MODULE-4

HAZARDOUS WASTE

Hazardous wastes refer to wastes that may, or tend to cause adverse health effects on the ecosystem and human beings. These wastes pose present or potential risks to human health or living organisms, due to the fact that they:

- are non-degradable or persistent in nature
- can be biologically magnified
- Are highly toxic and even lethal at very low concentrations.

Identification

By using either or both of the following criteria, we can identify as to whether or not a waste is hazardous:

- The list provided by government agencies declaring that substance as hazardous.
- Characteristics such as ignitibility, corrosivity, reactivity and toxicity of the substance.

Characteristics of hazardous wastes

The regulations define characteristic hazardous wastes as wastes that exhibit measurable properties posing sufficient threats to warrant regulation. For a waste to be deemed a characteristic hazardous waste, it must cause, or significantly contribute to, an increased mortality or an increase in serious irreversible or incapacitating reversible illness, or pose a substantial hazard or threat of a hazard to human health or the environment, when it is improperly treated, stored, transported, disposed of, or otherwise mismanaged.

1. **Ignitability:** A waste is an ignitable hazardous waste, if it has a flash point of less than 60C; readily catches fire and burns so vigorously as to create a hazard or is an ignitable compressed gas or an oxidizer. A simple method of determining the flash point of a waste is to review the material safety data sheet, which can be obtained from the manufacturer or distributor of the material. Naphtha, lacquer thinner, epoxy resins, adhesives and oil based paints are all examples of ignitable hazardous wastes.

2. **Corrosivity**: A liquid waste which has a pH of less than or equal to 2 or greater than or equal to 12.5 considered to be a corrosive hazardous waste. Sodium hydroxide, a caustic solution with a high pH, is often used by many industries to clean or degrease metal parts. Hydrochloric acid, a solution with a low pH, is used by many industries to clean metal parts prior to painting. When these caustic or acid solutions are disposed of, the waste is a corrosive hazardous waste.

3. **Reactivity**: A material is considered a reactive hazardous waste, if it is unstable, reacts violently with water, generates toxic gases when exposed to water or corrosive materials, or if it is capable of detonation or explosion when exposed to heat or a flame. Examples of reactive wastes would be waste gunpowder, sodium metal or wastes containing cyanides or sulphides.

4. **Toxicity:** To determine if a waste is a toxic hazardous waste, a representative sample of the material must be subjected to a test conducted in a certified laboratory. The toxic characteristic identifies wastes that are likely to leach dangerous concentrations of toxic chemicals into ground water.

CLASSIFICATION OF HAZARDOUS WASTE

Hazardous wastes are classified as:

1. **Radioactive substance:** Substances that emit ionizing radiation are radioactive. Such substances are hazardous because prolonged exposure to radiation often results in damage to living organisms. Radioactive substances are of special concern because they persist for a long period.
2. **Chemicals:** Most hazardous chemical wastes can be classified into four groups: synthetic organics, inorganic metals, salts, acids and bases, and flammables and explosives. Some of the chemicals are hazardous because they are highly toxic to most life forms. When such hazardous compounds are present in a waste stream at levels equal to, or greater than, their threshold levels, the entire waste stream is identified as hazardous.
3. **Biomedical wastes:** The principal sources of hazardous biological wastes are hospitals and biological research facilities. This group mainly includes malignant tissues discarded during surgical procedures and contaminated materials, such as hypodermic needles, bandages and outdated drugs.
4. **Flammable wastes:** Most flammable wastes are also identified as hazardous chemical wastes. This dual grouping is necessary because of the high potential hazard in storing, collecting and disposing of flammable wastes. These wastes may be liquid, gaseous or solid, but most often they are liquids. Typical examples include organic solvents, oils, plasticizers and organic sludge's.
5. **Explosives:** Explosive hazardous wastes are mainly ordnance (artillery) materials, i.e., the wastes resulting from ordnance manufacturing and some industrial gases. Similar to flammables, these wastes also have a high potential for hazard in storage, collection and disposal, and therefore, they should be considered separately in addition to being listed as hazardous chemicals. These wastes may exist in solid, liquid or gaseous form.

Sources of Hazardous Waste

The term hazardous waste often includes by-products of industrial, domestic, commercial, and health care activities. Rapid development and improvement of various industrial technologies, products and practices may increase hazardous waste generation. Major hazardous waste sources and their pollution routes in the environment are listed below.

- **Agricultural land and agro-industry**: Hazardous wastes from agricultural land and agro-industry can expose people to pesticides, fertilizers and hazardous veterinary product wastes. Farms are a major source of these wastes, and agrochemicals can leach into the environment while in storage or can cause damage after their application.
- **Domestic**: Households stock various hazardous substances such as batteries and dry cells, furniture polishes, wood preservatives, stain removers, paint thinners, rat poisons, herbicides and pesticides, mosquito repellents, paints, disinfectants, and fuels (i.e. kerosene) and other automotive products. These can present a variety of dangers during storage, use and disposal.
- **Mines and mineral processing sites**: Mining and mineral processing sites handle hazardous products that are present in the additives, the products and the wastes.
- **Health care facilities**: Health care facilities are sources of pathological waste, human blood and contaminated needles. Specific sources of these wastes include dentists, morticians, veterinary clinics, home health care, blood banks, hospitals, clinics and medical laboratories.
- **Commercial wastes**: Commercial waste sources include gasoline stations, dry cleaners and automobile repair shops (workshops). The types of hazardous wastes generated by these sources depend on the services provided.
- **Institutional hazardous waste sources**: Institutional hazardous waste sources are mainly research laboratories, research centers and military installations. Some military installations are used for the manufacture and storage of ammunition, and they are also used as testing grounds for military hardware. Military establishments also carry out activities that generate other types of hazardous wastes of household, commercial and industrial nature.
- **Industrial hazardous waste sources**: Hazardous wastes are created by many industrial activities. For example, the hazardous wastes from the petroleum fuel industry include the refinery products (fuels and tar), impurities like phenol and cyanides in the waste stream, and sludge flushed from the storage tanks.
- **Solid waste disposal sites**: These are mainly disposal sites for municipal solid waste, but hazardous wastes that have not been properly separated from other wastes are also at these sites. In developing countries, solid waste disposal sites are a major source of pollutant-laden leachate to surrounding areas, as well as recyclable materials for scavengers, who can collect and resell waste materials that have been exposed to or that contain hazardous substances.

