WASTE MINIMIZATION

Prof. Dr. S Mohan
Environmental and Water Resource Engineering
Depart of Civil Engineering
IIT Madras
Chennai - 36

WHAT IS HAZARDOUS WASTE

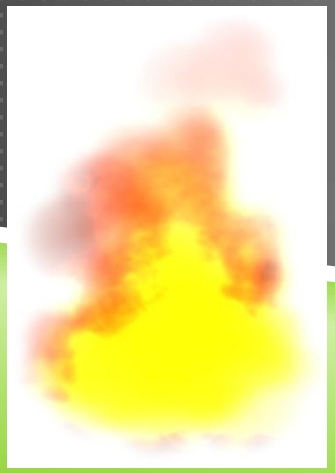
- Any waste that has the following characteristics:

- **Ignitable**

  Flash point < 140°F

  Examples:

  Alcohols, acetone, toluene, xylene, ether, other



- **Corrosive**

  pH ≤ 2.0 or pH ≥ 12.5

  Examples:

  Acids, glass cleaner, hydroxides, bases, drain cleaners, other

- **Reactive**

  Unstable

  Examples:

  Peroxide forming ethers

- **Toxic**

  Fails Toxic Characteristic Leaching Procedure (TCLP) Test

  Examples:

  Heavy metals: mercury, lead, silver, chromic acid

TYPES OF ECONOMIES

INTRODUCTION

Tiger Economy

(Parasitic Economy)

Feeding on other animals drinking their blood

(Introduce violence)

Monkey Economy

(Predatory Economy)

Self Interest without contribution

(Less violence, but destructive)

Economy of Honey Bee

(Economy of Enterprise)

Contribute their share and effort in obtaining the products

(Active Constructive Unit)

Mother Economy

(Economy of Services)

Feeds her young ones and risk her life in defending young ones

(Economy of Permanence)

Green Economy

(Economy of Environment)

improved human well-being and social equity, with less environmental and ecological risks

(Economy of Sustainable Development)

HISTORY

Hazardous Waste Management emerged in the United States as a response to the rise of environmental movements of the 1969 that raised awareness of the serious environmental effects of human activities which were inadequately controlled by existing planning regulation and pollution control measures.

SEQUEL TO THE LOVE CANAL PROJECT

A Little History

William T. Love (1844-1889) was a business man who wanted to serve the area's burgeoning industries with hydroelectricity. He purchased the vast amount of land and began constructing a canal that would connect the Niagara River to Lake Ontario. He was also a Republican and was a minister.

In 1892, Congress passed a law barring the removal of water from the Niagara River, to preserve the Niagara Falls. Love's plan fell through.

Because building canals was such a hard, tedious, and dirty job, the project was abandoned.

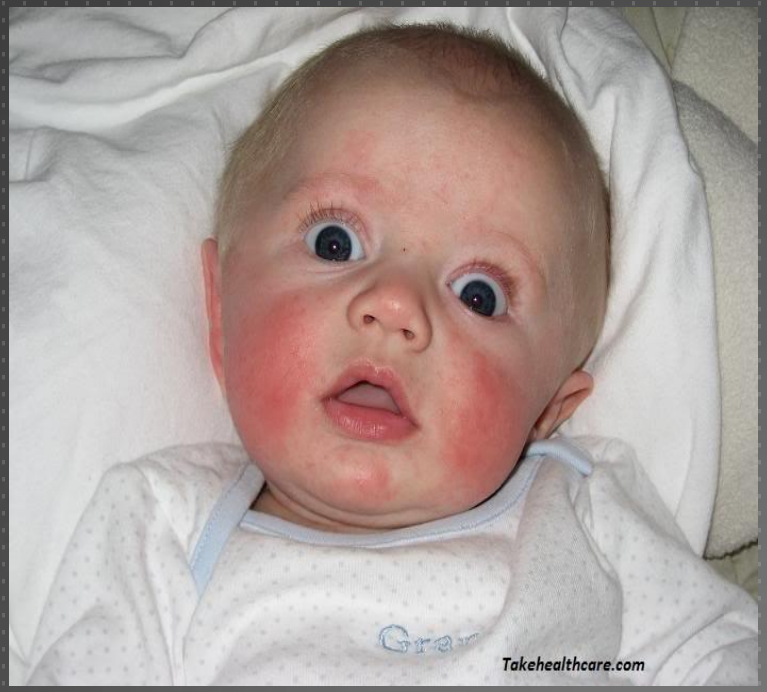
Years later, in the 1920's, the canal had begun to fill with water and the local children swam there during the summer and skated during the winter. The city of Niagara Falls also began to regularly dump its waste into the pit.

