PN-ACC-837

Train-The-Trainer

EFFLUENT MANAGEMENT COURSE

Presented by

Water Environment Federation

(WEF)

and

California Water Environment Association

(CWEA)

Why Are We Here?

Presented by

Water Environment Federation

(WEF)

and

California Water Environment Association

(CWEA)

WEF/CWEA/MOD1 1

Know your audience, % industry, government, academics,

Start with an open discussion

1 What do they want out of this training

2 What is important to us in our lives

Address discussion, tie into talk

Give brief history of what happens in their country,

what information can you gather from the chamber of industry etc

Why Are We Here?

- Protection of people
- Protection of business/industry
- Protection of capital investments
- Protection of environment

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Speaker

We are here for a variety of reasons In managing effluent we not only protect people who come in contact with wastewater or receiving streams, but we also protect the business/industry sector, the capital investments that business and/or cities have made to handle the effluents, and the environment, including the receiving waters themselves

Also address each country's specific problems (from researching their situation)

Add graphics or pictures if available

Participants

• Grand Rapids, Michigan The Grand Rapids wastewater treatment plant discharges treated wastewater into the Grand River The area had experienced fish kills due to cyanide and heavy metals in the wastewater in the early 1960s Controls on industrial dischargers of cyanide and metals into the municipal sewer system were instituted in 1969, and ten years later concentration of heavy metals had dropped by 87% in both incoming and treated wastewater Trout and Salmon returned to the Grand River by 1974

Protection of People

- Exposure to toxins
- Safety issues from damaged equipment
- Unsafe practices

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Speaker Notes

Whether they are workers who come in contact with the effluent, or citizens who might be exposed to toxins that affect them right away - acute or over time with many exposures - chronic Some pollutants may damage equipment exposed to the effluent making them unsafe to use

Provide examples that relates directly to the participants and not just general MAYBE ask questions

Participants

•Chicago, Illinois In the early 1970s , highly acidic wastes in the Chicago sewer system combined with sulfides discharged by leather tanneries to form hydrogen sulfide gas The gas caused nausea and dizziness among the Publicly Owned Treatment Works (POTW workers and there was a risk of fatal exposures The Metropolitan Sanitary District of Greater Chicago implemented both sulfide and pH controls to stop the formation of the hydrogen sulfide and other poisonous gases

Protection of Business/Industry

- Waste costs money
- Public image has high value
- Affects employee morale

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Speaker Notes

Waste translates to cost in business in one way or another That money could be used for other things Profits are literally going down the drain Public image and employee morale are priceless Both are improved with managing effluents

Participants

Need Examples of money saved by a company

Protection of Capital Investments

- Explosions, corrosion, clogging, and maintenance
- Treatment system upsets and over capacity

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Speaker Notes

In addition to not wasting money and boosting public image and employee morale, long term costs are better off as well Capital investment in the treatment system, the piping and pumps are better protected One reduces or eliminates the possibility of explosions, corrosion and maintenance Treatment system upsets and over capacity is reduced or eliminated

Participant Notes

•Washington Suburban Sanitary Commission (WSSC) The WSSC, which has six treatment plants serving Prince George and Montgomery Counties, Maryland, has experienced numerous corrosion problems due to highly acidic industrial discharges Several thousand feet of sewer line had to be replaced or repaired The WSSC developed extensive pretreatment requirements in 1972 and received federal approval of its program in 1983 The pretreatment program has enabled WSSC to identify and control the sources of its corrosion problems and reduce maintenance costs

Protection of Environment

- Polluted waters are unsafe for
  - drinking
  - harvesting fish/seafood
  - recreation activities
  - wildlife
- Sludges from treatment systems may be toxic

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Speaker Notes

Last, but not least, the environment that we live in continues to be a healthy place We have safe water to drink, and food supplies are not poisoned, or diminished The by-product of our treatment systems are not toxic, or lessened their toxicity and amount

Participant notes

Discuss the municipal sludge could be used for agricultural soil amendments

Need an article on biolsolids (WEF publication)

Why Are We Here?

Positive Results of Effluent Management

- improved water environment
- improved employee health and safety
- compliance with environmental laws
- lower wastewater treatment costs
- lower hazardous waste costs
- lower production cost, increased profits

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-We have been focusing on effects and problems

-The good news is that future incidents like these can be avoided by implementing an effluent management

-During the rest of the course, we will be looking in-depth at these positive aspects

Why Are We Here?

What are the biggest/worst industrial pollution problems?

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Speaker Notes

Exercise, break out the audience into groups of six Each group will develop a list of the biggest/worst industrial pollution problems

Depending on the composition, the trainer should define the area to be discussed in this exercise i e in the country , in the region , in the city

How do these pollution problems affect the water cycle, rain, bodies of water (rivers, lakes,ponds, marshes), groundwater, drinking water supply, food, $$$ income

Why Are We Here?

What are the causes of industrial pollution problems?

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Exercise, the same groups of six will identify the sources of these biggest/worst industrial pollution problems

Speaker Notes

It is important to understand the sequence of problems and causes and not jump into solution without identifying the cause

Examples of causes

•lack of education

•lack of laws

•human nature

•lack of proper training

Effects of Industrial Effluent in Wastewater

Presented by

Water Environment Federation(WEF)

and

California Water Environment Association(CWEA)

Pollution problems to be covered in this module:

- Solids
- BOD/COD (biological oxygen demand/chemical oxygen demand)
- Acidity/Alkalinity (pH)
- Toxic Organics
- Gases produced in the collection system under anaerobic conditions
- Gases introduced through direct discharge, leaks, or released in an acidic environment
- Fats/Oils/Grease
- Heavy Metals
- Nutrients

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Speaker Notes

Classify each of the examples given in the worst pollution problems

Make it applicable to the participants

Prepare a chart in advance or during the exercise at the end of module 1

Add example, and give brief definitions (if needed)

Participants Notes

1 ***Suspended Solids*** - This parameter is a measure of the concentration of solid particles suspended in the wastewater

2 ***Biochemical Oxygen Demand (BOD)*** - This pollutant category measures the tendency of wastewater to use oxygen in the receiving waters (I e , the surface water bodies into which the wastewater is discharged) Oxygen is consumed when organisms in the receiving waters metabolize the organic materials in the wastewater If too much oxygen is consumed, fish and other aquatic life in the receiving waters might be endangered Thus, POTW treatment systems are designed to reduce BOD of the wastewater

3 ***pH*** - pH is a measure of the acidity or the alkalinity of wastewater pH is measures on a scale of 1 to 14, 1 being extremely acidic, 7 neutral, and 14 extremely alkaline Most healthy surface waters have a nearly neutral pH, ie , they are neither strongly acidic nor alkaline Many aquatic species will not thrive or may die if the pH of their habitat changes even slightly Thus it is important to neutralize the wastewater prior to discharge

4 Organic Pollutants - These pollutants include pesticides, solvents, PCBs, and Dioxins Some of these compounds are lethal to animal life in as low concentration as 1 PPM (part per million)

5 Gases-

6 ***Fats Oil and Grease*** - These pollutants interfere with POTW treatment processes, impair the use of sludge as a soil conditioner, and degrade receiving water quality when present in excessive amounts

Toxic pollutants are those that are harmful to one or more forms of animal or plant life They are primarily grouped into organics and metals

7 ***Metals*** - The metals of concern are known as the "heavy" metals and include lead, silver, mercury, copper, chromium, zinc, and cadmium Most heavy metals are not immediately lethal, however, they can accumulate in vital organs of animals, including humans, causing serious health problems Cyanide and other non-organic pollutants frequently found in industrial wastewater will be discussed under other sections

Sources of Solids

Solids are found in most industries

- Washing Operations
- Pulp and Paper Facilities
- Timber Products Processing
- Food Processing
- Iron and Steel Manufacturing

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Speaker Notes

Total Suspended Solids (TSS) are common in most industries The above industries are just examples

Suspended materials are generated from, grinding, chopping, polishing and washing operations conducted at pulp and paper manufacturing facilities, timber processors, and the food processing industry Pickling operations at iron and steel manufacturing facilities also generate solid material, similar to grit Settleable solids and colloidal materials may be either organic or inorganic, depending upon the type of industrial processing operation

Types of Solids

- Screenable
  - Large >25 mm
- Non-Screenable
  - Grit sand or small gravel
- Settleable remove by sedimentation
- Suspended remains dispersed
- Colloidal very fine particles

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Solids are generally classified by size

large solids (at least 25 mm or 1 inch in diameter) interfere with flow

grit sand, gravel, other dense materials —settleable solids (generally have a diameter greater than 1 &m)

colloids (diameter from 10'6 mm to 10'3 mm) will not settle because their surfaces are electrically charged - they cannot be removed without treatment

Effects of Solids

- Excessive amounts can cause problems in the collection system and at the treatment plant
  - Wear out equipment such as pumps
  - Settleable solids clog lines and pump stations
  - Floating suspended solids accumulate in wet wells
  - Odor problems result from decomposition of biologically degradable solids
  - Affects life in the water body - fish, plants and aquatic life settles out thus filling ponds and clogging streams
  - Impairs other uses such as drinking, fishing and other water uses

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Use this slide in countries that have treatment systems For countries that do not have treatment plants/system substitute this slide with the next slide

Effects of Solids

- Excessive amounts can cause significant problems in the receiving waters
  - Affects life in the water body - fish, plants and aquatic life settles out thus filling ponds and clogging streams
  - Impairs other uses such as drinking, fishing and other water uses

Solids-
Types of Treatment

- Screening
- Gravity Settling /Floatation
- Filtration

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Three common techniques are used for solids removal These include passing wastewater through a strainer to remove large solids, using gravity for solids to settle or filtering wastewater through different type of media

Floatable products in the food processing industry can be recovered and sent off for rendering

BOD/COD-Definitions

- BOD
  - Biological oxygen demand is measured as oxygen demand resulting from aerobic bacteria and chemical reduction
- COD
  - Chemical oxygen demand is measured as equivalent oxygen demand by dichromate

BOD/COD-
Sources

- Fats, Oils and Grease
- Sugars
- Food Wastes
- Organic Acids
- Fatty Acids

Effects of BOD/COD

- Causes rivers, bays and oceans to experience oxygen depletion
- Reduced oxygen kills fish
- Organic materials must be stabilized

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Speaker Notes

Participant Notes

BOD/COD-
Types of Treatment

- Aerobic
  - oxidation
  - destruction
  - activated sludge/trickling filter
- Anaerobic
  - Decomposition
  - Reduction
  - Anaerobic digestion

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Speaker Notes

Explain what the treatment does?

Sources of Acid and Alkaline Wastes-

- Acid
  - Plating
  - Pickling
  - Food processing
- Alkaline
  - Chlorine generation
  - Scrubbers
  - Paint
  - Organics

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Cleaning activities

Manufacturing processes

Waste treatment

Effects of Acidity or Alkalinity

- Acids release toxic gases
- Acid and/or alkaline wastes are destructive to pipes and equipment
- Strongly acidic or alkaline wastes impair treatment of wastewater
- Affect aquatic life and quality of rivers and streams

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• acids release toxic gases when they come into contact with cyanide- or sulfide-containing wastes in the collection system

• acid and/or alkaline wastes are destructive to pipes and equipment - Melbourne, Florida replaced pump station due to a discharge of acid waste

• strongly acidic or alkaline wastes impair treatment plant performance The optimum pH for bacteria is generally between 6 5 and 8 5

neutralization of acid or alkaline wastewater can be a big economic issue for the treatment plant Neutralization chemicals are expensive and can be dangerous to handle

Sources of Toxic Organics

- Chemical manufacturers
- Petroleum refineries
- Pulp and paper mills
- Plastics and resin manufacturers
- Textile manufacturing
- Pesticide manufacturing

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•Generally three types

- polynuclear aromatic hydrocarbons (PAH),
- phenolic hydrocarbons (phenols),
- chlorinated hydrocarbons —

all can be incompatible with treatment systems

- Other types such as organophosphate pesticides,

can cause toxicity in the effluent

Effects of Toxic Organics

- Toxic to living organisms
- Inhibits treatment systems
- Bio-accumulate

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- Examples of toxic organics and the problems they can cause include
  - organic dyes
    - pass through the treatment process
  - high-molecular-weight PAHs
    - slow to degrade and tend to build up in solids
  - volatile organic compounds
    - cause air quality concerns
- Treatment systems are generally not designed to treat toxic organics

Gases produced in the collection systems under anaerobic conditions

- Hydrogen Sulfide
- Methane

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Hydrogen Sulfide (H_2S)

A colorless gas with a characteristic "rotten egg" odor at low concentrations H_2S is produced when organic matter containing sulfur decomposes Common in manholes, vaults, other underground spaces

Methane

colorless, odorless, tasteless It is generated under anaerobic conditions by bacterial action, and is lighter than air

Sources of Hydrogen Sulfide H_2S

IT IS THE BY PRODUCT OF ANAEROBIC PROCESSES

- Sewer systems
- Anaerobic Digesters
- Wet Wells
- Lagoons

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Effects of Hydrogen Sulfide H_2S

- Immediate effect on humans
  - Irritation of eyes and lungs
  - Nausea and dizziness
  - Loss of consciousness and DEATH
- Long term effects on humans
  - Eye damage
- Damage to vegetation
- Corrosion to pipes
- Flammable

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- Lethal at high concentrations

High concentrations reduce the oxygen-carrying capacity of the blood and depress the nervous system Causes respiratory failure and asphyxiation immediate collapse and death

High concentrations paralyze the olfactory nerve and create a false sense of security The smell has gone away but the H_2S has not!