Sources of Hazardous waste

Waste Category	Sources
Radioactive substances	Biomedical research facilities, colleges and university laboratories, offices, hospitals, nuclear power plants, etc.
Toxic chemicals	Agricultural chemical companies, battery shops, car washes, chemical shops, college and university laboratories, construction companies, electric utilities, hospitals and clinics, industrial cooling towers, newspaper and photographic solutions, nuclear power plants, pest control agencies, photographic processing facilities, plating shops, service stations, etc.
Biological wastes	Biomedical research facilities, drug companies, hospitals, medical clinics, etc.
Flammable wastes	Dry cleaners, petroleum reclamation plants, petroleum refining and processing facilities, service stations, tanker truck cleaning stations, etc.
Explosives	Construction companies, dry cleaners, ammunition production facilities, etc.

Storage and collection of Hazardous waste

Onsite storage practices are a function of the types and amounts of hazardous wastes generated and the period over which generation occurs. Usually, when large quantities are generated, special facilities are used that have sufficient capacity to hold wastes accumulated over a period of several days. When only a small amount is generated, the waste can be containerized, and limited quantity may be stored. Containers and facilities used in hazardous waste storage and handling are selected on the basis of waste characteristics. For example, corrosive acids or caustic solutions are stored in fibre glass or glass-lined containers to prevent deterioration of metals in the container. Great care must also be exercised to avoid storing incompatible wastes in the same container or locations.

Typical drum containers used for the storage of hazardous waste:

Light-Gauge Closed Head Drum

Light-Gauge Open Head Drum

The waste generator, or a specialized hauler, generally collects the hazardous waste for delivery to a treatment or disposal site. The loading of collection vehicles is completed in either of the following ways:

- Wastes stored in large-capacity tanks are either drained or pumped into collection vehicles;

- Wastes stored in sealed drums or sealed containers are loaded by hand or by mechanical equipment onto flatbed trucks.

The stored containers are transported unopened to the treatment and disposal facility. To avoid accidents and the possible loss of life, two collectors should be assigned when hazardous wastes are to be collected. The equipment used for collection vary with the waste characteristics.

Equipment for Collection of Hazardous Waste

Waste Category	Collection equipment and accessories
Radioactive substances	Various types of trucks and railroad equipment depending on characteristics of wastes; special marking to show safety hazard; heavy loading equipment to handle concrete-encased lead containers.
Toxic chemicals	Flatbed trucks for wastes stored in drums; tractor-trailer tank truck combination for large volumes of wastes; railroad tank cars; special interior linings such as glass, fibreglass or rubber.
Biological wastes	Standard packers' collection truck with some special precautions to prevent contact between wastes and the collector; flatbed trucks for wastes stored in drums.
Flammable wastes	Same as those for toxic chemicals, with special colorings and safety warning printed on vehicles.
Explosives	Same as those for toxic chemicals with some restriction on transport routes, especially through residential areas.

HAZARDOUS WASTE TREATMENT

The various options for hazardous waste treatment can be categorized under physical, chemical, thermal and biological treatments.

Physical and chemical treatment

1. **Filtration and separation:** Filtration is a method for separating solid particles from a liquid using a porous medium. The driving force in filtration is a pressure gradient, caused by gravity, centrifugal force, vacuum, or pressure greater than atmospheric pressure. The application of filtration for treatment of hazardous waste fall into the following categories:

- **Clarification,** in which suspended solid particles less than 100 ppm (parts per million) concentration are removed from an aqueous stream. This is usually accomplished by depth filtration and cross-flow filtration

and the primary aim is to produce a clear aqueous effluent, which can either be discharged directly, or further processed. The suspended solids are concentrated in a reject stream.

- **Dewatering** of slurries of typically 1% to 30 % solids by weight. Here, the aim is to concentrate the solids into a phase or solid form for disposal or further treatment. This is usually accomplished by cake filtration. The filtration treatment, for example, can be used for neutralization of strong acid with lime or limestone, or precipitation of dissolved heavy metals as carbonates or sulphate followed by settling and thickening of the resulting precipitated solids as slurry. The slurry can be dewatered by cake filtration and the effluent from the settling step can be filtered by depth filtration prior to discharge

2. **Chemical precipitation:** This is a process by which the soluble substance is converted to an insoluble form either by a chemical reaction or by change in the composition of the solvent to diminish the solubility of the substance in it. Settling and/or filtration can then remove the precipitated solids. In the treatment of hazardous waste, the process has a wide applicability in the removal of toxic metal from aqueous wastes by converting them to an insoluble form. This includes wastes containing arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, thallium and zinc. The sources of wastes containing metals are metal plating and polishing, inorganic pigment, mining and the electronic industries. Hazardous wastes containing metals are also generated from cleanup of uncontrolled hazardous waste sites, e.g., leachate or contaminated ground water.

3. **Chemical oxidation and reduction (redox):** In these reactions, the oxidation state of one reactant is raised, while that of the other reactant is lowered. When electrons are removed from an ion, atom, or molecule, the substance is oxidised and when electrons are added to a substance, it is reduced. Such reactions are used in treatment of metal-bearing wastes, sulphides, cyanides and chromium and in the treatment of many organic wastes such as phenols, pesticides and sulphur containing compounds. Since these treatment processes involve chemical reactions, both reactants are generally in solution. However, in some cases, a solution reacts with a slightly soluble solid or gas.

