

Pollution case studies

- Study from text books



Solid Waste Management



Types of Wastes

- vegetable waste,
kitchen waste,
household wastes,
cloths and rags etc.
- E-waste- discarded
electronic devices
like computer, TV,
music systems etc.



Classification of Wastes

- Metal waste- unused metal sheet, metal scraps etc
- Nuclear waste- unused materials from nuclear power plants
- Liquid waste- water used for different industries eg. tanneries, distilleries, thermal power plants
- Plastic waste- plastic bags, bottles, buckets etc.



Solid waste

A solid waste can be either a solid or a semi solid discarded material.

Sources of urban and industrial waste

- Domestic waste : Polyethene bags, glass bottles, waste paper, aluminium cans, cloth, food waste
- Waste from shops: Paper, packing materials, cans, bottles, scrap metal, tea leaves
- Biomedical waste: Anatomical wastes, pathological wastes, infectious wastes
- Construction and demolition wastes: Bricks, rubbles
- Horticultural wastes and wastes from slaughter houses: Vegetable parts, dried plants, remains of slaughtered animals
- Nuclear wastes from research laboratories, power plants

Hazardous and Non-hazardous waste

- **Hazardous Waste** is a "solid waste" which may pose a substantial potential hazard to human health or the environment when improperly treated, stored or disposed off, or otherwise mismanaged
- **Hazardous waste** is any waste that is harmful to life
 - Eg Thermometers, batteries, nuclear waste, Computers, circuit boards and monitors, Vacuum pump oil
- **Non-Hazardous** solid waste is defined as any garbage, refuse or sludge from a waste treatment plant of an industry, water supply treatment plant, or air pollution control that is not hazardous and does not give rise hazardous products upon treatment, storage or disposal.
- Eg: Domestic wastes like animal and vegetable wastes,
- metal scrap, empty cartons, paper,
- Industrial waste after treatment and waste from water treatment plant

TERMINOLOGY

- Biodegradable - Non-biodegradable
- Refuse: all decomposing and non decomposing combustible and non-combustible solid wastes
- Municipal Solid Waste (MSW) : Non-hazardous Trash or garbage consisting of everyday items like packaging materials, kitchen waste, newspapers, plastics, electrical, paints, batteries, bottles, clothing etc (Those generated in civilized areas)
- Illegal dumping: Illegal disposal of wastes in a non-permitted area – usually done to avoid fees
 - Open dumping, fly dumping or midnight dumping

Effects of solid wastes

- Municipal solid wastes heap up
 - Biodegradable materials decompose under uncontrolled conditions – increases **pathogens**
 - Non biodegradable materials accumulate
- Industrial solid wastes contain **toxic chemicals** and hazardous wastes – cause land degradation and may spread to food chain
- When all of them are burnt together they may produce **dioxins, furans** and polychlorinated biphenyls (PCBs) which are highly toxic.



Effects of solid wastes

- Stray animals are dying on streets and farmland due to consumption of plastic bags, which blocks the food movement in their stomach
- Cause damage to ecosystem



Solid Waste in India

- 7.2 million tones of high hazardous waste
- One Sq km of additional landfill area every-year
- Rs 1600 crore for treatment & disposal of these wastes
- In addition to this industries discharge about 150 million tones of high volume low hazard waste every year, which is mostly dumped on open low lying land areas.

Source: Estimate of Ministry of Environment & Forest

How solid waste affected us in recent years?

- Cloudburst in Mumbai (2005) clogged the sewage line due to large no. of plastic bags
- Blast in the Bhusan Steel factory at Noida, caused due to imported scrap from Iran
- Reduction in the number of migratory birds due to consumption of contaminated foods



<http://www.greenpeace.org/international/news/ghost-ship-121205>



French aircraft carrier Clemenceau

French aircraft carrier Clemenceau

- December 12, 2005, Clemenceau, Ghost ship nobody wants
- 27,000-ton warship full of asbestos, PCBs, lead, mercury, and other toxic chemicals
- Indian scrap yard of Alang (Bhavnagar district, Gujarat) , a place where environmental regulations are lax and workers' rights are practically nonexistent
- Greenpeace raised awareness campaigned against the ship in India as well as in France
- French President Chirac has announced a dramatic recall of the asbestos-laden warship Clemenceau