- Lower concentrations cause eye irritation, coughing, nausea and dizziness

Flammability LEL 4 3% UEL 46%

Include this table in the references

Concentration	Subjective Olfactory Response
0 02 ppm	No odor
0 13 ppm	Minimal perceptible odor
0 77 ppm	Faint but readily perceptible odor
4 60 ppm	Easily detectable, moderate odor
27 0 ppm	Strong, unpleasant, but not intolerable odor

Effects of Hydrogen Sulfide H_2S

- Immediate effect on humans
  - Irritation of eyes and lungs
  - Nausea and dizziness
  - Loss of consciousness and DEATH
- Long term effects on humans
  - Eye damage
- Damage to vegetation
- Corrosion to pipes
- Flammable

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The above slide is the same as the one before it's purpose is only for the notes Include this table in the references

H_2S Concentration and Physiological Response

Concentration (ppm)	Physiological Response
10	Beginning eye irritation
50 to 100	Slight conjunctivitis and respiratory tract irritation after one hour of exposure
100	Coughing, eye irritation, loss of sense of smell after 2 to 15 minutes Altered respiration, pain in the eyes, drowsiness after 15 to 30 minutes Throat irritation after 1 hour Symptoms become more severe over time Death within 48 hours
200 to 300	Marked conjunctivitis and respiratory tract irritation after 1 hour
500 to 700	Loss of consciousness Death possible in 30 minutes to 1 hour
700 to 1000	Rapid loss of consciousness Cessation of respiration Death
1000 to 2000	Immediate unconsciousness Early cessation of respiration Death in a few minutes (may occur even if the victim is removed to fresh air right away)

Sources of Methane Gas
CH_4

IT IS AN ENDING PRODUCT OF ANAEROBIC PROCESSES:

- Anaerobic Digesters
- Sewer Systems
- Marshes and Lagoons

Effects of Methane (CH_4)

- Explosive at 5 to 15%
- Nausea
- Asphyxiation

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Example of explosion

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Gases introduced through direct discharge, leaks or released in an acidic environment

- Solvents
- Hydrogen Cyanide (HCN)
- Vinyl Chloride

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Relate back to types of industries and reason to take note and pay attention

Make sure everyone is familiar with the abbreviations and the jargon Use examples of uses for clarification

Some examples of gases that pose health threats to workers in the collection system or at a treatment plant

Solvents, Hydrogen Cyanide, Vinyl Chloride

Sources of Solvents

- Cleaning Operations
  - Automotive and Parts Cleaning
  - Metal Finishing
  - Electroplating
  - Semiconductor Manufacturing
- Painting Operations
- Laboratories
- Refineries
- Tanneries
- Dry Cleaners and Commercial Laundries

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Very Common In Most Industrial Processes

Effects of Solvents

- Explosive, Flammable, and Combustible
- Toxic

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Relate back to types of industries and reason to take note and pay attention

Explosive (slide showing example of damage caused by a series of underground explosions

Hexane, a highly volatile industrial solvent used at a soybean extraction plant, was discharged into the collection system After entering the collection system, the solvent vaporized, creating an explosive atmosphere The explosion caused extensive damage to more than 3 miles of the collection system, overlying streets, and nearby buildings and vehicles The total damage exceeded $20 million Louisville, Kentucky - 1981)

New York, New York the New York City Department of Environmental Protection operates 12 treatment plants serving all of the Boroughs of New York City At one of the plants a worker was overcome by fumes emanating from rags saturated with industrial solvents The officials prohibited the facility from laundering rags contaminated by solvents, thereby eliminating the hazard -Better example?

List sources of following

TCE, PERC, METH, d-limonene - suspected carcinogens

N-methyl-pyrrolidone NMP - reproductive toxin

Methylene Bromide - toxin

2-butoxyethanol - central nervous system problems

Sources of Hydrogen Cyanide HCN

- Plating Operations
- Refineries
- Coal Coking

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HYDROGEN CYANIDE (HCN)

- is generated in acidic environment, usually by the reaction of cyanide salts from plating wastes with acid (closed sewer pipes are usually acidic)

Effects of Cyanide Gas

- It is created in acidic environment
- Lethal to workers

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HYDROGEN CYANIDE (HCN)

•is extremely toxic HCN prevents the transfer of oxygen in the bloodstream, causing death by asphyxiation Exposure at 100 to 200 ppm is usually fatal after 30 to 60 minutes

• has a slight odor of bitter almonds

• (Threshold Limit Value, or average concentration of toxic gas to which a normal person can be exposed without injury during an average work week) is 10 ppm

Sources of Vinyl Chloride

- Polyvinyl Chloride Manufacturing
- Resin Manufacturing
- Biological

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Sources

- Polyvinyl Chloride Manufacturing
- Resin Manufacturing
- Biologically, through the reduction of polyhalogenated ethylenes (industrial solvents and dry cleaning chemicals)

Effects of Vinyl Chloride

- Immediate effects on the human body
  - severe eye irritation
  - depression of central nervous system)
  - light headedness
  - nausea
  - dulling of visual and auditory responses
  - death from severe exposure
- Long term effects
  - liver damage
  - liver, lung, brain, and lymph system cancers

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Vinyl Chloride is

- Colorless gas with a pleasant odor
- Produced in manufacturing of polyvinyl chloride (PVC) and other resins
- Used as a chemical intermediate and solvent
- Can cause liver cancer with chronic exposure

Acute exposure effects

severe eye irritation,

depression of central nervous system (resembles mild alcohol intoxication),

lightheadedness,

nausea,

dulling of visual and auditory responses,

death from severe exposure

Chronic exposure effects

liver damage,

liver cancer,

lung, brain, lymph system cancers also reported

Sources of Fats, Oils and Grease

- Food processing
- Metalworking
- Laundries
- Tanneries
- Wool processing
- Petroleum refineries
- Organic chemical manufacturing

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Food processing facilities (dairies, restaurants, soap manufacturing, meat packing, etc)

Effects of Fats, Oils and Grease

- Blocks, coats and congeals to sewer pipes
- Corrosive to pipes
- Fire and explosion hazards

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- blocks, coats and congeals to sewer pipes
  - expensive to remove from the collection system,
  - causes overflows and backups,
  - reduces capacity of the collection system
- corrosive to pipes
  - can be very acidic, under anaerobic conditions (low or no oxygen) fats can break down to acids
- Petroleum oils can present fire and explosion hazards in the collection system and the treatment plant

Effects of Fats, Oils and Grease

- Accumulates in pumping stations
- Interfere with biological organisms within treatment processes
- Clogging of filters

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Leave separate and insert when talking in countries that have treatment plants/systems

•accumulates in pumping stations - expensive to clean out, interferes with monitoring equipment, obstructs flow and causes odor complaints

• can interfere with biological organisms within treatment processes by coating the organisms and blocking oxygen transfer and absorption of nutrients Petroleum-based oils are degraded slowly by bacterial processes they coat the organisms and interfere with oxygen transfer

• Petroleum oils can obstruct flow and contribute to maintenance problems like clogging of filters

Sources of Heavy Metals

- Water supply
- Manufacturing
- Construction
- Agriculture
- Transportation
- Residential activities

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the water supply (naturally-occurring metals and metals added at the water treatment plant or dissolved from water supply equipment and pipes)

Effects of Heavy Metals

- Concentrate in solids
- Decrease biological activities at the treatment plant
- Pass through the treatment plant

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Treatment processes usually are not designed to remove metals Heavy metals can pass through the treatment processes and cause water quality problems, i e , chronic toxicity to organisms in the receiving waters, or limit the opportunity for re-use, i e , metallic salts make reclaimed water unfit for use by industry

Dissolved heavy metals decrease biological activity of treatment plant organisms

Heavy metals also tend to concentrate in the system and can reach very high levels in solids produced, causing problems with sludge disposal, i e , limit the opportunity for land application

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Sources of Nutrients

- Fertilizers
- Organic Materials

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- generally, the term 'nutrients' refers to nitrogen and phosphorus
- nutrients are essential to the treatment process they allow organisms to oxidize organic materials
- in excess amounts, nutrients can overload or interfere with the treatment system

•Comments- how does fertilizers get into the flow? Storm water

Sources - Carbon, Nitrogen, and Phosphorus

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Effects of Nutrients

- Some forms are toxic
- Maintenance problems
- Algae blooms consume oxygen in the die off stage

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•ammonia (a nitrogen compound) can be toxic to microorganisms

➡ nitrate compounds, formed by oxidation of ammonia by microorganisms, can release substantial amounts of nitrogen gas during treatment The gas bubbles attach themselves to particles and float them into the effluent This causes operations problems and TSS (total suspended solids) increases in the effluent

➡ phosphate, in high amounts, can cause precipitates to form, which may increase maintenance problems

➡ excessive amounts of nutrients can cause algae blooms by speeding up growth Algae dies off and its decomposition consumes oxygen, depriving microorganisms of oxygen

References:

- Industrial Waste Inspection Study Manual, compiled by Bill Garrett and Chris Smith CWEA, 1989
- Pretreatment Facility Inspection - A Field Study Program (2nd Edition), prepared by Kenneth D Kerri, California State University School of Engineering, Office of Water Programs in cooperation with the Industrial and Hazardous Waste Committee of the CWEA for the U S EPA Office of Water Enforcement and Permits, 1991
- Industrial User Inspection and Sampling Manual for POTWs, prepared by the Office of Wastewater Enforcement and Compliance Water Enforcement Division U S EPA, 1994
- Pretreatment of Industrial Wastes Manual of Practice No FD-3, prepared by the Task Force on Pretreatment of Industrial Wastes, Water Environment Federation, 1994
- The Condensed Chemical Dictionary, Tenth Edition, revised by Gessner G Hawley, Van Nostrand Reinhold Company, 1981
- Handbook of Toxic and Hazardous Chemicals and Carcinogens, Second Edition, Marshall Sittig, Princeton University, Noyes Publications, 1985

This slide is not for use in presentation, but should be part of the manual

Identifying Potential Industrial Effluent Management Opportunities

Presented by:

Water Environment Federation(WEF)

and

California Water Environment Association(CWEA)

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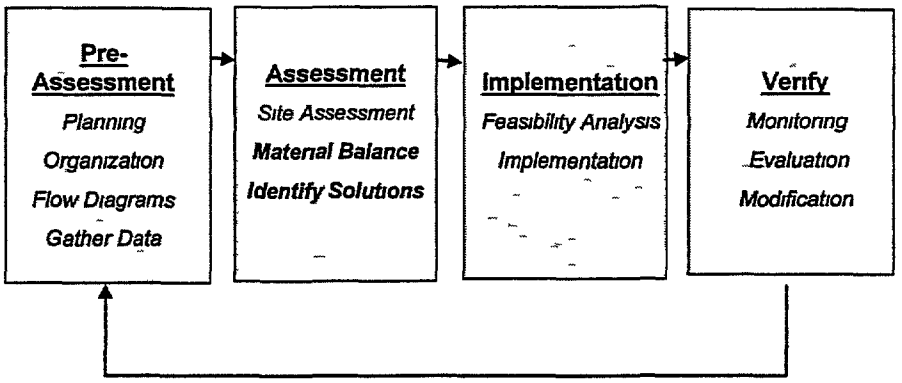
Effluent Management Phases



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Identifying Potential Industrial Effluent Management Opportunities

Pre-Assessment Phase

- Create flow diagrams
- Gather and review all pertinent data

Assessment Phase

- Conduct site assessment
- Calculate materials balance
- Identify possible solutions

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Notes

While Effluent Management can be thought of in four phases, it is important to remember that this is an on-going process

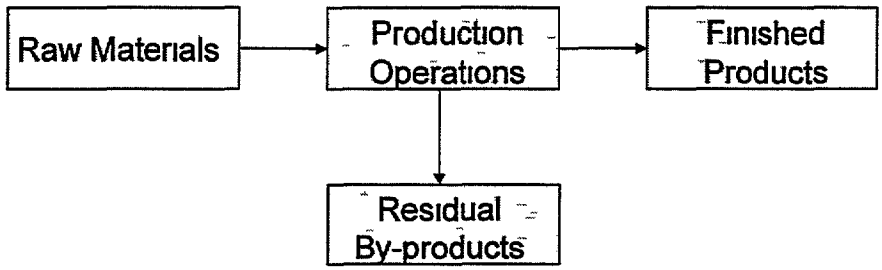
The Pre-Assessment and the Assessment phases are where most of the waste reduction opportunities will be identified in the first pass through of the effluent management process

Unit Operations and Flow Diagrams -- WHY?