4. **Evaporation:** Evaporation is defined as the conversion of a liquid from a solution or slurry into vapour. All evaporation systems require the transfer of sufficient heat from a heating medium to the process fluid to vaporise the volatile solvent. Evaporation is used in the treatment of hazardous waste and the process equipment is quite flexible and can handle waste in various forms – aqueous, slurries, sludges and tars. Evaporation is commonly used as a pre-treatment method to decrease quantities of material for final treatment. It is also used in cases where no other treatment method was found to be practical, such as in the concentration of trinitrotoluene (TNT) for subsequent incineration.

Thermal treatment

Incineration: Incineration can be regarded as either a pre-treatment of hazardous waste, prior to final disposal or as a means of valorizing waste by recovering energy. It includes both the burning of mixed solid waste or burning of selected parts of the waste stream as a fuel. The concept of treating hazardous waste is similar to that of municipal solid waste.

Pyrolysis: This is defined as the chemical decomposition or change brought about by heating in the absence of oxygen. This is a thermal process for transformation of solid and liquid carbonaceous materials into gaseous components and the solid residue containing fixed carbon and ash. The application of pyrolysis to hazardous waste treatment leads to a two-step process for disposal. In the first step, wastes are heated separating the volatile contents (e.g., combustible gases, water vapour, etc.) from non-volatile char and ash. In the second step volatile components are burned under proper conditions to assure incineration of all hazardous components.
To elaborate, pyrolysis is applicable to hazardous waste treatment, as it provides a precise control of the combustion process. The first step of pyrolysis treatment is endothermic and generally done at 425 to 760C. The heating chamber is called the pyrolyser. Hazardous organic compounds can be volatilized at this low temperature, leaving a clean residue. In the second step, the volatiles are burned in a fume incinerator to achieve destruction efficiency of more than 99%. Separating the process into two very controllable steps allows precise temperature control and makes it possible to build simpler equipment. The pyrolysis process can be applied to solids, sludge's and liquid wastes. Wastes with the following characteristics are especially amenable to pyrolysis:

- Sludge material that is either too viscous, too abrasive or varies too much in consistency to be atomized in an incinerator.
- Wastes such as plastic, which undergo partial or complete phase changes during thermal processing.
- High-residue materials such as high-ash liquid and sludge's, with light, easily entrained solids that will generally require substantial stack gas clean up.
- Materials containing salts and metals, which melt and volatilize at normal incineration temperatures. Materials like sodium chloride (NaCl), zinc (Zn) and lead (Pb), when incinerated may cause refractory spalling and fouling of the heat-exchanger surface.

Biological treatment

1. **Land treatment:** This is a waste treatment and disposal process, where a waste is mixed with or incorporated into the surface soil and is degraded, transformed or immobilised through proper management. The other terminologies used commonly include land cultivation, land farming, land application and sludge spreading. Compared to other land disposal options (e.g., landfill and surface impoundments), land treatment has lower long-

term monitoring, maintenance and potential clean up liabilities and because of this, it has received considerable attention as an ultimate disposal method. It is a dynamic, management-intensive process involving waste, site, soil, climate and biological activity as a system to degrade and immobilise waste constituents. In land treatment, the organic fraction must be biodegradable at reasonable rates to minimise environmental problems associated with migration of hazardous waste constituents.

2. **Enzymatic systems:** Enzymes are complex proteins ubiquitous in nature. These proteins, composed of amino acids, are linked together via peptide bonds. Enzymes capable of transforming hazardous waste chemicals to non-toxic products can be harvested from microorganisms grown in mass culture. Such crude enzyme extracts derived from microorganisms have been shown to convert pesticides into less toxic and persistent products. The reaction of detoxifying enzymes are not limited to intracellular conditions but have been demonstrated through the use of immobilised enzyme extracts on several liquid waste streams. The factors of moisture, temperature, aeration, soil structure, organic matter content, seasonal variation and the availability of soil nutrients influence the presence and abundance of enzymes.

Disposal

Regardless of their form (i.e., solid, liquid, or gas), most hazardous waste is disposed off either near the surface or by deep burial.

Although, controlled landfill methods have been proved adequate for disposing of municipal solid waste and limited amounts of hazardous waste, they are not suitable enough for the disposal of a large quantity of hazardous waste, due to the following reasons:

- possible percolation of toxic liquid waste to the ground water;
- dissolution of solids followed by leaching and percolation to the ground water;
- potential for undesirable reactions in the landfill that may lead to the development of explosive or toxic gases;
- Corrosion of containers with hazardous wastes.

E-WASTE

Electronics Waste: Popularly known as E Waste can be defined as electronic and electrical equipment's / Products (Including the connecting power plug and batteries) which has been obsolete due to:

i. Changes in fashion, style and status
ii. Nearing the end of their useful lifes

EFFECT OF E-WASTE ON ENVIRONMENT

Element	Effect on environment
Lead	Damage to central and peripheral nervous systems, blood systems and kidney damage. Affects brain development of children
Chromium	Asthmatic bronchitis. DNA damage
Cadmium	Toxic irreversible effects on human health. Accumulates in kidney and liver. Causes neural damage. Teratogenic
Mercury	Chronic damage to the brain. Respiratory and
Plastics including PVC	Burning produces dioxin. It causes Reproductive and developmental problems; Immune system damage; Interfere with regulatory hormones

Effects on Human Health

Plastic	Adverse Health Effects
Polyvinylchloride	Cancer, birth defects, vision failure, ulcers
Phthalates (DEHP, DINP)	Endocrine disruption, asthma, hormonal changes
Polycarbonate	Cancer, obesity, diabetes, hyperactivity
Polystyrene	Irritate eyes, nose and throat, dizziness
Polyethylene	Human carcinogen
Urea formaldehyde	Carcinogen, birth defects and genetic changes
Polyurethane Foam	Bronchitis, coughing, shin and eye problem
Acrylic	Vomiting, diarrhoea, nausea, headache and fatigue
Tetrafluoro Ethelyn	Breathing difficulties

Treating E-Waste

As of now, there are no proper methods being implemented even in the first world to eliminate the problem of e-waste.

