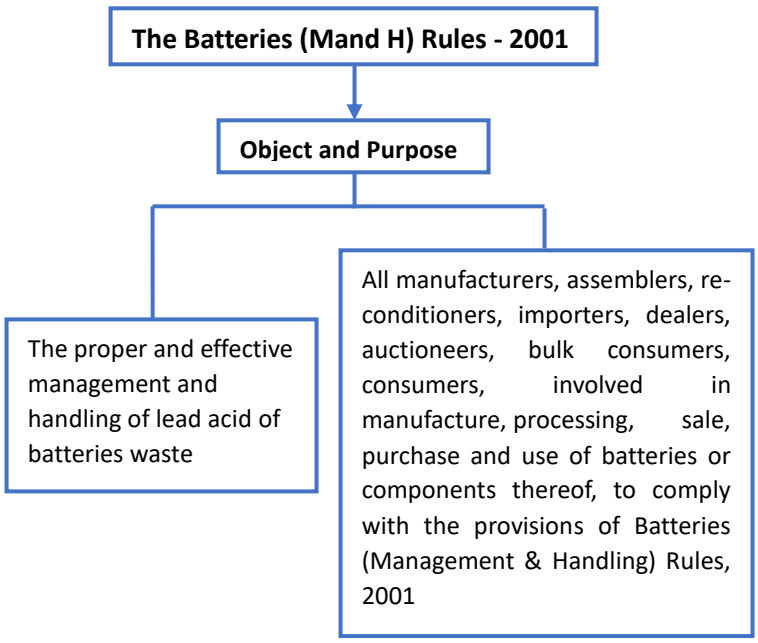

Fig 3.5 The Batteries (M&H) Rules 2001

Application

These rules shall apply to every manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer and bulk consumer involved in manufacture, processing, sale, purchase and use of batteries or components thereof.

Definitions

'Battery'- means lead acid battery which is a source of electrical energy and contains lead metal.'Assembler' - means a person who manufactures lead acid batteries by assembling various components.'Re-conditioner' - means a person involved in repairing of lead acid batteries for selling the same in the market.

Salient Features

1. Responsibilities of manufacturer, importer, assembler and re-conditioner
    i. Ensure that used batteries collected are sent only to the registered recyclers.
2. Registration of Importers. - The importer shall get himself registered with the Ministry of Environment and Forests or an agency designated by it by submitting details in Form-11.
3. Customs clearance of imports of new lead acid batteries. - Customs clearance of imports shall be contingent upon
    i. valid registration with the Reserve Bank of India (with Importer's Code Number)
    ii. one time registration with the Ministry of Environment and Forests or an agency designated by it in Form-11;
    iii. undertaking in Form-111; and
    iv. a copy of the latest half-yearly return in Form-IV
4. Responsibilities of dealer. - It shall be the responsibility of a dealer to
    i. ensure that the used batteries are collected back as per the Schedule against new batteries sold;
    ii. give appropriate discount for every used battery returned by the consumer;
5. Procedure for registration / renewal of registration of recyclers- Every recycler of used lead acid batteries shall make an application in Form VI along with the relevant documents to the Joint Secretary, Ministry of Environment and Forests or any officer designated by the Ministry or an agency designated by it for grant of registration or renewal
6. An appeal shall lie against any order of suspension or cancellation or refusal of registration passed by the Joint Secretary to the Ministry of Environment and Forests or any officer designated by the Ministry or agency designated by it.
7. Responsibilities of consumer or bulk consumer- It shall be the responsibility of the consumer or bulk consumer to ensure that used batteries are not disposed of in any manner other than depositing with the dealer, manufacturer, importer, assembler, registered recycler, reconditioner or at the designated collection centres.
8. Responsibilities of auctioneer- The auctioneer shall ensure that used batteries are auctioned to the registered recyclers only.
9. Prescribed Authority. - The prescribed authority for ensuring compliance of the provisions of these rules shall be the State Board. And, it shall file an annual compliance status report to the Central Pollution Control Board by 30th April of every year.
10. Duties of Central Pollution Control Board. - The Central Pollution Control Board shall compile and publish the data received every year from the State Boards. It shall review the compliance of the rules periodically to improve the collection and recycling of used Lead batteries and appraise the Ministry of Environment and Forests, Government of India.
11. Computerization of Records and Returns. - Ministry of Environment and Forests or an agency designated by it shall develop a system for computerized tracking of
    i. Distribution and sale of batteries
    ii. Collection, auction, transport and re-processing of used batteries
    iii. Sale of re-processed lead by registered recyclers and
    iv. Sale of lead from all domestic producers or importers.

Caselets

Judgement of the National Green Tribunal (Southern Zonal Bench, Chennai) in the matter of Kunjoonjamma Jose Vs Kerala Sate Pollution Control Board & Others dated 17/12/2015 regarding emission and deposition of lead particles in air, water and soil alleged to have been effected by the M/s. Perfect Alloys.

M/s. Perfect Alloys is stated to be having an industrial unit engaged in recycling of lead from used acid batteries after their service life to produce lead ingots mainly for reuse in the manufacture of new lead acid batteries. The unit is stated to be situated adjacent to the residence of the applicant who is living in Block No .8 Survey No. 30/4 of Chengannoor village, Alapuzha District.

The industrial activities of M/s. Perfect Alloys shall be closed forthwith till the SPCB grants renewal of Consent to Operate beyond 30-09-2015 which shall be done by the SPCB strictly in accordance with law, after satisfying that all directions, suggestions of the SPCB in its Status Report filed dated 22-04-2015 and 07-05-2015 are fully and effectively complied with. The polluting industry shall deposit an amount of equal to 10% of annual income from the financial year 2002-03 to 2013-14 for 12 years which shall be deposited with SPCB to be maintained in a separate fund, “Environment Protection Fund, Chengannoor” and shall be used for the purpose of further remediation as decided by the SPCB.

Summary

The Constitution of India enjoins the state to protect and improve the environment and to safeguard the forests and wildlife of the country. A duty is cast on every citizen to protect and improve the natural environment including forests, lakes, rivers, and wildlife. There are references to the environment in the Directive Principles of State Policy as well as the Fundamental Rights.

The Environment Protection Act 1986 (EPA) came into force soon after the Bhopal gas tragedy and is considered an umbrella legislation as it fills many gaps in the existing laws. Subsequently many laws came into existence, including specific rules for handling hazardous wastes, bio-medical waste, plastic, e-waste and the like.

The Environment Protection Act establishes the framework for studying, planning and implementing long-term requirements of environmental safety and laying down a system of speedy and adequate response to situations threatening the environment. The term "environment" is elastic and includes water, air and land as well as the interrelationship which exists between water, air and land, and human beings, other living creatures, plants, micro-organisms and property.

Under the Environment Act, the Central Government is empowered to take measures necessary to protect and improve the quality of environment by setting standards for emissions and discharges of pollution in the atmosphere by any person carrying on an industry or activity. The government can also regulate the location of industries; management of hazardous wastes, and protection of public health and welfare. Occasionally, the government issues notifications for the protection of ecologically-sensitive areas.

The regulatory framework is broadly decentralized. The Ministry of Environment and Forests and the pollution control boards -- Central Pollution Control Board and State Pollution Control Boards -- together form the regulatory and administrative core of the waste management sector in India. At the state level, the management of solid waste is the responsibility of Urban Local bodies. Industries generating hazardous wastes need to seek permission from the respective SPCB.

Likewise, the Biomedical Waste (Management and Handling) Rules, 1998, were formulated, along parallel lines, for proper disposal, segregation, transport, etc, of infectious wastes. In view of the short-comings and overlapping of some categories causing inconvenience in implementation of the Biomedical Waste (Management and Handling) Rules, 1998, the Ministry of Environment, Forest and Climate Change later formulated the draft BMW Rules, 2015. In 2016, the bio-medical waste management rules were notified to help efficiently manage the generated bio-waste for its proper treatment and disposal and to ensure environmentally sound management of these wastes in the country. Even the BMW Management Rules 2016 were amended to improve compliance and to strengthen the implementation of environmentally sound management of biomedical waste in India.

The 'E-Waste (Management) Rules, 2011 rules were notified to basically reduce the use of hazardous substances in electrical and electronic equipment by specifying threshold for use of hazardous material and to channelize the e-waste generated in the country for environmentally sound recycling. These rules apply to every manufacturer, producer, consumer, bulk consumer, collection centers, dealers, e-retailer, refurbisher, dismantler and recycler involved in manufacture, sale, transfer, purchase, collection, storage and processing of e-waste or electrical and electronic equipment listed in Schedule I, including their components, consumables, parts and spares which make the product operational.

Self Assessment Questions

1. What are the policies and regulations of Environmental Protection Act?
2. Discuss about Biomedical Waste Rules and its applications?
3. What is the significance of E-Waste (Management and Handling) Rules 2016?

Further Readings

- Bio-medical waste: NGT issues notice to four states - Read more at: http://timesofindia.indiatimes.com/articleshow/61668299.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst
- Hazardous Waste Management Project Formulation Study in Gujarat, India- A Study Report http://www.ecfa.or.jp/japanese/act-pf_jka/H22/india_extoshi.pdf
- Waste Management Caselets for reading to understand the importance of EP Acts and Rules
  - http://www.academia.edu/14197955/Case_study_Exploration_of_Biomedical_Waste_in_Multispecialty_Hospital_in_Madurai - A.Aravindan Assoc. Prof, LathaMathavanEngg.College, Madurai and Dr.A.M.Vasumathi, Dean & Head Of The Dept., KLN Colege Of IT, Madurai
  - http://www.academia.edu/36052117/A_Case_Study_of_Biomedical_Waste_Management_in_Hospitals
- Status Review Report on Implementation of Batteries (Management and Handling) Rules, 2001 (as amended thereof) 2016 - Central Pollution Control Board Ministry of Environment, Forest and Climate Change, Govt. of India - http://cpcb.nic.in/uploads/hwmd/compliance_br_100417.pdf
- https://www.indianbarassociation.org/wp-content/uploads/2013/02/environmental-law-article.pdf
- http://envfor.nic.in/soer/2001/ind_waste.pdf
- http://ibasecretariat.org/india_asb_time_bomb.pdf -India's Asbestos Time Bomb- Edited by David Allen and Laurie Kazan –Allen-2008

Video Lessons

- https://youtu.be/EDmtawhADnY
- https://youtu.be/ILeQ2E9yVDAby Prof. Shantanu Pethe (CACSCMA COACH) on Environment Protection Act 1986

- https://youtu.be/o-WpeyGlV9Y - Environment Protection Act 1986 - MPPSC Mains Paper2
- https://youtu.be/Cr3RJjub6mI - Environment Protection Act 1986 Part-1 in Hindi.
- Part-1 https://youtu.be/R2YpWrGX-Gs
- Hazardous and other Wastes (Management and Transboundary Movement) Amendment Rules, 2016- https://youtu.be/PhEwwzkrxVg
- Solid Waste Management Rules, 2016 – https://youtu.be/zjD8i3tcqEk
- Biomedical Waste Management Rule, 2016 - https://youtube/eD9PSwX3tMU

Chapter4
Environmental Laws for Pollution Control and Waste Management-III

Objectives

- To understand municipal solid wastes, plastic wastes, construction and demolition waste management Rules
- To understand extended producer responsibility and cleaner production option and waste management

Structure

4.1 Municipal Solid Waste Management Rules 2016
4.2 Plastic Waste Management Rules 2016
4.3 Construction and Demolition Waste Management Rules 2016
4.4 EPR- Extended Producer Responsibility
4.5 Cleaner Production Option and Waste Management

To Do Activities

- Visit a nearby industry to understand how far plastic waste is recycled.
- Conduct a survey to understand how far these Acts have been implemented in the respective arenas.
- Discuss caselets on various Acts
- Provide topics for group or individual presentation

4.1 The Municipal Solid Waste Management Rules 2016

Municipal Solid Waste Management is one of the major environment problems of Indian cities. Improper management of Municipal Solid Waste (MSW) causes hazards to inhabitants. About 90% of the MSW disposed off unscientifically in open dumps and landfills, create problems to public health and environment. About 12 million tons of inert waste is generated annually in India and in the landfill sites, occupying about one third of total MS Waste. 377 Million people residing in urban area generate 62 million tons of MSW per annum currently and it is projected that by 2031 these urban centers will generate 165 million tons of waste annually and by 2050 it can reach 436 million tons (Planning Commission 2014).As per CPCB Annual Report 2015-16, submitted in May 2017, 135198 TPD of Solid Waste is generated, of which 111028 TPD (82%) is collected. Of this, only 25572 TPD (23%) is treated and 47451 TPD is land-filled.

Definition

Municipal Solid Waste- MSW includes commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid form excluding industrial hazardous wastes but including treated bio-medical wastes.

Object and Purpose

The objective of the SWM Rules 2016 aim at

1. Dealing with the management of solid waste including its segregation at source, transportation of waste, treatment and final disposal.

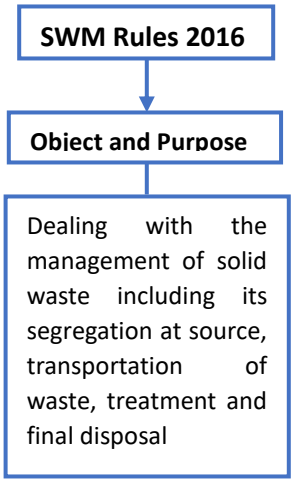

Fig 4.1 SWM Rules

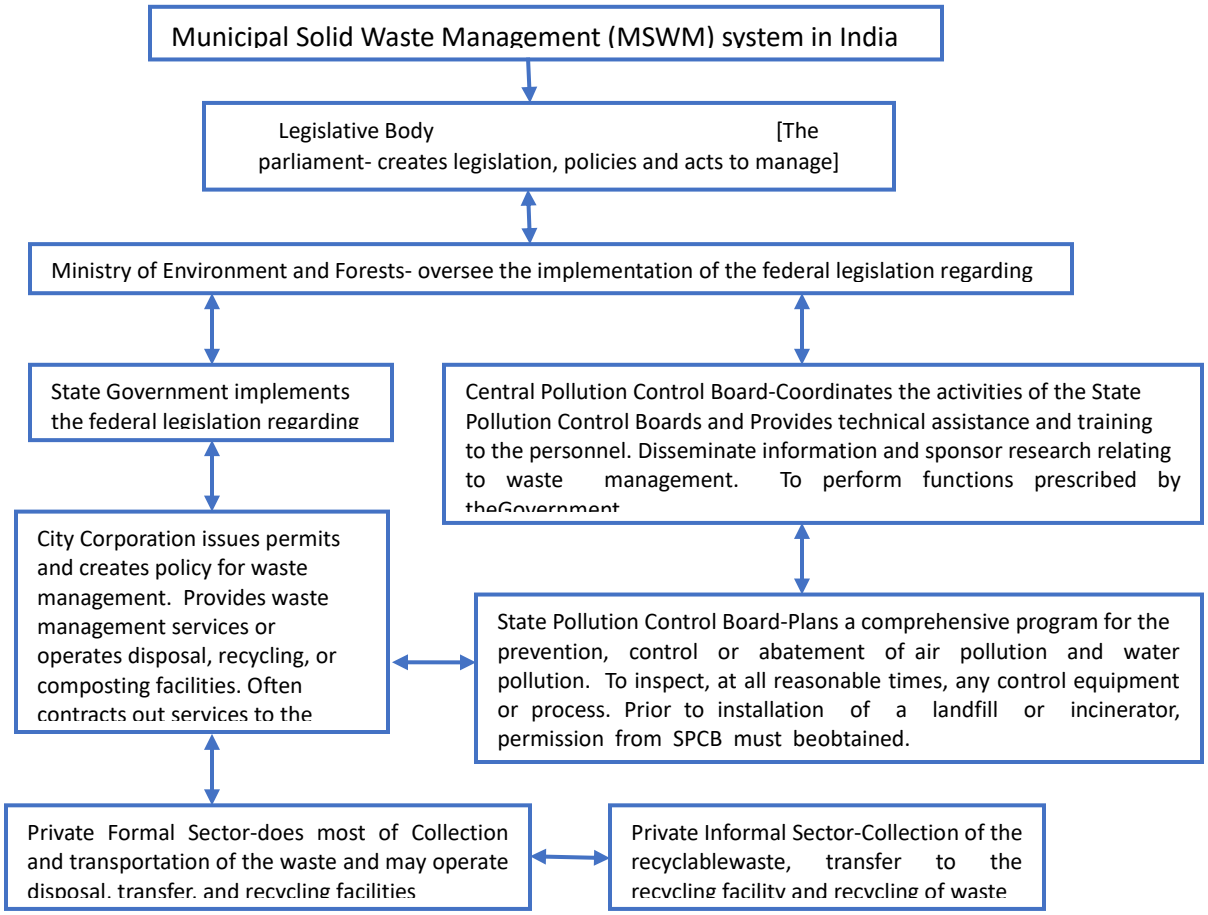

Fig 4.2 Municipal Solid Waste Management (MSWM) System in India[13]

[13]https://www.researchgate.net/publication/313598485_An_overview_of_legal_framework_for_waste_management_system_in_india_with_special_allusion_to_SWM_rules_2016

MSW Rules

Municipal Solid Wastes (Management & Handling) Rules, 2000 (MSW Rules) are applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid, to enable municipalities to dispose municipal solid waste in scientific manner

In view of the short-comings and overlapping of some categories causing inconvenience in implementation of the MSW (Management and Handling) Rules, 2000, under Ministry of Environment, Forest and Climate Change New Delhi, 2016 S.O. 1357(E). Central Government in exercise of the powers conferred by sections 3, 6 and 25 of the Environment (Protection) Act, 1986 (29 of 1986) and in supersession of the MSW Rules 2000, Government of India notified the "The Solid Waste Management Rules, 2016" for management of Solid Waste.

Table 4.1 The SWM Rules-Four Schedules

Schedule I	Relates to implementation Schedule
Schedule II	Specifications relating to collection, segregation, storage, transportation, processing and disposal of municipal solid waste (MSW)
Schedule III	Specifications for land filling indicating, site selection, facilities at the site, specifications for land filling, pollution prevention, water quality monitoring, ambient air quality monitoring, plantation at landfill site, closure of landfill site and post care.
Schedule IV	Indicate waste processing options including, standards for composting, treated leachates and incinerations.

The Solid Waste Management Rules, 2016

1. Applicable to

The Rules shall apply to every urban local body, outgrowths in urban agglomerations, census towns as declared by the Registrar General and Census Commissioner of India, notified areas, notified industrial townships, areas under the control of Indian Railways, airports, airbases, Ports and harbors, defense establishments, special economic zones, State and Central government organizations, places of pilgrims, religious and historical importance as may be notified by respective State government from time to time and to every domestic, institutional, commercial and any other non residential solid waste generator situated in the areas except industrial waste, hazardous waste, hazardous chemicals, bio medical wastes, e-waste, lead acid batteries and radio-active waste, that are covered under separate rules framed under the Environment (Protection) Act, 1986.