Municipal (Urban) Solid Waste Management



Municipal Solid Waste (MSW) and its management

- The waste generated in urban areas pose most of the problems

- MSW Management methods are:
- Avoid/Reduction
- Reuse
- Recycle
- Treat & Dispose

Wastes declared as prohibited in MSW management are

- Hazardous, nuclear
- Industrial
- Infectious waste
- Asbestos sludge
- Pesticide, herbicides and their containers
- Batteries
- PCBs,
- Motor oil

Municipal Solid Waste (MSW) and its management

- Reduce/Avoid :
- Reduction in the use of non-biodegradable materials will reduce the waste
- This has to be done individually.
- Never buy anything unnecessarily.
 - Eg: Reduction in use of metallic products reduces the mining

Municipal Solid Waste (MSW) and its management

- Reuse:
- The materials discarded by one are used by another
- In poor countries reuse is very common
- Eg: Clothes, _____
- Used furniture
- Used vehicles

Managing Waste

Recycling: Processing of a waste item into usable forms.

- Eg. Converting kitchen waste to fuel pellets,
- Melting and reusing aluminium cans etc
- Making decorative from wastes
- Revulcanize vehicle tyres and use as a binder for road construction



Managing Waste - recycling contd.

Benefits of recycling:

- Reduce environmental degradation
- Making money out of waste,
- Reduce the cost and need of raw materials
- Save energy that would have gone into waste handling & product manufacture

Saving through recycling:

- When Al is resmelted- considerable saving in cost
- Making paper from waste saves 50% energy
- Every ton of recycled glass saves energy equivalent to 100 liters of oil

Recycling not a solution to all problems!

Recycling is not a solution to managing every kind of waste material

For many items recycling technologies are unavailable or unsafe

In some cases, cost of recycling is too high.

Other ways of Managing Waste - Composting:



What is Composting?

- Composting is the speeding up of natural degradation of organic material into humus and minerals by microorganisms
- It is an aerobic microbiological process that returns plant nutrients to the soil where they can again be absorbed by plants for new growth.

Materials for Composting



Acceptable

- Grass clippings
- Leaves and Weeds
- Coffee and tea Grounds
- Wood Chips, Sawdust
- Bark, Stems, Stalks
- Garden & Canning Waste like weeds
- Peels and scrap from Fruit & Vegetables
- Egg shells
- Wool and cotton rags
- Non recyclable paper

Not Acceptable

- Meats
- Bones
- Synthetic Products
- Plastics
- Pet or Human Solid Wastes
- Oils and fats
- Diseased plant products



Composting - key factors

Carbon and Nitrogen ratio

- It is important for growth of the microorganisms
- Ideally C:N is 25-40: 1 for MSW
- High carbon materials are browns like, **Leaves, Straw, Paper, Sawdust etc**
- High nitrogen materials are Greens like vegetable scraps
- If adequate amount of nitrogen is not available, urea or sewage sludge can be used



Browns



Greens



Composting – key factors

Moisture

- Moisture is essential for growth of microorganisms.
 - But excess moisture fills the pores between the materials and prevents oxygen.
 - If oxygen is absent decomposition takes place anaerobically, leading to the formation of foul smelling matter and toxic gases
 - Ideal moisture content is 50-55%.



Composting – key factors

▪ Oxygen and Temperature

- If oxygen is present aerobic decomposition takes place, during which oxygen is used up quickly.
- Decomposition is accompanied by release of temperature.
- Optimum temperature for decomposition is 45-59 degree centigrade.
- Aeration ensures proper oxygen supply and removal of excess heat



- **Turning the pile mixes fresh air into the pile**

Composting – key factors, Particle size

Smaller particles decompose faster



Smaller particles have greater surface area per unit volume

Allows microbes to get at more of the food

Therefore, chipping or shredding of coarse materials will speed up the composting rate.

But if particle size is too small oxygen and moisture flow will be less

Composting – the process



- It is done either in bins or piles
- The material is first screened to remove unacceptable material
- Size is reduced if necessary
- Carbon and nitrogenous materials are put alternatively and water is poured
- May take about six months
- Mixed the contents in between to aerate
- After completion the compost is screened for undecomposed material

Vermicomposting

- Vermicomposting is a process in which special varieties of bugs or earthworms aid the composting. Over time the food materials are replaced by the bug/earthworm droppings
- It is faster, requires less space.