- The two methods found to be interesting for proper treatment of e-waste are **recycling** and **refurbishing**.
- For recycling, there may be products that cannot be recycled completely. PVC layers, for example, stay as such for ages and cannot be recycled. It would be better if the manufacturers use recyclable material so that the e-waste is converted into something that can be used again without harming the planet and its inhabitants. Thus, one of the major factors in treating e-waste is to compel manufacturers to use green elements.
- If electronics are refurbished, they can be sold again at a lower price. Thus, both the society and environment will benefit. Instead of simply dumping your old TV into the garbage bin, you might want to think about calling the vendor and ask him where to present the item for refurbishing. If you cannot find, consider donating the item to some charity that can either use it as such or get it repaired and use it. I do not think it is a practice well implemented, but it would be nice if all vendors provide a refurbishing facility.

E -Waste Disposal Methods

- **LANDFILLING**

This is the most common methodology of e-waste disposal. Soil is excavated and trenches are made for burying the e-waste in it. An impervious liner is made of clay or plastic with a leachate basin for collection and transferring the e-waste to the treatment plant. However, landfill is not an environmentally sound process for disposing off the e-waste as toxic substances like cadmium, lead and mercury are released inside the soil and ground water.

- **ACID BATH**

Acid bath involves soaking of the electronic circuits in the powerful sulphuric, hydrochloric or nitric acid solutions that free the metals from the electronic pathways. The recovered metal is used in the manufacturing of other products while the hazardous acid waste finds its ways in the local water sources.

- **INCINERATION**

This is a controlled way of disposing off the e-waste and it involves combustion of electronic waste at high temperature in specially designed incinerators. This e-waste disposal method is quite advantageous as the waste volume is reduced extremely much and the energy obtained is also utilized separately. However, it is also not free from disadvantages with the emission of the harmful gases mercury and cadmium in the environment.

Step-by Step Process of E-waste Recycling

The e-waste recycling process is highly labor intensive and goes through several steps. Below is the step-by-step process of how e-waste is recycled,

1. **Picking Shed -** When the e-waste items arrive at the recycling plants, the first step involves sorting all the items manually. Batteries are removed for quality check.
2. **Disassembly -** After sorting by hand, the second step involves a serious labor intensive process of manual dismantling. The e-waste items are taken apart to retrieve all the parts and then categorized into core materials and components. The dismantled items are then separated into various categories into parts that can be re-used or still continue the recycling processes.

3. **First size reduction process -**Here, items that cannot be dismantled efficiently are shredded together with the other dismantled parts to pieces less than 2 inches in diameter. It is done in preparation for further categorization of the finer e-waste pieces.

4. **Second size reduction process -** The finer e-waste particles are then evenly spread out through an automated shaking process on a conveyor belt. The well spread out e-waste pieces are then broken down further. At this stage, any dust is extracted and discarded in a way that does not degrade the environmentally.

5. **Over-band Magnet -** At this step, over-band magnet is used to remove all the magnetic materials including steel and iron from the e-waste debris.

6. **Non-metallic and metallic components separation. -** The sixth step is the separation of metals and non-metallic components. Copper, aluminum, and brass are separated from the debris to only leave behind non-metallic materials. The metals are either sold as raw materials or re-used for fresh manufacture.

7. **Water Separation-** As the last step, plastic content is separated from glass by use of water. One separated, all the materials retrieved can then be resold as raw materials for re-use. The products sold include plastic, glass, copper, iron, steel, shredded circuit boards, and valuable metal mix.

E-cycle components re-use

1. Plastic. All the plastic materials retrieved are sent to recyclers who use them to manufacture items such as fence posts, plastic sleepers, plastic trays, vineyard stakes, and equipment holders or insulators among other plastic products.

2. Metal. Scrap metals materials retrieved are sent to recyclers to manufacture new steel and other metallic materials.

3. Glass. Glass is retrieved from the Cathode Ray Tubes (CRTs) mostly found in televisions and computer monitors. Extracting glass for recycling from CRTs is a more complicated task since CRTs are composed of several hazardous materials. Lead is the most dangerous and can adversely harm human health and the environment. Tubes in big CRT monitors can contain high levels of lead of up to 4 kilograms. Other toxic metals such as barium and phosphor are also contained in CRT tubes. To achieve the best environmentally friendly glass extraction, the following steps ensure a specialized CRT recycling:

- Manual separation of the CRT from the television or monitor body
- Size reduction process where the CRT is shredded into smaller pieces. Dust is eliminated and disposed in an environmentally friendly way.
- All metals are removal through over-band magnets, where ferrous and non-ferrous components are eliminated from the glass materials.
- A washing line is then used to clear oxides and phosphors from the glass
- Glass sorting is the final step whereby leaded glass is separated from non-leaded glass. The extracts can then be used for making new screens.

4. **Mercury**. Mercury containing devices are sent to mercury recycling facilities that uses a specialized technology for elimination for use in dental amalgams and metric instruments, and for fluorescent lighting. Other components such as glass and plastics are re-used for manufacture of their respective products.
5. Printed Circuit Boards. Circuit boards are sent to specialized and accredited companies where they are smelted to recover non-renewable resources such as silver, tin, gold, palladium, copper and other valuable metals.
6. 6. Hard Drives. Hard drives are shredded in whole and processed into aluminum ingots for use in automotive industry.