- Identify logical process steps
- Identify raw materials input
- Identify intermediate inputs
- Identify energy inputs
- Identify outputs
- Identify losses and residuals

Process Flow Diagram

The simplest process flow diagram can be presented as



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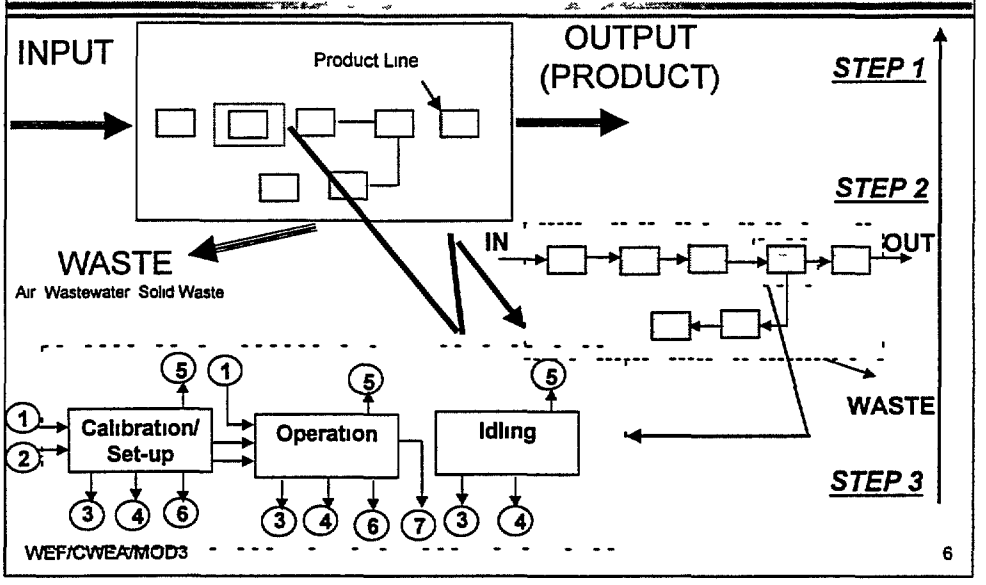
Notes

In developing a flow diagram it is often easier best to break an organizations processes into smaller and smaller steps

The purpose is to get to a level of detail where all inputs, outputs and fugitive emissions can be identified

FLOW DIAGRAMS



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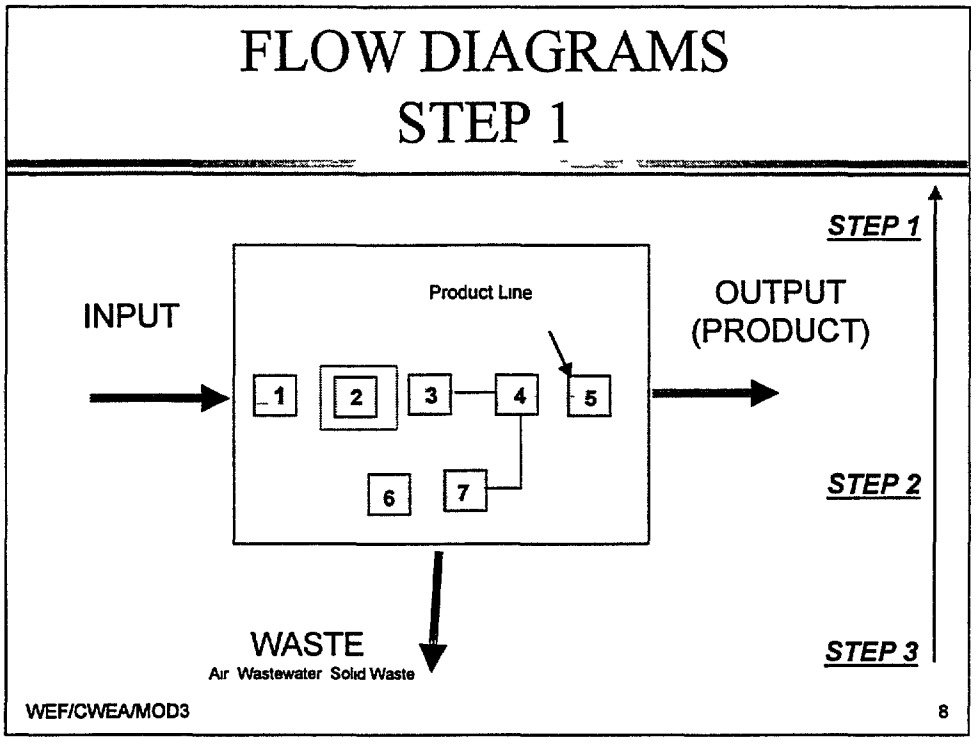
Flow Diagram

- A visual mechanism to organize information about flows of material and energy and the composition of the flows entering and leaving the system
- The first step to preparing a mass balance



Notes

Step 1 is at the macro level At this level the major operations within a company are identified

These may often be thought of as departments or divisions

Process Flow Diagram

A process flow diagram is a graphic line sketch that includes symbols and arrows that represent all the steps of the process necessary for converting the incoming raw materials, energy, and labor into the finished products and residual by-products

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Flow Diagram Map

- A schematic depiction for documenting a process
- Units or procedural steps diagraming functions of the process
- It is not a physical layout

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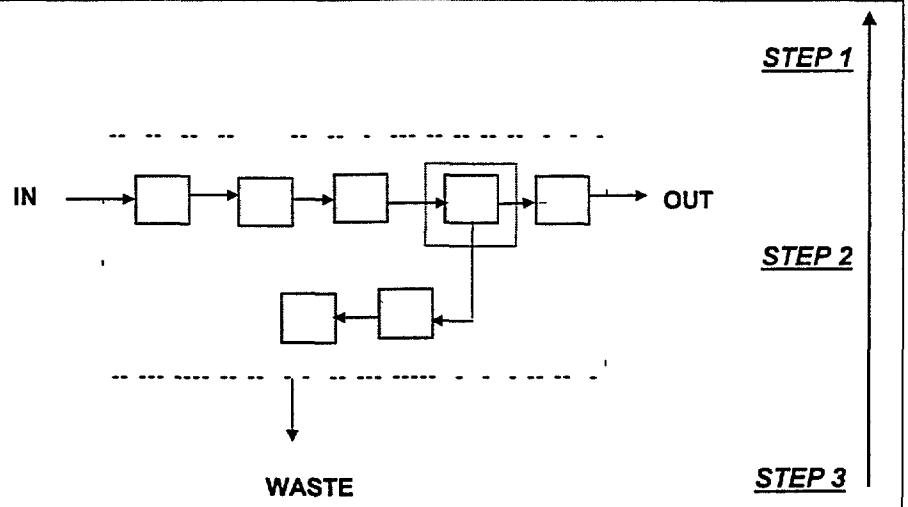
Process Mapping

- Simplified Process Flow Diagram
- Provide Details as Required
- Include intermittent/Ancillary Operations
- Verify and Determine Function

FLOW DIAGRAMS
STEP 2



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Notes

Step 2 will break each of the macro level operations, defined in Step 1, in to a more detailed level

For example, you might identify the specific operations within the production process

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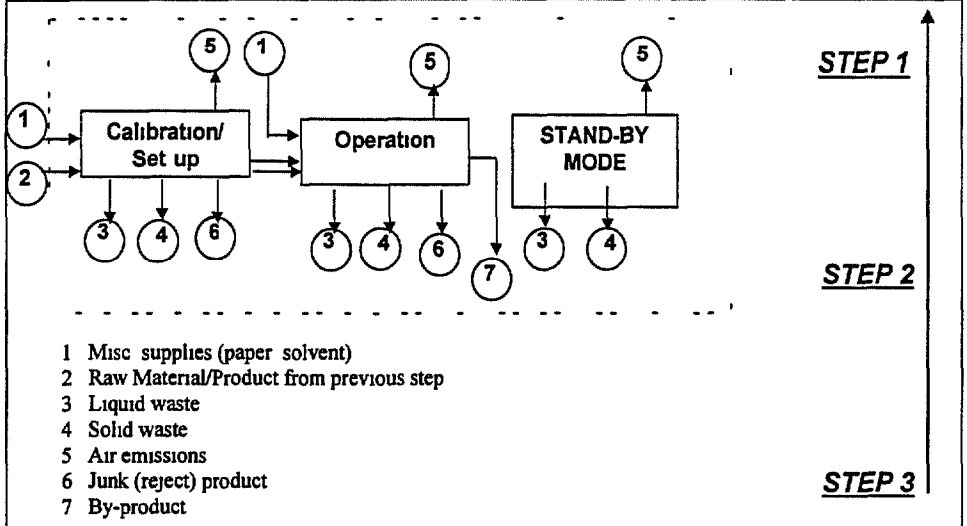
FLOW DIAGRAMS
STEP 3



WEF/CWEA/MOD3 13

Notes

Step 3 is the most detailed level of the flow diagram

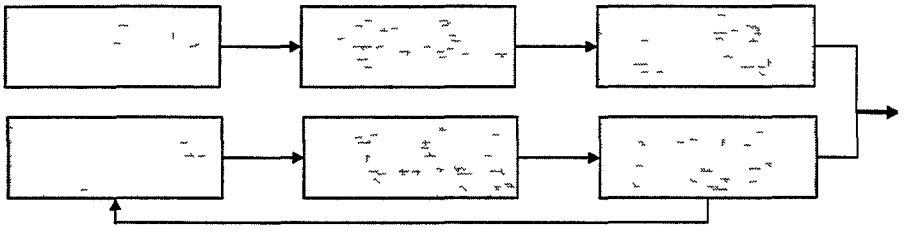
Here all of the inputs, outputs, and fugitive emissions should be identified for each operation

Constructing the Flow Diagram

- Use boxes to depict the series of steps through which the input materials must pass in the course of transformation into product
- Lines may represent movement of materials from one process step to another or the time sequence of the functions

Constructing the Flow Diagram
(continued)

- Sequence of operations may be serial (i e , left to right) to parallel There may also be recycle stream loops



FUNCTIONALITY

- For any process there is a functional sequence of events or actions
- One action initiates others, which in turn initiates still others, until the process has completed its overall function with some kind of product (i e throughput) or result

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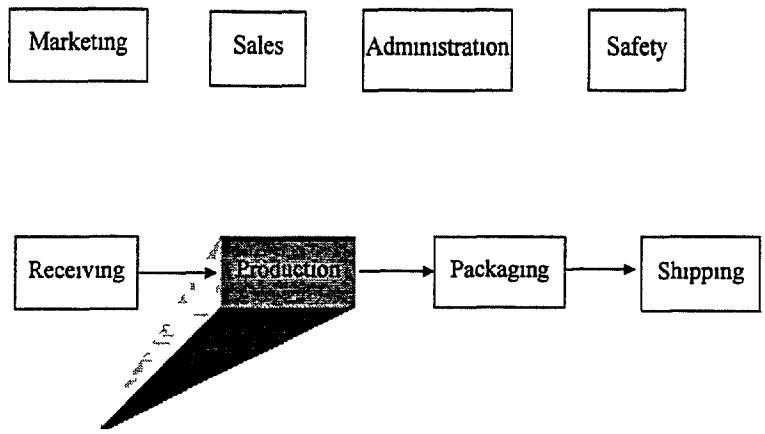
Flow Diagram (Step 1)
for the production of Tool Boxes



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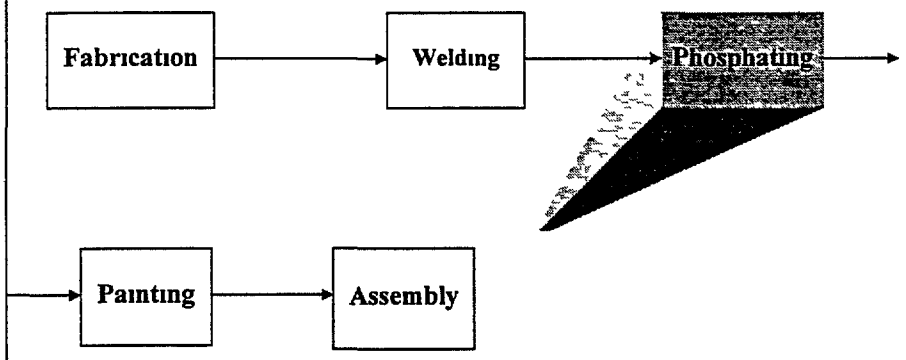
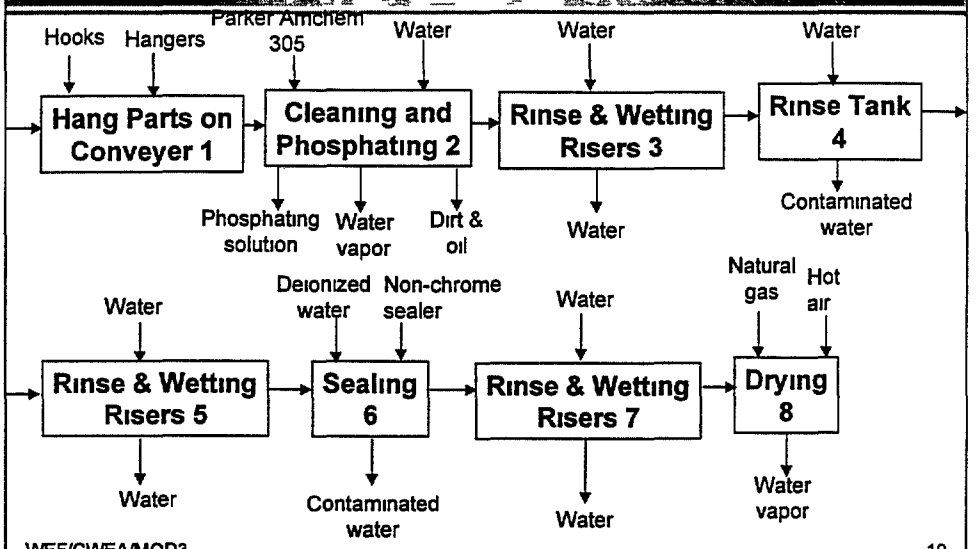
FLOW DIAGRAM (STEP2)

for the Production of Tool Boxes



FLOW DIAGRAM (STEP 3)
For the Phosphating Process



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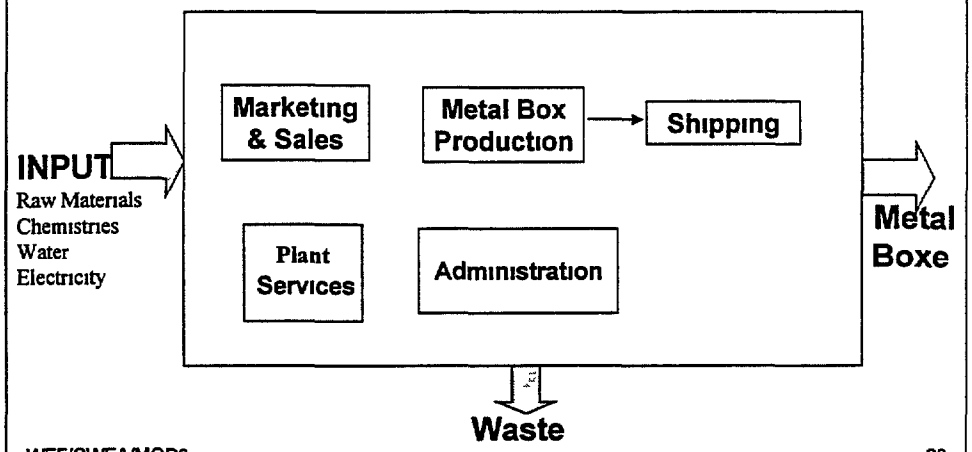
FLOW DIAGRAM (STEP 1)

for the Elect-Tek Company (Exercise)



Pre-Assessment Exercise

EXERCISE - FLOW DIAGRAMS

The Manufacturing of Boxes for Electrical Boards

Tasks

1. Make a list of the unit operations at Elect-Tek
2. Draw a flow diagram which describes the MAJOR PRODUCTION PROCESSES AT Elect (Flow Diagram Step 2)
3. Pick one of the production processes and draw a detailed production unit flow diagram (Flow Diagram Step 3), showing all inputs and outputs

Identifying Potential Industrial Effluent Management Opportunities

Pre-Assessment Phase

- Create flow diagrams
- Gather and review all pertinent data

Assessment Phase

- Conduct site assessment
- Calculate materials balance
- Identify possible solutions

Gathering and Reviewing Data

- Locate all pertinent data sources
  - Product design information
  - Raw materials and production information
    - product composition and batch sheets, raw material inventories, production schedules, Material Safety Data Sheets, etc
  - Waste manifests, inventories or analyses
  - Utility bills - water, sewage, electricity, etc
  - Environmental compliance inspection reports

Gathering and Reviewing Data

Another way to think about this is where would you find information about

- Materials Purchased
- Materials in inventory or storage
- Materials used in the manufacturing process
- Materials used in the maintenance of equipment
- Materials as products
- Materials as by-products
- Materials reused
- Materials wasted, spilled contaminated, rejected
- Materials disposed
- Materials lost through fugitive emissions
- Energy consumed
- Water used
- Water wasted

EXCERCISE

RESOURCES FOR MATERIALS ACCOUNTING

EXERCISE (continued)

RESOURCES FOR MATERIALS ACCOUNTING

HINT

Be sure that you are thinking about the information that all of the various departments might have Not only engineering and manufacturing but accounting, purchasing, the warehouse, the sales department, etc

Possible Resources for Materials Accounting

- Materials Procurement
  - raw material purchase records
  - transfer records
  - vendor invoices
  - receiving dock records

ASK EMPLOYEES, AT ALL LEVELS, FOR THEIR INPUT!