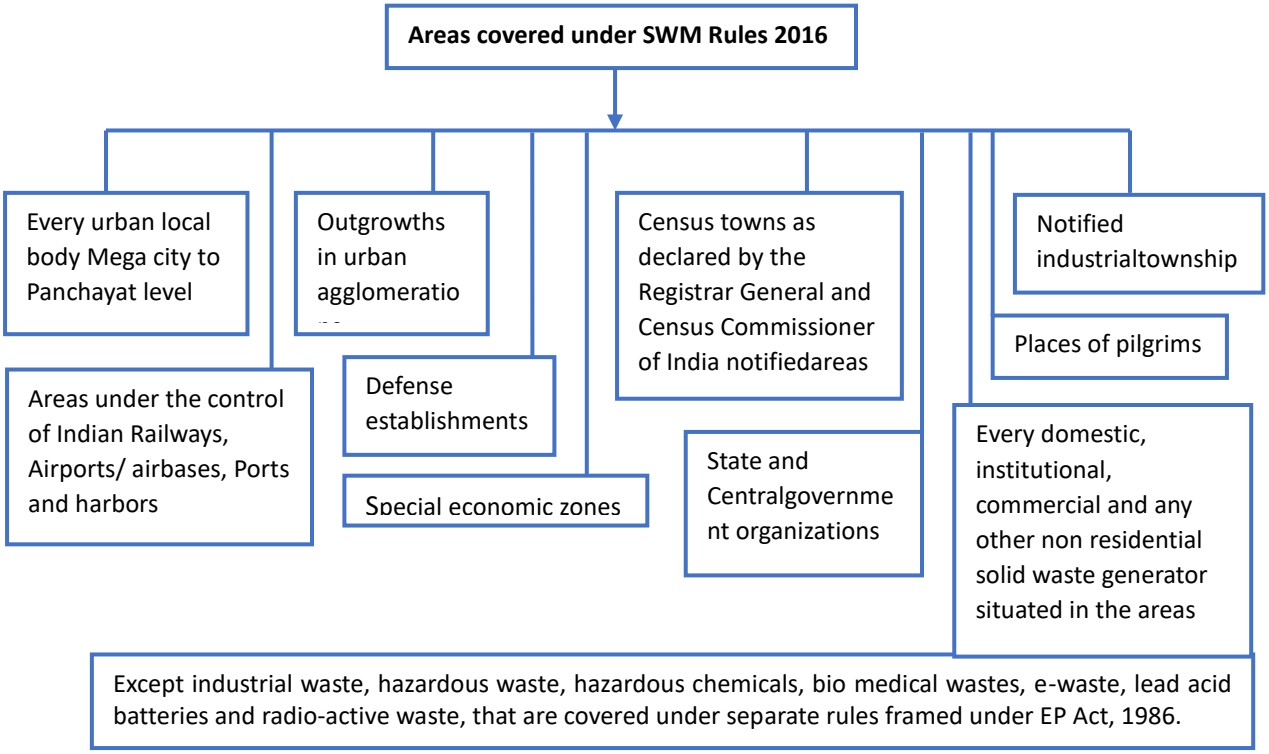

Fig 4.3 Areas Covered Under MSW Rules 2016

2. The Waste Generators

- Every household
- Event organizers
- Street Vendors
- RWAs & Market Associations
- Gated Community having more than area 5000 sq.m.
- Hotels & restaurants.

3. Duties of Waste Generators

- All waste generators shall segregate and store the waste generated by them in three separate streams namely bio-degradable, non biodegradable and domestic hazardous wastes in suitable bins.
- Handover segregated wastes to authorized waste pickers or waste collectors as per the direction or notification by the local authorities from time to time
- Wrap securely the used sanitary waste like diapers, sanitary pads etc., in the pouches provided by the manufacturers or in a suitable wrapping material in the bin meant for dry waste or non- bio-degradable waste
- Store separately construction and demolition waste, as and when generated, in his own premises and shall dispose off as per the Construction and Demolition Waste Management Rules, 2016
- Store horticulture waste and garden waste generated from his premises separately in his own premises and dispose of as per the directions of the local body from time to time.
- No waste generator shall throw, burn or burry the solid waste generated by him/her, on streets, open public spaces outside his premises or in the drain or water bodies.

- All waste generators shall pay such user fee for solid waste management, as specified in the bye-laws of the local bodies.
- No person shall organize an event or gathering of more than one hundred persons at any unlicensed place without intimating the local body, at least three working days in advance and such person or the organizer of such event shall ensure segregation of waste at source and handing over of segregated waste to waste collector or agency.
- Every street vendor shall keep suitable containers for storage of waste generated during the course of his activity such as food waste, disposable plates, cups, cans, wrappers, coconut shells, leftover food, vegetables, fruits, etc., and shall deposit such waste at waste storage depot or container or vehicle.
- All gated communities and institutions with more than 5,000 sqm area, the resident welfare & market associations and the hotels & restaurants shall in partnership with the local body ensure:

  Segregation of waste at source
  - Facilitate collection of segregated waste in separate streams
  - Handover recyclable material to either the authorized waste pickers or the authorized recyclers
  - The bio-degradable waste shall be processed, treated and disposed off through composting or bio-methanation within the premises as far as possible.
  - The residual waste shall be given to the waste collectors or agency as directed by the local body.

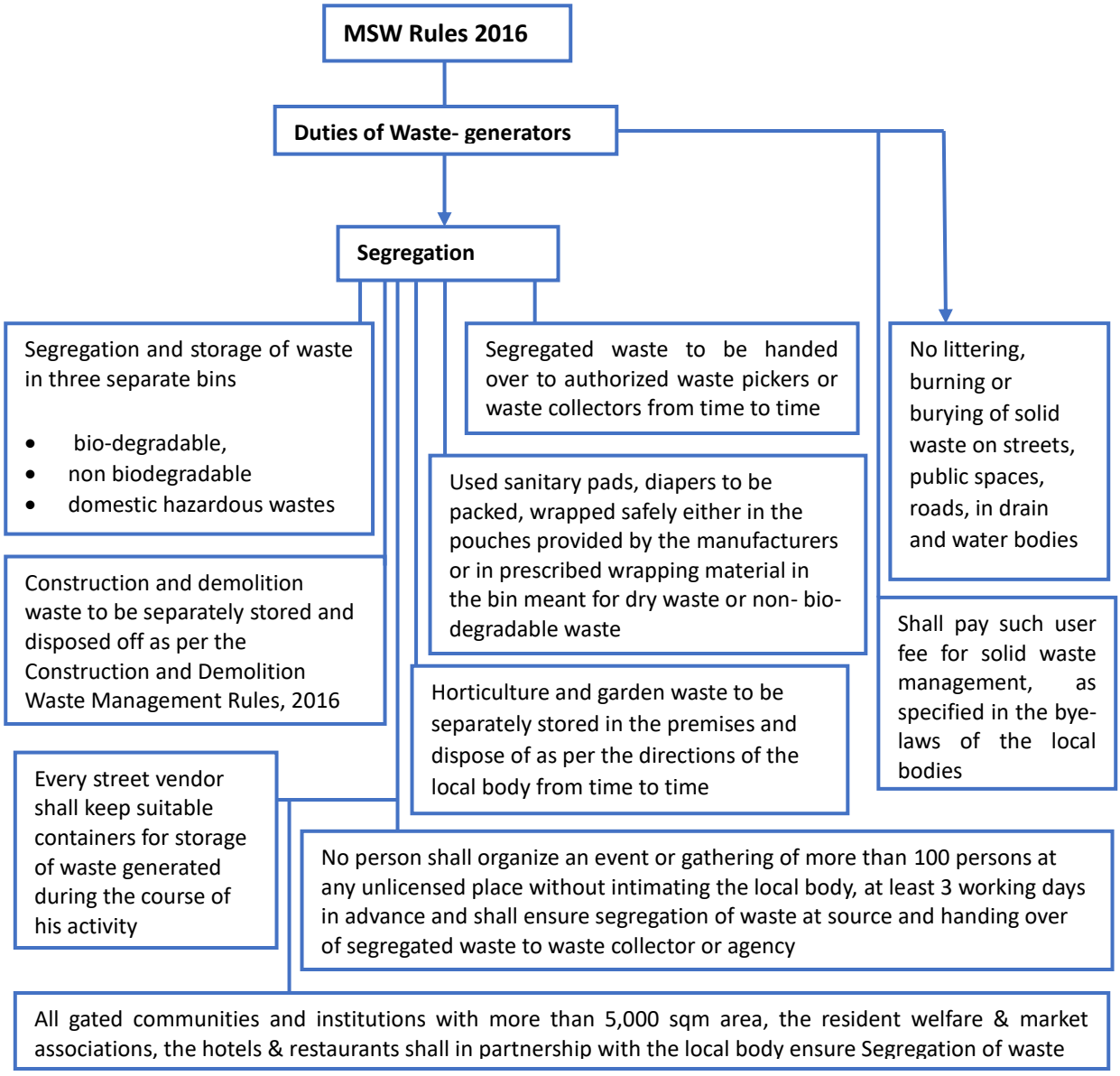

Fig 4.4 MSW Rules 2016- Duties of Waste Generators

Criteria for Hilly Region: Avoid landfill, make waste transfer stations, strict action for littering and construct landfill at plain areas.

Waste to Energy plant for waste with 1500 Kcal/kg and above for co-incineration in cement and power plants.

Time Frame for Implementation of SWM Rules:

(a) Landfill Identification: 1 year
(b) Procurement of waste processing facilities: 2 years
(c) Ensure segregation of waste: 2 years
(d) Cities up to 1 million population: 2 Years
(e) Million plus cities: 3 years
(f) Setting up sanitary landfills: 3 years
(g) Bioremediation/capping of old landfills: 5 years

Review of implementation of rules at various levels:

(a) MoEF& CC, Central Monitoring Committee: Every year
(b) District Collector review performance of Local authorities: Quarterly
(c) SPCBs/PCCs review implementation of Rules with DMA: half yearly
(d) Secretary In-charge, UD- State level Advisory Committee: half yearly

Caselets

VirendarGaur State of Haryana

Apart from the municipal authorities, the pollution control boards also have a basic duty under EPA, 1986 to assist in proper disposal of the wastes. In Virendar Gaur v. State of Haryana, the Supreme Court declared that right to life under Article 21 encompasses right to live with human dignity, quality of life and decent environment. Thus, pollution free environment and proper sanitary condition in cities and towns is considered to be integral part of right to life. In the famous case of Municipal Corporation, Ratlam Shri VardhichandJustice Krishna Iyer declared that 'the guns of section 133 go into action wherever there is a public nuisance'. The court also pointed out that Article 47 of the Indian constitution makes it imperative that 'steps taken for the improvement of public health as amongst the primary duties of the municipalities.' The landmark case that drew attention to and changed the manner in which waste is handled in major cities is ruling in Almitra Patel case. A writ petition was filed by Almitra Patel regarding the management of solid waste disposal in four metropolitan cities namely, Mumbai, Chennai, Calcutta and Delhi. The Court by an order in January 1996 appointed a committee to look into the aspects of 'municipal solid waste management'. Later the pronouncement made by the Supreme Court compelled the central government and the MoEF to notify the Municipal Solid Waste Management and Handling) Rules, 2000. In addition to this, environmental laws is, perhaps par excellence, an area where national lawmakers, policy makers and authorities can learn from each other's mistakes and success. In this context, specific criteria for evaluating environmental policies are efficiency, fairness, incentive for improvement and enforceability. Judicial interpretation has strengthened this constitutional mandate. In the case of Tarun Bharat Sangh Alwar Union of India [68], the Supreme Court had ruled that 'the issues of environment must and shall receive the highest attention from this court'. In the same case, the Supreme Court said, 'This litigation concerns environment'. There is need to select technologies that produce no or low quantities of wastes and recycle or reuse waste products

Waste Management Caselets for reading to understand the importance of EP Acts and Rules[14]

MSW in Pune

The Bombay Provincial Municipal Corporations Act (BPMC) of 1949 applies to the Pune Municipal Corporation (PMC) and Pimpri Chinchwad Municipal Corporations (PCMC). After MSW Rules 2000, the state of Maharashtra enacted Maharashtra Non-biodegradable Garbage Control Act, 2006. The civic bodies in these cities are mandated by the act to provide for public receptacles for garbage, transport of garbage and its final disposal in such manner that is not detrimental to public health. The municipalities are also required to undertake sweeping of public areas such as roads, markets and other open spaces, cleaning of gutters, drains and the sewage channels and fumigation. Pune model related with MSWM is sustainable and one of the ideal examples in the country. The city has best implemented the primary collection models as per MSW Rules 2000 where social enterprises are allowed and employed for door-to-door collection (DTDC) of wastes. More credit goes to state managers and implementers as it integrates the waste pickers and socially marginalized people along with support from NGO's and peoples of city. Recovery of recyclable materials by informal system is up to 56% in Pune [77]. Cities such as Bangalore, Chennai, Mumbai and Pune have very active community based and

[14]For more information on Solid Waste Management please read report on Consolidated Annual Review Report on Implementation of Solid waste management Rules- 2016 -http://cpcb.nic.in/cpcbold/MSW_AnnualReport_2015-16.pdf

decentralized composting schemes, by which sorted waste is turned into high-quality compost. Composting is a feasible option when degradable and non-degradable wastes are handled separately[15]

4.2 The Plastic Waste Management Rules 2016

Introduction

The physical and chemical properties and the multiple uses of Plastic has lead to commercial success. However, the indiscriminate disposal of plastic has become a major threat to the environment. In particular, the plastic carry bags are the biggest contributors of littered waste. Every year, millions of plastic bags end up into the environment vis-a-vis soil, water bodies, and water courses. It takes an average of one thousand years to decompose completely. Therefore, to address the issue of plastic waste management scientifically, the Plastic Waste (Management and Handling) Rules, 2011 were notified in 2011.

The Government has notified the Plastic Waste Management Rules, 2016, in suppression of the earlier Plastic Waste (Management and Handling) Rules, 2011. The Ministry of Environment, Forest and Climate Change, declared that the minimum thickness of plastic carry bags has been increased from 40 microns to 50 microns. Also stated that 15, 000 tons of plastic waste is generated every day, out of which 9, 000 tons is collected and processed, but 6, 000 tons of plastic waste is not being collected. The rules, which were admissible up to municipal areas, have now been extended to all villages. The new Plastic Waste Management Rules is a part of the revamping of all Waste Management Rules.

'Minimum Thickness of Plastic Carry Bags Increased from 40 to 50Microns'
Shri Prakash Javadekar
Minister of State for Environment, Forest and Climate Change, Mar 18, 2016

The Plastic Waste Management Rules, 2016 aim to

- Increase minimum thickness of plastic carry bags from 40 to 50 microns and stipulate minimum thickness of 50 micron for plastic sheets also to facilitate collection and recycle of plastic waste
- Expand the jurisdiction of applicability from the municipal area to rural areas, because plastic has reached rural areas also
- To bring in the responsibilities of producers and generators, both in plastic waste management system and to introduce collect back system of plastic waste by the producers/brand owners, as per extended producers responsibility
- To introduce collection of plastic waste management fee through pre-registration of the producers, importers of plastic carry bags/multilayered packaging and vendors selling the same for establishing the waste management system
- To promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc. for gainful utilization of waste and also address the waste disposal issue; to entrust more responsibility on waste generators, namely payment of user charge as prescribed by local authority, collection and handing over of waste by the institutional generator, event organizers.
- An eco-friendly product, which is a complete substitute of the plastic in all uses, has not been found till date. In the absence of a suitable alternative, it is impractical and undesirable to impose a blanket ban on the use of plastic all over the country. The real challenge is to improve plastic waste management systems.

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https://www.researchgate.net/publication/274956378_A_Critical_Overview_of_Legal_Profile_on_Solid_Waste_Management_in_India-Mane Ashish Vilas Int. J. Res. Chem. Environ. Vol. 5 Issue 1 (1-16) January 2015 ISSN 2248-9649 International Journal ofResearch in Chemistry and Environment, Available online at: www.ijrce.org

Plastic Waste Management Rules 2016

- Rural areas have been brought in ambit of these Rules since plastic has reached to rural areas also. Responsibility for implementation of the rules is given to Gram Panchayat.
- First time, responsibility of waste generators is being introduced. Individual and bulk generators like offices, commercial establishments, industries are to segregate the plastic waste at source, handover segregated waste, pay user fee as per bye-laws of the local bodies.
- Plastic products are left littered after the public events (marriage functions, religious gatherings, public meetings etc) held in open spaces. First time, persons organizing such events have been made responsible for management of waste generated from these events.
- Use of plastic sheet for packaging, wrapping the commodity except those plastic sheet's thickness, which will impair the functionality of the product are brought under the ambit of these rules. A large number of commodities are being packed/wrapped in to plastic sheets and thereafter such sheets are left for littered. Provisions have been introduced to ensure their collection and channelization to authorized recycling facilities.
- Extended Producer Responsibility: Earlier, EPR was left to the discretion of the local bodies. First time, the producers (i.e. persons engaged in manufacture, or import of carry bags, multi-layered packagingand sheets or like and the persons using these for packaging or wrapping their products) and brand owners have been made responsible for collecting waste generated from their products. They have to approach local bodies for formulation of plan/system for the plastic waste management within the prescribed timeframe.
- State Pollution Control Board (SPCBs) will not grant/renew registration of plastic bags, or multi-layered packaging unless the producer proposes the action plan endorsed by the concerned State Development Dept..
- Producers to keep a record of their vendors to whom they have supplied raw materials for manufacturing carry bags, plastic sheets, and multi-layered packaging. This is to curb manufacturing of these products in unorganized sector.
- The entry points of plastic bags/plastic sheets/multi-layered packaging in to commodity supply chain are primarily the retailers and street vendors. They have been assigned the responsibility of not to provide the commodities in plastic bags/plastic sheets/multi-layered packaging which do not conform to these rules. Otherwise, they will have to pay the fine.
- Plastic carry bag will be available only with shopkeepers/street vendors pre-registered with local bodies on payment of certain registration fee. The amount collected as registration fee by local bodies is to be used for waste management.
- Central Pollution Control Board (CPCB) has been mandated to formulate the guidelines for thermoset plastic (plastic difficult to recycle). In the earlier Rules, there was no specific provision for such type of plastic.
- Manufacturing and use of non-recyclable multi-layered plastic to be phased in two years.
  (To access the complete Plastic Waste Management Rules, 2016 find the link in the bibliography.)

Plastic Waste Management (Amendment) Rules 2018

The Ministry of Environment, Forest and Climate Change has further notified the Plastic Waste Management (Amendment) Rules 2018.

- The amended Rules lay down that the phasing out of Multilayered Plastic (MLP) is now applicable to MLP, which are "non-recyclable, or non-energy recoverable, or with no alternate use."
- The amended Rules also prescribe a central registration system for the registration of the producer/importer/brand owner.
- The Rules also lay down that any mechanism for the registration should be automated and should take into account ease of doing business for producers, recyclers and manufacturers.
- The centralized registration system will be evolved by Central Pollution Control Board (CPCB) for the registration of the producer/importer/brand owner.
- While a national registry has been prescribed for producers with presence in more than two states, a state-level registration has been prescribed for smaller producers/brand owners operating within one or two states.
- In addition, Rule 15 of the Plastic Waste Management (Amendment) Rules 2018 on "explicit pricing of carry bags" has been omitted.

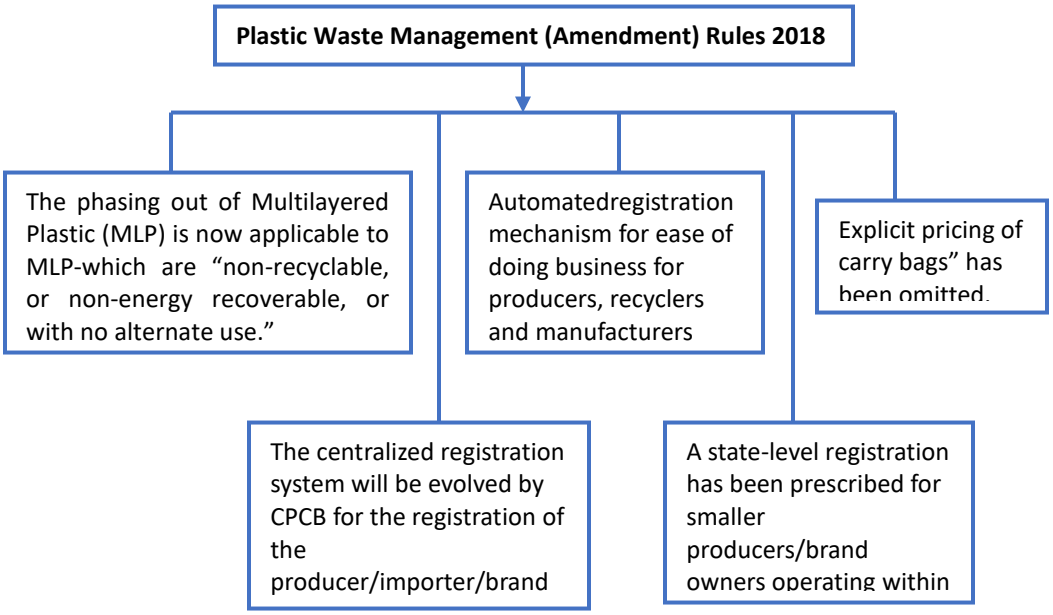

Fig 4.5 Plastic Waste Management (Amendment) Rules 2018

Caselet

Ankur Gutkha versus India AsthamaCare Society &Others-2007

The Honorable Supreme court of India in the SLP(C) 16308 2007 in the matter of AnkurGutkha versus India Asthama care society & others vide its order dated 10th December 2010, has inter-alia, restrained the manufacturers of Gutkha, Tobacco and Pan Masala from using plastic material in the Sachets of Gutkha, Tobacco and Pan Masala.