7. Ink and Toner Cartridges. Ink and toner cartridges are taken back to respective manufacturing industries for recycling. They are remanufactured while those that can't are separated into metal and plastic for re-use as raw materials.
8. Batteries. Batteries are taken to specialized recyclers where they are hulled to take out plastic. The metals are smelted is specialized conditions to recover nickel, steel, cadmium and cobalt that are re-used for new battery production and fabrication of stainless steel.

CONSTRUCTION WASTE

Construction waste is anything generated as a result of construction and then abandoned, regardless of whether it has been processed or stockpiled. It comprises surplus materials from site clearance, excavation, construction, refurbishment, renovation, demolition and road works.

Construction waste is generated from construction building and demolition activities consisting of concrete, tiles, bricks, drywall, asphalt, plastics, metals, wood, rocks and more. These construction waste materials are often inert and non-biodegradable, heavy, bulky and overload landfills.

Construction waste recycling and management involves the process and separation of salvaging the recoverable waste materials for recycling and reuse. Krause Manufacturing's innovative approach and advanced solutions to construction waste disposal and commercial waste recycling will boost your productivity and bottom line profitability.

DIFFERENT TYPES OF CONSTRUCTION WASTE

- **BUILDINGMATERIALS**

  Construction, demolition, restoration, and remodeling projects all produce a lot of building material waste. This waste may include insulation, nails, electrical wiring, rebar, wood, plaster, scrap metal, cement, and bricks. These materials may be damaged or unused, but can be recycled or reused in other forms. Waste wood can be recovered and recycled into wood for new building projects. Cement, bricks, and plaster can be crushed and reused in other construction or building projects. These materials can be collected in a roll of dumpster that can then be picked up by your waste management or recycling company.

- **DREDGING MATERIALS**

  Dredging materials are materials or objects that are displaced during the preparation of a construction or demolition site. These materials may include trees, tree stumps, rubble,

dirt, and rocks. A waste management company can provide waste disposal and trash removal of dredging materials. If any of these materials can be reused or recycled, they will be taken to a recycling plant. A waste management company can also provide dumpster rentals in which you can collect this waste.

- **HAZARDOUSWASTE**

The sites of construction, demolition, restoration, and remodeling projects often produce hazardous waste. Hazardous waste may include lead, asbestos, plasterboard, paint thinners, strippers, and solvents, mercury, fluorescent bulbs, and aerosol cans. These materials need to be disposed of according to strict state and federal laws, and there are harsh fines and punishments for non-compliance. A waste management company in Atlanta can help you comply with city, county, and state guidelines, as well as with your insurance requirements for the safe disposal of hazardous waste.

SOURCES OF CONSTRUCTION WASTE

- Waste from different construction activities of building roads. Consists of: -
- Concrete
- Brick
- Timber
- Sanitary ware
- Glass
- Steel
- Plastics

CONCRETE

- Concrete is one of the most important construction material.
- Approximately one ton of concrete is used per capita per year through out the world
- Recycling of concrete reduces
  - Cost of aggregate
  - Disposal costs
  - Environmental damage
  - Consumption of natural resources &
  - Valuable landfill space

- Recycled coarse aggregates may be more durable than virgin material.
- It can also be used in residential construction.

BRICK

- Broken & discarded brick can be used as construction infill or as aggregate for non – structural concrete.
- Brick that are part of demolish rubble can be crushed and used in the same way.
- Brick masonry rubble contains mortar upto 20% by volume.
- Crushed brick & roofing tiles are the bulk of demolition waste which were earlier being dumped in landfills, but now they can be recycled into mortar plaster & building blocks.

TIMBER

- It is mostly crushed into chip & used as fuel.
- It can also be utilized to manufacture wood –chip concrete by injecting cement grout into voids of compacted wood chips in moulds.
- Wood-chip in concrete can be used as building material.
- This chip can be sawn & nailed as well.
- In Japan alone about 12 million cubic meters of used timber from demolished houses are used.

SANITARY WARE

- Sanitary ware includes tiles also.
- There can be reused as it is, if they are not damaged.
- If sanitary where are chipped (or) cracked (or) otherwise damaged are advised to crush and use them as construction infill (or) as filler in concrete.
- Pozzolanic value of such crushed & powdered sanitary ware is a desirable property in concrete mixes.

GLASS

- One ton of recycled waste glass corresponds to savings in energy equivalent to 125lit of fuel oil & 1.2 tonnes of raw materials
- Recycling of glass reduces non-biodegradable glass out of landfills.
- Glass can be used as substitute for Quarts & Feldspar in the manufacturing of high strength porcelain sanitary ware.

- It can also be used to make mineral wool an insulation product & in granular form as part of the aggregate in concrete mixes.
- In USA an experiment was conducted on metal free glass constituents separated from municipal incinerator residue. This glass was used to produce brick, glass-wool thermal insulation & as a major component of a light weight aggregate use in structural concrete.

STEEL

- Steel is most commonly used metal in the world.
- Steel reinforcement from demolished concrete is usually separated from the rubble on site & sold scrap to recycling plants.
- The world produces over 783 million tons of raw steel. It currently recycles over 320 million tonnes of iron & steel every year.
- Scrap metal can yield energy savings of upto 76%.
- In Europe steel is most recycled.

PLASTIC

- There is an over abundance of waste plastic.
- It is very difficult to dispose plastics.
- Waste plastic can be shredded & used as filler in other materials such as concrete & also in construction of roads.
- House hold plastic waste can be recycled to obtain artificial light weight aggregates for mortar.
- Plastic reduces the possibilities of cracking.