By the 1940's, the US Army turned it into a toxic waste dump. During World War II, toxic waste, including that from the Manhattan Project, was disposed into the canal.

In 1942, the land was purchased by the Hooker Chemical & Plastic Company and would be used to dump chemical waste into the canal. Within 10 years, the Hooker Company had dumped an estimated 21, 800 tons of chemical waste into the canal.

The 1950's are when things seemingly started to go downhill. The Hooker Chemical Company believed the thick clay walls from the clay based canal would be ideal for protecting the surrounding land from possible leaking chemicals. When the dumping ceased, the rest of the land was covered with more "impermeable" clay. In 1953, the land was sold to the Niagara Falls Board of Education for an incredible- $1.

The construction of the 99th Street Elementary school then went underway. The surrounding area was also sold to realtors, and houses begin to be constructed.



During the 1968, strange problems began to occur. Strong odors protruded through the streets of the town. Children and dogs began developing skin irritations. It was even recorded that rocks would explode when dropped. Heavy rain and snowfalls raised water levels in areas of Hooker's landfills, revealing 55-gallon drums..

Physical evidence showed corrosion of sump-pumps, oily residues arising in peoples' basements, contaminated ponds, and other surface water.

Investigations went underway, testing several sump-pumps near the love canal. The results: many hazardous chemicals have been leaking from the poorly insulated Love

Canal, spreading many harmful toxins to peoples homes infecting any living organism (s): plants, animals, humans, etc.

The *Niagara Falls Gazette* was the first to investigate the toxic dumpsite testing many of the sump-pumps located near the Love Canal and founded them to be contaminated. Oddly enough, the situation went quiet for more than a year.

A unique kitty cat found wandering around the Love Canal area.

The issue was resurrected in 1970 by reporter Michael Brown who went door-to-door surveying potential health risks. His findings included a vast amount of birth defects and abnormalities including:

-enlarged feet, heads, hands, and legs
-children with a dozen or more birth defects
-abnormal miscarriages
-mental retardation
-nervous disorders
-cancers
-unexplained illness, and many other medical conditions whose causes were unknown.

August 2, 1970, a state of emergency was declared on the town near Love Canal. Nearly 1,500 families were evacuated from the area.

Test ran on the Love Canal revealed the water supply was contaminated.

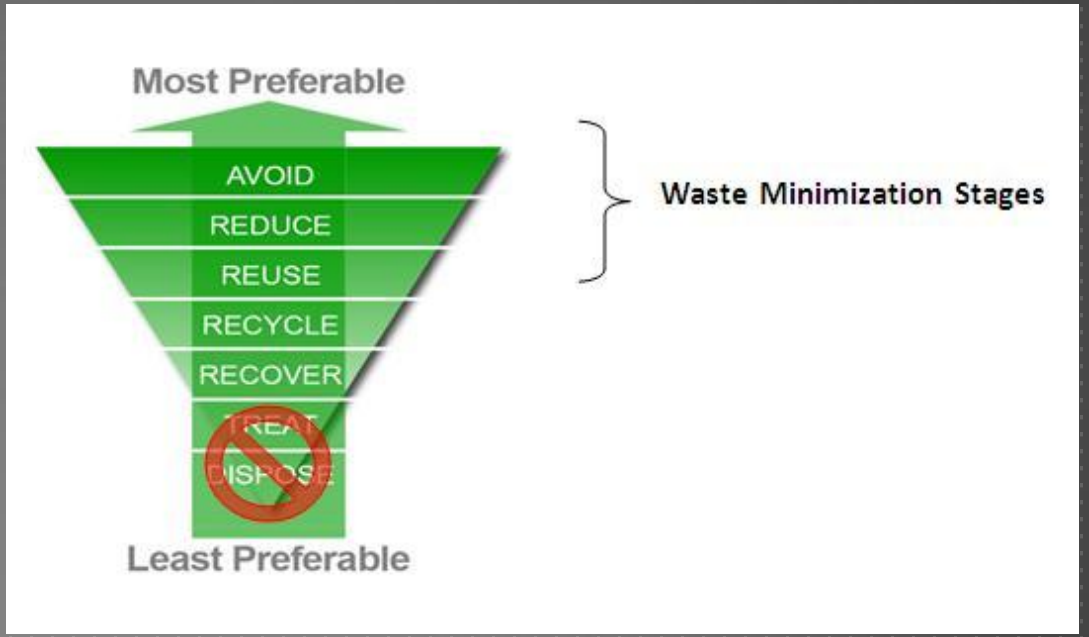
The tragedy at Love Canal was a rude awakening for the country. The coming of mans' advances also revealed mans' destruction.. but ultimately with nature prevailing.