The Honorable Court in the Contempt petition (C) No. 237 of 2011 filed regarding alleged disobedience of the order of the court by Center for Public Interest Litigation (CPIL) in SLP 16308 of 2007, with a view to ensure that no attempt is made by anyone to circumvent the aforesaid courts order dated 7-12 2010, has further clarified

that manufacturers of Gutkha, Tobacco and Pan Masala shall not use plastic material in any form in any package for packing their products.

The Honorable Court vide its aforesaid orders has directed the Government of India, Ministry of Environment, Forest and climate change and all concerned agencies to ensure that orders dated 7-12 2010 and 11-05-2011 are faithfully implemented by all the manufacturers throughout the country and anybody found violating the directions of this court shall be proceeded against in accordance with law.

Fig 4.6 Plastic Bottles Segregated for Recycling at Bhopra in New Delhi

[Picture Courtesy Indian Express 4th June 2018]

The Central Government in the Ministry of Environment, Forest and climate change, has also notified the Plastic Waste Management Rules 2016 under the Environment Protection Act 1986 for proper handling and management of plastic waste in the country and Rule 4(i) and Rule 4(f), inter-alia prohibit the use of plastic material, in any form including Vinyl Acetate –Maleic Acid – Vinyl Chloride Copolymer, for packaging Gutkha, Tobacco and Pan Masala and in all forms whereas the use of plastic packaging material has been found in the Gutkha, Tobacco and Pan Masala in the market.

The concerned manufacturers have failed to ensure the compliance to the directions of the Honorable Supreme Court as well as the provisions of PWM rules 2016 and there is indiscriminate use of the plastic for packaging of Gutkha, Tobacco and Pan Masala.The littered Plastic Sachets/Pouches are posing an environmental threat and the manufacturers of Gutkha, Tobacco and Pan Masala have not taken effective action to prevent the use of plastic in packaging their products.

Therefore, in exercise of the powers conferred under Section 5 of the Environmental protection Act 1986 and keeping in view the gravity of pollution being caused by littered plastic sachets/pouches of Gutkha, Tobacco and Pan Masala, Central Government under Ministry of Environment Forest and Climate change has Sent notifications to 20 Brand owners and Manufacturing units in India, regarding the implementation of the plastic waste management rules 2016, which failed to ensure compliance to the directions of the Honorable Supreme court as well as the provisions of PWM Rules 2016. The ministry directed the listed companies to stop using plastic material in any form.

Success stories

Ban on Use of Plastic Water Bottles in Government Offices

Haryana Government decided to ban single use plastic bottles in all Government offices in the State. The decision was taken by Chief Minister of Haryana dated 04-06-2018. All Government Dept.s / Boards/ Corporations / Autonomous Units in State of Haryana shall dispense with use of water bottles and make alternate arrangements for safe drinking water that does not result in generation of plastic waste. Only multi-use water bottles will be allowed like glass, steel, aluminum can be used.

SuchitwaSagaram

Ministry of fisheries, Kerala Government launched this mission in 2017, mission to remove plastic from ocean and to stop dumping plastic in ocean and secondly the plastic removed from ocean is reused. Up to now 25 tons of plastic was removed from ocean, thus removed plastic is been put in shedding machine and turns into material to reuse for resurfacing the roads. The fishing community settled along the Neendakara harbor in Kollam, undertook the responsibility of recovering plastic waste along the coast under the SuchitwaSagaram campaign in June last year. With this success story, Kerala Government is going to expand this exercise to other cities also.

Fig 4.7 Work Flow Collecting Plastic Waste from Sea And Shredding[16]

[16]The Better India, 2018 https://www.thebetterindia.com/144055/news-kerala-fisherfolk-25-tonnes-plastic-suchitwa-sagaram-neendakara-harbour/

4.3 The Construction and Demolition Waste Management Rules 2016

IntroductionAs per Rule 3 (c) "construction and demolition waste" means waste comprising of building materials, debris and rubble resulting from construction, re-modeling, repair and demolition of any civil structure. Composition of demolition wastes is project specific and varies depending on age of building being demolished / renovated or the type of buildings being constructed. Under Rule 4 sub-rules (3) of the C & D Waste Management Rules, 2016 the segregation by bulk C & D waste shall be done into four streams such as:

1. Concrete
2. Soil
3. Steel, wood and plastics
4. Bricks & mortar Wastes like surplus and damaged products and materials arising in the course of construction work or used temporarily during the course of on-site activities come under C&D wastes. Key characteristics of C&D wastes include:

a) Demolition waste characteristics: In India, when old buildings are demolished the major demolition waste is soil, sand and gravel accounting for bricks (26%) & masonry (32%), concretes (28%), metal (6%), wood (3%) others (5%).

b) The major constituents are concrete, soil, bricks, wood, asphalt and metal. Brick & masonry, soil, sand & gravel account for over 60% of total waste. (Source - Municipal Corporation of Delhi, Burari facility).

Environmental Pollutant Generated During Handling of Construction Material and C&D Wastes

The concerns of controlling dust / fine particles generated during handling of Construction material and C&D wastes on site include:

a. Dust emissions are an environmental nuisance both on-site and off-site.
b. Dust during handling (loading / unloading) release a wide range of particle sizes and material types that can cause serious health problems ranging from eye irritation, nose, mouth to affecting the respiratory system.
c. The larger heavier particles settle out of the air quickly and are hazard to the operators of plant and equipment (on-site) and to those in the immediate vicinity (off-site). The finer particles (usually invisible) are transported further can cause health hazards (off-site).

The construction and demolition waste generated is about 530 million tonnes annually. The Ministry of Environment, Forest and Climate Change (MoEF&CC) notified the Construction & Demolition Waste Management Rules, 2016 on 29 March 2016. The rules are an initiative to effectively tackle the issues of pollution and waste management.

C & D Waste Management Rules 2016 the areas cover include the following

1. Major DUST generating activities
2. Composition of Construction and Demolition wastes / material
3. Major dust borne material
4. Dust management in C&D Waste Management Facilities
5. Dust management during transportation

6. Dust control measures during storage
7. Dust control measures at site
8. Other dust mitigation measures
9. NGT Order w.r.t. Compensation on Construction related works for Delhi.

Salient Features of C&D Rules 2016

Application
Applies to everyone who generates construction and demolition waste.

1. **Duties of waste Generators**
   b. Every waste generator shall segregate construction and demolition waste and deposit at collection centre or handover it to the authorized processing facilities
   c. Shall ensure that there is no littering or deposition so as to prevent obstruction to the traffic or the public or drains.
   d. Large generators (who generate more than 20 tons or more in one day or 300 tons per project in a month) shall submit waste management plan and get appropriate approvals from the local authority before starting construction or demolition or remodeling work,
   e. Large generators shall have environment management plan to address the likely environmental issues from construction, demolition, storage, transportation process and disposal / reuse of C & D Waste.
   f. Large generators shall segregate the waste into four streams such as concrete, soil, steel, wood and plastics, bricks and mortar.
   g. Large generators shall pay relevant charges for collection, transportation, processing and disposal as notified by the concerned authorities.

2. **Duties of Service providers and Contractors**
   - The service providers shall prepare a comprehensive waste management plan for waste generated within their jurisdiction, within six months from the date of notification of these rules,
   - Shall remove all construction and demolition waste in consultation with the concerned local authority on their own or through any agency.
3. **Duties of State Government and Local Authorities**
   - The Secretary, UDD in the State Government shall prepare their policy with respect to management of construction and demolition of waste within one year from date of final notification of these rules.
   - The concerned Dept. in the State Government dealing with land shall provide suitable sites for setting up of the storage, processing and recycling facilities for construction and demolition waste with one-and-a-half years from date of final notification of these rules.
   - The Town and Country planning Dept. shall incorporate the site in the approved land use plan so that there is no disturbance to the processing facility on a long term basis.
   - Shall procure and utilize 10-20% materials made from construction and demolition waste in municipal and Government contracts.
   - Local Authority shall place appropriate containers for collection of waste, removal at regular intervals, transportation to appropriate sites for processing and disposal.
   - LA shall seek detailed plan or undertaking from large generator of construction and demolition waste and sanction the waste management plan;
   - Seek assistance from concerned authorities for safe disposal of construction and demolition waste contaminated with industrial hazardous or toxic material or nuclear waste if any,
   - LA shall give appropriate incentives to generator for salvaging, processing and or recycling preferably in-situ,

- LA shall establish a data base and update once in a year,
- Million plus cities (based on 2011 census of India), shall commission the processing and disposal facility within one-and-a-half years from date of final notification of these rules
- 0.5 to 1 million cities, shall commission the processing and disposal facility within two years from date of final notification of these rules
- For other cities (< 0.5 million populations), shall commission the processing and disposal facility within three years from date of final notification of these rules

4. **Duties of Central Pollution Control Board, State Pollution Control Board or Pollution Control Committee**
   - The Central Pollution Control Board shall prepare operational guidelines related to environmental management of construction and demolition waste.
   - SPCB shall grant authorization to construction and demolition waste processing facility
   - Monitor the implementation of these rules by the concerned local bodies
   - Submit annual report to the Central Pollution Control Board and the State Government.

5. **Standards for products of construction and demolition waste**
   - The Bureau of Indian Standards need to prepare code of practices and standards for products of construction and demolition waste
   - Indian Roads Congress need to prepare standards and practices pertaining to products of construction and demolition waste in roads construction.

6. **Duties of Central Ministries**
   - The Ministry of Urban Development, and the Ministry of Rural Development, Ministry of Panchayat Raj, shall facilitate local bodies in compliance of these rules;
   - The Ministry of Environment, Forest and Climate Change shall review implementation of these rules as and when required.

7. **Facility for processing / recycling facility**
   - The operator of the facility shall obtain authorization from State Pollution Control Board or Pollution Control Committee.
   - The processing / recycling site shall be away from habitation clusters, forest areas, water bodies, monuments, National Parks, Wetlands and places of important cultural, historical or religious interest.
   - The processing/recycling facility exceeding five Tones per day capacity, shall maintain a buffer zone of no development around the facility.

Caselets

Supreme Court order bans all States and Union Territories from further construction activity until they frame a solid waste management policy. Following the ban, many states are hurriedly putting together policies in line with the Court directives and indications.

It was on August 31, 2018 that the Supreme Court stayed further construction activities in all states and Union Territories that had failed to formulate solid waste management policies in compliance with the Solid Waste Management Rules, 2016. The order was issued in response to a case filed in 2016 on the inaction of the Delhi government and municipal authorities regarding adequate waste management efforts to curb mosquito breeding.

The PIL was filed by a Delhi-based doctor Anil Mittal, seeking court intervention to direct the centre and the Delhi government to provide better and timely medical facilities and proper garbage disposal.

The Court converted the PIL into *a* suomotu matter, taking cognisance of a case where the parents committed suicide after their child died of dengue in 2015. That was the year Delhi reported a whopping 15,867 cases of dengue. There was public uproar when seven-year-old Avinash Rout died after five hospitals turned him away due to lack of space. Avinash was finally admitted into Batra Hospital in a critical condition and succumbed to the disease. His parents committed suicide the next day.

Before the latest ban order, the apex court had on July 10, 2018, levied a fine of Rs 1 lakh each on Bihar, Chhattisgarh, Goa, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Meghalaya, Punjab, West Bengal, Lakshadweep and Puducherry, who were represented in the Court. The remaining defaulting states and Union Territories which were not represented were slapped a fine of Rs 2 lakh.

The top court has slapped further fines of Rs 3 lakh on Uttarakhand, Maharashtra, Madhya Pradesh and Chandigarh, and Rs 5 lakh on Andhra Pradesh for not following the order of July 10, 2018. Not only had these states not formulated a policy on waste management, they were not even represented at the Court hearing.

The fines may not have amounted to much, but the blanket ban is a sign of the bench being irked by the callous attitude of the states in failing to formulate policies in compliance with a central law—Solid Waste Management Rules (SWM Rules), 2016. By handing out the extreme punishment, the bench was clearly showing its frustration at the impunity with which states have violated its orders.

Thus the Ministry of Environment, Forests and Climate Change (MOEF) had notified the updated SWM Rules on April 8, 2016.

4.4 EPR - Extended Producer Responsibility

The concept of Extended Producer Responsibility (EPR) signifies that the responsibility of the producer of a product extends beyond the conventional point of sale to its post-consumer or end-of-life (EOL) stage. The producer thus is made responsible for collection of the used products or packaging material and ensures its safe recycling or disposal.

EPR is the main feature of the E-Waste (Management and Handling) Rules, 2011. Under these rules, the producer of say electrical and electronic equipment is also responsible for managing such equipment after its 'end of life'. In other words, the producer is responsible for his products even after the consumer discards them. Under this EPR, producer is responsible for financing and organizing a system to meet the costs involved in complying with EPR.

The whole idea behind EPR is to encourage producers to consider the end-of-life processing of their products right from the design stage. It induces producers to designproducts which are long-lasting and easily recyclable.

There is a significant cost of collection and recycling of these wastes which should be borne by the producer. It cannot be passed on to the government; nor can the environment be allowed to suffer.

Specifically, a producer is required to make arrangements to:

- Collect and channelize of e-waste generated in repairing activity and 'end of life' of the product
- Create all-round awareness through publications & information dissemination
- Obtain authorization from pollution control authorities -- SPCB/CPCB
- Maintain records & file annual returns

India and EPR policies

Currently India has EPR policies for Electronic waste and Plastic packaging waste.

Under the E-Waste (Management & Handling) Rules 2011, all producers of electronics like phones, computers, washing machines were made responsible for setting up reverse logistics for collection of e-waste and channelizing it to State Pollution Control Board authorized recyclers.

Under the new E-Waste (Management) Rules 2016, there are stringent targets for producers to collect and recycle end-of-life (EOL) products starting from 30% in the first two years and increasing to 70% by the seventh year. The process of applying for EPR Authorization has been simplified.

Under the Plastic Waste Management Rules 2016, EPR is enforced for a plastic producer in the country and a ban has been imposed on manufacturing of non-recyclable plastics in two years of implementation.

EPR policies and the globe

EPR, differing for variedstreams of material, is a popular concept in the western countries. EPR for packaging materials exists in EU, Canada, and Germany. Similarly, we have EPR for automobiles in countries like Germany and Netherlands. EPR exists for paints in British Columbia.

Challenges in implementing EPR

- Segregation at source is essential for resource recovery of EPR products. Producers need to help improve awareness of source segregation and the need to recycle.
- In spite of mounting plastic waste and e-waste across the country, there is a woeful lack of formalized reverse logistics companies. This is because setting up a collection network has become complex and expensive.
- As 90% of all these waste streams are managed by the informal sector, raising them into the formal sector for responsible waste management while ensuring compliance with rules will be difficult.

Towards a circular economy

- When it comes to EPR policies, the road ahead is not all that disappointing. There is room to bring about effective collaborations between various stakeholders like the central and state government, producers, consumers as well as the informal sector. This will help in effectively mitigating the impact on climate change and pollution caused by these waste materials. Stringent EPR policies will help implement the 3R principle (Reduce-Reuse-Recycle).

- Upgrading the informal sector into the formal set-up would strongly influence better livelihood options for disadvantaged sections of the community and provide scope for building reliable careers in waste management industry.
- Producers ought to contribute significantly by teaming with specialist collection partners so that large volumes of their EOL products are recovered through a proper reverse logistics network.

4.5 Cleaner Production Option and Waste Management

As an asp86ect of sustainability, Cleaner Production (CP) is an option that is preventative approach to managing the environmental impacts of business processes and products. Cleaner Production requires the organization to implement changes in technology, processes, resources or practices. The larger objectives include reducing waste, environmental and health risks; minimizing environmental damage; using energy and resources more efficiently; increasing business profitability and competitiveness; and increasing the efficiency of production processes. CP is applicable to all businesses, regardless of size or type. As an ongoing process, CP basically involves:

- Modifications in technology.
- Relook at input materials.
- Tweaking operating practices.
- Redesigning design.
- Changes in waste use.
- Improved maintenance.
- Changes in packaging.

Essentially, prevention of waste generation involves:

- Good housekeeping
- Input substitution
- Better process control
- Equipment modification
- Technology change
- Product modification
- Efficient use of energy resources
- On-site recovery/reuse

Advantages of CP include:

- Improving environmental situation
- Increasing economic benefits
- Continuous environmental improvement
- Increasing productivity
- Gaining competitive advantage

Impediments to CP include:

- Lack of information and expertise
- Low environmental awareness
- Competing business priorities
- Financial obstacles

- Lack of communication in firms
- Middle management inertia
- Labour force obstacles
- Difficulty in accessing cleaner technologies
- Difficulty in accessing external finance

CP and Sustainability

CP is related to various sustainability concepts, including eco-efficiency; environmentally sound technologies; life cycle assessment; green procurement and zero emissions. The spin-off of a sound CP option is that it can result in the reduction of operation or pollution licence fees; fewer regulations to follow; waning peer pressure; improved corporate image; additional corporate environmental plans or policies; significant cost savings; and insulation from product bans.

Challenges to CP

The major challenges to implementing a CP option include:

- lack of finances (perceived or real);
- low environmental awareness or concern of the organisation;
- lack of organisational support;
- lack of human resources;
- limited access to appropriate technology.

Summary

Municipal Solid Wastes present the most formidable challenge when it comes to their safe handling and disposal not only because of their gargantuan dimensions, but also their character, composition and profiles.

Initially, The Municipal Solid Wastes (Management & Handling) Rules, 2000 (MSW Rules) were applicable to every municipal authority responsible for collection, segregation, storage, transportation, processing and disposal of municipal solid. The idea was to enable municipalities to dispose municipal solid waste in scientific manner. However, in view of the short-comings and overlapping of some categories causing inconvenience in implementation of the MSW (Management and Handling) Rules, 2000, the Union Government subsequently notified the "The Solid Waste Management Rules, 2016" for management of Solid Waste. The 2016 Municipal Solid Wastes (Management and Handling) Rules apply to all forms of wastes generated under civic bodies, including commercial and residential wastes generated in municipal or notified areas in either solid or semi-solid form, excluding industrial hazardous wastes but including treated bio-medical wastes.

It has been estimated across India that about90% of the MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and environment. So, SWM Rules are aimed at dealing with the management of solid waste, including its segregation at source, transportation of waste, treatment and final disposal. The areas covered under MSW Rules 2016 include every household, event organizers, street vendors, RWAs &market associations, gated community having more than area 5000 sqm, and hotels & restaurants.

In general, all waste generators are required to segregate and store the waste generated by them in three separate streams: bio-degradable, non-biodegradable and domestic hazardous wastes in suitable bins. Waste generators need to handover segregated wastes to authorized waste pickers or waste collectors. They need to store separately construction and demolition waste on their own premises and dispose them of as per the

Construction and Demolition Waste Management Rules, 2016. A person organizing an event or gathering of more than one hundred persons should ensure segregation of waste at source and handing over of segregated waste to waste collector or agency. Street vendors need to keep suitable containers for storage of waste generated during the course of his activity such as food waste, disposable plates, cups, cans, wrappers, coconut shells, leftover food, vegetables, fruits, etc., and ensure proper disposal of such wastes.