Possible Resources for Materials Accounting

- Materials as Inventory
  - end-of-year inventory records
  - storage records

ASK EMPLOYEES, AT ALL LEVELS, FOR THEIR INPUT!

Possible Resources for Materials Accounting

- Materials Use
  - operating log
  - samples, analysis, and flow measurements
  - batch make-up records
  - product specification
  - production line job sheet

ASK EMPLOYEES, AT ALL LEVELS, FOR THEIR INPUT!

Possible Resources for Materials Accounting

- Materials as Product
  - product shipment records
  - loading docks records
  - product specification
  - invoices to customers

ASK EMPLOYEES, AT ALL LEVELS, FOR THEIR INPUT!

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Toxic release inventory might be only an american term However, the concept of reporting toxic releases might exist in different countries under different terminology

Possible Resources for Materials Accounting

- Materials as By-products
  - waste transport records (manifests)
  - waste transport invoices
  - invoices to scrap buyers and recyclers
  - sewer discharge records
  - Toxic Release Inventory
  - DEP air source registration records

ASK EMPLOYEES, AT ALL LEVELS, FOR THEIR INPUT!

WEF/CWEA/MOD3 31

Toxic release inventory might be only an american term However, the concept of reporting toxic releases might exist in different countries under different terminology

Possible Resources for Materials Accounting

- Materials Reuse
  - recycling records
  - reclaim records

ASK EMPLOYEES, AT ALL LEVELS, FOR THEIR INPUT!

Identifying Potential Industrial Effluent Management Opportunities

Pre-Assessment

- Create flow diagrams
- Gather and review all pertinent data

Assessment

- Conduct site assessment
- Calculate materials balance
- Identify possible solutions

Identifying Potential Industrial Effluent Management Opportunities

- Conduct a site assessment
  - Identify the causes of all generated wastes
  - Identify pollution prevention or pollution control practices already in place
- Collect and review additional data
- Calculate material balance

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Identifying Wastes

- Anything that does not contribute to the final product is a waste
- The quantity of waste material must be measured to estimate the cost of the waste
- The costs of waste from each unit of a particular product should be estimated

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Identifying Waste Sources

- Same waste material may come from several operations in the plant
- Teams should be formed for detailed analysis
- Begin on plant-wide basis and steadily get more focused
- Waste quantities should be measured and and compared to effluent management goals

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Conducting a Site Assessment

- Be well prepared in advance
  - Use the pre-assessment phase to "plan"
- Conduct the audit in a systematic manner
  - Use standardized auditing forms and practices but only as guides
- Carefully observe how the manufacturing and material handling processes are conducted
  - The actual process may differ from the methods reported in a written policy manual

Some Questions to Ask in Conducting an Assessment

- What types of wastes are produced?
- How much waste is generated?
- How are the wastes produced?
- Which areas produce the most wastes?
- Which processes output ANY waste water?
- Which processes require the frequent servicing or cleaning of process equipment?

Some Questions to Ask in Conducting an Assessment

- Which processes affect a physical or chemical change in raw materials from the input stage to the output stage?
- Which processes utilize known hazardous products in there process?
- Are there process steps or areas that could be easily changed or perhaps eliminated?

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Which of the Generated Waste Products may be a *"Hazardous Waste"*?

- Can the waste material be reused in a process as a "raw material"?
- Can the waste material be recycled or reclaimed?
- Does the waste material exhibit any "hazardous" or "toxic" characteristics?
- Are there any environmental regulatory considerations towards the waste material?

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Identifying Potential Industrial Effluent Management Opportunities

Pre-Assessment

- Create flow diagrams
- Gather and review all pertinent data

Assessment

- Conduct site assessment
- Calculate materials balance
- Identify possible solutions

Materials Balance

- Identify existing data
- Verify data
- Identify data gaps
- Perform materials balance
- Make additional measurement
- Recalculate materials balance (on-going)

Materials Balance

- A system organized to determine the flow, generation, consumption, and accumulation of materials in a process
- Material that enters = Material that exits

Calculating Material Balances

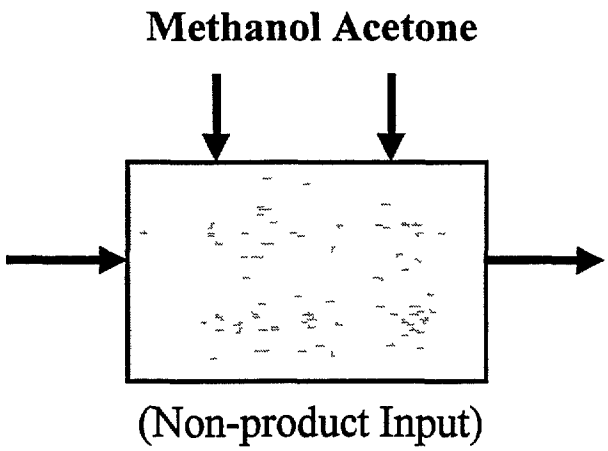
- Prioritize the identified processes or waste streams
- Use all available data and flow diagrams
- Limit the scope of material balances to specific process
- Calculate each component that enters and leaves the process
- If necessary, calculate "elemental balances" for specific chemical elements

Calculating Material Balances

- The Mass Conservation Principle
  - A Simple Formula

MASS IN = MASS OUT + MASS ACCUMULATED

MATERIALS USED



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Notes

To calculate a mass balance it is necessary to identify all materials that are put in to the process product introduced from previous stage of production, the addition of new raw materials, energy, water, etc

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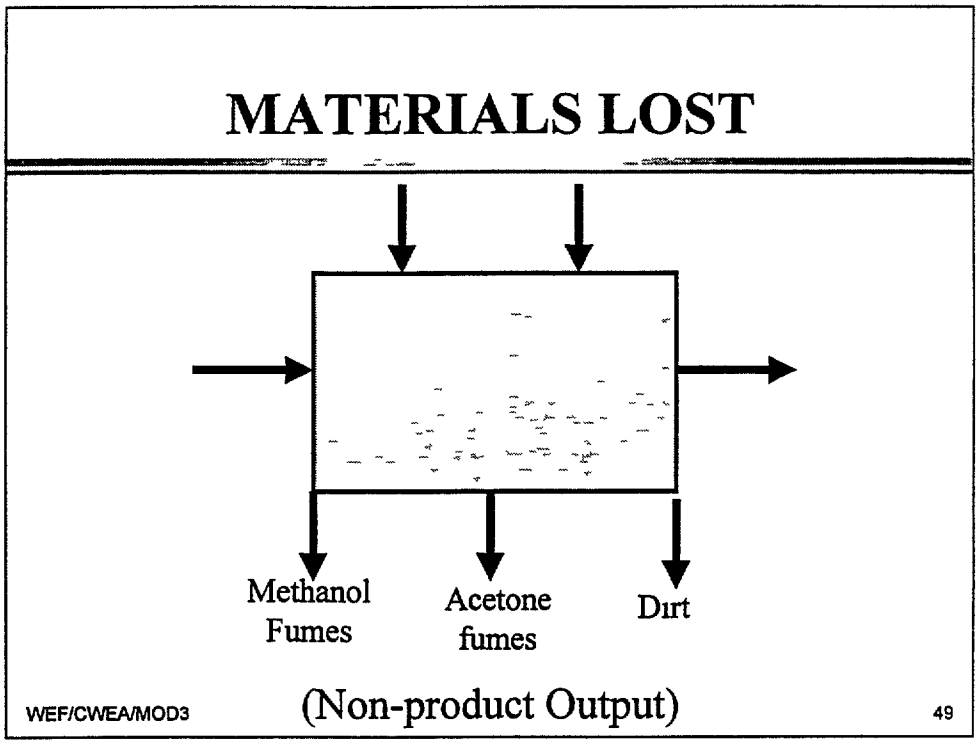
Record ALL Losses

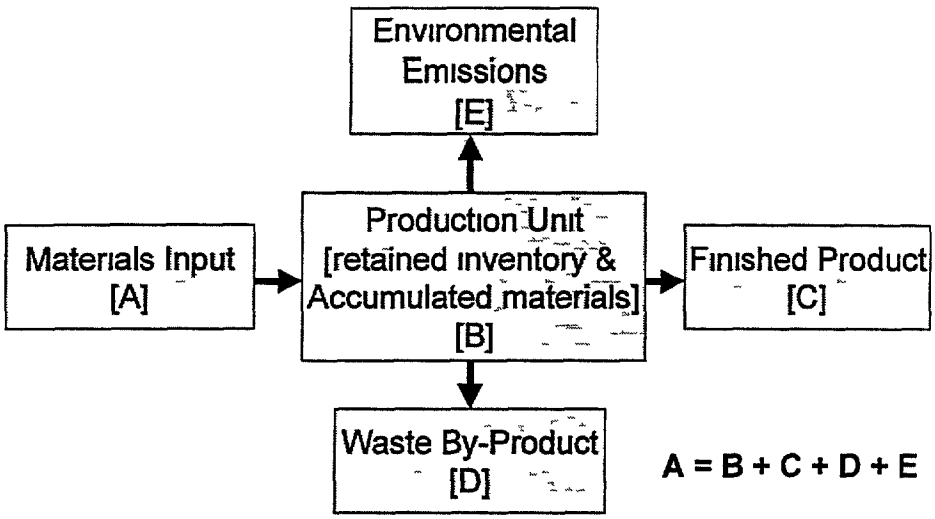
- Air
- Water
- Solid Waste
- Spill / Leaks
- Accidental Losses
- Energy and Water Losses (optional)



Notes

To calculate mass balance it is necessary to identify all outputs product, by-products, wastes, fugitive emissions, etc

Materials In = Materials Out + Materials Accumulated



A = B + C + D + E

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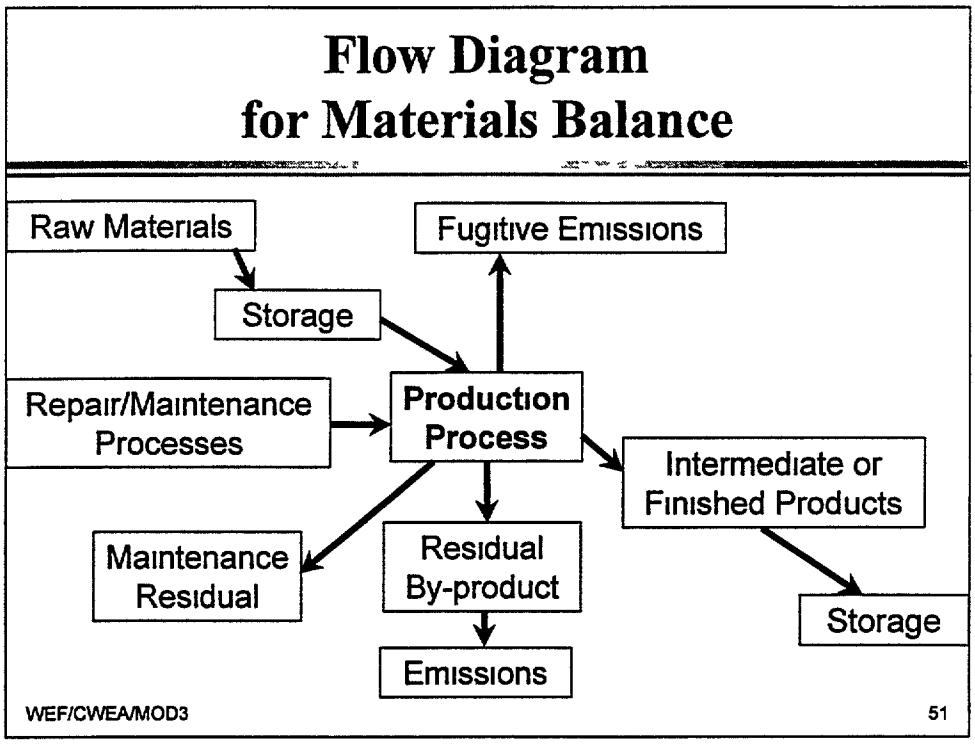

Notes

This diagram shows how many other departments or areas may really be involved in identifying inputs and outputs necessary to calculate a mass balance for the production process

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Utilizing Material Balance Analyses

- Common pitfalls
  - In large quantity processes, measuring the input and output streams may be quite imprecise
  - The quantities of materials *purchased* and used in a particular time frame may not correspond to the amount *used* in the same time frame