Waste disposal: Resource recovery

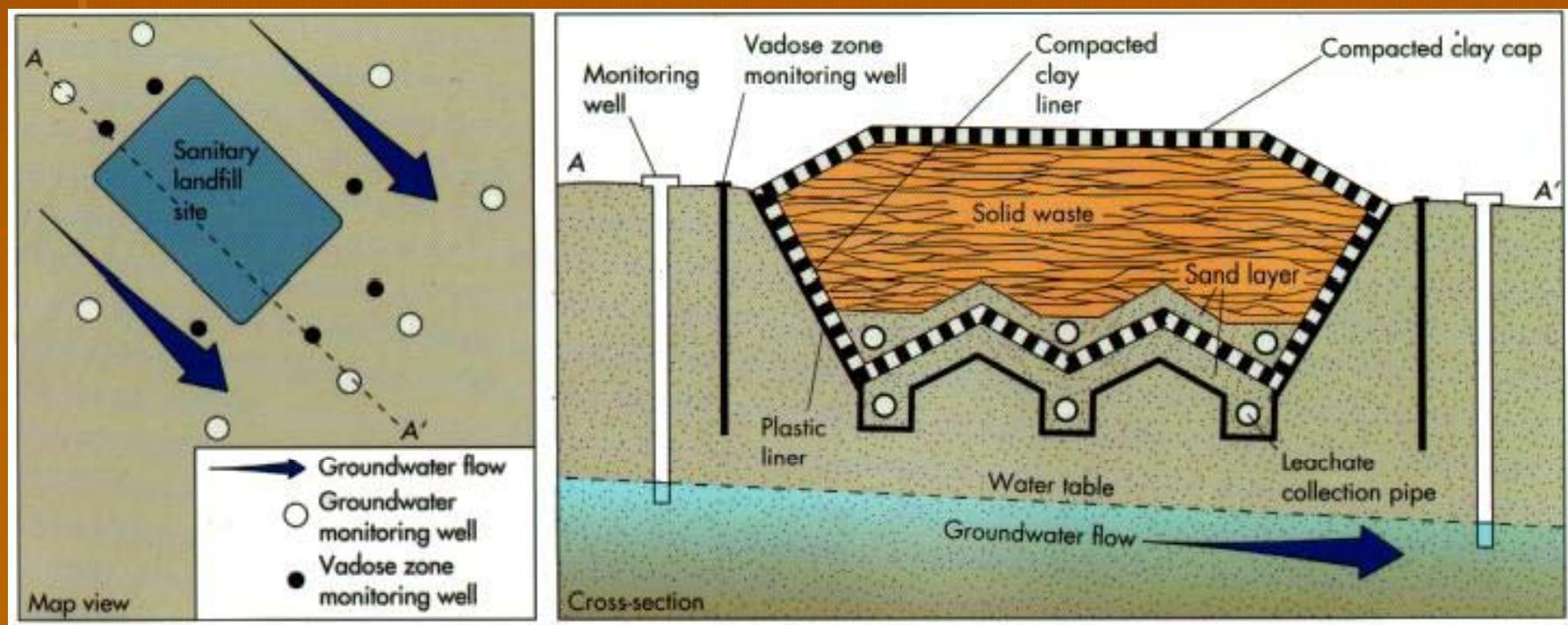
- Also known as Waste to energy, in which energy is produced from waste materials
- Eg: Biogas, Biomass energy etc.

Waste disposal:

- Process involves
- Physical removal: Manually collecting wastes
- Dumping: Transfer of solid waste from place of collection to the site of disposal
- Compaction and bailing:
 - Pressing with bulldozers is compaction
 - Rolling the compressed waste is bailing