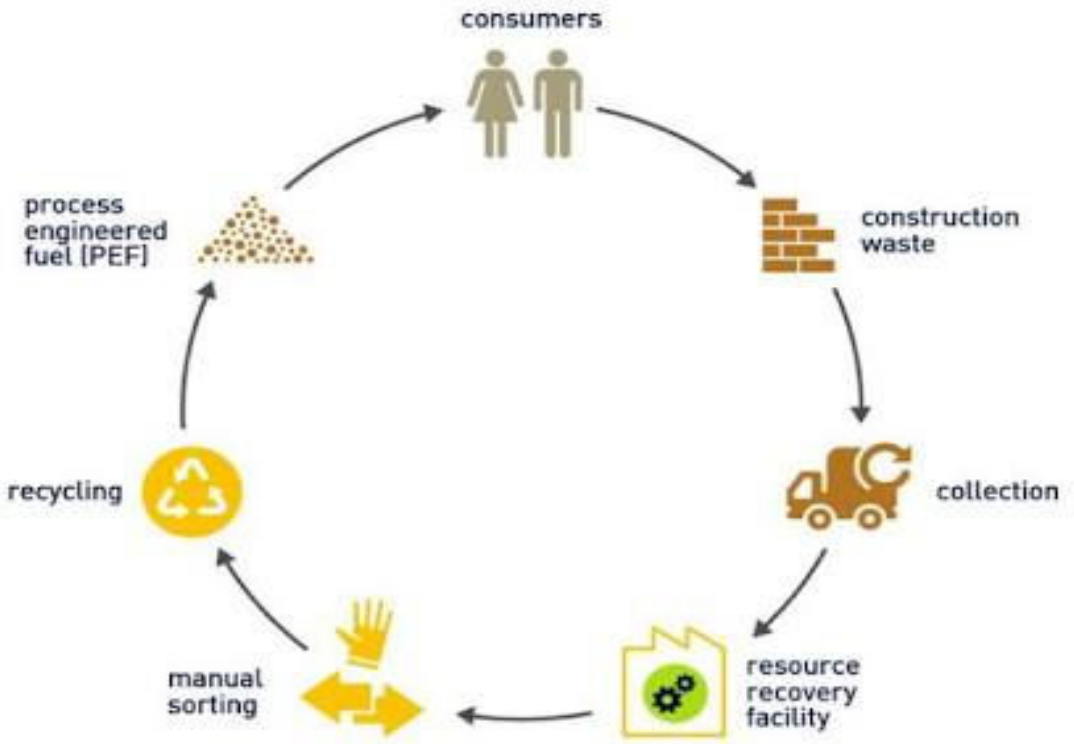
REASONS FOR INCREASE OF CONSTRUCTION WASTE

- Many old buildings concrete pavements bridges and other structures have overcome their age and limit of use due to structural deterioration beyond repairs and need to be demolished.
- New construction for better economic growth.
- Structures are turned into debris resulting from natural disasters like earthquake, cyclone and floods etc.

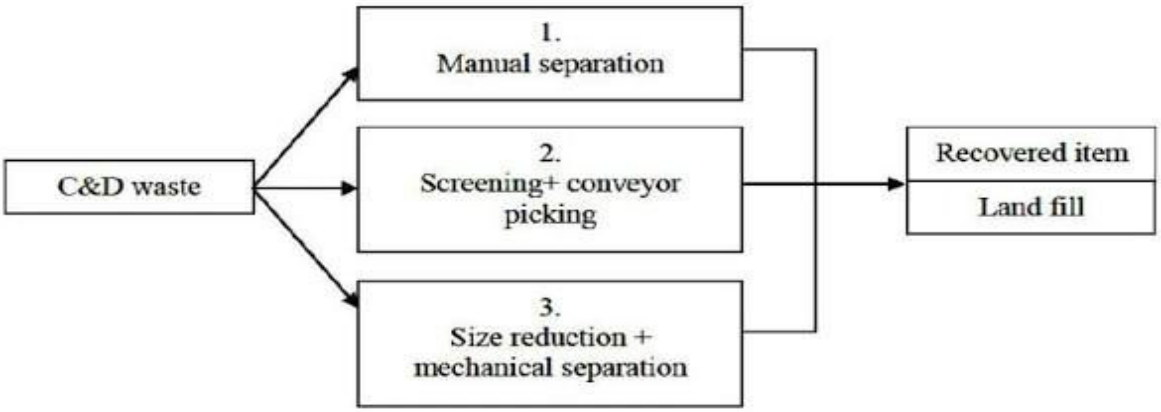
COLLECTION OF CONSTRUCTION WASTE

The construction and demolition waste include waste forming during construction, reconstruction, repairs or demolition of buildings, also a construction product waster.

- Construction and big-sized waste forming during construction, repairs or demolition of buildings may be collected in three ways: -
- On special routes: according to a schedule settled in advance waste is collected from yards of apartment buildings and sites of domestic waste containers located near buildings;
- In construction waste containers: special metal containers are placed in residential or commercial areas or building lots. Their capacity may amount to from 5 up to 20 cbm. Full containers are replaced by empty ones;
- In big-bags: this pre-payable service is especially important to individuals or enterprises, holding low amounts of construction or big-sized waste – those who are repairing their homes or willing to get rid of unnecessary things. Also, to those who are not willing to hire a construction container or have no place for it.



TREATMENT OF CONSTRUCTION WASTE



Details of the treatment method : Refer previous Module Notes

DISPOSAL OF CONSTRUCTION WASTE

- Being predominantly inert in nature, construction and demolition waste does not create chemical or biochemical pollution
- The material can be used for filling/levelling of low-lying areas.
- In the industrialised countries, special landfills are sometimes created for inert waste, which are normally located in abandoned mines and quarries.
- The same can be attempted in our country also for cities, which are located near open mining quarries or mines where normally sand is used as the filling material.