Materials Accounting Steps

1 Obtain a list of chemicals used in the facility
2 Attribute use to individual process units
3 Locate losses by process unit
4 Estimate Materials Flows (± 30%)

Identifying Potential Industrial Effluent Management Opportunities

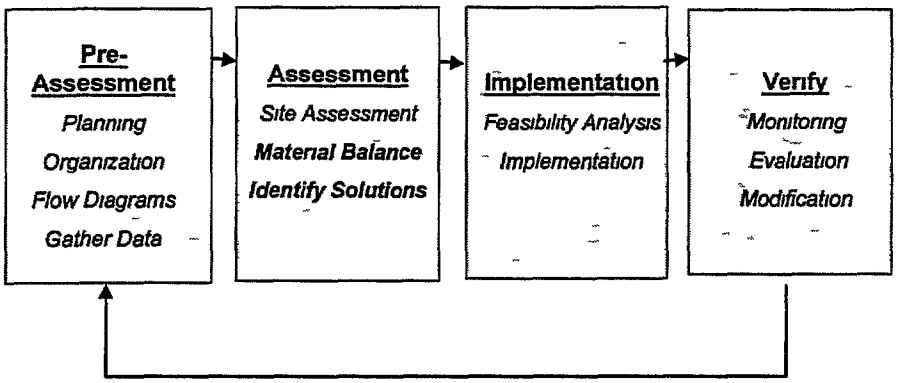
Pre-Assessment

- Create flow diagrams
- Gather and review all pertinent data

Assessment

- Conduct site assessment
- Calculate materials balance
- Identify possible solutions

Effluent Management Phases



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Hierarchy of Effluent Management

Presented by

Water Environment Federation(WEF)

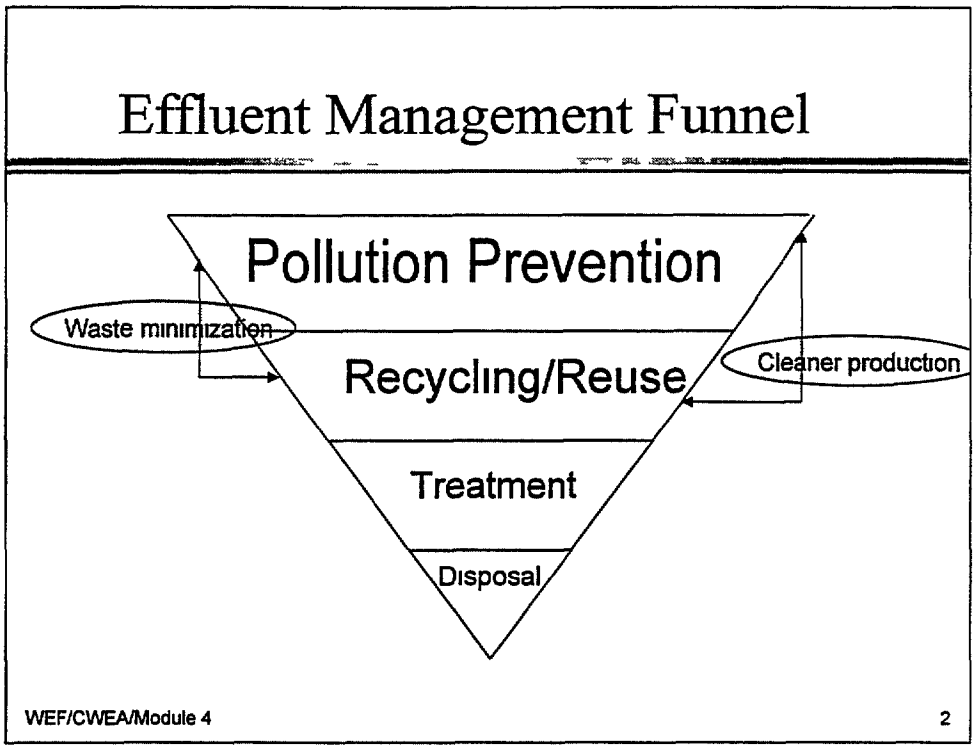
and

California Water Environment Association(CWEA)

WEF/CWEA/Module 4 1

Note to presenter this module gives the overview of effluent management Module 5 goes into more detail on pollution prevention

examples of p2 cases studies relevant to the country should be reviewed and incorporated a bit here and definitely in Module 5



The best strategy of handling pollutants is to use the pollution prevention funnel It is an inverted pyramid, with the base at the top That is because the largest gains of reducing pollutants will be at the top As you go down the funnel, the gains will be less They will also be more costly

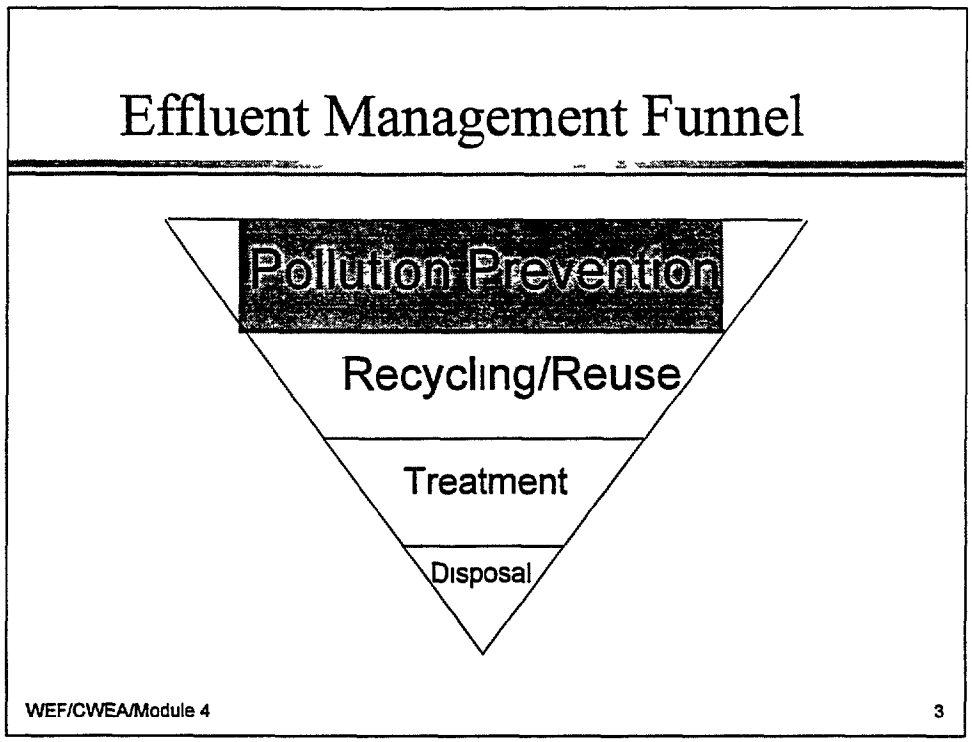
"waste minimization consists of source reduction and recycling USEPA

The reduction to the extent feasible, of waste that is generated or subsequently treated, stored, or disposed of

Waste minimization eliminates and/or reduces the use of hazardous materials and/or the generation of hazardous waste at the point of generation

Waste minimization is a win-win situation for regulators and generators alike with reduced regulation, disposal costs, and liability for the facility and reduced risk to the public health and the environment Cleaner production is an industrial term for waste minimization

(Review EP3 audits in the country and find examples from the audits to demonstrate source reduction include cost savings over time)



Pollution prevention is the first and most important step in effluent management Reduce pollution at it's source rather than relying on other means of treatment or disposal

Industries will find 80% of the pollutants can be removed at the top of the funnel with just source control By addressing the pollutant with source control, you will have less pollutant that you will need to recycle These are also the least costly measures for controlling or eliminating pollutants in the waste water

(Review EP3 audits in the country and find examples from the audits to demonstrate source reduction include cost savings over time)

Effluent Management Funnel
Pollution Prevention Examples

- Good Operating Practices
- Changes in Technology
- Material Substitution
- Product Reformation

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Examples of pollution prevention include

•Good Operating Practices

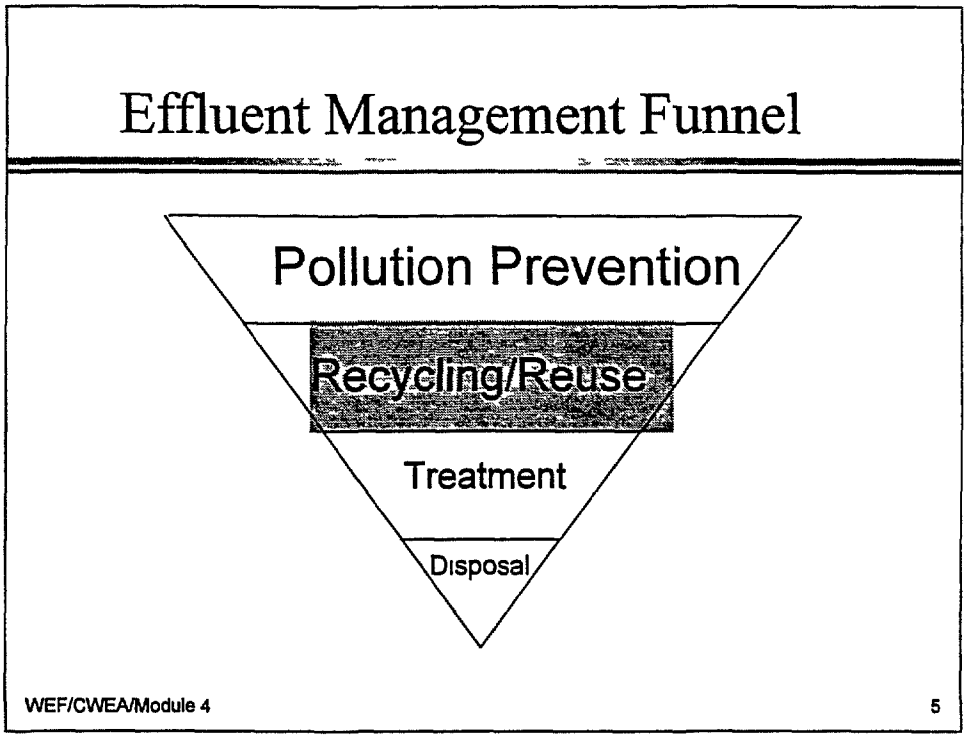
• Changes in Technology

• Material Substitution

• Product Reformation

Again, it we are just introducing the concept of pollution prevention Module 5 goes into greater detail and gives examples

1/14



Again attendees can give examples

After reducing the pollutant at the source as much as possible, the next priority is to recycle or reuse the pollutant

Remember that waste is cost! Reusing and recycling the pollutant may even bring in revenue to offset the cost of implementing recycling if it is used by another industry The best recycling is what you can recycle "in house"

Effluent Management Funnel
Recycling/Reuse/Reclaim

- Reuse
- Recycle
- Reclaim

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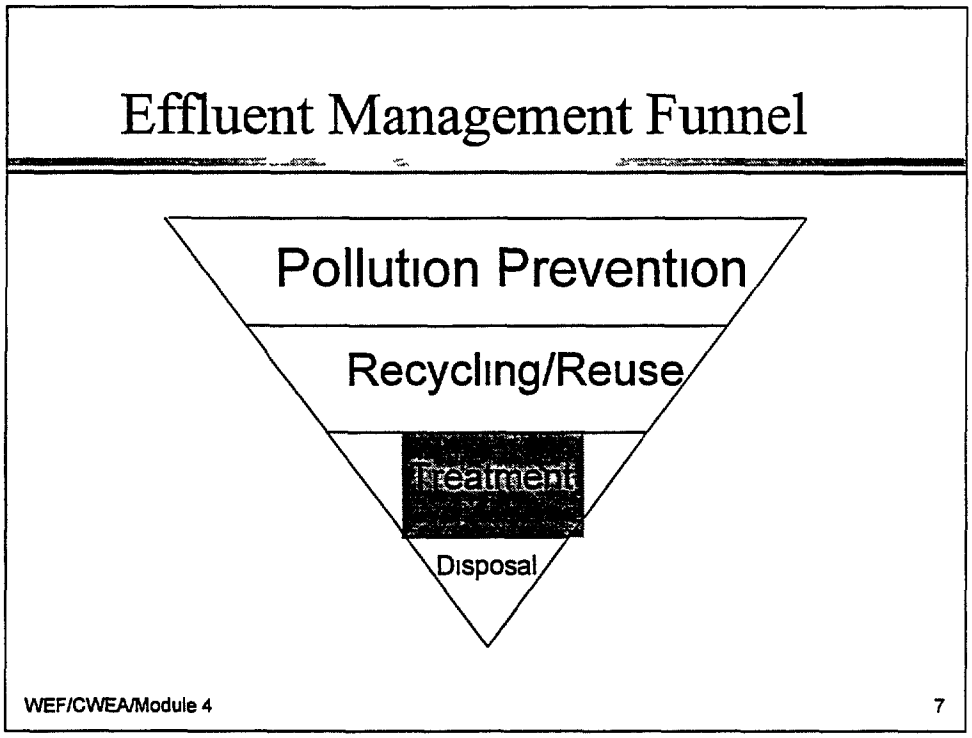
This slide is just to introduce concept and definition (See speaker notes on module 5 page 27 for more information)

Reuse-to directly reuse a hazardous waste in the same process (in-process recycling) Reuse does not require re-processing

Recycle- re-processing the waste into the same or another product

Reclaim- to recover or regenerate a component for reuse within the same or other operation



By employing source reduction and recycling of waste materials and waste water, there is less water that needs treatment In many cases, this allows industry to use less costly treatment systems