Self Assessment Questions

- Discuss about the areas covered under SWM Rules 2016
- What are the aims of plastic waste management rules 2016
- Describe some of the success stories that you might have heard on ban on use of plastic water bottles in government offices.

Further Readings

- Law Society of India Vs. Fertilizers and Chemicals Travancore Ltd. and ors. - Court Judgment –1994 https://www.legalcrystal.com/case/719164/law-society-india-vs-fertilizers-travancore
- http://envfor.nic.in/sites/default/files/Direction%20PWMR%20Rules%202016.PDFPlastic for laying Roads- https://youtu.be/BGJXjbxH5lIhttps://www.thebetterindia.com/43685/plastic-waste-in-road-construction-plastic-man-india-prof-vasudevan/
- Waste Management Caselets for reading to understand the importance of EP Acts and Rules:
- https://www.academia.edu/30888007/A_Study_of_Construction_Waste_Material_Management_Case_Study_Gwalior
- http://www.academia.edu/35485649/Study_of_Construction_and_Demolition_Waste_Management_in_India
- http://www.indialegallive.com/cover-story-articles/focus/solid-waste-management-waste-building-54490- Solid Waste Management: Waste of a building, Sep 16 2018 –India Legal Stories that count.

Video lessons

- https://youtu.be/Nz6pOOIdhYM -
- Principles of environmental law Part 12. https://youtu.be/DZHCaI5VkVQ -
- Principles of environmental law Part 23. https://youtu.be/EDQtBLf0vjc -
- Principles of environmental law Part 3-https://youtu.be/qmcK3l7USVc - Rules 2016
- https://youtu.be/FDCmJ0ei9Vs - Rules 2016
- https://youtu.be/42e7Xq1vSqI -Amendment Rules 2018
- https://youtu.be/PDc-5tzoeBo
- https://youtu.be/trfWkoXcUfg- ECL = Public Liability Insurance Act 1991 (For Jun/Dec 2016)By Prof. Shantanu Pethe (CACSCMA coach)

Chapter 5

International and Local Instruments

Objectives

- To understand international instruments
- To study corporate social responsibility
- To study local AP laws

Structure

5.1 International Instruments
5.2 Corporate social responsibility
5.3 International Conventions
5.4 An assessment of the legal and regulatory framework in India

To Do Activities

- Visit a nearby industry to understand how far CSR activities are followed
- Conduct a survey to understand how far these Acts have been implemented in the respective arenas.
- Discuss caselets on various Acts
- Provide topics for group or individual presentation
- Organize debates on the important Acts and check for monitoring and practical implementation

5.1 International Instruments

Environment and the Organisation for Economic Co-operation and Development

The Organisation for Economic Co-operation and Development (OECD) seeks to promote policies that will improve the economic and social well-being of people around the world.The OECD provides a forum in which governments can work together to share experiences and seek solutions to common problems. It works with governments to understand what drives economic, social and environmental change. It measures productivity and global flows of trade and investment. It analyzes and compares data to predict future trends. It sets international standards on a wide range of things, from agriculture and tax to the safety of chemicals.

The OECD also look at issues that directly affect everyone's daily life, like how much people pay in taxes and social security, and how much leisure time they can take. It compares how different countries' school systems are readying their young people for modern life, and how different countries' pension systems will look after their citizens in old age.

Drawing on facts and real-life experience, it recommends policies designed to improve the quality of people's lives. It works with business, through the Business and Industry Advisory Committee to the OECD (BIAC), and with labour, through the Trade Union Advisory Committee (TUAC). OECD has active contacts as well with other civil society organizations. The common thread of its work with organizations is a shared commitment to market economies backed by democratic institutions and focused on the wellbeing of all citizens. Currently, OECD is focused on helping governments around the world to:

- Restore confidence in markets and the institutions that make them function.
- Re-establish healthy public finances as a basis for future sustainable economic growth.
- Foster and support new sources of growth through innovation, environmentally friendly 'green growth' strategies and the development of emerging economies.

- Ensure that people of all ages can develop the skills to work productively and satisfyingly in the jobs of tomorrow.

5.2 Corporate Social Responsibility

From the standpoint of environment, Corporate Social Responsibility (CSR) refers to a wide range of actions that businesses may make - from donating to charity to ethical trading. All told, the focus of CSR is the environment.

Environmental CSR

Environmental CSR aims to reduce any damaging effects on the environment from business processes. Activities may focus on:

- energy use
- water use
- waste management
- recycling
- emissions
- eco-friendly office and business travel policies
- Some of these are significant from both environmental and financial point of view.

Advantages

Green CSR can reduce business risk, improve reputation and provide opportunities for cost savings. Even the simplest energy efficiency measures can generate savings and make a difference to a corporate entity or an institution. For example:

- Switching off lights and equipment when not in use
- Reducing the use of water
- Reducing the amount of paper wasted
- Caring about the environment can increase revenue too. Many customers prefer to buy from responsible companies.

Reducing environmental impact

A corporate entity or an institution can reduce its environmental impact in many ways. This may include:

- Creating products that can be recycled
- Optimising product life cycle
- Source responsibly (say using recycled materials and sustainable timber)
- Reducing packaging
- Buying locally to save fuel costs
- Creating an efficient (and fuel-efficient) distribution network
- Working with environmentally-conscious suppliers and distributors

5. 3 International Conventions

An international environmental agreement or environmental protocol, is a type of treaty binding in international law, allowing countries to reach an environmental goal. In other words, it is "an intergovernmental document intended as legally binding with a primary stated purpose of preventing or managing human impacts on natural resources." If the agreement is made among three or more nations, it is called a multilateral environmental agreement (MEA). Such agreement are primarily made by the United Nations.

India is signatory to a number of Multilateral Environment Agreements (MEA) and conventions. An overview of some of the major MEAs and India's obligations under these is presented below. These are discussed at length in the respective chapters.

Montreal Protocol on Substances that deplete the Ozone Layer (to the Vienna Convention for the Protection of the Ozone Layer), 1987

The Montreal Protocol to the Vienna Convention on Substances that deplete the Ozone Layer, came into force in 1989. The protocol set targets for reducing the consumption and production of a range of ozone depleting substances (ODS). In a major innovation the Protocol recognized that all nations should not be treated equally. The agreement acknowledges that certain countries have contributed to ozone depletion more than others. It also recognizes that a nations obligation to reduce current emissions should reflect its technological and financial ability to do so. Because of this, the agreement sets more stringent standards and accelerated phase-out timetables to countries that have contributed most to ozone depletion (Divan and Rosencranz, 2001).

India acceded to the Montreal Protocol along with its London Amendment in September 1992. The MoEF has established an Ozone Cell and a steering committee on the Montreal Protocol to facilitate implementation of the India Country Program, for phasing out ODS production by 2010.

To meet India's commitments under the Montreal Protocol, the Government of India has also taken certain policy decisions.

- Goods required to implement ODS phase-out projects funded by the Multilateral Fund are fully exempt from duties. This benefit has been also extended to new investments with non-ODS technologies.
- Commercial banks are prohibited from financing or refinancing investments with ODS technologies.

The Gazette of India on 19 July 2000 notified rules for regulation of ODS phase-out called the Ozone Depleting Substances (Regulation and Control) Rules, 2000. They were notified under the Environment (Protection) Act, 1986. These rules were drafted by the MoEF following consultations with industries and related government Departments.

Basel Convention on Transboundary Movement of Hazardous Wastes, 1989

Basel Convention, which entered into force in 1992, has three key objectives:

- To reduce transboundary movements of hazardous wastes;
- To minimize the creation of such wastes; and
- To prohibit their shipment to countries lacking the capacity to dispose hazardous wastes in an environmentally sound manner.

India ratified the Basel Convention in 1992, shortly after it came into force. The Indian Hazardous Wastes Management Rules Act 1989, encompasses some of the Basel provisions related to the notification of import and export of hazardous waste, illegal traffic, and liability.

UN Framework Convention on Climate Change (UNFCCC), 1992

The primary goals of the UNFCCC were to stabilize greenhouse gas emissions at levels that would prevent dangerous anthropogenic interference with the global climate. The convention embraced the principle of common but differentiated responsibilities which has guided the adoption of a regulatory structure.

India signed the agreement in June 1992, which was ratified in November 1993. As per the convention the reduction/limitation requirements apply only to developed countries. The only reporting obligation for developing countries relates to the construction of a GHG inventory. India has initiated the preparation of its First National Communication (base year 1994) that includes an inventory of GHG sources and sinks, potential vulnerability to climate change, adaptation measures and other steps being taken in the country to address climate change. The further details on UNFCC and the Kyoto Protocol are provided in Atmosphere and climate chapter.

Convention on Biological Diversity, 1992

The Convention on Biological Diversity (CBD) is a legally binding, framework treaty that has been ratified until now by 180 countries. The CBD has three main thrust areas: conservation of biodiversity, sustainable use of biological resources and equitable sharing of benefits arising from their sustainable use.

The Convention on Biological Diversity came into force in 1993. Many biodiversity issues are addressed in the convention, including habitat preservation, intellectual property rights, bio-safety, and indigenous peoples rights.

The Biological Diversity Act, 2002

The Biological Diversity Act 2002 was born out of India's attempt to realize the objectives enshrined in the United Nations Convention on Biological Diversity (CBD), 1992 which recognizes the sovereign rights of states to use their own Biological Resources. The Act aims at the conservation of biological resources and Assoc. d knowledge as well as facilitating access to them in a sustainable manner. The National Biodiversity Authority in Chennai has been established for the purposes of implementing the objects of the Act.

These include the promulgation of the Wildlife (Protection) Act of 1972, amended in 1991; and participation in several international conventions such as CITES.

UN Convention on Desertification, 1994

Delegates to the 1992 UN Conference on Environment and Development (UNCED) recommended establishment of an intergovernmental negotiating committee for the elaboration of an international convention to combat desertification in countries experiencing serious drought and/or desertification. The UN General Assembly established such a committee in 1992 that later helped formulation of Convention on Desertification in 1994.

The convention is distinctive as it endorses and employs a bottom-up approach to international environmental cooperation. Under the terms of the convention, activities related to the control and alleviation of desertification and its effects are to be closely linked to the needs and participation of local land-users and non-governmental organizations. Seven countries in the South Asian region are signatories to the Convention, which aims at tackling desertification through national, regional and sub-regional action programmes. The Regional Action Programme has six Thematic Programme Networks (TPN's) for the Asian region, each headed by a country task manager. India hosts the network on agro-forestry and soil conservation.

5.4 An Assessment of the Legal and Regulatory Framework in India

The extent of the environmental legislation network is evident from the above discussion but the enforcement of the laws has been a matter of concern. One commonly cited reason is the prevailing command and control nature of the environmental regime. Coupled with this is the prevalence of the all-or nothing approach of the law; they do not consider the extent of violation. Fines are levied on a flat basis and in addition, there are no incentives to lower the discharges below prescribed levels.

Some initiatives have addressed these issues in the recent past. The Government of India came out with a Policy Statement for Abatement of Pollution in 1992, before the Rio conference, which declared that market-based approaches would be considered in controlling pollution. It stated that economic instruments will be investigated to encourage the shift from curative to preventive measures, internalize the costs of pollution and conserve resources, particularly water. In 1995, the Ministry of Environment and Forest (MoEF) constituted a task force to evaluate market-based instruments, which strongly advocated their use for the abatement of industrial pollution. Various economic incentives have been used to supplement the command-and-control policies. Depreciation allowances, exemptions from excise or customs duty payment, and arrangement of soft loans for the adoption of clean technologies are instances of such incentives. Another aspect that is evident is the shift in the focus from end-of-pipe treatment of pollution to treatment at source. The role of remote sensing and geographical information systems in natural resource management and environmental protection has also gained importance over time.

An important recent development is the rise of judicial activism in the enforcement of environmental legislation. This is reflected in the growth of environment-related public litigation cases that have led the courts to take major steps such as ordering the shut-down of polluting factories.

Agenda 21 highlights the need for integration of environmental concerns at all stages of policy, planning and decision-making processes including the use of an effective legal and regulatory framework, economic instruments and other incentives. These very principles were fundamental to guiding environmental protection in the country well before Rio and will be reinforced, drawing on Indias own experiences and those of other countries.

Summary

There are several international and national instruments that seek to protect and conserve environment. These instruments require nations to broadly adhere to internationally accepted standards, while enacting pieces of legislation to deal with specific local conditions.

The one provided by the Organisation for Economic Co-operation and Development (OECD) seeks to promote policies that will help improve the economic and social well-being of people around the world. Through its forum governments can share experiences, work together, and find solutions to common problems. Drawing on facts and real-life experiences, it recommends policies designed to improve the quality of people's lives. It works with business, through the Business and Industry Advisory Committee to the OECD (BIAC), and with labour, through the Trade Union Advisory Committee (TUAC).

Under Corporate Social Responsibility (CSR), corporate entities, particularly MNCs, keep an eye on the environment at least in the areas where their business practices have social and environmental impacts. Thus, Environmental CSR aims to reduce any damaging effects on the environment from business processes, with the studied focus being on energy use, water use, waste management, recycling, emissions as well as eco-friendly office and business travel policies.

The Montreal Protocol to the Vienna Convention on Substances that deplete the Ozone Layer, which came into force in 1989, set targets for reducing consumption and production of a range of ozone- depleting substances (ODS). The agreement sets stringent standards and accelerated phase-out timetables to countries that have contributed most to ozone depletion India acceded to the Montreal Protocol, along with its London Amendment in September 1992.

The Basel Convention on Transboundary Movement of Hazardous Wastes, 1989, which took effect in 1992, seems to reduce transboundary movements of hazardous wastes; minimize the creation of such wastes; and prohibit their shipment to countries lacking the capacity to dispose hazardous wastes in an environmentally sound manner. India ratified the Basel Convention in 1992, shortly after it came into force. The Indian Hazardous Wastes Management Rules Act 1989, encompasses some of the Basel provisions related to the notification of import and export of hazardous waste, illegal traffic, and liability.

The 1992 UN Framework Convention on Climate Change seeks to stabilize greenhouse gas emissions at levels that would prevent dangerous anthropogenic interference with the global climate. The convention embraced the principle of common but differentiated responsibilities that have guided the adoption of a regulatory structure. The Convention on Biological Diversity, 1992 has for its thrust areas the conservation of biodiversity, sustainable use of biological resources, and equitable sharing of benefits arising from their sustainable use. Many biodiversity issues are addressed in the convention, including habitat preservation, intellectual property rights, bio-safety, and indigenous people's rights.

The Biological Diversity Act 2002 was borne out of India's attempt to realize the objectives enshrined in the United Nations Convention on Biological Diversity (CBD), 1992, which recognizes the sovereign rights of states to use their own Biological Resources. The National Biodiversity Authority in Chennai has been established for the purposes of implementing the objects of the Act. These include the promulgation of the Wildlife (Protection) Act of 1972, amended in 1991; and participation in several international conventions such as CITES.

The UN Convention on Desertification, 1994 endorses and employs a bottom-up approach to international environmental cooperation. Under the convention, activities related to the control and alleviation of desertification and its effects are to be closely linked to the needs and participation of local land-users and non-governmental organizations. Some of the States in India have enacted laws to meet specific local conditions. Under the Andhra Pradesh Water, Land and Trees Act 2002, authorities have been appointed at the state, district and mandal levels to promote water conservation, enhance tree cover, and regulate exploitation of ground and surface water in state. The Act was amended for insurance of new agriculture wells and introduction of single window approach for speedy clearance of the applications for new bore wells.

Self Assessment Questions

1. Discuss about corporate social responsibility and its impact
2. Discuss on your respective state local laws for air, water, land and trees law.

Video Lessons

Conservation of Biodiversity Biological Diversity Act

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Course 11

Internship

PG Diploma in Waste Management & Environmental Hygiene

Mahatma Gandhi National Council of Rural Education

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Foreword

The impact of waste management on the environment is an acknowledged fact and is being widely recognized developing countries like India. Controlled collection from various waste streams from households, small shops, medical/healthcare sector, industry sector, and several other sources, allows their proper handling, treatment and disposal. The innovative and entrepreneurial efforts towards simple solutions for waste management often have tremendous effects on the health and safety standards in developing countries. Collection of waste is the basis for all subsequent managerial measures and treatment technologies. Establishing a basic regulatory framework, of collection schemes, and of appropriate treatment and disposal facilities to prevent further damage to the environment is the need of the hour. The transfer of know-how can run at least basic collection and recycling operations, landfills or compost plants in the best possible way under the given circumstances. In this context, students' training and internship in waste related sectors is a key element for fulfilling careers. Local authorities, companies, non-profit organizations and the unorganized sector can definitely benefit considerably by giving out internships and subsequently jobs to students who are pursuing waste management courses.

This Internship guide will help students of all streams - Commerce, Humanities, Science, Management, Journalism, Mass Media, Healthcare services (B Pharm, Social Work), Education, and Engineering. The extent of environmental damage and the innovations in combating the issues require scientific understanding of the subject.

Waste Management and Environmental Hygiene has vast possibilities and several interlinking themes. There is extensive scope to explore and experience different aspects of sanitation, pollution, environmental hygiene and waste management during classroom learning, practical experiments in field and laboratory, internship and dissertation. There is a sea of opportunity in this field of waste management and environmental hygiene, and an urgent need of skilled as well as dedicated workers to make our country clean and green.

Nature has interlinked realms. Similarly, subjects dealt in this course cannot be compartmentalized. They necessarily have to merge with one another. It is therefore important that students try to make these linkages in their minds rather than treating subjects in isolation. Students can make the most of this learning opportunity as they prepare to launch their careers in a field that holds great premise.

Dr. W G Prasanna Kumar
Chairman, MGNCRE

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The sincerity with which the course curriculum was completed and published can be assessed from the fact that a prior National Consultation Workshop was held with several subject matter experts and academicians across the country, to review the contents of the course material.

The workshop was held to familiarize Central, State and Private Universities, local and social bodies with the contents of the curriculum and to discuss and share feedback on ways to improve the course curriculum. The workshop also focused on building industry–academia partnerships in Waste Management and Environmental Hygiene through an intellectual interaction. The findings and inputs of the consultation were subsequently incorporated in the course material.

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Course Objective: Internship

- To promote waste management and environmental hygiene related career options
- To promote the pre-employment field exposure
- To promote industry- institution partnership

Introduction to Internship

The intensity of global competition has prompted organizations to devise strategies that enable them to have a talented and innovative workforce, giving them a competitive edge. Developing an internship policy is key to any strategy directed at creating a future talent pool for the industry. A robust Internship programme not only helps fresh pass-outs in gaining a foothold in professional know-how, but also benefits corporate entities by yielding them mint-fresh perspectives on business issues and even discovering future business leaders.

All along the interaction of technical institutions with the industries has been restricted to the level of faculty communications and of course 2 to 4-hour industrial visits by the students. The institutions are under great stress to constantly update education offered by them so as to be as close as possible to requirements on the industrial front.

Competition in the job sector is rising exponentially and securing entry-level jobs is becoming more and more difficult, as the students passing out from technical institutions lack the experience and skill sets required by industry. As a way to bridge this gap, the Mahatma Gandhi National Council of Rural Education (MGNCRE) has initiated a slew of activities for promoting industrial Internship. These initiatives are designed for enhancement of the employability and skill sets of students passing out from technical institutions. MGNCRE has prepared the working draft of a model curriculum with the help of prominent academicians of the country so that the nation may produce competent employable graduates in line with the needs of the industries. The model curriculum includes the Internship for students of six months' duration at different stages of the programme.

Keeping the big picture in view, MGNCRE has developed Model Internship Guidelines that can help in organizing Internship for students through smooth processes and link-ups at institutional levels. These guidelines basically comprise steps for establishing, maintaining and fostering Internships. The via media for MGNCRE's MoUs with various Ministries, Government/ Non-Government/ Private organizations to facilitate Internship has also been included.

The Internship experience needs to augment outcome-based learning process and inculcate various attributes in a student in line with well-established benchmarks, particularly the Graduate Attributes defined by the National Board of Accreditation (NBA).