The problem facing us now is how many more times will occurrences like this happen, and how many more of our children be affected? Either way, nature is always one step ahead.

This Tragedy made the Govt. to enact the National Environmental Protection Act, USA in 1969

THE WASTE MANAGEMENT HIERARCHY

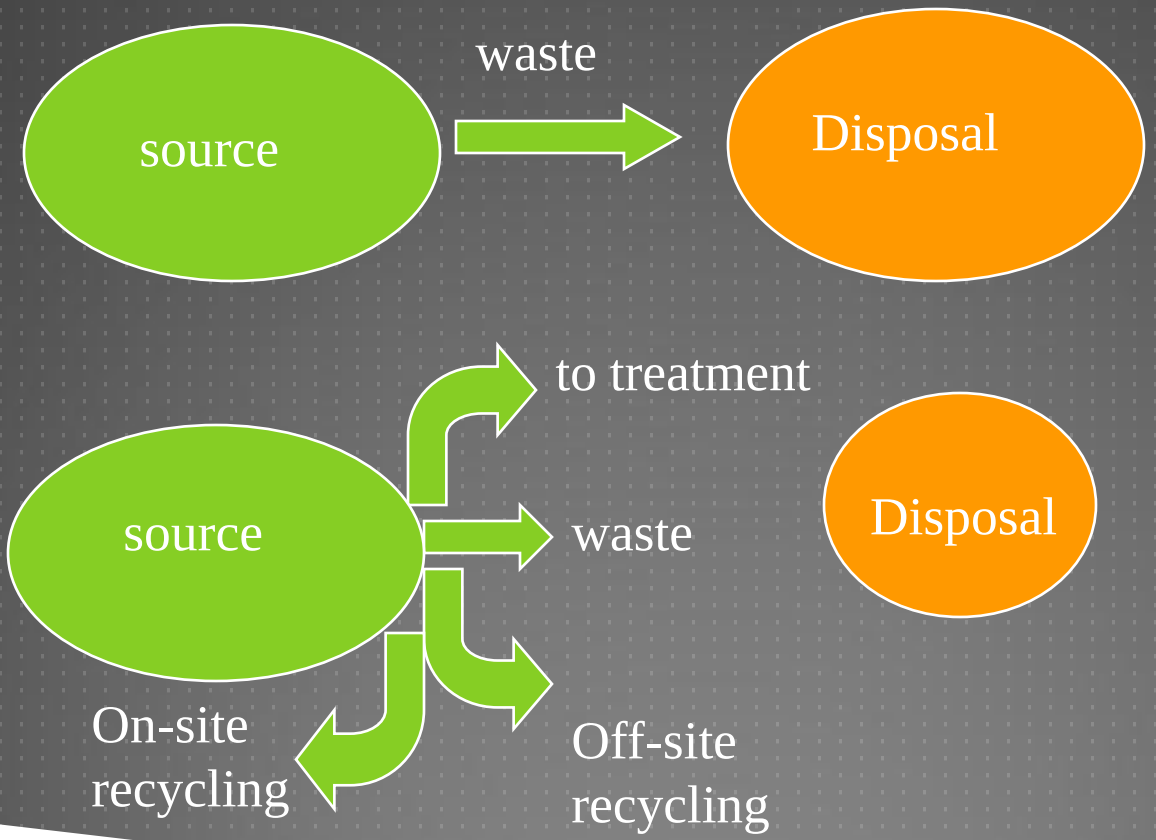
- A ranking of waste management methods in terms of their 'desirability'
- The hierarchy is based largely on the concept of the 3R's – reduce, reuse, recycle.
- The most preferable approach is that which produces as little waste as possible, thus minimizing the amount entering the waste stream.



WHAT IS WASTE MINIMIZATION?