However, proper sampling of the material for its physical and chemical characteristics has to be done

BIOMEDICAL WASTE

Biomedical waste is any kind of waste containing infectious materials. It may also include waste associated with the generation of biomedical waste that visually appears to be of medical or laboratory origin (e.g., packaging, unused bandages, infusion kits, etc.), as well research laboratory waste containing biomolecules or organisms that are restricted from environmental release.
Biomedical waste may be solid or liquid. Examples of infectious waste include discarded blood, sharps, unwanted microbiological cultures and stocks, identifiable body parts, other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in contact with blood and body fluids. Waste sharps include potentially contaminated used (and unused discarded) needles, scalpels, lancets and other devices capable of penetrating skin.

Biomedical waste is generated from biological, medical sources and activities, such as the diagnosis, prevention, or treatment of diseases. Common generators (or producers) of biomedical waste include hospitals, health clinics, nursing homes, emergency medical services, medical research laboratories, offices of physicians, dentists, and veterinarians, home health care, and morgues or funeral homes.

- **Eight Categories of Bio Medical Waste**

It's important to know what kind of medical waste your facility produces then you can determine the proper disposal.
The WHO classified the medical waste into eight (8) categories of medical waste:

1. **Infectious waste** – Waste that may transmit infection from virus, bacterial, parasites to human, i.e.: lab cultures, tissues, swabs, equipment and excreta
2. **Sharps** – Sharp waste, such as needle, scalpels, knives, blades, etc.
3. **Pathological** – Human tissue or fluids i.e. body parts, blood, other body fluids
4. **Radioactive –** Unused liquid in radiotherapy or lab research, contaminated glassware, etc.
5. **Chemical** – Expired lab reagents, film developer, disinfectant
6. **Pharmaceuticals** – Expired and contaminated medicines
7. **Pressurized containers** – Gas cylinders and gas cartridges
8. **General waste (UMW) –** No risk to human health because no blood or any related bodily fluid, i.e.: office paper, wrapper, kitchen waste, general sweeping, etc.