Treatment

- Treatment after pollution prevention
- On-site treatment
- Off-site treatment

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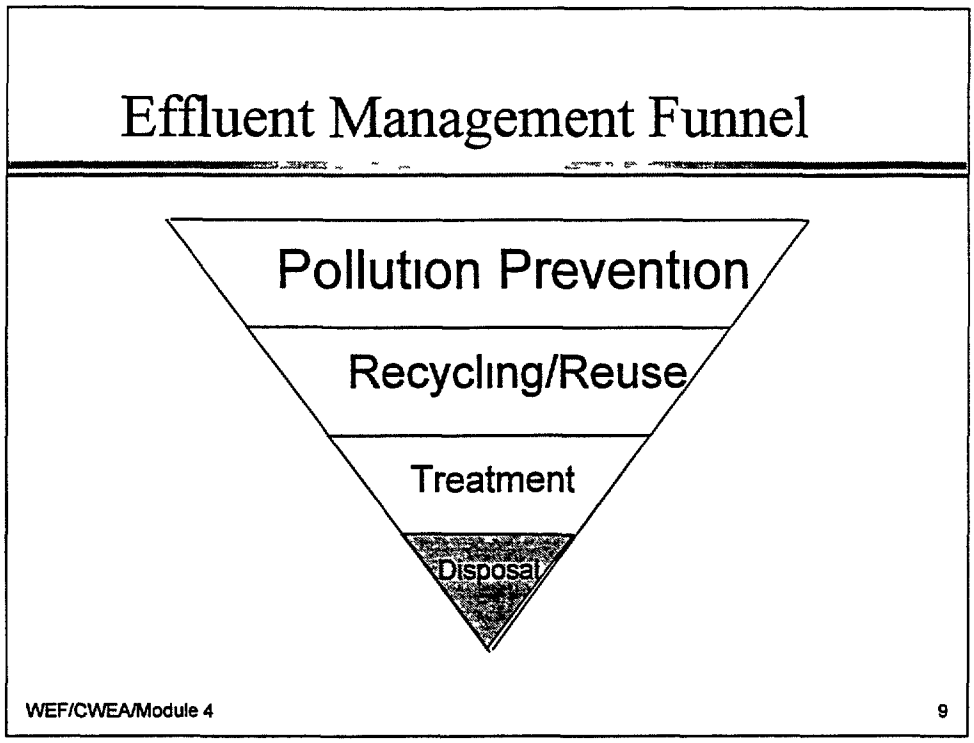
Treatment should be looked at after all steps have been taken to prevent or reduce the pollution Treatment can take place onsite or off-site Cost-analysis of of treatment on-site or hauling off-site will be a factor in determining the best treatment option



Disposal is the most costly option If you have been following the pollution prevention funnel you will have greatly reduced costs of disposal or eliminated the need to sewer wastewater or dispose of other wastes entirely

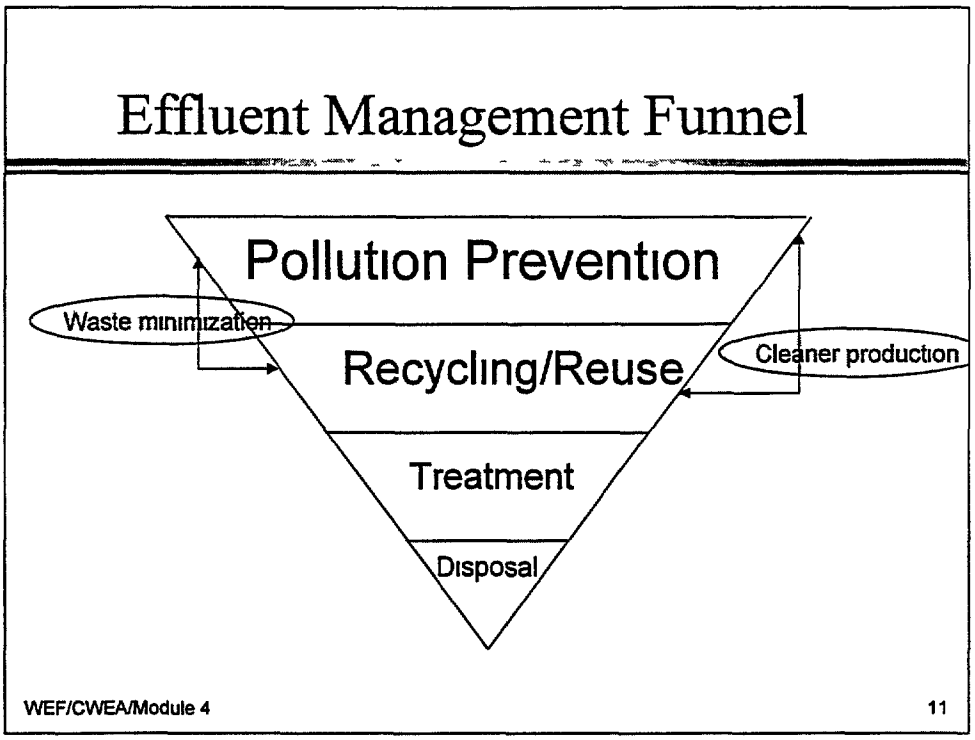
Starting at the top of the funnel may require significant changes While each tier may have costs associated with them, but they provide the greatest economic rewards In the United States we thought we could solve our problems by starting with treating the pollutants We have discovered it is easier and more cost-effective to start with reducing the pollutants first, at the source

Effluent Management Funnel
DISPOSAL

- Air Discharge
- Water Discharge
- Stabilization
- Land Disposal

WEF/CWEA/Module 4 10

Disposal only takes the waste from one media to the other-- it does not treat or remove the pollution



Again emphasis pollution prevention as the first step in effluent management

Pollution Prevention First

Presented by
The Water Environment Federation (WEF)
and
The California Water Environment Association (CWEA)

WEF/CWEA/MOD5 1

Note to presenter examples of p2 case studies relevant to the country is required

A Definition of Pollution

"pollution is the undesirable change in the physical, chemical or biological characteristics of air, water, or land that may or will harmfully effect the human life or that of other desirable species, our industrial processes, living conditions or cultural assets, or that may or will waste or deteriorate raw material resources "

(Science Advisory Board, U S EPA)

IF SOMETHING IS NOT
A PRODUCT

IT IS A WASTE

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Pollution=Waste=Cost

Definition of Pollution Prevention

Any practice which reduces the amount of any hazardous substance, or pollutant entering any waste stream or otherwise released into the environment (including fugitive emissions)

prior to offsite recycling, treatment, or disposal.

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Pollution prevention is a proactive environmental management approach for reducing pollution

It may be good to give an example of prevention that people can relate to-- such as flossing teeth, vaccinations, etc as a means of describing prevention

Speaker Note Recycling and reuse <u>within individual processes</u> is considered to be pollution prevention Pollution prevention is not recycling and reuse outside the targeted process-- for example reuse pallets, or reusing any waste product

Pollution Prevention Benefits

- Saves money in raw materials, disposal & treatment
- Net reduction in the generation of waste
- Eliminates the problems associated with handling wastes
- Improves worker health & safety
- Reduces or eliminates adverse ecological impacts

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Pollution Prevention Benefits

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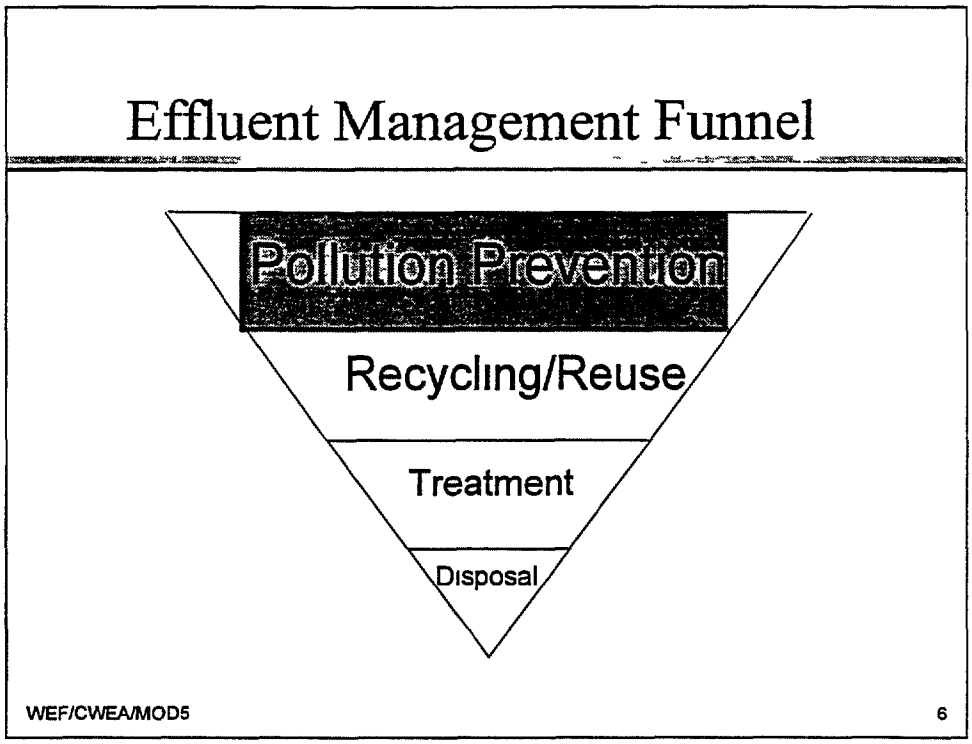

Note to presenter If attendees have not been to intro - maybe have them provide examples

Industries will find 80% of the pollutants can be removed at the top of the funnel with just source control By addressing the pollutant with source control, you will have less pollutant that you will need to recycle These are also the least costly measures for controlling or eliminating pollutants in the waste water

(Review EP3 audits in the country and find examples from the audits to demonstrate source reduction include cost savings over time)

Pollution Prevention Activities

- Good Operating Practices
- Changes in Technology
- Material Substitution
- Product Reformulation

What are Good Operating Practices?

- Administrative procedures
- "Good Housekeeping" practices
- Minimization of water use

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Note to presenter If attendees have not been to intro - maybe have them provide examples

Industries will find 80% of the pollutants can be removed at the top of the funnel with just source control By addressing the pollutant with source control, you will have less pollutant that you will need to recycle These are also the least costly measures for controlling or eliminating pollutants in the waste water

(Review EP3 audits in the country and find examples from the audits to demonstrate source reduction include cost savings over time)

Good Operating Practices- Administrative Procedures

- Management commitment
- Training
- Preventative maintenance

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Good Operating Practices which are administrative include Management commitment, training, and preventative maintenance

Examples of the practices will be discussed in greater detail in the next overhead

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Good Operating Practices- Administrative Practices

- Examples
  - written policy statements
  - on-going employee training
  - employee incentives
  - weekly/monthly inspections

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Management Commitment- includes written policy statements These polices stress pollution prevention is integral to all levels of operations To remind employees of the commitment to pollution prevention, issue ongoing memos Commitment also includes allocating resources to eliminate or minimize wastes Establish a task force to review or identify pollution prevention opportunities

Training- Establish training programs for all staff on the importance of pollution prevention Train employees on proper chemical handling, storage, disposal, spill clean-up techniques, follow-up procedures, emergency response, how to read product labels, proper hazardous waste disposal practices Pollution prevention practices should be geared to all personnel, including administrative staff, operational staff, and management Provide follow-up training

Employee incentives- to further motivate employees to practice pollution prevention, establish incentives Incentives include financial, awards, and recognition programs for employees that develop and implement pollution prevention options

Preventative Maintenance- Establish weekly or monthly inspections for all operations

Good Operating Practices- Administrative Practices

- Questions to consider
  - Does management view pollution prevention as a priority?
  - Do employees understand the benefits of pollution prevention?
  - Are employees trained in pollution prevention?
  - Are there regularly scheduled preventative maintenance checks?
  - Do frequent operation inspections take place?

Good Operating Practices- Good Housekeeping

- Inventory control
- Storage
- Spill management
- Waste stream segregation
- Procedural scheduling
- Cleaning

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Inventory Control Careful control of inventory to avoid overstocking Storage Store all products neatly- this will prevent purchasing products already on hand Store compatible products together Do not store incompatible, such as flammable products with oxidizers to prevent a potential exposure

Spill Management Prevent spills and leaks by keeping containers covered, inspecting containers regularly, and using pumps or spigots to dispense materials Contain spills that may occur by installing sloped floors and curbs or berms in storage areas Double contain products Keep a spill kit in all areas-- spill kit should contain absorbent, drain plugs, acid and base neutralization kits, etc) Clean spills immediately

Waste stream segregation Segregate different types of waste to promote recycling and avoid contaminating nonhazardous wastes For example, keep waste inks separated from waste solvents

Procedural scheduling keep records of inputs and outputs Keep a schedule of operations

Cleaning Sweep and vacuum work areas frequently Mop rather than hose down work areas Keep all work areas clean on a daily basis

Good Operating Practices- Good Housekeeping

- Examples
  - First in- first out policy
  - Tracking systems
  - Cover tanks of solvents when not in use
  - Use drip pans
  - Use tight-fitting lids
  - Maintain filters and machinery to eliminate fumes
  - Inspect for corrosion and leaks
  - Install automatic closing valves
  - Dry and clean floors with brooms

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Additional Examples of Good Housekeeping

For inventory control first-in, first-out policy- assign an employee to be the stockroom attendant Establish a tracking systems- a computerized inventory control system is sometimes the best way to implement this policy

Storage cover tanks of solvents when not in use

Spill Management use drip pans, use tight-fitting lids

Waste stream segregation

Preventative maintenance maintain filters and machinery to eliminate fumes, inspect for corrosion and leaks, install automatic closing valves,

Cleaning dry and clean floors with brooms,

Good Operating Practices- Good Housekeeping

- Questions to consider
  - Are spills cleaned up immediately?
  - Do plans exist to prevent spills, leaks and fumes?
  - Are toxic materials and dangerous waste correctly inventoried and stored?
  - Are storage areas clean?
  - Are cleaning products adding pollutants to the waste stream?
  - What cleaning or processing operations can cause later problems?

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Good Operating Practices- Minimization of Water Use

- Examples
  - good housekeeping practices
  - reuse water in operations
  - counter-current rinsing
  - water meters
  - spray and mist instead of drip tanks

Good Operating Practices- Minimization of Water Use

- Questions to consider
  - Where and what is water used for in each operation?
  - Are water conservation measures, recycling, and reuse techniques practiced in the processes?

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What are Changes in Technology?