Waste disposal - Landfill

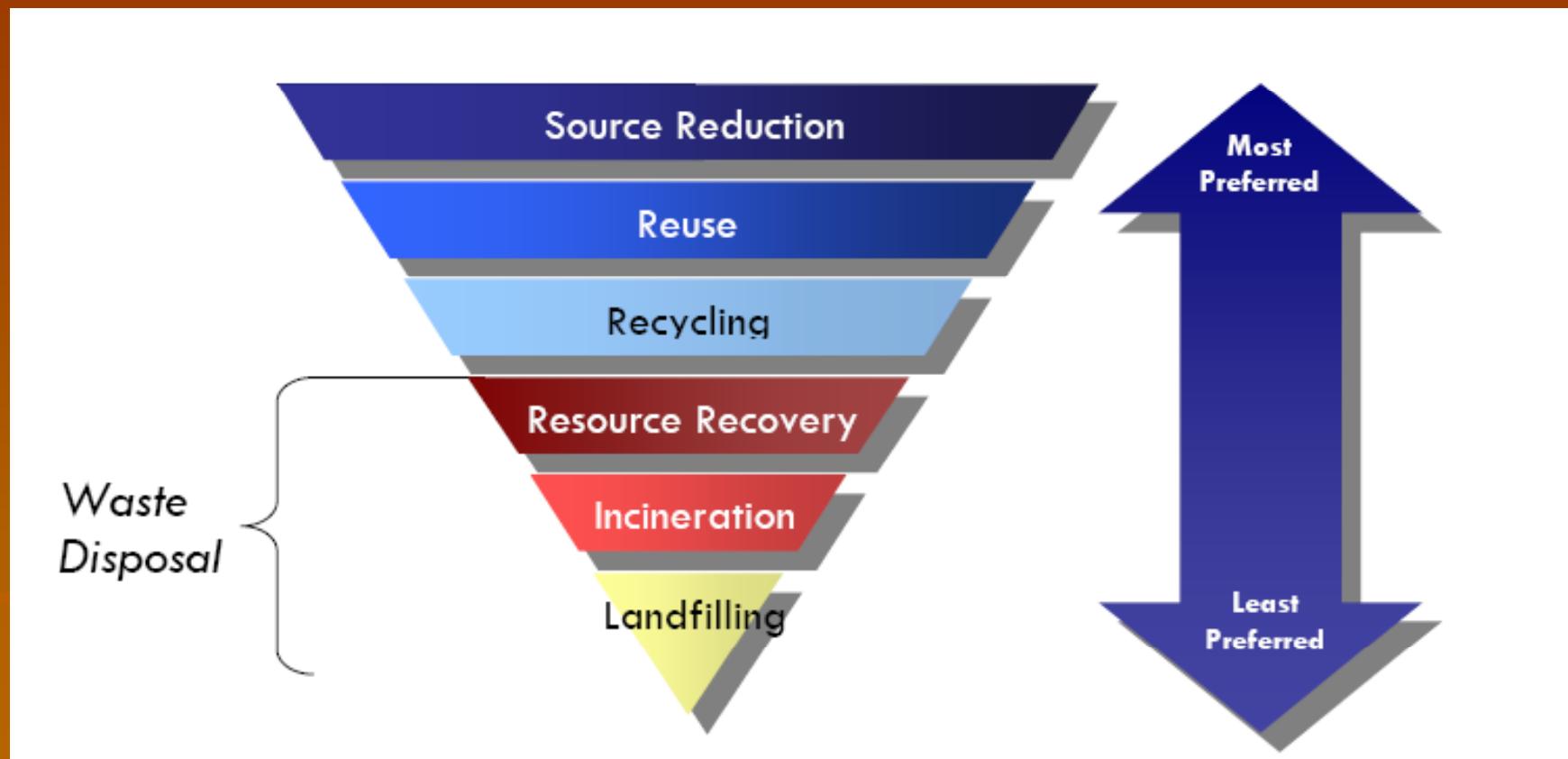
- In sanitary landfill waste is spread out, compacted and covered with layers of clay, sand or gravel or plastic foam
- The bottom is covered before landfill to prevent leaching of ground water
- Several wells are dug nearby to monitor leakage from ground water contamination
- Methane gas if formed, is collected and used as a fuel or for electric heating.



Waste Disposal - Incineration

- Burning of waste materials that are combustible.
- Initial cost of setting up of the plant is high but may become self sustained due to gases produced during incineration
- Removal of plastics prior to incineration prevents formation of gases like dioxins, PCBs etc.
- Advantages are:
 - substantial reduction in waste volume
 - Although initial set up cost is high, later becomes self sustainable
 - Removes pathogenic organisms when medical waste is incinerated

MSW management - Hierarchy



Hazardous waste management

- A hazardous waste is any material that can pose threat to life when discarded directly and therefore requires special precaution
- Types of hazardous waste -
 - Specifically listed under various categories by EPA
 - classified according to the characteristics of the waste
 - Ignitable
 - Corrosive
 - Reactive
 - Toxic