- Preventing or reducing generation of waste through an emphasis on source reduction and recycling
  - source reduction is preferred, where possible
  - for lasting waste minimization, focus on working with the medical staff to make changes towards less wasteful clinical practices

WHY MINIMISE WASTE?



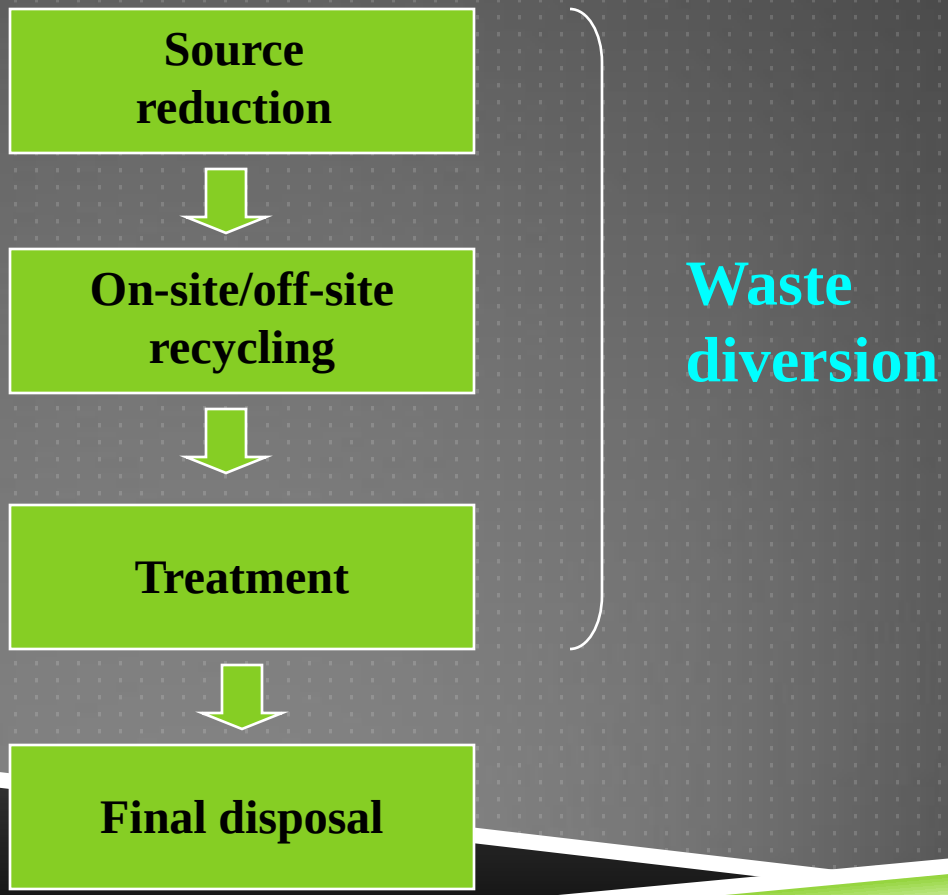
BENEFITS OF WASTE MINIMIZATION

- Reduces cost of waste disposal
- Reduces environmental impact
- Enhances public health
- Enhances worker safety
- Improves public image