Chapter 1
Internship in Waste Management and Environmental Hygiene

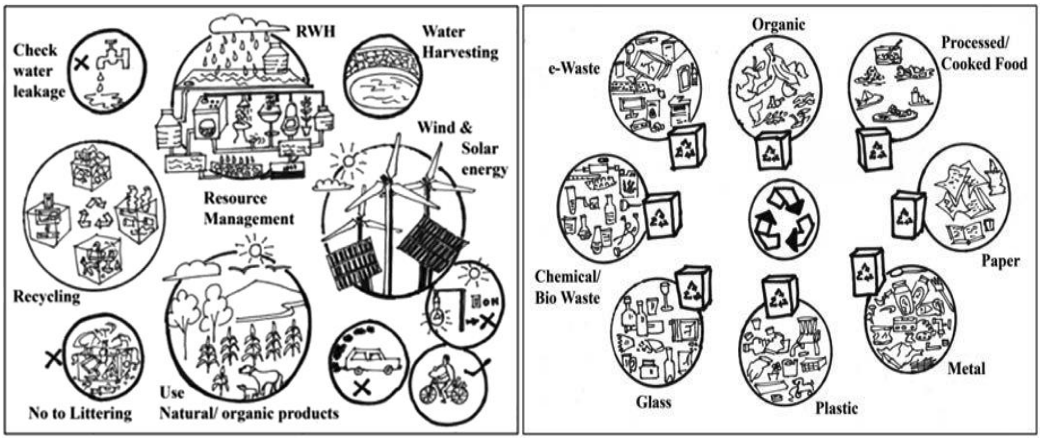
Structure

1.1 Overview
1.2 Purpose& Objectives
1.3 Impact of Internship/Training
1.4 Impact on the Employers
1.5 Impact on the Students

1.1 Overview

Internships are educational and career development opportunities, providing practical experience in a field or discipline. They are structured, short-term, supervised placements often focused around particular tasks or projects with defined timescales. An internship may be compensated or non-compensated. The internship has to be meaningful and mutually beneficial to the intern and the organization.

The waste management sector – Resource Management/Types of Waste



1.2 Purpose & Objectives

It is important that the objectives and the activities of the internship program are clearly defined and understood. Following are the intended objectives of internship training:

- Expose students to the industrial environment, which cannot be simulated in the classroom and hence creating competent professionals in the industry.
- Provide possible opportunities to learn understand and sharpen the real time technical / managerial skills required at the job.
- Get exposed to the current technological developments relevant to the subject area of training.
- Use the experience gained from the 'Industrial Internship' in discussions held in the classrooms.
- Create conditions conducive to quest for knowledge and its applicability on the job.
- Learn to apply the Technical knowledge in real industrial situations.
- Gain experience in writing reports in Technical works/projects.
- Expose students to the employees' responsibilities and ethics.

- Familiarize themselves with various materials, processes, products and their applications along with relevant aspects of quality control.
- Promote academic, career and/or personal development.
- Expose the students to future employers.
- Make students available to industry for employment.
- Understand the psychology of the workers and their habits, attitudes and approach to problem solving.
- Understand the social, economic and administrative considerations that influence the working environment of industrial organizations

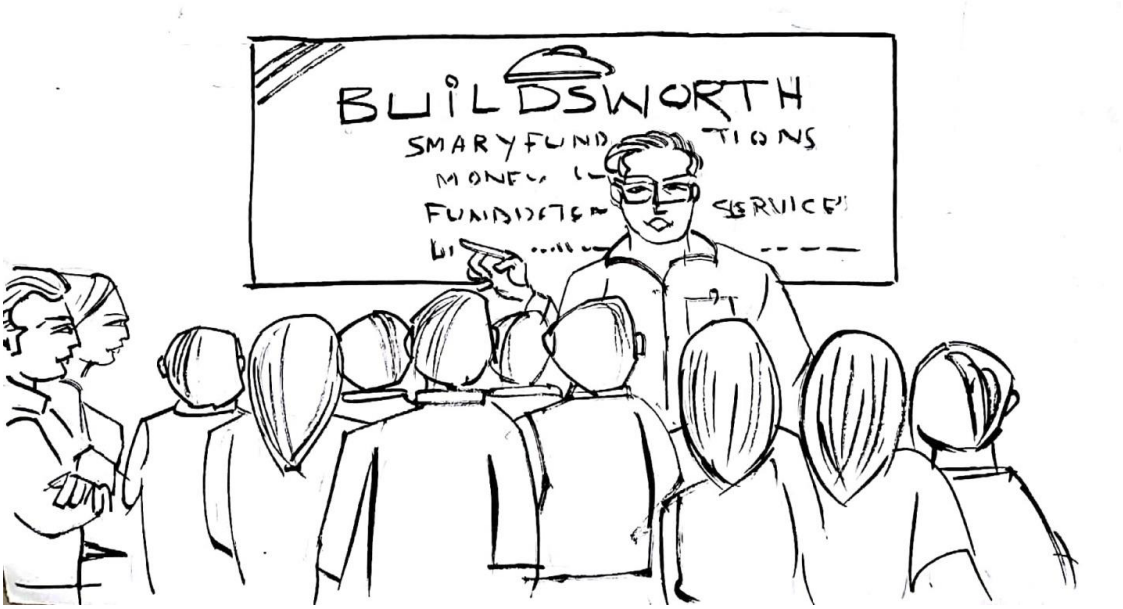
1.3 Impact of Internship/Training

- Employers' feedback on interns can help in curriculum revision.
- Helps in retention of students.
- Eases the placement process.
- Institutional credibility & branding efforts get boost.
- Highly effective teaching-learning process

1.4 Impact on the Employer

Even if employers are not able to retain or employ their best interns, there are many benefits to the employers of interns

- Creating a brand image on the campus and creating awareness about the company amongst the students
- Shortlist future employees
- Word of mouth publicity by interns about the experience during internship
- Use new ideas and new perspectives of the interns.
- Receive genuine feedback about the company and its policies at the end of the internship period
- Internship is a noble way of giving back to the community



1.5 Impact on the Students

An internship helps students to:

- Build an interface and contacts with industrial houses and nurture relations.
- Apply academic knowledge gained and skills in the industry
- Be a part of a highly effective teaching-learning process
- Exposes staff to industrial process.
- Add credentials to the résumé
- Review skill sets and narrow down prospective employers

The benefits to students**:**

- An opportunity to get hired by the Industry/organization through sheer quality of work, without having to go through some of the formal processes.
- Practical experience in an organizational setting.
- Excellent opportunity to see how the theoretical aspects learned in classes are integrated into the practical world. On-floor experience provides professional insights which are seldom gained during classroom teaching.
- Helps them decide as an insider if the industry and the profession is the best career option to pursue.
- Scope to learn new skills and supplement knowledge base.
- Real-life scenarios to practice communication and teamwork skills.
- Opportunity to learn strategies like time management, multi-tasking etc. in an industrial setup.
- Provides diverse settings to meet new people and give full play to one's networking skills.
- Valuable addition to their résumé highlights.
- Boosts their preparedness for higher education.
- Opens the door to job offers or employment recommendations.
- Builds networks and social circles, apart from developing relationships with industry people.
- Gives one a rare chance to assess the organization before committing to a full-time position.

Chapter 2

Guidelines for Internship

Structure

2.1 Internship Period and Credits
2.2 Campus Placements and Training for Internship
2.3 Pre-Internship Preparation of the Institutes
2.4 Preparation by the Students
2.5 Importance of Health, Safety and Welfare of Interns

2.1 Internship Period and Credits

The following framework is proposed to give academic credits for the Internship undergone as part of the programme.

A minimum of 16 credits of Internship/ Entrepreneurial activities / Project work/ Seminar and Inter/ Intra Institutional Training/Weekly Field Visits may be counted toward PG Diploma programme.

Here, 1 credit is equivalent to minimum 36 hours of field work. Therefore, a full-time Intern is expected to spend 36 hours per week on Internship, Training, Project Work, Seminar Activities etc. This will result in 450-500 hours for Diploma.

Internships are full-time; they are full-time during vacation and once a week field visit during the academic sessions. MGNCRE curriculum is flexible to adjust Internship duration. Therefore, opportunities need to be provided for experiences that cannot be anticipated when planning the course. The Higher Education Institutes have the flexibility to schedule Internship, Field Visits, Project Work, Seminars duration in accordance with available opportunities. However, the minimum requirement regarding duration and credits are as follows:

Table- 2.1: Credit Framework for Internship

S No	Internship	Credits	Activities	Credits	Total Credits
1	Short vacation after 1st Semester(4 Weeks)	4	Inter/ Intra Institutional Activities/Weekly Field Visits (Mandatory)	2	6
2	Long vacation after 2nd Semester (8 Weeks)	8	Internship/ Innovation/ Entrepreneurship Activities/ Weekly Field Visits (Mandatory)	2	10

As is clear from Table2.1, during the vacation, after the 1st semester, students are required to take up Inter/Intra Institutional Activities such as training with higher institutions or soft skill training organized by the Training and Placement Cell of the respective institutions; contribution at incubation/innovation /entrepreneurship cell of the institute; participation in conferences/ workshops/ competitions etc.;

Learning at Departmental Lab/Tinkering Lab/ Institutional workshop; weekly field visits and working for consultancy/ research project within the institutes.

During the vacation after 2nd semester, students are ready for industrial experience. Therefore, they may choose to undergo Internship or take up activities related to Innovation / Entrepreneurship. That is, students may work on innovation, take up entrepreneurial activities resulting in start-up, or undergo Internship with industry/NGOs/Government organizations/ Micro/ Small/Medium enterprises to make themselves ready for the industry. In case a student wants to pursue his family business and doesn't want to undergo Internship, a declaration by a parent may be submitted.

Every student is required to prepare a report containing documentary proofs of the activities done by him. The evaluation of these activities will be done by Programme Head/Cell In-charge/ Project Head/ Training and Placement Officer/ Faculty Mentor or Industry Supervisor as specified in the Table 2.2
Table 2.2 gives an overview of internship activities, list of sub-activities under each of these segments, the level of achievement expected, evidence needed to assign the points and the minimum duration needed for certain activities.

Internship Activities' Details:

Table 2.2 Overview of Internship Activities/Credit Framework

Major Head of Activity	Credits (max)	Suggested Period (Max)	Total Duration/ Weeks	Sub Activity Head	Proposed Document as Evidence	Evaluated By	Performance Appraisal/Maximum Points/Activity
Inter/ Intra Institutional Activities	2	During vacation after 1st semester	3-4	Inter/ Intra Institutional Workshop/ Training	Certificate	Programme Head	Satisfactory/ Good/ Excellent
				Working for consultancy/ research project	Certificate	Programme Head	Satisfactory/ Good/ Excellent
				Festival(Technical / Business / Others) Events	Certificate	Programme Head	Satisfactory/ Good/ Excellent
				Contribution in Incubation/ Innovation/ Entrepreneurship Cell	Certificate	Cell-in-charge	Satisfactory/ Good/ Excellent
				Learning at Departmental Lab/Tinkering Lab/ Institutional Workshop	Certificate	Cell-in-charge	Satisfactory/ Good/ Excellent

Major Head of Activity	Credits (max)	Suggested Period (Max)	Total Duration/ Weeks	Sub Activity Head	Proposed Document as Evidence	Evaluated By	Performance Appraisal/Maximum Points/Activity
Innovation/ IPR / Entre-preneurship	2	During vacation after 2nd semester	4-6	Participation in innovation related competitions for e.g. Hackathons etc.	Certificate	Faculty Mentor	Satisfactory/ Good/ Excellent
				Development of new product/ Business Plan/ registration of start-up	Certificate	Programme Head	Satisfactory/ Good/ Excellent
				Work Experience at Family Business	Declaration by Parent	TPO	Satisfactory/ Good/ Excellent
Internship	2	During vacation after 2nd semester	4-6	(Internship with Municipality Hospital/ Hotel. / Residential Complex/ Gated Community/ Residential Campus	Evaluating Report	Faculty/Mentor/TPO/Industry Supervisor	Satisfactory/ Good/ Excellent
Project Work/ Seminar	2	2nd semester	4-6	As specified in the curriculum of the Institute.	Project Report	Project Head	Marks/Grade
Weekly Field Visits (Mandatory Each Week)	2	During 1st and 2nd Semester	Across the course duration, one day per week	As specified in the curriculum of the Institute.	Project Report	Project Head	Marks/Grade

2.2 Campus Placements and Training for Internship

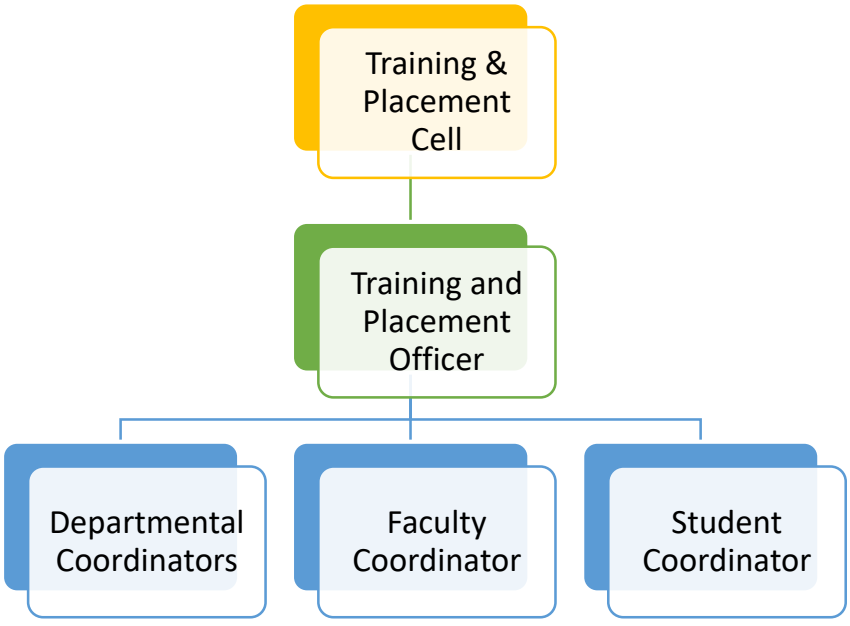
All institutions promoting this course for Internships are required to have a dedicated Training and Placement Cell headed by a Training and Placement Officer (TPO). The Training and Placement Cell, with the help of the department coordinators, will organize Internships and Training sessions in addition to placement activities. Every institute may allocate 1% of their total budget to facilitate the functioning of

Training and Placement Cell and meet the funding requirements for various activities. In any institute TPO plays an important role in boosting the career of students. The purpose of the Training and Placement Officer is to guide students to choose the right career and to plan for programs and activities to enhance knowledge, skills, attitude and the right kind of aptitude to meet the manpower requirements of the Industry. The overall role of the Training & Placement Cell is that of a facilitator and counselor for training- and placement-related activities.

Employers are always on the lookout for students who are vibrant, energetic, ready to accept challenges, attentive, with a good academic background, fast learners, open to learning even at work, and, more importantly, possessing good communication skills. The TPO would do well to assist students to develop/clarify their academic and career interests, and their short- and long-term goals through individual counselling and group sessions. So, the placement cell should also be a contact place where the TPO acts as a facilitator for students' Internship, campus visits, and conduct of recruitment process of employers for purposeful placement of students of the institution.

The Training and Placement Cell needs to assist students in industrial training at the end of fourth and sixth semester. Towards this end, it would be helpful if it designs and implements internal curriculum, takes classes, arranges talks by expert, arranges platforms for student's personality development, improves communication skills, enhances vocabulary, prepares students for writing résumé& emails, group discussion, interviews, conducts aptitude training & practice tests, technical report writing, presentation skills, foreign languages proficiency etc.

Fig 2.2 Organizational Structure of Training and Placement Cell



The Training and Placement Officer (TPO) of the Institute will be supported by a departmental coordinator for Department/Principal concerned. Each department will have a Student's Committee comprising 1-3 students from each class for supporting Training and placement activities, headed by Student Coordinator. Departmental coordinator and Faculty Supervisors/Mentors will be nominated at the start of the academic year for each batch. However, Student Coordinator, being the representative of students, will be selected by the students with the help of Training and Placement Officer.

Faculty Mentor/Supervisors need to play active roles during the Internship and a minimum of 20 students are to be supervised by each faculty mentor, should the departmental strength permit.

2.3Internship Guidelines

The T&P cell will arrange Internship for students in industries/organization after second, fourth and six/seventh semester(s). The general procedure for arranging Internship is given below:

Step 1: Request Letterfrom the office of Training & Placement Cell of the institution should go to industry to allot various slots during vacation as Internship periods for students. The student's request letter/profile/interest areas may be submitted to industries. (Sample attached)

Sample Letter 2.3 Request letter from institute to internship provider

To

The General Manager (HR)

.....

.....

Subject: **Request forApprenticeship ofStudents for 1 year PG Diploma Programme**

Dear Sir,

Our Students have undergone internship training in your esteemed Organization in the previous years. I acknowledge the help and the support extended to our students during training in previous years.

In view of the above, I request your good self to allow our following students for practical training in your esteemed organization. Kindly accord your permission and give at least one-week time for students to join training after confirmation.

A line of confirmation will be highly appreciated.

S. No.	Name	Roll No.	Year	Discipline

With warm regards,

Yours Sincerely,

Training & Placement Officer

Step 2: Industry will confirm the training slots and specify the number of seats allocated for Internships via Confirmation Letter. In case the students can arrange the training themselves, the confirmation letter will be submitted by the students in the office of Training & Placement Cell through the department concerned. Based on the number of slots given, the TPO will allocate students to the Industry. In addition, the Internship slots may be conveyed telephonically or through written communication (by fax, email, etc.) by the TPO or other members of the T&P Cell /faculty members who are particularly looking after the final/summer Internship of the students.

Step 3: Students on joining training at the Industry/Organization concerned, submit the Joining Report/Letters.

Step 4: Students undergo industrial training at the Industry/Organization concerned. Periodically faculty member(s) evaluate(s) the performance of students once/twice by visiting the Industry/Organization and the Evaluation Report of the students is submitted at the Department office/TPO with the consent of and in consultation with the Industry persons/trainers. (Sample Below)

Sample Format 2.3 Faculty Evaluation of Intern

Student Name			**Date**	
Institution Name				
Work Supervisor			Title	
Company/Organization				
Internship Address				
Dates of Internship	From		To	

Please evaluate your intern by indicating the frequency with which you observed the following behaviors:

Behaviors	**4**	**3**	**2**	**1**
Performs in a dependable manner				
Cooperates with co-workers and supervisors				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/originality				
Analyzes problems effectively				
Is self-reliant				
Communicates well				

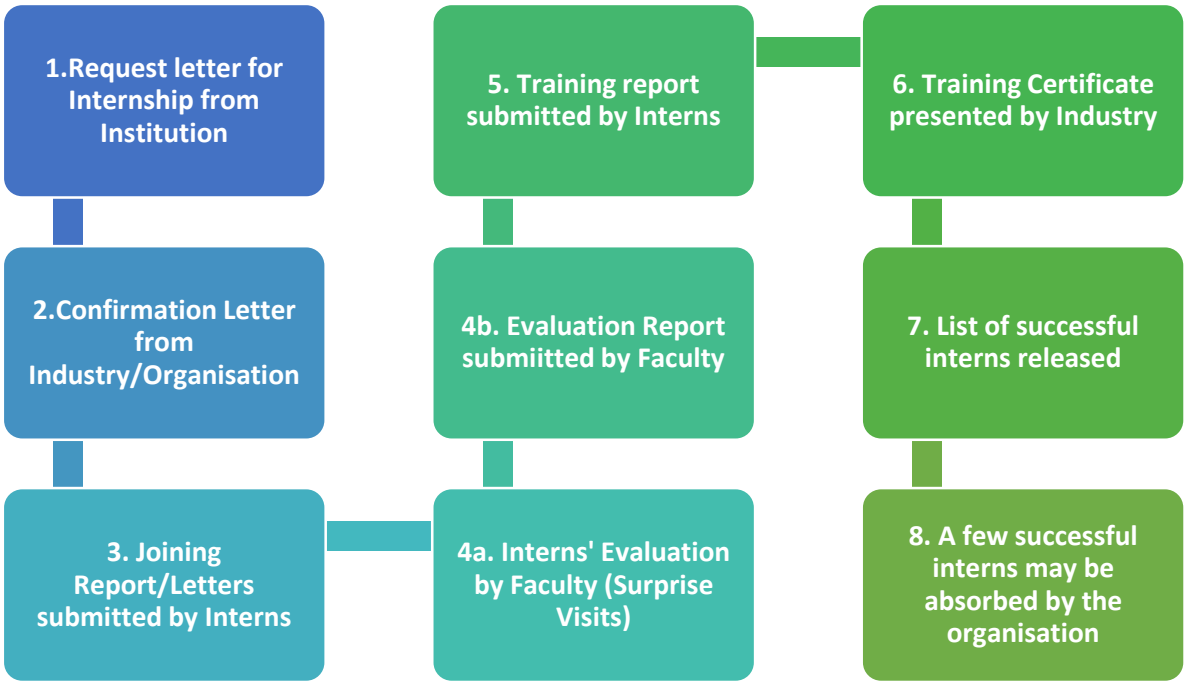
Writes effectively				
Has a professional attitude				
Gives a professional appearance				
Is punctual				
Uses time effectively				
Overall performance of student intern (circle one):(Satisfactory/ Good/ Excellent)				
Additional comments, if any:				
Signature of Mentor Faculty		HR Manager		

Step 5: Students will submit training report after completion of internship.