Types of Hazardous wastes - Ignitable

- **An Ignitable waste is one that can create a fire or spontaneously combust at temperatures less than 60°C or 140°F.**
- **Examples:**
- spent low flash point cleaning solvents or mineral spirits;
- discarded cylinders still containing compressed ignitable gases;
- paint and/or solvent soaked rags or sorbants which may spontaneously combust while stored



Reactive

- A **Reactive waste** is one that tends to be unstable at normal temperatures and pressures. It may react violently with water, air, and other materials.
- Examples: magnesium shavings; old unstable chemicals; certain cyanide or sulfide wastes; forbidden explosives
- Perchloric acid explodes in the presence of sulfur containing compounds – combination used in fire crackers causes death of several fire cracker workers



Corrosive



- A **Corrosive waste** is one with a pH less than or equal to 2 or a pH greater than or equal to 12.5.
- Which corrodes steel by 0.25 in/year
- Example: extreme acidic or alkaline cleaning solutions; battery acid

Toxic

- A **Toxic waste** is a material that can be harmful or fatal if you are exposed and can pollute groundwater if released on land. Toxic wastes are listed by EPA.
- Wastes determined by laboratory analysis (TCLP, or Toxicity Characteristic Leaching Procedure) to contain any of 40 specified constituents (primarily heavy metals, organic compounds, and pesticides/herbicides) above threshold concentrations
- Examples: **lead-based paints, cadmium, arsenic, waste from paints with high chromium or lead content; battery acid (lead); discarded gasoline or cleanup wastes (benzene); cleaning compounds containing certain solvents, or picking up contaminants such as lead or chromium in use; discarded mercury switches**



Effects of HHW on Environment

- Improper storage allow HHW chemicals to leak into the environment, causing dangerous chemical reactions, poisoning or pollution.
- Improper disposal allow HHW chemicals to **contaminate soil and/or water**.
- **Groundwater contamination** if dumped on the ground
- Pollutes rivers, streams and lakes when poured through storm drains.
- **Toxic materials** in wastewater can kill the **helpful bacteria** and the Wastewater treatment system will not operate properly.
- Contribute to air pollution or an explosion when burnt.

Hazardous waste management strategies

- Minimize, recycle, reduce the volume, stabilize/solidify, stimulate waste exchange, detoxify, incinerate, dispose in special landfills
- Treatment options:
 - Biological treatment
 - Physical : Precipitation, reverse osmosis, distillation, electrodialysis, carbon adsorption, solvent extraction etc
 - Chemical: Neutralization, redox, incineration

House hold hazardous wastes



Household Hazardous Wastes generated from Domestic use

Household HWM

discard HHW separately – do not mix with non-hazardous wastes!

- Examples of HHW
- Automotive products

Examples: gasoline, motor oil, antifreeze, windshield wiper fluid, car wax and cleaners, lead-acid batteries, brake fluid, transmission fluid.

- Home improvement products

Examples: paint, varnish, stain/paint thinner, adhesives.

Household HWM

- Pesticides

Examples: insecticide and insect repellent, weed killer, rat and mouse poison, pet spray and dip, flea collars, mothballs, disinfectant, wood preservative.

- Household cleaners

Examples: furniture polish and wax, drain opener, oven cleaner, tub and tile cleaner, toilet bowl cleaner, spot remover, bleach, ammonia.

- Other

Examples: LPG gas, Tube light bulbs, household batteries, cosmetics, shoe polish, lighter fluid, prescription medicines

Present Practices of Disposal of HHW in Bangalore

- Segregation of hazardous waste from household is usually not done
- Usually HHW is mixed with MSW at source
- Separation of Organic and Inorganic waste done in some parts of the capital city and later again mixed while dumping
- No designated landfills available for dumping of segregated waste
- Three compost pits located mix up the segregated waste
- The hazardous waste impair the biological activity of composting

HHW management

Keep out of reach of children

- Read labels
- Reduce use -Buy only what is needed
- Don't store with food
- Find out non-toxic alternatives and use
- Do not mix HHW with MSW
- Take unused to HHWM facility
- Drain all liquid into a news paper
- Close the lid tightly
- Exchange

Biomedical Wastes



- **Hospital waste:** refers to all waste, biological or non biological, that is discarded and is not intended for further use
- **Medical waste:** refers to materials generated as a result of patient diagnoses, treatment, immunisation of human beings or animals