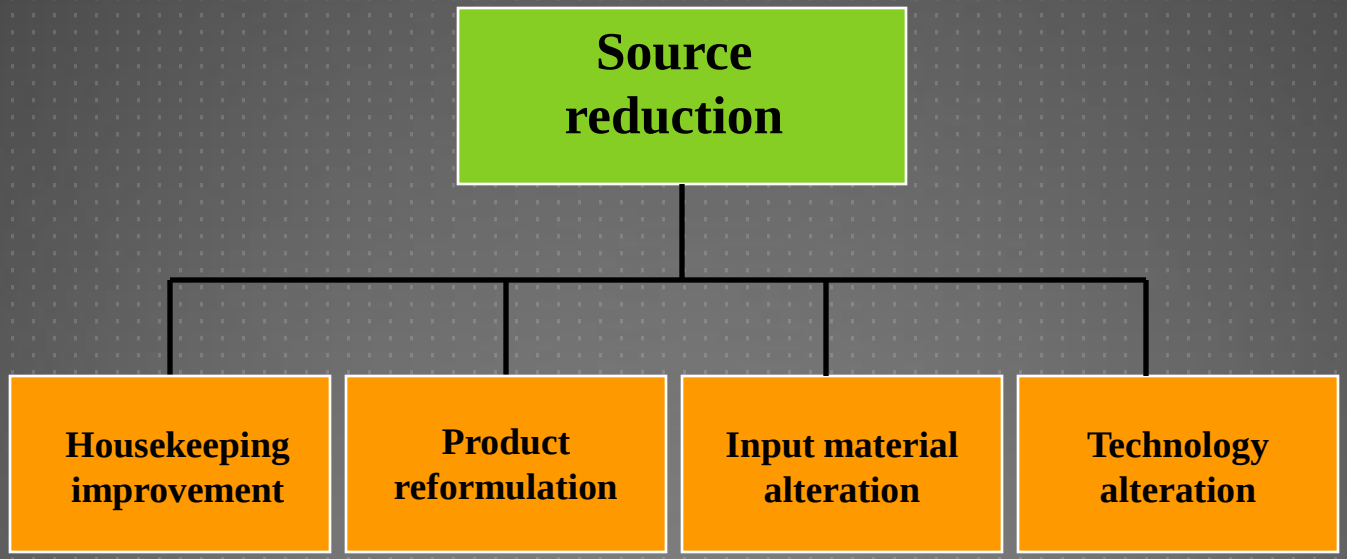
WASTE MINIMIZATION OPPORTUNITY ASSESSMENT

- Systematic procedure for identifying ways to reduce or eliminate waste
- Four phases:
  - Planning and organization
  - Assessment phase
  - Feasibility analysis phase
  - Implementation

PREFERRED HIERARCHY OF WASTE MANAGEMENT OPTIONS



SOURCE REDUCTION OPPORTUNITIES



SUCCESSFUL EXAMPLE: 3M

- reduced effluent discharges by 3.7 billion litres
- eliminated 10,000 tonnes of water pollutants
- eliminated 140,000 tonnes of sludge
- eliminated 90,000 tonnes of air pollutants

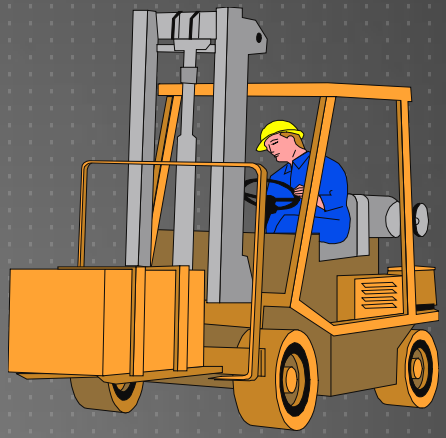
Savings = US$192million

FACTORS INFLUENCING WASTE MINIMISATION

- Government policy and regulations
- Technological feasibility
- Economic viability
- Management commitment and support

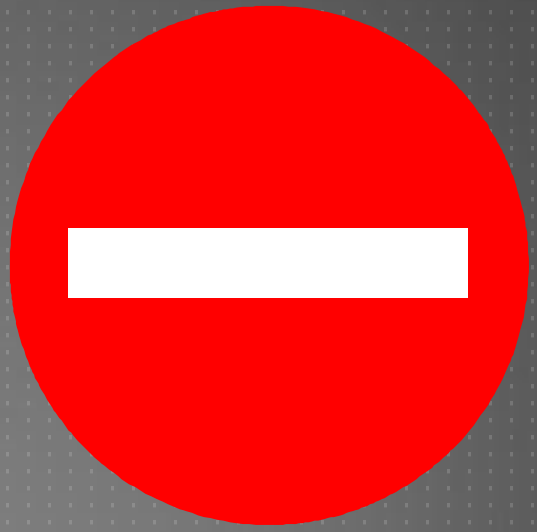
WASTE MINIMISATION - INCENTIVES

- Reduced costs:
  - raw materials, energy, water
  - storage and handling
  - waste disposal
  - health and safety
- Regulatory compliance
- Improved efficiency
- Improved Industry/Corporate image



WASTE MINIMISATION - BARRIERS

- Economic barriers
- Technical barriers
- Regulatory barriers



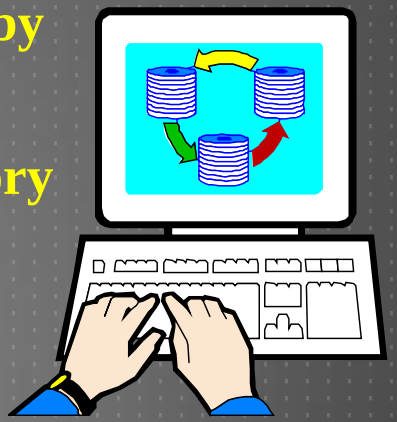
WASTE MINIMIZATION OPPORTUNITIES

- Use higher purity materials
- Use less toxic raw materials
- Use non-corrosive materials
- Convert from batch to continuous process
- Improve equipment inspection & maintenance
- Improve operator training
- Improve supervision
- Improve housekeeping