Step 6: Training certificate to be obtained from industry.

Step 7: List of students who have completed their internship successfully will be issued by Trainingand Placement Cell.

Step 8 : A few successful interns may be absorbed by the Industry/Organization



Flow Chart 2.3 Internship Flow Chart

2.4 Guidelines for the Students

Internship/Placement is a student-centric activity. Therefore, students need to play a major role. The TPOs may involve students in the following activities too:

- Design and printing of placement brochure – soft copy as well as hard copy.
- Preparing list of potential recruiters and past recruiters.
- Placement presentation at various organizations, if required.
- Coordinating activities related to placement, including visits of companies' HR teams to institutes.

At the commencement of the session, members of the Student Placement Committee would be selected from interested students, who submit applications to TPO, to work on the Placement Committee. Among the volunteers, one student would be nominated as "Student Coordinator" who would be assigned major responsibilities and would be accountable to TPO.

For availing of allotted Internship slots, students are required to submit "Student internship programme application" before the prescribed date (Sample below).

Sample Format 2.4 Student Internship Program Application

Complete and submit to the Internship Program Coordinator. Type or print clearly.

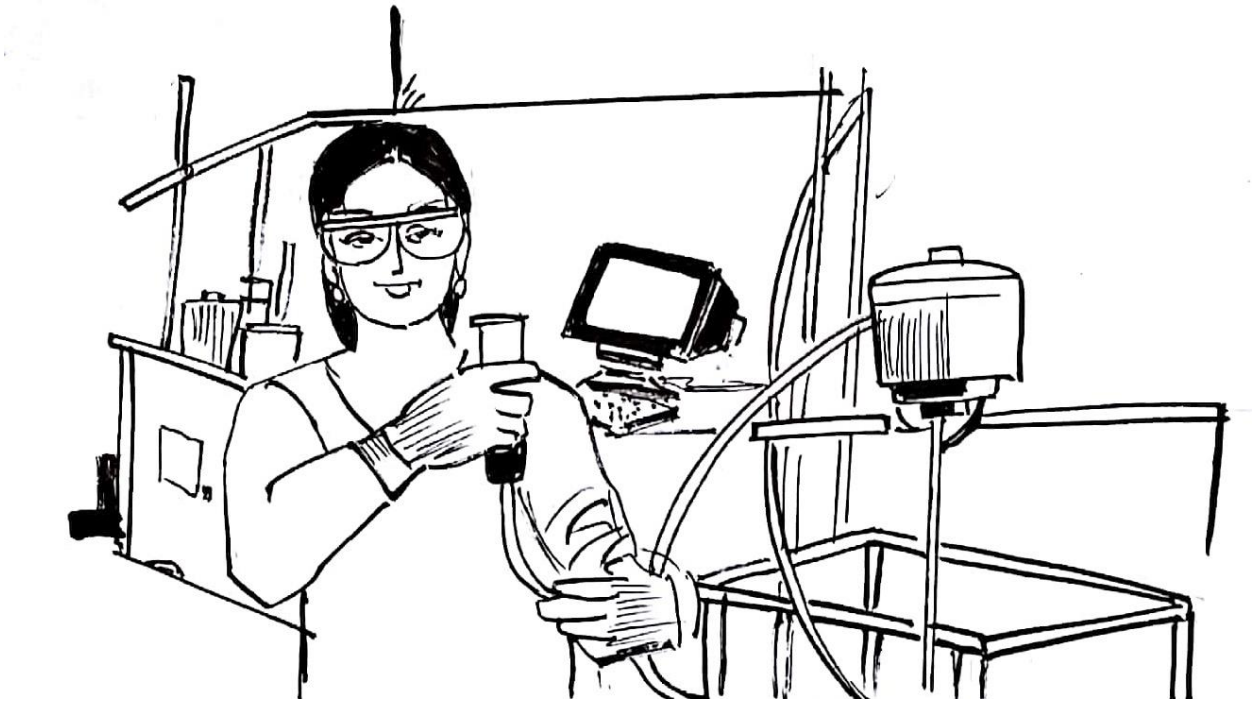
Student Name		**Contact number**	
Campus Name & Address			
Campus Contact person		Contact number	
Home address			
Home contact details		Contact number	
Intern E Mail address			
Internship Semester No.			
Overall GPA			
Internship Preference	**Location**	**Core Area**	**Company/Organization**
Preference 1			
Preference 2			
Preference 3			
Mentor Faculty Signature		Date	
Signature confirms that the student has attended the internship orientation and has met all paperwork and process requirements to participate in the internship program, has met the minimum overall GPA and average GPA within major and has received approval from his/her Advisor..			
Student Signature		Date	
Signature confirms that the student agrees to the terms, conditions, and requirements of the Internship Program			

The offer letter given by the company needs to be accepted, irrespective of the company/job profile or job location or stipend offered.

A student who voluntarily gives in writing that he/she does not require placement assistance from the Institute would be exempted from participation in placement activities. This could be because of acceptable reasons such as – joining family business, medical reasons, etc.

Although organizations select individual students, recruitment is a team effort. Hence, all students should be careful and behave responsibly while interacting with the recruitment teams.

2.5 Health, Safety and Welfare



The provisions of law in relation to the health, safety and welfare of the apprentices as if they were workers within the meaning of The Apprentices Act; and, when any apprentices are undergoing training in a mine, the provisions of Chapter V of the Mines Act, 1952, shall apply in relation to the health and safety of interns as if they were persons employed in the same category.

Action to be taken by the Intern in case of any safety problem faced:

1. Intern must immediately report any problem with respect to safety to the mentor faculty, TPO and supervisor.
2. Ensure amicable resolution to the problem and communicate the same to the mentor faculty and TPO.
3. Intern needs to ensure that there is no problem caused by him/her as it could result in termination from the internship.

Fig 2.5 Examples of Safety Risks

Chapter 3
Guidelines for Industry

Structure

3.1 Finalise Targets/goals
3.2 Pre-plan for Internships
3.3 Policy Document and Annual Plan
3.4 Selection of intern(s)
3.5 Supporting/ orienting the intern(s)

For meeting the objectives of the Internship programme and for its successful implementation, each Internship programme have to be designed keeping in view the company's requirements and student profile. Design of Internship programme can be developed by the industry in collaboration with the institute concerned. It would comprise the following steps:

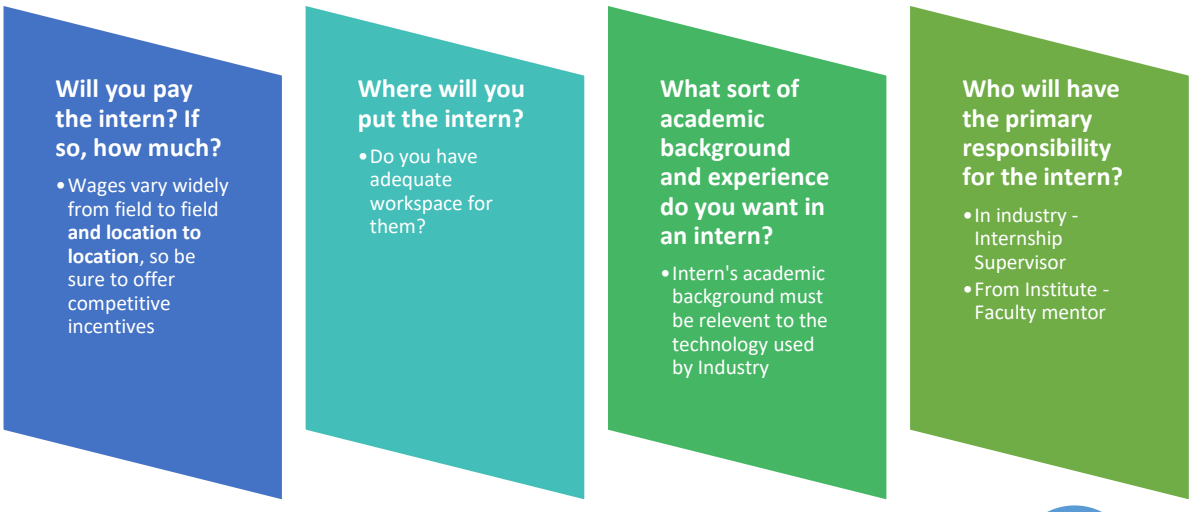
3.1 Finalise Targets/goals

A meaningful discussion with the management in the organization can help arrive at a consensus on programme goals that can be understood by all involved.

1. What does the company hope to achieve from the interns?
2. Is a small company searching for technical help?
3. Is the company growing quickly and having difficulty in finding motivated new employees?
4. Is it a non-profit organization that doesn't have a lot of money to pay, but can provide an interesting and rewarding experience?
5. Is the organization looking for new employees with management potential?

3.2 Pre-plan for Internships

Fig3.2. Internship Planning by Industry



3.3Prepare a Written Plan

Carefully plan and write the internship program: An internship plan has to be developed which will be referred to by industry supervisor/mentor, interns and institute faculty. An internship plan should incorporate at least the following:

- Description of duties associated with Internship on the lines of job description.
- Name of the project, if any.
- Internship schedule and expected learning outcomes.

Students can offer a fresh perspective to business strategies and plans, since their perceptions are generally not coloured by long-standing issues. So, it pays to engage interns in brainstorming sessions, meetings etc. The interns may also be given an opportunity to understand Project Management and finances. This will help them apply learning to their own work as member of a team and as leader of a team. It's no secret that this generation is more tech-savvy than any other before. Companies may take the opportunity to use them to find out some digital solutions for various issues.

3.4 Allocation of Students to Industry

After the allocation of internship slots by the industry to the institute, students have to be allocated to the industry. In case the industry wants to select students based on their requirements, the industry can conduct an interaction/interview with the students and pick the ones best suited to their needs. In case the industry leaves it to the Institute to select the students, the TPO needs to go by transparent criteria for allocation of students to the industry based on the requirements of the industry and students' interests.

3.5 Managing/Facilitating Intern(s)

Orientation of Interns: Orient interns in the new workplace. This could involve a walkthrough or a conventional orientation program based at office, depending on the size of the company. Give interns an overview of the organization; some companies arrange talks, play videos or hand out information about the company's history, vision and services. Explain who does what and what the intern's duties will be. Introduce him or her to co-workers.

Provide resources to interns: Give the intern a desk, point out the room with supplies, and introduce the technical support people.

Guidance and feedback: Apart from hand-holding, it is important to give them lots of feedback, especially if the interns have never done that kind of work before. It is natural that they'll want to know if their work is measuring up to organizational expectations.

Monitoring of intern's progress: Daily progress of the intern is to be charted and evaluated by an industry supervisor. Maximum use of short-term internship has to be ensured for the intern as well as industry. Periodically, examine what the intern has produced and make suggestions. Weekly supervision meetings can help monitor the intern's work effectively.

Chapter 4
Daily and Term-end Reporting

Structure

4.1 Intern's Diary/ Daily Activity Log

4.2 Internship Term end Report

4.3. Internship Report Format/ Template

4.1 Intern's Diary/Daily Activity Log

The main purpose of writing daily activity log is to cultivate the habit of documenting among interns and to encourage them to look for details. It develops interns' thought process and reasoning abilities. The interns need to record in the daily activity log the day-to-day account of their observations, impressions, information gathered and suggestions given, if any. It needs to contain the sketches & drawings related to the observations made by the interns.

The daily training activity log needs to be signed every day after work by the supervisor/ in charge of the section where the intern has been working. The diary needs to also be shown to the faculty mentor visiting the industry from time to time and needs to get ratified on the day of his/her visit.

The intern's Daily Activity Log and Internship Report need to be submitted by the interns, along with attendance record and an evaluation sheet duly signed and stamped by the industry, to the Institute immediately after completion of the training. It needs to be evaluated on the basis of the following criteria:

- Regularity in maintenance of the Daily Activity Log.
- Adequacy & quality of information recorded.
- Drawings, sketches and data recorded.
- Thought process and recording techniques used.
- Organization of the information

Sample Format 4.1 Suggested Format for Intern's Daily Activity Log

DAY #		**DATE**	
Time of arrival	Time of Departure	Remarks	
Dept./Division		Tasks done	
Name of HOD/Supervisor With e-mail id			
Main points of the day			

Signature of Industry Supervisor

4.2 Intern's Term End Report

After completion of Internship, the intern needs to prepare a comprehensive report to describe what he has observed and learnt during the training period. The intern may contact Industrial Supervisor/ Faculty Mentor/TPO for assigning special topics and problems and needs to prepare the final report on the assigned topics. The Daily Activity Log will also help to a great extent in writing the internship report, since much of the information has already been incorporated by the student into the daily activity log. The internship report needs to be signed by the Internship Supervisor, TPO and Faculty Mentor. The Internship report needs to be evaluated on the basis of following criteria:

i. Originality.
ii. Adequacy and purposeful write-up.
iii. Organization, format, drawings, sketches, style, language etc.
iv. Variety and relevance of learning experience.
v. Practical applications relationships with basic theory and concepts taught in the course.

4.3 Suggested Format for Internship Report

1. Cover page
2. Acknowledgements
3. Table of Contents
4. Abstract
5. Body of the report
    a. Introduction of the Internship Employer
    b. Details about the Department assigned for Internship
    c. Internship responsibilities
    d. Learning from the Internship experience
    e. Reflection on performance during Internship
6. Bibliography
7. Glossary
8. Annexures

Sample Format 4.2 Internship Report

INTERNSHIP REPORT

Company Name & Address

Academic Year: 20____ - 20____

2nd Semester of PG Diploma in Waste Management and Environmental Hygiene

Full Name of Student/Intern:

Internship Supervisor Name:

Mentor Faculty Name:

Name of Institution

Internship Period:

ACKNOWLEDGMENTS

Thanking those who contributed to the success of your internship. In general, thank first your supervisor, direct team members and possibly one or two other colleagues with whom you have worked and the team from your institution. Remember to include the name and position of each person you want to thank and the role he/she has played during your internship. Acknowledgments should be on one page maximum knowing that you do not have to fill an entire page.

TABLE OF CONTENTS

The table of contents states all the chapters and the sub-chapters of the report with page numbers. You can choose to divide the chapters in sections and sub-sections (1, A, 1st, a) or choose a decimal organization (1, 1.1, 1.2…).

ABSTRACT

This will include a synopsis of the Internship Learning and Experience

BODY OF THE REPORT

a. INTRODUCTION OF THE INTERNSHIP EMPLOYER

a. Identification **(**Name, Headquarters, Size, History…)
b. Location and Branches
c. Presentation of the activity sector (waste management/environmental hygiene)
d. Organizational chart
e. Relationships with the external environment (optional)

b. DETAILS ABOUT THE DEPARTMENT ASSUGNED FOR INTERNSHIP

a. Presentation of the department in which you are carrying out your internship

c. INTERNSHIP RESPONSIBILITIES

a. Description of the mission and the tasks (imposed or personal choice)
b. Explain your position and role in the organization of the Company

d. LEARNING FROM THE INTERNSHIP EXPERIENCE

a. Describe what you have learned (the responsibilities, the progress all along the internship, your integration in the team)

e.REFLECTION ON PERFORMANCE DURING INTERNSHIP

b. Evaluation of the internship (obtained results, the most useful parts of the internship, your degree of satisfaction towards the Company and your work)

BIBLIOGRAPHY

The bibliography is a sequence of records with documents in alphabetical order of the names of authors (the author (full name), the title of the book(underlined), place of publication, the name of the publisher, date of publication, number of pages, the collection.

GLOSSARY

It is particularly useful to provide a glossary when a large number of special or technical terms are provided since the world is filled with acronyms of all kinds. It is, therefore, essential to develop a good understanding. These are to be listed in the glossary.

ANNEXURES

Documents related to the internship are in the Annexures (photo, press article, technical sheets, brand model, certificate of training completion (if any), organizational chart, table, graph etc.)

Chapter 5
Monitoring & Evaluation of Internship

Structure

5.1 Agency Evaluation

5.2 Institute/University Evaluation by University Staff/ Faculty Mentor

5.3. Term end evaluation through seminar presentation/viva-voce at the Institute

5.1 Agency Evaluation

The industry/agency needs to evaluate the students based on their punctuality, eagerness to learn, maintenance of Daily Activity Log Book and skill test in addition to any feedback on performance.

Sample Format 5.1 Supervisor Evaluation of Intern

Student Name			**Date**	
Institution Name				
Work Supervisor			Title	
Company/Organization				
Internship Address				
Dates of Internship	From		To	
Please evaluate your intern by indicating the frequency with which you observed the following behaviors:				
Behaviors	**4**	**3**	**2**	**1**
Performs in a dependable manner				
Cooperates with co-workers and supervisors				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/originality				
Analyzes problems effectively				
Is self-reliant				

Communicates well				
Writes effectively				
Has a professional attitude				
Gives a professional appearance				
Is punctual				
Uses time effectively				
Overall performance of student intern (circle one): (Satisfactory/ Good/ Excellent)				
Additional comments, if any:				
Signature of Industry Supervisor		HR Manager		

5.2 Institute/University Evaluation by University Staff/ Faculty Mentor

Staff/ Faculty Mentor of the institute needs to make a surprise visit to the Internship site to check on the intern's presence physically. If the intern is found to be absent without prior intimation to the institute, his internship needs to be cancelled. Interns need to inform the institute, faculty mentor as well as the industry supervisor at least one day prior to availing leave by email. Interns are eligible to avail 1 day leave in 4 weeks and 2 days' leave in 6 weeks of the internship period.

5.3. Term-end Evaluation through Seminar Presentation/Viva-Voce at the Institute

The intern needs to present a seminar based on his/her Internship Report, before an expert committee constituted by the department concerned as per norms of the institute. The evaluation needs to be based on the following criteria:

- Quality of content presented.
- Proper planning for presentation.
- Effectiveness of presentation.
- Depth of knowledge and skills.

Attendance record, daily activity log, departmental reports need to be also analyzed along with the Internship Report.

Seminar presentation needs to enable sharing knowledge & experience amongst interns& teachers and build communication skills and confidence in students.

Chapter 6
Waste Management and Environmental Hygiene Activity Point Programme

Structure

6.1 Spin-offs of Internship
6.2 Characteristics of an Internship Project
6.3 Learning Outcomes
6.4 Areas of internships

6.1 Spin-offs of Internships

There are plenty of opportunities for Internship in companies and agencies engaged in Waste Management and Environmental Hygiene. Students with the right kind of skill sets can do wonders.