- Production processes
- Equipment, piping or layout changes
- Use of automation
- Operating conditions

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Insufficient or outdated production processes that could be sources of hazardous waste generation can be upgraded or replaced by a more efficient process thereby minimizing the waste generated These may include

-Production processes changes in operation settings and schedules

-equipment modifications- equipment changes, piping or layout changes

-process automation use of automation

-operating conditions changes in the placement or order of equipment

Changes in Technology

- Examples
  - Installation of systems that will recapture solvents, water, reduce fluids, etc
  - Change mechanical cleaning apparatus that will eliminate the use of solvents
  - Use more efficient motors for pumps and other equipment

Changes in Technology

- Questions to consider
  - Can the generation of wastes be reduced by modifying equipment or the use of new technology?
  - Can changes in production processes reduce waste?
  - Can operating conditions be altered?

What is Material Substitution?

- Replacing input material
  - eliminates pollution in production processes
  - generates less or non-hazardous waste

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Often a company can minimize hazardous wastes or avoid generating them altogether by using non-hazardous or less hazardous materials to produce products or provide services

Replacing input materials can also lead to eliminating pollution

Material Substitution

- Examples
  - Use solvents that are less toxic in the cleaning or painting processes
  - Use raw materials that are free of traces of toxic substances and impurities

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Examples

Offset Printing change from methanol to isopropyl alcohol- Eliminates worker exposure to methanol

Paint Production 1)substitute organic biocide for mercury- Eliminates use of mercury and avoid future liability 2) Subsitute non-metal bearing pigments for lead and chrome pigments- Eliminates heavy metals in product and avoids future liability

Carton & Packaging Printer 1) Convert to waterbased ink for flexible packaging on paper- Reduces solvent use and reduces air emissions 2) Replace rags with rubber squeegees- Reduces volume of rags to landfill and reduces solvent use

Electroplating Replace solvent degreasing with aqueous alkaline cleaner- Eliminates cyanide use in cleaning

Material Substitution

- Questions to consider
  - Will a change in raw material that is less-hazardous result in the same product?
  - Will the substitution of raw materials result in the use of toxic substances later in the process?
  - Does the opportunity exist to reduce or substitute toxic materials?
  - Can the use of alternative materials result in a less-hazardous waste?

What is Product Reformulation?

- Product substitution
- Changes in product composition
- Product conservation

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Reformulating a product can eliminate or minimize the generation of hazardous wastes during production as well as eliminate or minimize the purchase of hazardous materials

Product reformulation can also result in changes in production and product conservation

Product reformulation can also minimize environmental and health impacts during use and from disposal

Product Reformulation

- Examples
  - water-based products vs solvent-based products
  - phosphate-free detergents
  - lead free paints
  - vinegar window cleaners

WEF/CWEA/MOD5 24

Examples

Producing water-based products vs solvent-based products will reduce the need for solvent materials for product generation and reduce the amount of solvent waste by-products that require treatment and/or disposal

Phosphate-free detergents reduce the environmental impact of phosphate on receiving waters

Lead-free paints-reduces the water quality and health impacts associated with lead

Vinegar window cleaners- eliminates the need for the raw materials ammonia commonly used in window cleaners Also present a lower health risk to the worker/ consumer

Product Reformulation

- Questions to consider
  - Will a change in raw material result in a product that is less toxic or dangerous?
  - Can the use of alternative materials result in generating less waste?

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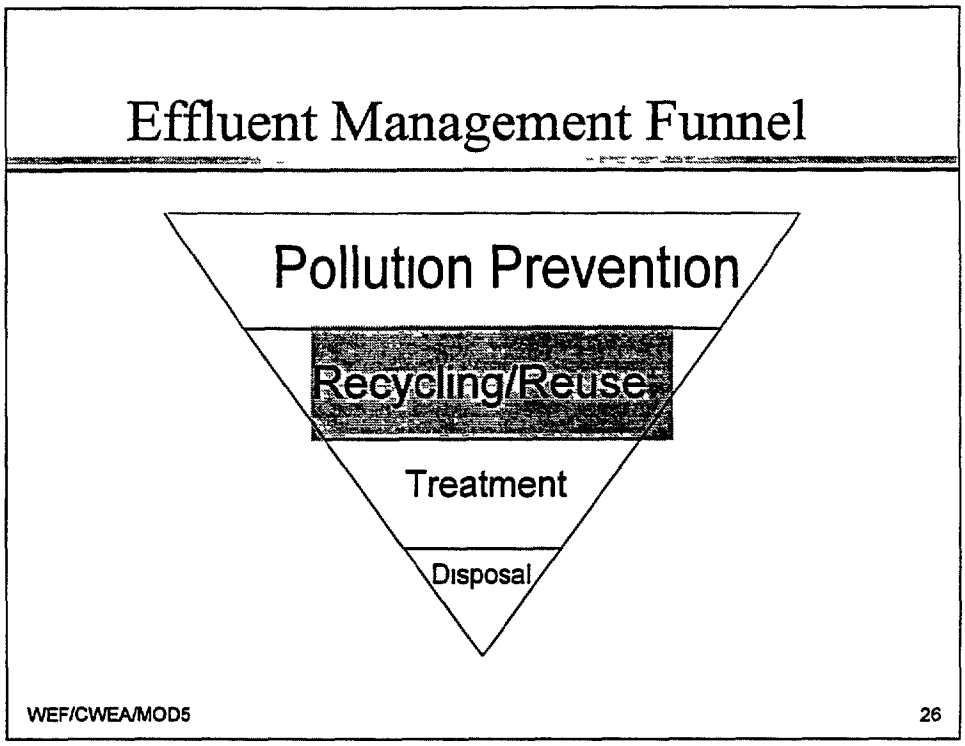

Again attendees can give examples

After reducing the pollutant at the source as much as possible, the next priority is to recycle the pollutant Remember that waste is cost! Reusing and recycling the pollutant may even bring in revenue to offset the cost of implementing recycling if it is used by another industry The best recycling is what you can recycle in house

Recycling/reuse reduces the amount of waste and waste disposal costs

The 3 Rs

- Reuse
- Recycle
- Reclaim

WEF/CWEA/MOD5 27

Reuse-to directly reuse a hazardous waste in the same process (in-process recycling) Reuse does not require re-processing

Recycle- re-processing the waste into the same or another product

Reclaim- to recover or regenerate a component for reuse within the same or other operation

Recycling in the industry can happen within the process, or for another process that might not need as high a quality or concentration of the pollutant/parameter (give examples from EP3 audits in the country and case studies or industries attending the training)

For example

onsite examples - countercurrent rinsing for in process

reuse examples - wastewater for cooling waters

materials reuse - printing inks waste to become fill for black ink

off-site recycling - fats and grease sold for animal food, also whey from cheese manufacturing sold for animal food

Reuse

- Examples of reuse
  - Packaging material
  - Rinse water reused
  - Metal casting for aggregate
  - Excess paints & ink blending
  - Shipping materials

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Reuse

- Questions to consider
  - Are there waste streams that can be reused in another operation or within the same operation?
  - Do methods exist to recuperate and reuse materials that otherwise will be waste?

Recycling

- Closed loop recycling
- Onsite recycling
- Off-site recycling

WEF/CWEA/MOD5 30

Generally there are 3 ways of recycling closed loop, onsite recycling, and off-site recycling

Important point to get across for recycling options- Need to determine if it is more cost-effective to recycle on-site or off-site? Generally depends on the type and volume of wastes generated hauling off-site or purchasing equipment for recycling

Each type of recycling is discussed in the following overheads

"Closed Loop" Recycling

Examples

- Installation of recovery systems for
  - solvents,
  - lubricants,
  - process water, etc
- Collect and reprocess metal wastes (shavings and scraps)

WEF/CWEA/MOD5 31

Recovery systems can be used for solvents, lubricants, and process water
These closed loop systems will enable "clean" the waste for re-use within operations

On-site Recycling Techniques

- Examples
  - Solvent recycling
  - Counter-current rinsing
  - Pulp & paper
  - Aluminum scrap

Off-site Recycling Techniques

- Examples
  - Rendering
  - Paper, aluminum, and glass
  - Industry waste exchange

WEF/CWEA/MOD5 33

Off-site recycling requires the wastes to be hauled off for re-processing at another facility

Recycling

- Questions to consider
  - Do methods exist to recycle materials within the production processes?
  - Do methods exist to recover and reuse materials that otherwise will be waste?
  - Do opportunities exist within the process to eliminate impurities in the wastes to obtain relatively pure reusable substances?
  - Is it more cost-effective to recycle on-site or off-site?

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Reclamation

- Examples
  - Metal recovery from a spent bath
  - Volatile organic recovery

Reclamation

- Questions to consider?
  - Can products or materials be reclaimed from wastes?
  - Do methods exist to recycle materials within the production processes?
  - Can wastes be sold?

Pollution Prevention and Waste Minimization Should Be:

- A continuous process
- Part of a quality management program
- Multi-media and multi-disciplinary in focus
- Implemented by all sectors of the society
  - industry
  - government
  - agriculture
  - energy
  - transportation
  - consumers

WEF/CWEA/MOD5 37

Implemented by all sectors of the society

industry
government
agriculture
energy
transportation
consumers

Management Strategies for Industrial Effluent Management

Presented by

The Water Environment Federation (WEF)

and

The California Water Environment Association (CWEA)

Management Strategies

A major part of emerging environmental management strategies is not based on pollution reduction technologies, but on organizational management efforts.

It is necessary to substitute the classical approach of managing residuals and emissions, with the practices of waste minimization and pollution prevention.

As this slide summarizes, the current direction of today's environmental management strategies, are based on the reduction of pollutants at the source This is in contrast to the "end of pipe" treatment that has served as the past management model

The major focus of an Environmental Management System, or EMS, is aimed toward establishing sound management practices within the organization

As we will see, pollution prevention and waste minimization play an important role in executing an effective EMS

Environmental Management Strategies

- Adopting an Environmental Management System (EMS)
  - Driving forces for adoption
    - Increasing environmental legislation & enforcement
    - Stakeholder pressure, awareness, image, & reputation
    - International competitiveness
    - Financial impacts

WEF/CWEA/Module 6 3

Before we examine the salient features of an Environmental Management System, lets talk about why you might be motivated to develop such an environmental management strategy

As you can see from the points outlined here, many of the answers depend on recognizing the current global economic climate, as well as knowing the social and economic climate around your facility

Environmental Legislation & Enforcement

- Increasing government control on industrial discharges
- Increasing penalties for violations
- Broader definition of "liability" to include damage without evidence of fault ("strict" liability)

WEF/CWEA/Module 6 4

One key reason to adopt the approaches of environmental management strategies are as a preemptive move against regulatory agencies

There is increasing control on pollution generating industrial activities This is realized through increasing monetary penalties, and a broader definition of liability

For these reasons alone, it would be wise to perform the self-audit procedures which play an important role in an environmental management system

Environmental Legislation & Enforcement (continued)

- A good compliance record may ease negotiations with regulatory agencies
- Shift from command/control to market-based incentives
- Accurate, useful information allows optimal strategies for cost savings

WEF/CWEA/Module 6 5

How would implementing an EMS help you in a climate of increasing regulation? Proactive efforts in the environmental arena allow you to do a lot of things

First, with an EMS, it is likely that your compliance record will improve This gives you a good negotiating stance with regulatory agencies

Additionally, regulatory agencies in many areas, while increasing their regulation, are also moving to market-based incentives These market- based incentives may, for example, allow you to install the best-available pollution control technology in lieu of fines and penalties for emissions

Finally, implementing an EMS allows you to gather detailed information about your industrial and manufacturing processes This process information, analyzed with the contributions of your employees, can result in identifying valuable many cost savings opportunities through advantageous process changes, materials usage, and similar functions

Stakeholder Pressure

- Peer pressure to maintain minimum standards
- Consumers
- Financial institutions, insurance companies
- Local community resistance

WEF/CWEA/Module 6 6

A business has many stakeholders Other businesses, stockholders, consumers, financial institutions, not to mention the local community, including residents, regulators and planning departments

In any given industry, the competing business community will exert varying amounts of peer pressure, with the intent of maintaining a public relations based "minimum standards" for the environmental image of the industry as a whole

With these environmental "report cards" in mind, some consumers are choosing products which are manufactured under conditions that are more environmentally sensitive, and less burdensome on the environment

Similarly, financial institutions such as lenders and insurance companies, are taking into account the environmental performance of an enterprise before providing loans or related services

Finally, the local community is a key stakeholder whose trust must be earned Extreme reactions of local communities can include protests, and damage to facilities While more commonly, planning and other regulatory permits may be delayed, resulting in considerable costs to business

Awareness, Image, Reputation

- Harm to reputation may also harm productivity and morale
- "Clean" companies, responsible neighbors are
  - more likely to be consulted in policy development
  - in a better negotiating position with regulators
  - able to increase value & market share

WEF/CWEA/Module 6 7

You should also be aware of the internal effects of your company's image If employees see their company portrayed badly, it can have effects on morale, and thereby on productivity

Conversely, if your company has a positive environmental image, these benefits may be a result (Refer to slide)

All this ties into the good compliance record we talked about earlier

Competitiveness

- Avoided costs
  - Wasted materials and energy
  - Accidents, community & worker exposures
- Globalization & access to international markets
  - Regional & global standard harmonization
  - "Green" consumerism

WEF/CWEA/Module 6 8

How does an environmental management system affect your business' competitiveness?

First, it allows you to avoid costs, and the reduced productivity from accidents, exposures, community protests

To retain access to international markets, a business has to be aware of the effects of globalization Laws in regions and countries distant from your manufacturing facility may have a great effect on your environmental management Increasingly, regions are standardizing their environmental laws and requirements

The European Union, for example, has standardized SOx, NOx and VOC emission standards for energy facilities, hazardous waste transport requirements, and the standards for importing, packaging, and labeling of chemicals

In addition, consumers and investors are increasingly demanding that enterprises minimize their impact on the environment Consumers and suppliers will often require evidence of proactive environmental impact minimization, and for investors, poor environmental performance translates to a lower investment value

Financial Impacts & Cost Savings

- Cost savings
  - Energy efficiency, emission reductions
  - Recycling, recovering value from waste
  - Minimize raw and other input material usage
- Effect on investors
  - Environmental performance affects investment value

WEF/CWEA/Module 6 9

We've talked a lot about external drivers that might encourage you to utilize an EMS What about the internal reasons?