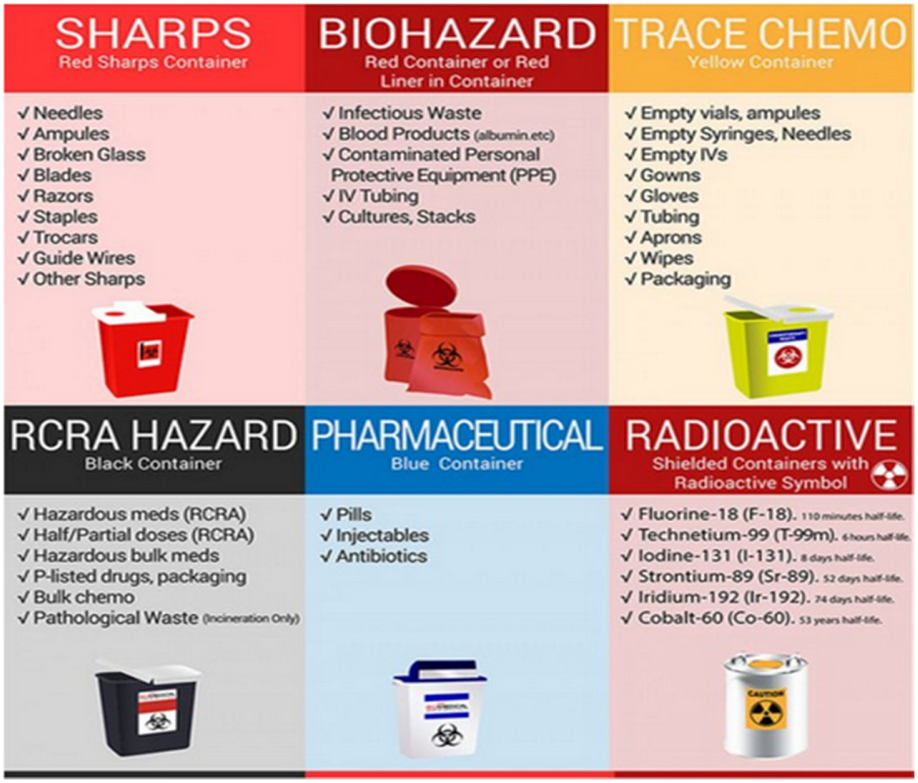
Stages of Medical Waste Disposal

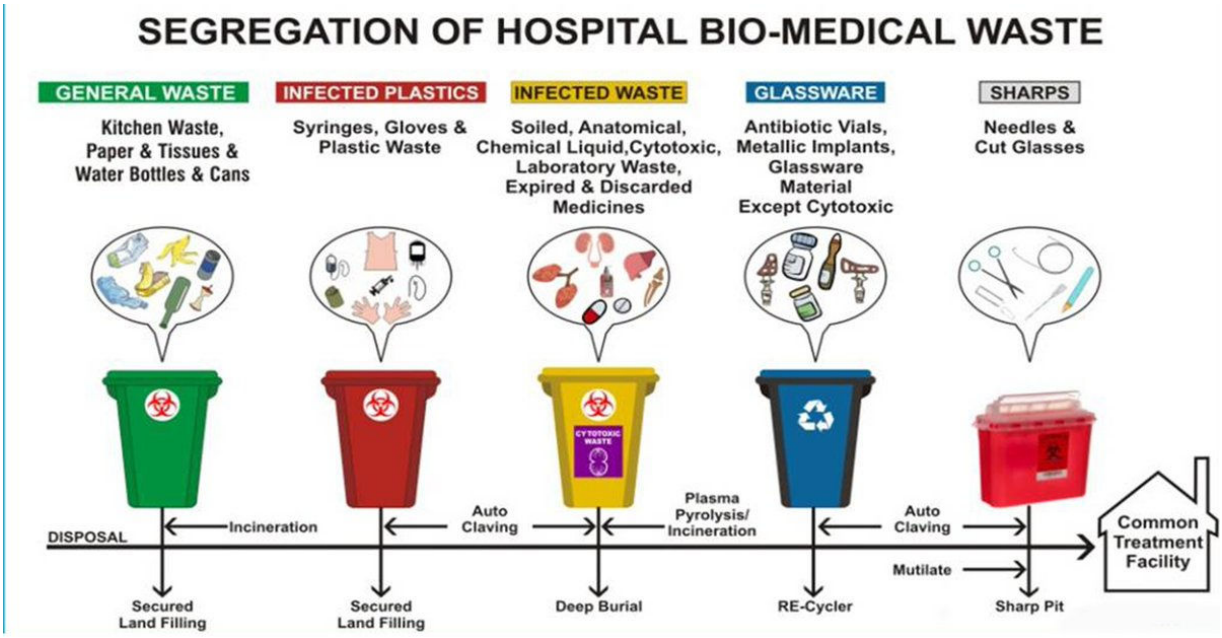
Stage 1 – Collecting & Segregating

The biomedical waste has to be collected in containers that are resilient and strong from breakage during the handling process. Do not place sharps, used needles, syringes, or other contaminated tools in common waste disposal or recycle bin because the entire waste will be infectious by doing so. The segregation also needs to be performed between the liquid and solid biomedical waste products. Categorizing the medical waste with correct segregation to isolate and manage each waste in the proper way. For this purpose, the segregations come in colored waste containers, label coding and plastic bags.

Storage of waste

Storage refers to keeping the waste until it is treated on-site or transported off-site for treatment or disposal. There are many options and containers for storage. Regulatory agencies may limit the time waste can remain in storage. Handling is the act of moving biomedical waste between the point of generation, accumulation areas, storage locations and on-site treatment facilities. Workers who handle biomedical waste must observe *standard precautions*





Generation and accumulation

Biomedical waste should be collected in containers that are leak-proof and sufficiently strong to prevent breakage during handling. Containers of biomedical waste are marked with a biohazard symbol. The container, marking, and labels are often red.

- Discarded sharps are usually collected in specialized boxes, often called *needle boxes*.

Sources of Biomedical waste

Major Sources

- Government Hospitals, private hospitals & Nursing homes
- Primary Health centers
- Medical Colleges and Research centers
- Veterinary Colleges and animal Research centers
- Blood Bank & mortuaries
- Biotechnology Institutions

Treatment

The goals of biomedical waste treatment are to reduce or eliminate the waste's hazards, and usually to make the waste unrecognizable. Treatment should render the waste safe for subsequent handling and disposal. There are several treatment methods that can accomplish these goals.

Biomedical waste is often incinerated. An efficient incinerator will destroy pathogens and sharps. Source materials are not recognizable in the resulting ash.

1. INCINERATION

Type 1 of Medical Waste Treatment The incineration technology used a high temperature thermal process that can convert inert material and gases with the combustion process. It will process the waste to convert into ash, gas, and heat. There are three types of incinerators that are commonly used for biomedical waste:

1. **The Multiple Hearth Type**– it has a circular steel furnace that contains solid refractory hearths with a central rotating shaft to convert the waste into ash
2. **Rotary Kiln** – it is an incinerator, shape like a drum, commonly for medical and hazardous waste
3. **Controlled Air** – there are two process chambers that will handle the waste. The complete combustion and oxidizing it, leading to a stream of gas with carbon dioxide and water vapor composition. It is commonly used for waste that has organic materials.

In addition, for some cases, performing a shredding for biomedical waste needed as an aid for incineration process.

2. AUTOCLAVE

An autoclave may also be used to treat biomedical waste.

1. The **autoclaving system** is commonly used for the human body fluid waste, sharps, and microbiology laboratory waste. This system requires high temperature (thermal) that produces steam to decontaminate the biomedical waste.

2. An autoclave uses steam and pressure to sterilize the waste or reduce its microbiological load to a level at which it may be safely disposed of. The steam plays a critical role in the medical waste autoclaving process therefore a good waste holding container is required.
3. Beside autoclaving, **irradiation** is the other thermal method which uses a high frequency microwave for disposal. The wave will generate heat to the waste materials and kill all the bacteria, or any other contamination in the tools. Many healthcare facilities routinely use an autoclave to sterilize medical supplies.

3. MICROWAVE DISINFECTION

Microwave disinfection can also be employed for treatment of Biomedical wastes.

- Microwave irradiation is a type of non-contact heating technologies for disinfection. When exposed to microwave frequencies, the dipoles of the water molecules present in cells re-align with the applied electric field.
- As the field oscillates, the dipoles attempts to realign itself with the alternating electric field and in this process, energy is lost in the form of heat through molecular friction and dielectric loss.
- Microwave disinfection is a recently developed technology which provides advantage over old existing technologies of autoclaves as microwave based disinfection has less cycle time, power consumption and it requires minimal usage of water and consumables as compared to autoclaves.
- For liquids and small quantities, a 1–10% solution of bleach can be used to disinfect biomedical waste. Solutions of sodium hydroxide and other chemical disinfectants may also be used, depending on the waste's characteristics. Other treatment methods include heat, alkaline digesters and the use of microwaves.

Disposal

For solid waste, once medical waste producers have adhered to regulations for collecting, storing, transporting, and treating their waste, they may then use their municipal landfill and sanitary sewer system as their final disposal method.
That's right, your local municipal landfill is commonly used as the final place of your treated decontaminated biomedical waste.
For fluids such as blood, suctioned fluids, excretions and secretions, almost **every state and local government** has its own regulations and guidelines to provide the best way to dispose it.

In general, there are two recommended ways to handle medical waste fluids:

1. Collect fluids in a leak proof container, and solidified for autoclave treatment
2. Thermally (autoclave) fluids then they be disposed into the sanitary sewer system

An extra precaution should be performed before pouring treated fluids in sewer because they may clog and leak.