Skills required:

- Flexibility and self-motivation.
- Ability to work both on your own and as part of an international team.
- Ability to multitask and organize your work with minimal supervision and limited resources.
- Strong communications skills.
- Interest and motivation to collaborate with community and team members.
- Facing challenges and unexpected events in creative, open-minded and positive manner.

Benefits accrued

- Learn how to plan, research, manage, empower, and work individually and as part of a team
- Gain on-ground exposure to the operations of a grassroots development agency
- Develop deep understanding of challenges faced by developing countries like India as well as what is making it succeed
- Gain cross-cultural fieldwork experience in a multi-cultural team
- Develop project management and leadership skills
- Maximise recycling know-how
- Gain first-hand perspective with a developing, self-sustainable social enterprise model agency
- Develop new perspectives and connections within the development sector

6.2Characteristics of an Internship Project

Concrete

- **Project-oriented:** The student's experience needs to include intentional real-world activities in a professional setting or context.
- **Time commitment:** The student's experience needs to last over a significant duration of time. Relative duration and time commitment need to be discussed with the mentor(s) and supervisor at the beginning of the experience. Internships need to adhere to university/departmental guidelines.
- **Concrete outcome:** The student needs to produce tangible evidence reflective of their experience. Evidence might include writing press releases, drafting a consulting report, creating a marketing plan, developing a website, analyzing data and compiling reports, etc.

- **Authentic experience:** The level of scholarship and engagement needs to be appropriate to the field(s) of study. The Internship or Professional Experience need to align with the student's career interest and/or course of study.

Active

- **Hands-on:** The student's experience needs to include application of knowledge and skills. Student is assigned specific roles and responsibilities.
- **Student ownership:** The student's ideas need to be original. The student needs to take at least partial responsibility for the scope and direction of the project.

Reflective

- **Student reflection:** The student needs to show evidence of reflective thinking about the experience. Student needs to complete a final evaluation of the experience. Student needs to include experience on resume and might be asked to create an e-portfolio, participate in a poster presentation, keep a journal, etc.
- **Mentorship/Supervision:** The student needs to work with one or more faculty/staff member(s) who serve as a guide(s) and mentor(s). Student need to also have supervisor who needs to provide an orientation, be available to answer questions, assign duties, provide constructive feedback and complete a final evaluation.

Dynamic

- **Evidence of change:** Engagement needs to promote change or increased awareness in the organization. Student's tasks and projects are expected to make a meaningful impact.
- Personal transformation: Student needs to have opportunities to reshape their personal and academic profiles. Students develop confidence and acquire professional skills. Experience helps student determine how the position/industry aligns with their interests, skills, values and personality.

6.3 Learning Outcomes

- Students need to connect theory to practice and vice versa.
- Students need to adapt to dynamic situations; employ and develop a range of professional skills (such as technical, analytical, organizational, leadership, and interpersonal skills).
- Students need to practice teamwork; demonstrate creative problem-solving skills.
- Students need to exhibit strong work ethics and initiative; display integrity in decision-making.
- Students need to engage in reflection and demonstrate self-awareness; display passion and openness for continual learning.

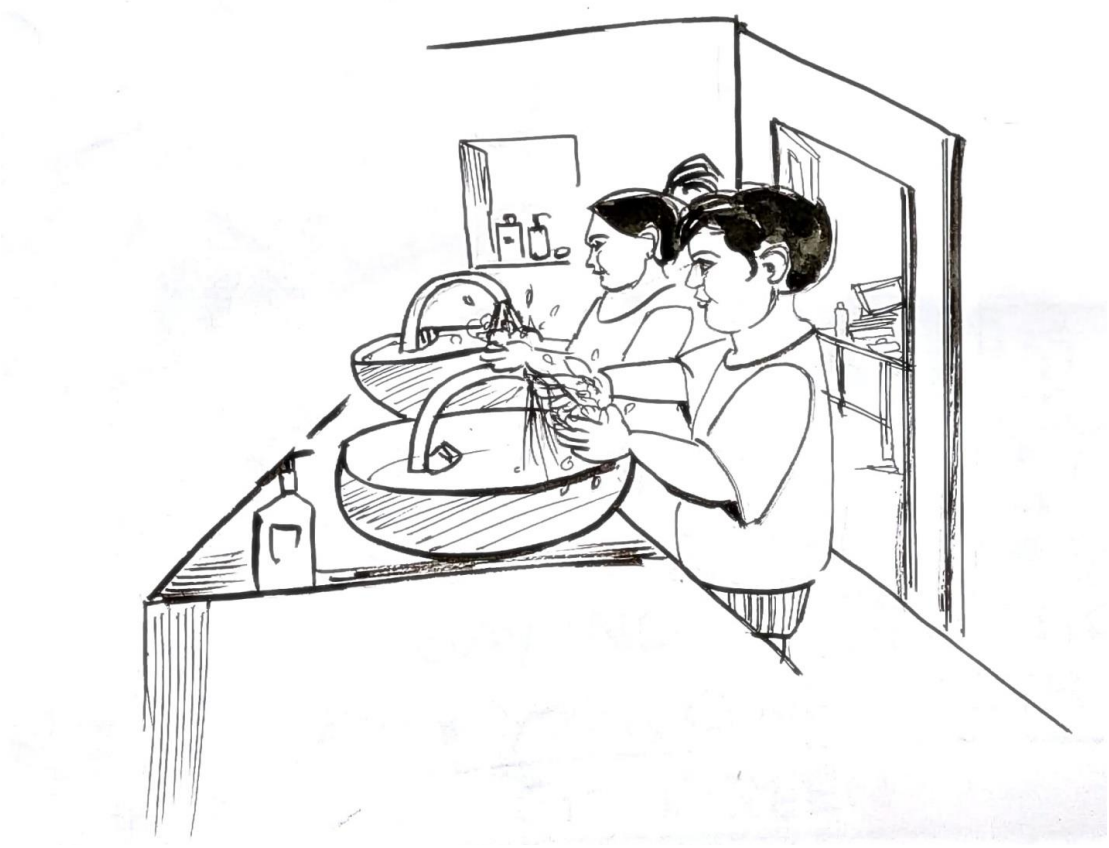
6.4 Areas of Internship

1. Solid Waste Management Prototype Creation and Management
2. Planning & Facilitation of Zero Waste System in a Residential Complex or a Campus or a Gated Community

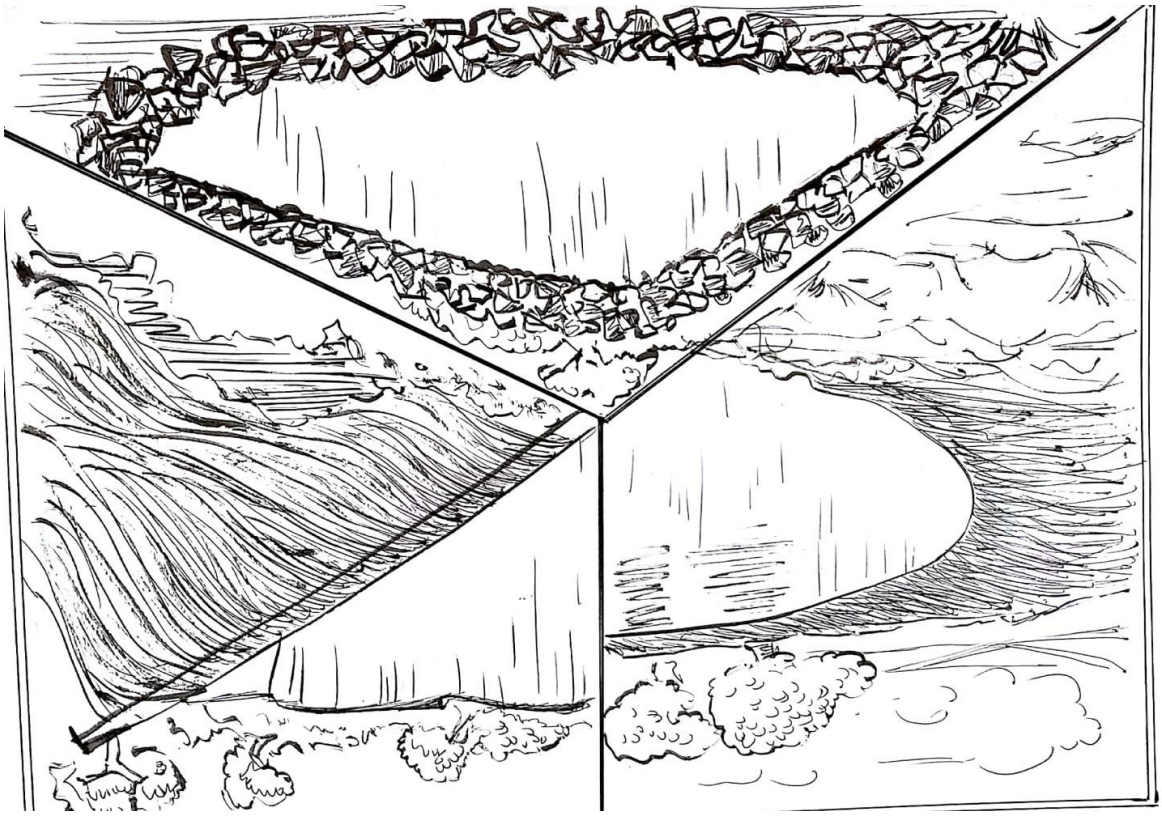
3. Service Learning, Community Research & Engagement
4. Waste Market Research & Database Development for different Waste Products
5. Waste Disposal Management– Reduce/Reuse/Recycle

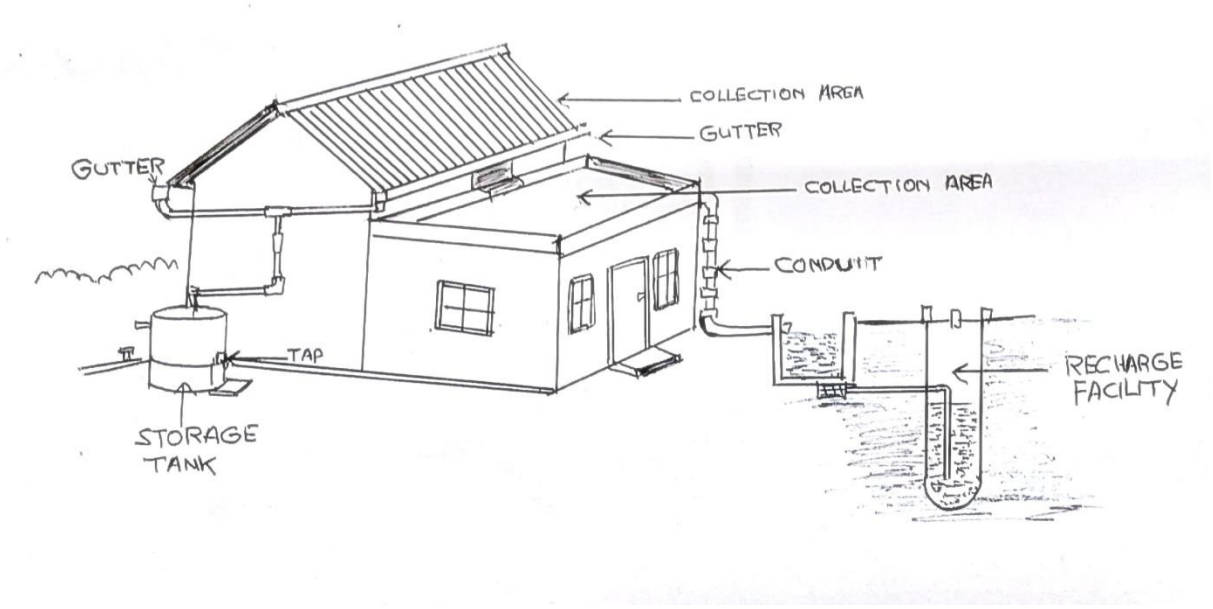
6. GIS Mapping for Waste Management – location-wise: terrain, resources, vulnerabilities, opportunities, quantities
7. Compost, Products, Packaging Research & Development

8. Waste Management Facility Design Management
9. Managing a Water, Sanitation and Health Project



10. Campus or complex or community Household Grey-water Recovery / Reuse Project
11. Campus or complex or community Rainwater Harvesting / Recharging ground water





Volunteer – Internship opportunities in Sanitation and Waste Management

1. **Solid Waste Management Prototype Creation and Management**

Here a waste management system is planned that includes waste collection from all stakeholders (including households, hotels, restaurants, grocery shops, non-grocery shops & food stands) and the construction of a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' campus in which all waste is recycled and reused and no waste reaches the landfill.

In order to test whether a new Solid Waste Management project can work in a tourist, yet rural setting with many stakeholders(including hotels, restaurants, grocery shops, food stands and households), first a prototype in discussion with all stakeholders needs to be designed and implemented in order to appraise whether it is functional and thus also determine whether the prototype is replicable on a large scale in the entire village.

The Intern needs to undertake most of the following tasks/responsibilities:

- In collaboration with fellow team members design a Solid Waste Management prototype for all stakeholders, including at least two households, two hotels, two restaurants, two grocery stores, two food stands, one non-grocery store and the local school.
- Test implementation of this prototype.
- Appraise replaceability of prototypes to all members of each stakeholder group- e.g. in the case of grocery shops, if there has been a trial with two grocery shops appraise whether it is functional and can be extended to all grocery shops in the village.
- Appraise replaceability of prototypes for each stakeholder group as part of an integrated system so that all parts of the waste management system (i.e. all stakeholders) can function interrelatedly.
- If necessary, make improvements to individual stakeholders or the entire system.
- In collaboration with fellow team members, Assistant Programme Coordinator and Chief Programme Director implement the successful prototype for all groups of stakeholders.

2. **Planning &facilitation of Zero Waste System in a residential complex or a campus or a gated community**

In this, a Solid Waste Management system is planned that includes waste collection from all stakeholders (including households, hotels, restaurants, grocery shops, non-grocery shops & food stands) a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' village in which all waste is recycled and reused and no waste reaches the landfill. To ensure sound implementation, the system needs to be backed by awareness raising and educational measures. Under the ultimate aim of 'Zero Waste', the Intern needs to be responsible for the planning and facilitation of the introduction of a Zero Waste System.

The Intern needs to undertake at least several of the following tasks/responsibilities:

- Conduct workshops on new Solid Waste Management System with all stakeholders in village, i.e. households, hotels, restaurants, food stands, grocery shops, non-grocery shops and local school, including on environmental & health impacts of adverse waste practices- e.g. on personal health, animals, plants, ground water, global warming; also provide education on how to improve one's own waste practices through "Reduce, Reuse, Recycle" under overarching goal of zero waste.
- Design & distribute user manuals for all stakeholders accompanying smooth introduction of the Zero Waste System;
- Provide training that is necessary to diverse stakeholders
- Design, construct and put up signs warning against the dangers of burning & littering throughout the village including concisely explaining the effects mentioned in workshops
- Plan and carry out community cleanup involving diverse stakeholders while incorporating an educational component
- Continuously keep rapport through interpersonal communication with all stakeholders in community and, if necessary, make improvements to the Zero Waste System design.
- In collaboration with local municipal government and local resource manager, recruit one to two waste collectors and provide training on waste collection.

3. **Service Learning, Community Research & Engagement**

A Waste Management System is planned so that it includes waste collection from all stakeholders (including households, hotels, restaurants, grocery shops, non-grocery shops & food stands), a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' area in which all waste is recycled and reused and no waste reaches the landfill. In order to achieve these goals and to implement a completely locally-owned and sustainable Waste Management System for the village, comprehensive data needs to be collected through community surveys. Moreover, continuous rapport with a diverse range of stakeholders in the community needs to be built through interpersonal communication that raises awareness and tackles behavioural change of community members.

The Intern needs to undertake at least the following tasks/responsibilities:

- Build and nurture positive, proactive attitudes towards waste management in the village, raise awareness, and promote self-responsibility towards environmental sustainability. To achieve this, employ behavioural change communication and/or any other viable methods.
- If necessary, conduct community surveys on waste behaviours.

4. **Waste Market Research & Database Development for Different Waste Products**

A Waste Management System is planned that includes waste collection from all stakeholders (including households, hotels, restaurants, grocery shops, non-grocery shops & food stands), a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' village in which all waste is recycled and reused and no waste reaches the landfill. The solid waste management projects need researchers who have on board all key stakeholders in the area involved in the generation of waste(except households) i.e. hotels, restaurants, grocery shops, service shops, food stands and the local school.

The Intern needs to undertake at least one of the following tasks/responsibilities(the second and third tasks predispose the first):

- Identify types and amounts of inventory of all stakeholders and list materials of all waste products and materials moving through the commercial supply chain and people, such as through hotels and guest houses, grocery shops, service shop providers, restaurants, food stands and the local school.
- For example, a takeaway drink with a straw would be classified as tetra pack for the packet and the type of soft plastic at hand for the straw e.g. low-density polyethylene, whereas a sold toothbrush would likely involve a certain hard plastic for the tube e.g. high-density polyethylene, cardboard for the packaging and polypropylene for the lid.
- Create database and does statistical analysis using Excel, SPSS or other statistical programme.
- Performs online market research that includes exploring alternative and similar products with a low waste index.
- Writes report on findings.

5. **Waste Disposal Management– Reduce/Reuse/Recycle**

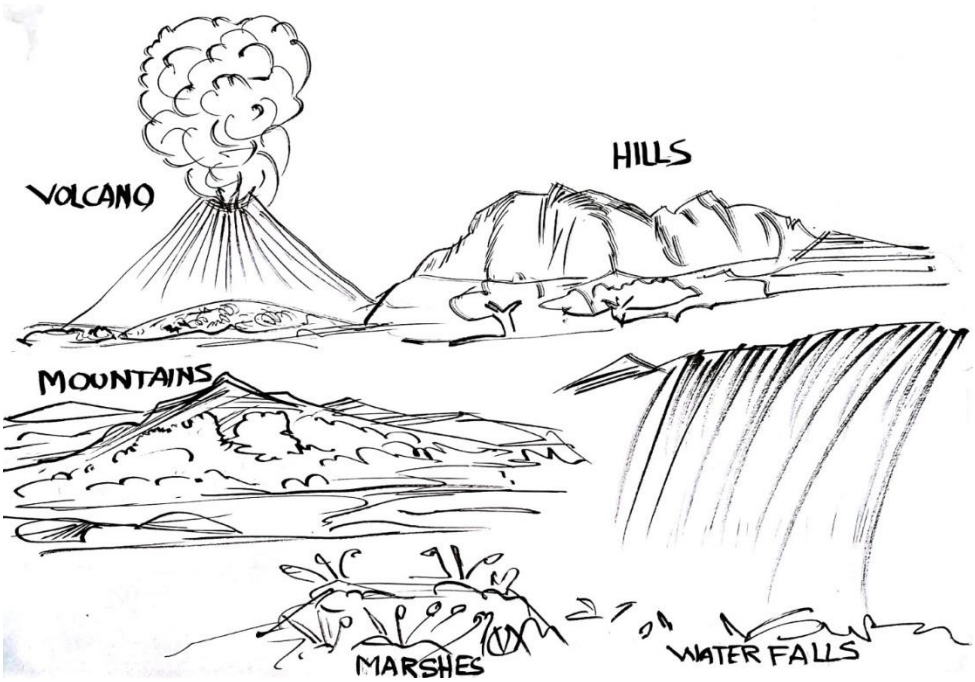
Reduce/Reuse/Recycle/Replenish in four villages of different topographic environments (hills, agricultural plains, and desert/arid region) in India

A waste management system is planned that includes waste collection from all stakeholders (including households, hotels, restaurants, grocery shops, non-grocery shops & food stands), a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' area in which all waste is recycled and reused and no waste reaches the landfill.

Under the ultimate aim of 'Zero Waste' the engineer/project manager needs to be responsible for the planning, design and implementation of a waste processing facility that converts soft plastic into another usable and sellable material, e.g. fishing baits, handbags or another viable product. Ideally, a second role needs to be to recycle paper and cardboard waste into new paper and cardboard or to recycle a third kind of waste prevalent in the village- depending on the candidate's skills and interests. The goal is to create local environmental and economic value through attaining maximum resource efficiency from existing waste.