WASTE MINIMIZATION OPPORTUNITIES

Improve material tracking and inventory control:

- avoid over-purchasing
- inspect deliveries before acceptance
- make frequent inventory checks
- label all containers accurately
- ensure materials with limited shelf-life are used by expiry date
- where possible, install computer-assisted inventory control



IMPLEMENTING A COMPANY WASTE MINIMIZATION PROGRAMME

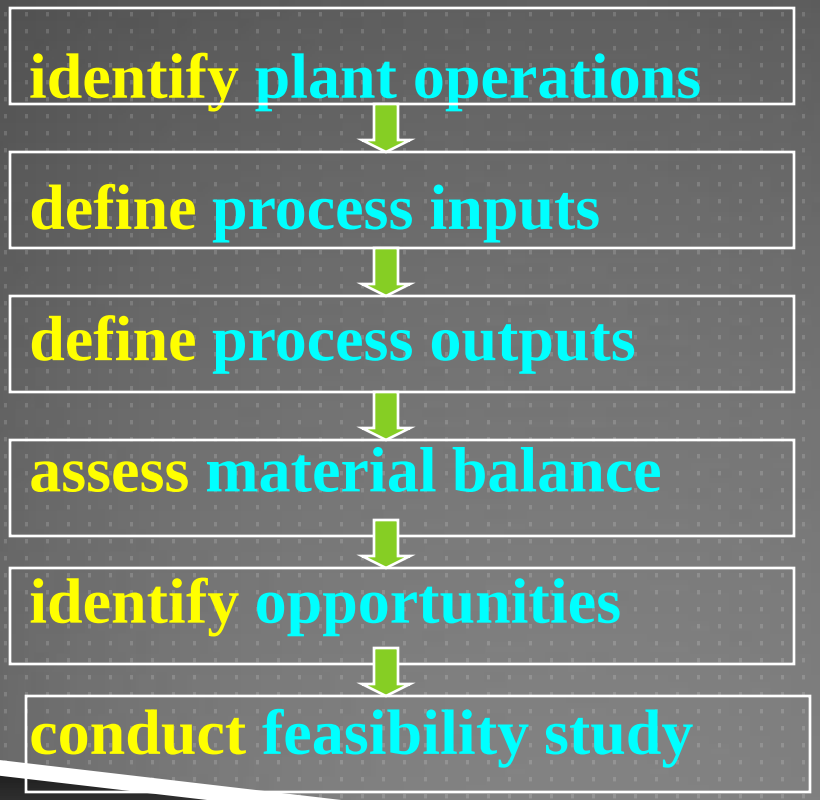
- A systematic and ongoing effort to reduce waste generation
- Must be tailored to specific company needs and practices
- 3 main phases:
  - planning and organization
  - conducting a waste audit
  - implementing, monitoring and reviewing

PHASE 1: PLANNING AND ORGANIZATION

- Obtain management commitment
- Establish programme task force
- Set goals and priorities
- Establish an audit team

PHASE 2: WASTE AUDIT

6 main steps:



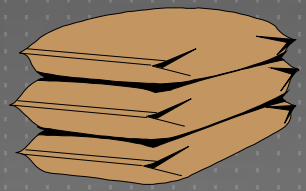
STEP 1: IDENTIFY PLANT OPERATIONS

- Inspect the site
- Identify different processes undertaken on site
- List processes and obtain as much information as possible on them

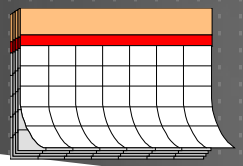
STEP 2: DEFINE PROCESS INPUTS

Account for all the material flows into each individual process

- **materials**
- **energy**
- **water**



Make sure all inputs are accounted for in detail eg kg of raw materials, kilowatts of electricity, litres of water