Biomedical Wastes requiring - special Treatment

The World Health Organisation (WHO) has classified medical waste into different categories. These are:

- Infectious: material-containing pathogens in sufficient concentrations or quantities that, if exposed, can cause diseases. This includes waste from surgery and autopsies on patients with infectious diseases;
- Sharps: disposable needles, syringes, saws, blades, broken glasses, nails or any other item that could cause a cut;
- Pathological: tissues, organs, body parts, human flesh, fetuses, blood and body fluids;
- Pharmaceuticals: drugs and chemicals that are returned from wards, spilled, outdated, contaminated, or are no longer required;
- Radioactive: solids, liquids and gaseous waste contaminated with radioactive substances used in diagnosis and treatment of diseases like toxic goiter;
- Waste discharge
- Others: waste from the offices, kitchens, rooms, including bed linen, utensils, paper, etc.

Treatment of Hospital Wastes

- Technologies which are used for the Treatment of Hospital Wastes are as follows:
- Incineration:
- Steam Autoclaving
- Chemical Treatment
- Microwave Radiation
- Deep burial

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Treatment of chemical waste

- Chemicals react in waste collection if not discarded properly:
 - Emit toxins, explode, cause diseases
- Material safety data sheet
- Do not mix incompatible chemicals
 - Acids and alkalis
 - Bleaches
 - Oxidizing agents
 - Reducing agents
 - Solvents and inflammables
 - Learn about

 ScienceLab.com
Chemicals & Laboratory Equipment


3
Z 0

Health 2
Fire 3
Reactivity 0
Personal Protection H

Material Safety Data Sheet
Benzene MSDS

Section 1: Chemical Product and Company Identification

Product Name: Benzene	Contact Information:
Catalog Codes: SLB1504, SLB3055, SLB2881	ScienceLab.com, Inc. 14025 Smith Rd. Houston, Texas 77396
CAS#: 71-43-2	US Sales: 1-800-901-7247 International Sales: 1-281-441-4400
RTECS: CY1400000	Order Online: ScienceLab.com
TSCA: TSCA 0(b) inventory: Benzene	CHEMTRAC (24HR Emergency Telephone), call: 1-800-424-9300
CII: Not available.	International CHEMTRAC, call: 1-703-527-3887
Synonym: Benzol; Benzene	For non-emergency assistance, call: 1-281-441-4400
Chemical Name: Benzene	
Chemical Formula: C ₆ H ₆	

Section 2: Composition and Information on Ingredients

Composition:		
Name	CAS #	% by Weight
Benzene	71-43-2	100

Toxicological Data on Ingredients: Benzene: ORAL (LD50): Acute: 930 mg/kg [Ref]. 4700 mg/kg [Mouse]. DERMAL (LD50): Acute: >3400 mg/kg [Rabbit]. VAPOR (LC50): Acute: 10000 ppm 7 hours [Ref].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of eye contact (irritant), of inhalation. Hazardous in case of skin contact (irritant, permeator), of ingestion. Inflammation of the eye is characterized by redness, watering, and itching.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Classified A1 (Confirmed for human.) by ACGIH, 1 (Proven for human.) by IARC.
MUTAGENIC EFFECTS: Classified POSSIBLE for human. Mutagenic for mammalian somatic cells. Mutagenic for bacteria and/or yeast.

TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Classified Reproductive system/toxin/female [POSSIBLE].
The substance is toxic to blood, bone marrow, central nervous system (CNS).
The substance may be toxic to liver, Urinary System.
Repeated or prolonged exposure to the substance can produce target organs damage.

Computer and electronic scrap

- Production requires several materials like compounds made from Hg, Cd, Pb, Brominated flame retardants
- Not easy to separate
- Manufacturing releases toxic gases like dioxins -Cause health problems during manufacture
- Solution:
 - Add surcharge to reduce – use the amount to treat e-waste
 - Make it mandatory to take back old equipment while supplying new equipment
 - Buy electronics made of recyclable materials

Nuclear waste

- Radioactive wastes are classified into
 - High-level – long lived
 - Low-level – fast decaying
- Should not mix the two
- High-level: Store indefinitely, reprocess, dispose of by burial or isolation
- Low-level: Waste minimization, volume reduction by compression or incineration, containment