6. **GIS Mapping for Waste Management – location-wise: terrain, resources, vulnerabilities, opportunities, quantities**

GIS Mapping for Waste Management system is planned. This must fit in with the system that includes waste collection from all stakeholders (including households, hotels, restaurants, grocery



shops, non-grocery shops & food stands) a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' area in which all waste is recycled and reused and no waste reaches the landfill. In order to gain a sound understanding of waste processes in the area, the project manager needs to undertake the following tasks:

- Using QGIS or other GIS software, map the area and surroundings- including households, hotels, guest houses, restaurants, food stands and grocery shops.
- Present findings to Chief Project Director and fellow team members.
- Perform additional GIS-related tasks as required.

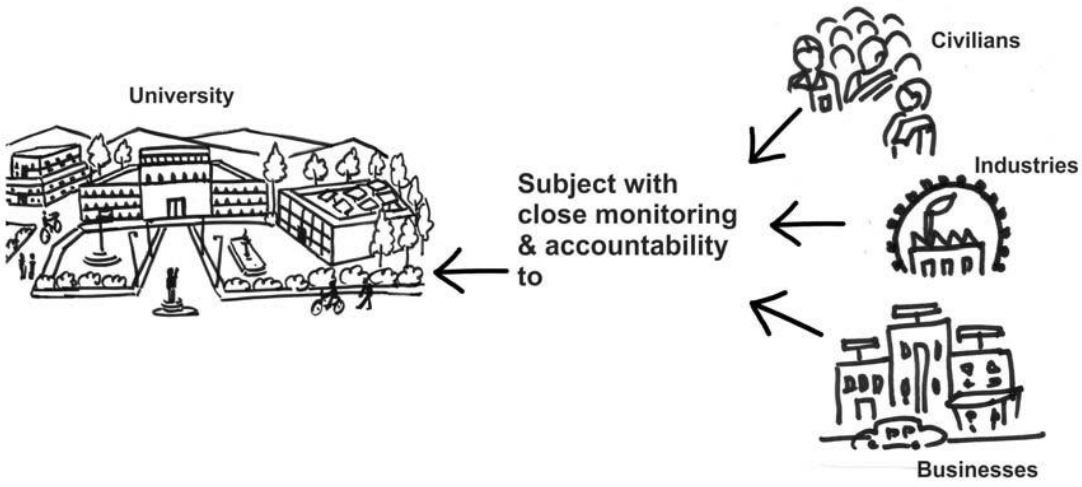
7. Compost, Products, Packaging Research & Development

Products and Packaging Research & Development in four different topographic environments (hills, agricultural plains, and desert/arid region) in India

As part of the project, a Waste Management System is planned that includes waste collection from all stakeholders (including households, hotels, restaurants, grocery shops, non-grocery shops & food stands) a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' area in which all waste is recycled and reused and no waste reaches the landfill. The goal of zero waste can only be attained by also reducing waste at the production / product / supply / storage and consumption level.

Thus, the Intern needs to undertake at least two of the following tasks/responsibilities:

- Identify and promote the sale and purchase of products in the village made using eco-friendly, sustainable processes and with no or very little toxic packaging.
- Trigger alternative means of production to mass-produced industry packaged and supplied products that can be made using local, safe and recyclable materials. This may include liaising with local entrepreneurs.
- Promote the avoidance of toxic and non-recyclable materials in the village so that maximum resources can be recovered with least harm to the environment. This may be achieved through conducting workshops, seminars or other education-enhancing methods and utilizing behavioural-change communication.

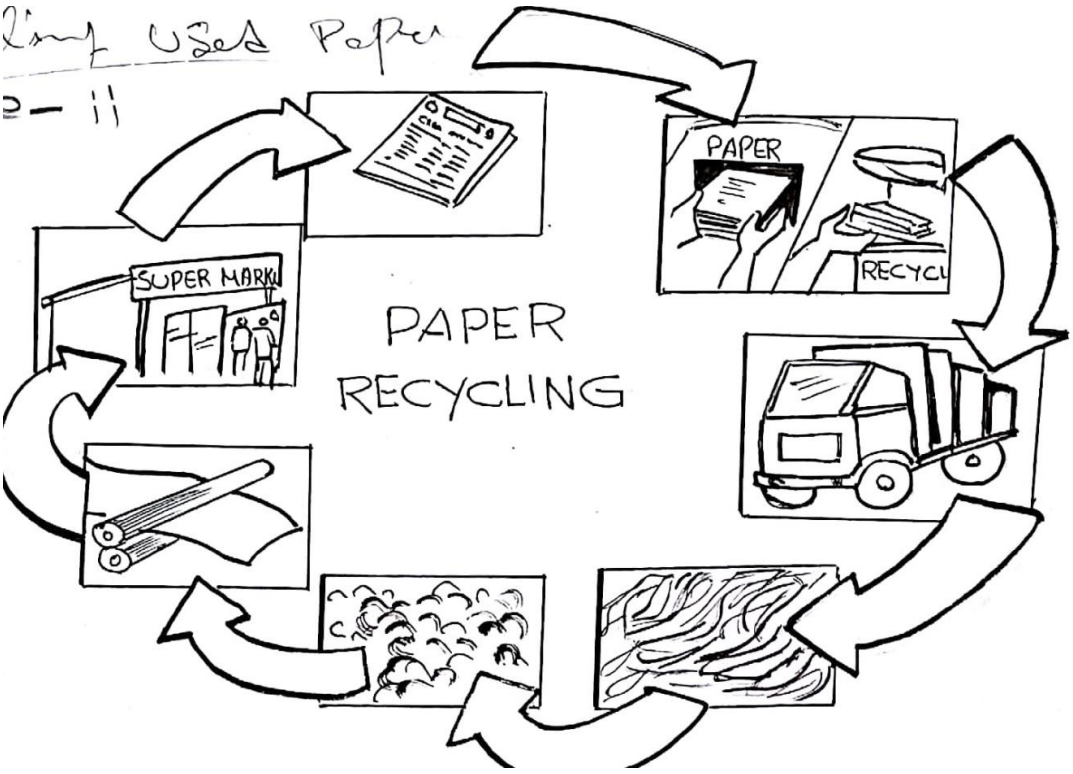


8. Waste Management Facility Design Management

"Design Management" in different topographic environments (hills, agricultural plains, and desert/arid region) in India

A Waste Management System is planned that includes waste collection from all stakeholders (including households, hotels, restaurants, grocery shops, non-grocery shops & food stands), a waste collection and storage facility as well as a waste processing facility. The ultimate goal is for the locality to be a 'Zero Waste' location in which all waste is treated as a resource for recycling and reused to prevent any waste from reaching the landfill.

In order to construct a robust and sustainable Waste Management System, its design and processes need to be well-defined and informed. This need to be done, in particular in collaboration with the project managers for "Waste Management Prototype Design" and "Planning & Facilitation of Zero Waste System". In addition, in collaboration with the manager for the "Planning & Facilitation of Zero Waste System," policies need to be drafted that ensure the sustainability of the Waste Management System, especially on how to keep the community members involved and establish leaders that take ownership and responsibility of the village's Waste Management System and judge it to be crucial to community development. The method/design to be used is up to the project manager(s) to decide.

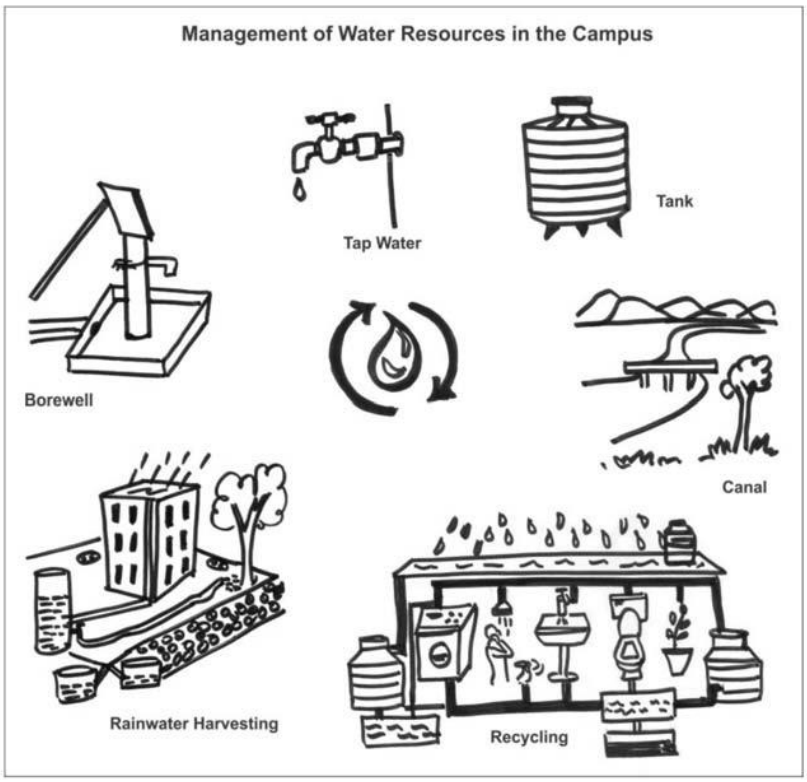


9. Managing a Water, Sanitation and Health Project

Safe water is critical for rural poor and children, who are the most vulnerable to water-related diseases. We need to develop economical and simple-to-use household solutions for water sanitation in impoverished rural areas. The larger goal is to decrease illnesses, improve health, and lessen the burden on women and children by reducing the distance to water collection points in some arid areas

.

The water and sanitation program also helps sensitise and train communities to obtain adequate supplies of safe water and sanitation facilities through various ecological methods, including developing spring and rainwater catchments, providing water storage, building household filtration systems, and constructing household latrines, refuse dumps, and surface water drainage systems. These initiatives become sustainable as community members are motivated to maintain water sources and supply, and serve on water and sanitation committees that oversee community improvements. This project design should include hygiene education for children and adults, including proper hand and face washing, to prevent disease.



10. Campus or complex or community household grey-water recovery /reuse project

Grey-water Recovery / Reuse project involves the collection of bath and shower water which is then filtered, disinfected, and recycled with grey water treatment for the use of toilet flushing. The quantity of water used for hand basins, showers and baths is similar to that used for toilet flushing. In most buildings, water consumption needs to be reduced by 50%. Supply roughly equates to demand as each person is generating their own water.

The project should be so designed that it is aimed at promoting greywater reuse as a way to increase the productivity of sustainable backyard ecosystems that produce food, clean water, and shelter wildlife. Such systems recover valuable "waste" products–greywater, household compost, and humanure–and reconnect their human inhabitants to ecological cycles. By modeling appropriate technologies and social behaviours for food production, water, and sanitation in rural areas, a culture of water conservation can be engendered.

12. Campus or complex or community rainwater harvesting / recharging ground water

Rainwater harvesting is one strategy in the greater scheme of reducing domestic water use. Through harvesting rainwater, we can utilize the rainwater falling onto our homes and landscapes for beneficial purposes, while preventing it from becoming stormwater pollutant as it runs off into the storm-drain. Rainwater harvesting inspires other practices that lead to greater sustainability. Growing plants that provide summer shade to cool our homes reduce energy use; increasing

home food production reduces demand for wasteful water use in industrial fields. Above all, rainwater harvesting increases quality of life the world over.

In arid climates and in places with salty irrigation water, rainwater flushes salts and chemicals out, allowing for long-term health and soil vitality. Collected rainwater can supplement other water sources when they become scarce or are of low quality like brackish groundwater or polluted surface water in the rainy season. It also provides a good alternative and replacement in times of drought or when the water table drops and wells go dry.

On any house plot, the potential sources for harvesting the rain can be direct rainfall, street harvesting, and roof-harvesting. Simple low-cost techniques of rainwater harvesting (RWH) can be employed as they require minimum specific expertise or knowledge and offer many benefits, such as collecting rainwater on the roof and transporting it with gutters to a storage reservoir, where it provides water at the point of consumption. For rainwater harvesting for agricultural bunds, field trenches, planting pits, micro-basins, retention basins, sand dams, conjunctive use, gully plug, controlled drainage or fog drip etc can be implemented.

Chapter 7
MGNCRE Assistance/Facilitation

Structure

7.1 MoUs with Recipient Agencies to Facilitate Internship

7.2 Guidelines of Internships

7.3 Internship Programme Outcomes and Attributes

7.1 MoUs with Recipient Agencies to Facilitate Internship

In order to facilitate Internship of students, MGNCRE has begun identifying organizations with which it can sign MoUs, including those in the service industry, training institutions, and Govt. bodies. The institutions are requested to adequately publicise this information on their website so that students can apply for internship.

7.2 Guidelines of Internship

Internship is always more valuable compared to a college project as it enables interns to understand how the service and hospitality sectors work, build new contacts, develop a network and, most importantly, work on real-life projects that are executed within the organization. Institutes are advised to send students for internship at least twice during the complete program once in six months and every week field visits.

1. Many interns seem to judge the organization by the number of employees in it. Do use more meaningful criteria to judge the organisation for the internship such as the time and training that they are going to devote to you, type of products, value addition and services offered by the company in relation to what you want to learn, technologies employed by the company with respect to what you want to master.
2. An internship is a great opportunity to learn in industrial environment without being an employee of the company. Students are advised to set their goals prior to starting their internship and focus on completing them during the internship
3. If a student joins a very large organization to do an internship, he needs to use the opportunity to learn about the activities performed in the various departments by doing short stints in each of them. This experience needs to provide him the big picture for better understanding of his career prospects.
4. Attitude and mindset play a great role in the learning process. Do tackle all tasks given with enthusiasm and positive attitude.
5. Interns need to avoid negativity and never ignore a chance offered to them to learn more about a concept, technology, industry or company.
6. Interns need to ask more and more questions to try and get as much exposure as possible.
7. Interns need to identify a good mentor within the company and take initiative to execute new projects where one can make a difference to the organization.
8. Interns need to learn and enjoy learning during the internship and leave with tangible accomplishments.
9. The intern needs to maintain a regular internship schedule determined by the Intern and his/her project head.
10. Interns need to view an internship as a bridge between college and the workplace. They need to use it to their full advantage while they are at it.

11. The intern needs to demonstrate honesty, punctuality and a willingness to learn during the internship program.
12. The intern needs to obey the policies, rules and regulations of the industry and comply with the organization business practices and procedures.
13. No fee would be charged from the interns by industry.
14. Internship duration is to be certified by the department sponsoring the intern.
15. Internship is very rigorous, serious and fast-paced. It requires full dedication and attention of interns for the entire internship period.
16. During the internship period, the intern needs to only pursue this internship; no other side projects or internship needs to be allowed.
17. Students interested in pursuing internship opportunities need to meet project expectations all through the programme.
18. Students need to strive for and demonstrate a high level of sincerity and honesty in their research work and interactions.
19. Intern needs to pursue individual project related to Waste Management & Environmental Hygiene.
20. Projects needs to be finalized before the start of the internship and cannot be changed. Since projects would be on diverse topics, it is likely that the topic may be entirely new to the intern.
21. Each intern is required to make document submissions, field visits and make open presentation at the end of the period to the other students in the department/university.
22. Each intern needs to maintain a daily activity logbook as per the format shared in which he/she would note down any and all information directly so as to serve as a record of activities in a chronological sequence.
23. Each intern needs to submit a Final Project Report as a soft copy by the completion of the project period to be eligible to get stipend and Certificate of Internship.
24. Each intern needs to communicate with the mentor/supervisor at least once every week.
25. Each intern needs to adhere to internship requirements, rules and regulations. Internship of the students not observing the discipline and rules needs to be terminated.
26. The contents of the reports and the findings need to be the property of Department/University.
27. Intern needs to certify that the research report and its content work is original work, which is not published anywhere.
28. Any of the contents of the report if quoted from anywhere else, need to contain the detailed reference to its original author and location
29. Internship report needs to be certified by the Head of the Department of the University/ Institute

7.3 Internship Programme Outcomes and Attributes

Student Attributes	Activities Proposed	Outcomes
1. Field knowledge: Apply the knowledge of mathematics, science, Waste Management fundamentals anda Managementspecialization for the solution ofcomplex waste management problems.	Practical experience during Industrial internship/ Project work.	Seamless application of Waste Management techniques, toolsandresources ontheproject. Theapplication of Systematic DesignProcesses.
2. Problem analysis: Identify, formulate, research literature and analyze complex Waste Management problems; reach a substantiated conclusion using principles of mathematics, Natural Sciences and Waste management	Working for Consultancy/Research Projects in the institutes.	HelpingFacultyMembersin theirResearchand Consultancy projects. To help student learnresearchmethodologies andanalytical tools.
3. Design/development ofsolutions: Design solutions forcomplex waste managementproblems and design systemcomponents or processes thatmeet the specified needs withappropriate consideration forpublic health and safety andcultural, societalandenvironmentalc onsiderations.	IndustrialInternship working experience.	Practical applications and their co-relationwith basic theory andconcepts taught in thecourse.
4. Conduct investigations of complex problems:	Project work/ industrial training or advancedengineering courses are considered for meetingInternship credit requirements.	Globalcompetitivenessande mployability ofstudentswillbeenhanced.
5. Modern tool usage: Create, select and apply appropriate techniques, resources, and modern Waste Management and IT tools, including prediction and modeling of complex Waste Management activities,with an	Work on the modern tools, processesbeing used in the industry. Wherepossibleinterns need to exposethemselves to advanced tools like simulation and modeling.	Students willbe able to usemoderntools and processes to solve thelive problems.

understanding on limitations.		
6. TheInternandsociety: Apply reasoning informed bythe contextual knowledge toassess societal, health, safety,legal and cultural issues andthe consequentresponsibilities relevant to theprofessionalengineering practice.	The Programfocuses on supporting all the sections ofsociety especially in villages.	Studentswilllearn social responsibilities and touse their professional knowledgetoassesssocietal, health, safety,legalandculturalissues
7. EnvironmentAndSustainability: Understand the impact of the professional waste management Solution in societal and Environmental contexts and demonstrate the knowledge of & need for sustainable development.	Under the community service activities, focus on environment and sustainability issues	Students will learn theimportanceandmethods ofenvironmentprotection andsustainability.
8. Ethics: Apply ethical principles, committo professionalethics, responsibilities andnormsof the waste management practice.	The intern needsto learn to demonstratehonesty,punctuality andobey company'sbusiness practicesandprocedures.	Learningofprofessional ethicsandpracticeswillmakes tudentreadyfor the future.
9. Individuals and team work: Functioneffectivelyas anindividual and as a memberor leader in diverse teams andin multidisciplinary settings.	Studentsare requiredtohelpthe committeefororganizingconference/workshop/competition atInstitutional Level.	This will help student to learn teamwork and work for commongoals.
10. Communication: CommunicateEffectivelyon complex Waste management activities with the community at large suchas being able to comprehendandActivities Withthe Waste management Communityand with the society at large, suchas being able to	To assist students in industrial trainingat the end of first and secondsemester. Training & Placement Cellneeds to also organize training for student'sPersonality Development, improving Communication Skills, Report Writing, Presentation Skills, Foreign Languages , etc.	Thestudentwill developan ability to communicateeffectively(oral andwritten communication),reportwriting,presentation skills.

comprehendandwriteeffective reports&design documentation,make effective presentationsand give & receive clear instructions.		
11. ProjectManagement and Finance: Demonstrateknowledgeand understanding ofthe Waste ManagementPrinciples and apply these toone's own work, as a memberand leader in a team, tomanageprojectsandinmultidisciplinary environments	The industry needsto make sure toinclude interns in brainstormingsessions and also be given opportunityto understandProject Management andfinances.	Thesecompetencies will help the studentinhorizontalandvertical mobility.
12. Life-long learning: Recognizethe need for and have thePreparation and ability to engagein independentand life-long learning in thebroadest contextoftechnological change.	Interns need to learn to implementknowledge into practice and innovate.	Interns'abilitytoinnovate and theircapacityto adjust tochange needs tobeenhanced.

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