Make sure figures are on same basis eg annual, monthly, weekly inputs

STEP 3: DEFINE PROCESS OUTPUTS

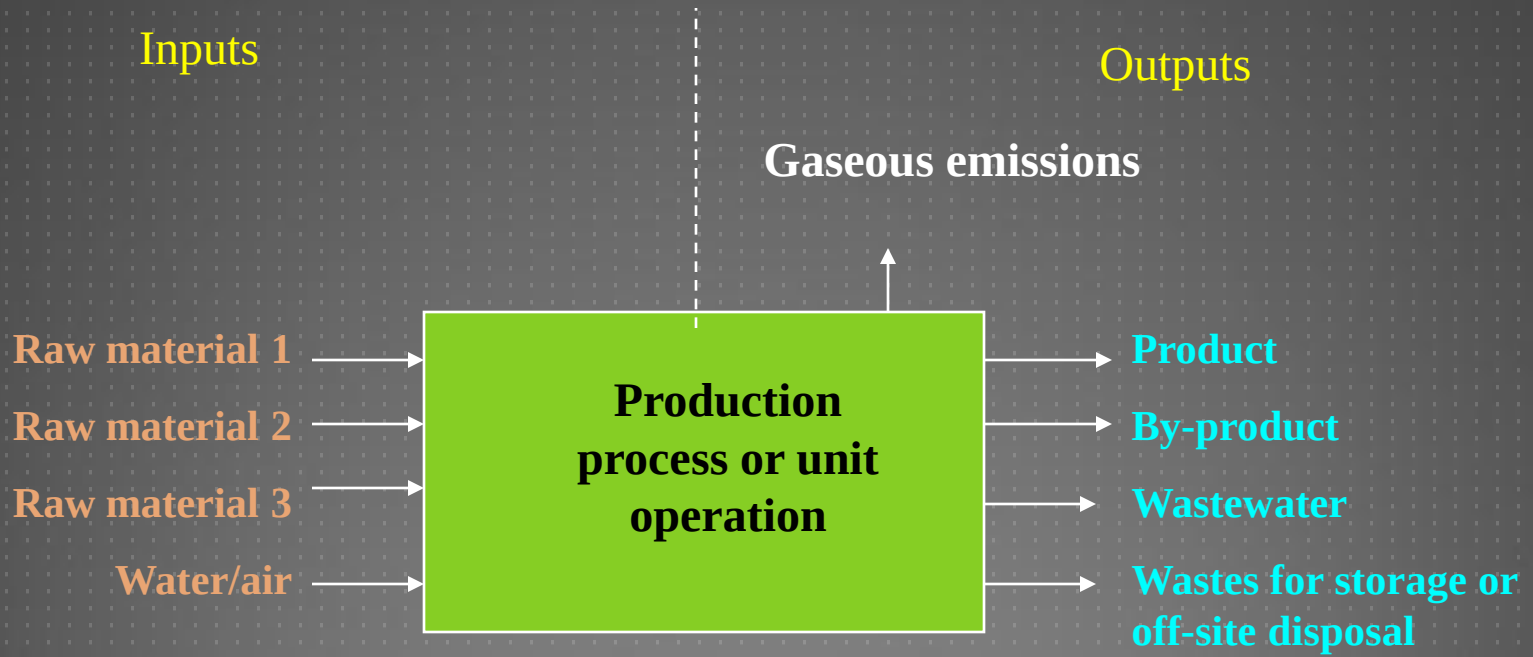
Identify and quantify all process outputs

- **primary products**
- **co-products**
- **waste for re-use or recycling**
- **waste for disposal**

STEP 4: ASSESS MATERIAL BALANCE

To ensure that all resources are accounted for, conduct a materials balance assessment

TYPICAL COMPONENTS OF A MATERIAL BALANCE



STEP 5: IDENTIFY OPPORTUNITIES FOR WASTE MINIMISATION

Using data acquired during the waste audit, make preliminary evaluation of the potential for waste minimisation

Prioritise options for implementation

STEP 6: CONDUCT FEASIBILITY STUDY

Conduct feasibility analysis of selected options

Technical considerations:

- **Availability of technology**
- **Facility constraints including compatibility with existing operation**
- **Product requirements**
- **Operator safety and training**
- **Potential for health and environmental impacts**

Economic considerations:

- **Capital and operating costs**
- **Pay-back period**

PHASE 3: IMPLEMENTING, MONITORING AND REVIEWING

- Prepare Action Plan
- Identify resources
- Implement the measures
- Evaluate performance

CASE STUDY – PHARMACEUTICAL INDUSTRY