One powerful internal driver is the possibility of cost savings (Refer to slide)

Demonstrated cost savings also translates to a more positive image in the eyes of investors

What Is an Environmental Management System (EMS)?

- "An organized, comprehensive, and continual effort to systematically reduce waste generation " *USEPA*
- A framework or method of guiding an organization to achieve, sustain, and improve performance
- A system of policies and goals for waste minimization, established by an organization's top management
- An effective program that integrates pollution prevention practices into an organization's everyday business philosophy

WEF/CWEA/Module 6 10

You may be asking yourself, "What exactly is an Environmental Management System?" Well, an EMS can be quite comprehensive, yet not complex

Let's look at some of the aspects of an EMS

This slide includes some of the more frequently encountered definitions

SPEAKER NOTE Discuss billeted items

Goals of an EMS

- Identify & control
  - Major environmental impacts
  - Environmental opportunities
  - Relevant regulatory requirements
- Set priorities, determine objectives, work towards their achievement
- Monitor performance, evaluate effectiveness

WEF/CWEA/Module 6 11

Now that you have several definitions of what an EMS may be, why might you want to utilize an EMS? And, exactly what can an EMS do for you?

An EMS is a structured, systematic management method, with the goal of continuous improvement in pollution prevention

The process of implementing an EMS includes an evaluation of environmental impacts and opportunities, prioritizing these impacts, then setting, implementing ,and monitoring your performance goals

SPEAKER NOTE Quickly use an example of a successful case study

At a minimum slide 11-30 should be used for this management section

Benefits of Implementing an EMS

- Provides assurance that the company may proactively address future environmental compliance issues
- Ensures that the company management and employees have clearly established objectives, backed with accountability
- Protects worker health and safety
- Reduces operating costs in many ways
- Helps to create increased market opportunities and enhance global competition

SPEAKER NOTE Review bullets on slide - discuss as appropriate

Overcoming Aspects of Organization

- Its culture
  - generally train, reward, and punish employees to reinforce organization's beliefs
- Its ability to process information
  - generally understand details of current production process, rather than look for new technical possibilities
- Its politics
  - unwilling or unable to offer suggestions outside management hierarchy

WEF/CWEA/Module 6 13

Now you have an idea of why you might want to utilize an EMS, you probably want to know, well, exactly what can an EMS do for me?

An EMS is a structured, systematic method used at national and international levels, with the goal of continuous improvement The process of implementing an EMS includes an evaluation of environmental impacts and opportunities, then prioritizing these, and setting achievable performance goals

(Example recycling of waste paper --- reduce disposal costs, reduce materials purchase costs)

Overcoming Resistance to Change

- Adopt an explicit policy
- Have plant managers, not only environmental managers, responsible for adapting waste minimization methods
- Create employee training and programs
- Reward good waste minimization ideas and results

Elements of an Effective EMS

- Management commitment
- Effluent management goals
- Mission/policy statement
- Detailed objectives
- Planning
- Task force
- Pre-assessment study
- Implementation
- Management Review

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Elements of an Effective EMS

- Management Commitment
  - Perhaps the most crucial aspect of a successful EMS
  - Must come from the TOP MANAGEMENT
  - Must be a part of the organization's complete business philosophy

WEF/CWEA/Module 6 16

A company that is committed to environmental stewardship, must begin at the top by putting their commitment into the fabric of their business

The design of successful EMS, such as ISO 14000, requires a solid, 110% commitment from the top players in an organization

These top few individuals **must** provide a vision, and reinforce this vision to at all times

Upper level management must derive as an example to the remainder of the staff, otherwise ISO 14000, as well as any EMS will be sure to fail

Elements of an Effective EMS

- Establish "Company-wide" goals which are
  - Acceptable
  - Flexible
  - Measurable
  - Motivational
  - Suitable
  - Understandable
  - Achievable

Elements of an Effective EMS

- Goals may include
  - Amount of raw materials used
  - Amount of waste(s) produced
  - Types of waste(s) produced
  - Effects on the environment

Elements of an Effective EMS

- Mission Statement
  - Put the commitment into words

  Example
    - [A major company] "is committed to continued excellence, leadership, and stewardship in protecting the environment, while providing only the best in products and services for our customers "
  - Reflects environmental goals of company

WEF/CWEA/Module 6 19

People sometimes think that the mission of a business, as well as its objective, is simply to make a profit

This may be true, however, this still entails the setting of goals, the formulating of strategies, and the implementation of policies and procedures Without these components in place, no company can succeed in its mission of "making a profit "

Environmental management is no different than management that is designed to make a profit

Objectives, policies, procedures and rules must be written to show the commitment

Such expression of commitment is first accomplished by creating a mission statement which expresses this new commitment in words

This is a fundamental part of any EMS, as well as the backbone behind ISO 14000

Elements of an Effective EMS

- Determine objectives
  - may be identified company wide or by dividing the company into smaller groupings
    - Departments, activities, or processes
- Establish objectives that are clearly definable
  - Quantitative
  - Qualitative
  - Realistically Obtainable
  - Include timelines

CWEA/IHWC/Module 6 20

After a mission statement is put into writing, it is imperative that the "basic plans" be made prior to any further action

"Objectives" and "program goals" are two terms that may be used interchangeably

These objectives serve to focus and outline the additional management components of organizing, staffing, leading and controlling These are critical functions of an EMS such as ISO 14000

The important characteristics of an objective or program plan are

SPEAKER NOTE Review bullets on slide

Objectives - Which Departments or Areas to Target ?

- All areas should be reviewed
- Prioritize the areas for importance
  - Some considerations when prioritizing areas
    - Ease of waste minimization, costs involved
    - Quantity of waste generated
    - Hazardous properties of waste generated
    - Potential environmental and safety liability
    - Potential recovery of valuable by-products
    - Compliance with current and future regulations

Elements of an Effective EMS

- Planning
  - Identify and understand legal and other requirements
  - Establish documented environmental objectives and targets
  - Establish and maintain programs for achieving objectives and targets

CWEA/IHWC/Module 6 22

After identifying the areas you want to work on, it is imperative to assess the environment in which you need to operate In other words, you must understand the codes of practice of your industry, both the regulatory and non-regulatory guidelines

The latter two bullets are the heart of an EMS

An objective is a long-term goal A target is specific, measurable, and includes a definite time frame

For example, your **objective** may be to "reduce waste in relationship to the total quantity of a final product" In this case a possible **target** might be "By the end of 1998, we will reduce waste 10% from the 1995 total yearly waste levels "

Next, you must establish the necessary programs to achieve these objectives and targets This may include designating responsibility at the appropriate level within your organization

Whatever level of employee is given the responsibility, it is important to provide a solid commitment to support the documented goals

This entails providing the responsible individuals with the means to achieve these goals, including establishing the appropriate time frames for completion of each target and objective

Elements of an Effective EMS

- Planning (continued)
  - Identify environmental aspects/impacts of activities, products, or services
    - Legislative & regulatory requirements
    - Significant environmental aspects
    - Existing environmental management practices and procedures

CWEA/IHWC/Module 6 23

Once a guiding policy is in place, you can move on to the stage of planning

This involves identifying environmental aspects and impacts of your company's activities, products, or services This is accomplished by identifying those aspects that your company can control , then determining which are significant in their environmental impact

For example, in the EU, this analysis has resulted in redesign of televisions so that they can be easily taken apart and the pieces recycled at the end of their useful lives

To further clarify, an **aspect** is the interaction your company has with the environment The **impact**, however, is the change resulting from that interaction

For example an aspect might be air emissions <u>from</u> your plant, while the impact may be an increase in the emissions <u>near</u> your plant

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Elements of an Effective EMS

- The Program Task Force
  - Organize the Program Task Force to include a representative from each division or area of the organization
  - Have one individual be the "champion" for the cause
  - Include ALL the employees that can contribute to key aspects of the plan's success

CWEA/IHWC/Module 6 24

Although management commitment and direction are fundamental to the success of ISO 14000, employees often control the generation of waste and they can contribute to the overall success of the program

The Program Task Force should include members of all groups and departments that have a significant interest in the outcome of the program

The Task Force should be headed by one individual who will serve as the "cause" champion who is familiar with the facility, people and management

The remaining members of the Task Force should represent people from a wide range of departments such as production, quality control, environmental, purchasing and legal

Who Should Be Task Force Members ?

- Individuals from ALL key areas
- People who know the facility processes and its policies and operating procedures
- People who are well respected in their department or work area

- Production
- Maintenance
- Engineering
- Quality Control
- Environmental
- Safety/Health
- Marketing
- Purchasing
- Legal
- Financial/Accounting
- MIS

Elements of an Effective EMS

➢ **The Pre-Assessment Study**

- The job of the Program Task Force
- Establish the overall working objectives of the program
- Identify which divisions or areas to be targeted
- Determine what data should be used
- Define a waste tracking system to be used

CWEA/IHWC/Module 6 26

In order to develop an effective EMS it is necessary to have a detailed understanding of a facility's operations and waste generating processes

An assessment should be conducted in order to examine information regarding the processes, operations and waste management practices at the facility

These are some of the important points to consider before the assessment is conducted

SPEAKER NOTE Refer to bullets on slide

Pre-Assessment Phase Information

- Develop flow diagrams
- Gather information on raw and other input materials
  - quantity used
  - toxicity content
- Gather known output information
  - products
  - wastes

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Elements of an Effective EMS

- Implementation
  - Structure & Responsibility
    - Define, document, communicate roles, responsibilities and authorities
  - Training, Awareness, & Competence
    - Human, physical and financial resources
    - Identify training needs

CWEA/IHWC/Module 6 28

There are seven key elements to EMS implementation These are the first two

This first one takes the important step of establishing accountability The second ensures that with the responsibility and assignment of implementing some portion of an EMS, your staff also get the tools they need --- the resources and the training The biggest mindset shift in quality management is that quality, in this case, the EMS, is everyone's responsibility

In developing a training plan and identifying training needs, keep in mind that training will differ depending on an individual or group's role in implementing the EMS The 14001 standard does not require training for your contractors and suppliers, but suggests that you obtain evidence of their training

In developing and providing training, ensure that your training also complies with regulatory and other requirements As with all quality elements, document and continuously improve your training program with employee feedback and input

Elements of an Effective EMS

- Implementation (continued)
  - Communication internal & external
    - open internal communication critical
    - required procedures for response to information requests
  - Documentation
    - policy manual
    - company operating procedures
    - work instructions
    - records (compliance with EMS requirements)

CWEA/IHWC/Module 6 29

Two things we will continue to emphasize throughout as critical to these processes is management commitment and communication Open internal communication motivates employees and helps to solve problems by raising their awareness

External communication is what we used to call public relations Establish procedures to provide information relevant to interested parties, keeping in mind that full disclosure to someone unfamiliar with your plant may cause misunderstandings While other standards, specifically BS 7750 and EMAS, which we will touch on later, require a published register of significant environmental effects ISO 14000 does not

The EMS documentation system is similar to that outlined in ISO 9000 It begins with the broad vision of the policy manual, works through the increasingly detailed levels of operating procedures and specific work instructions, and, finally, concludes with records that work was done according to the procedures, consistent with policy, and in compliance with the EMS standards

Elements of an Effective EMS
(continued)

- Management Review
  - Review EMS for continuing suitability, adequacy & effectiveness
    - compare performance with objectives and targets
    - determine and correct root causes of deficiencies
    - identify further opportunities for improvement
    - establish a continuous improvement process

CWEA/IHWC/Module 6 30

Management review overlaps with what we just talked about in an EMS audit Management should take the results of the audit and review the entire system with these criteria in mind to see if the system still meets the company's needs

Things to be considered include changing circumstances, such as changes in legislation, or changing expectations from interested parties

The organizational activities or products themselves may have changed Technology may have advanced, or marketing information may have been obtained on your customer base

Finally, you may have feedback from your responses to environmental incidents

Environmental Management Systems

- TQM/TQEM
- ISO 9000/14000
- Other International Standards
  - Chemical industry initiatives
  - BS 7750 and NSF 110
  - Eco-Management and Audit Scheme (EMAS)

CWEA/IHWC/Module 6 31

Many management approaches have developed in the last couple of decades
Many have common elements and themes, with slightly different approaches
We'll be discussing the key elements of each of these, and this will give you some ideas of what might work in your own workplace

SPEAKER NOTE Review 3 types of EMS strategies bulleted

Total Quality Management (TQM)

- Customer Focus
  - Internal and external customers
- Continuous Improvement
  - Build quality into the product
- Teamwork
  - Empower employees
- Strong Management Commitment
  - TQM will not succeed without it

CWEA/IHWC/Module 6 32

Many of you may be familiar with Total Quality Management, or TQM These are the elements of TQM Everyone in the organization must focus on the customer's needs and on finding opportunities for improvement throughout the organization

Please review the content, I will reformat the slide to look a lot better

Total Quality Environmental Management (TQEM)

- Customer Focus
  Include people & environments affected by production process & waste
- Continuous Improvement
  Minimize waste generation with goal of zero waste
- Teamwork
  Identify ways to reduce and prevent pollution throughout the process
- Strong Management Commitment
  TQEM will not succeed without it

CWEA/IHWC/Module 6 33

SPEAKER NOTES Review bullets on slide contrasting against previous slide

ISO 9000 /ISO 14000

- Emphasis on organizational rather than technical solutions
- Management of total process
- Cooperation between elements of the production chain

WEF/CWEA/Module 6 34

ISO 14000 built on the success of ISO 9000, and contains many of the same tools and approaches, as both are, essentially, total quality management systems

ISO 9000 focuses on the quality of the product, and ISO 14000 focuses on the environmental quality of the production process that produces it

The two systems share these common themes

SPEAKER NOTE Go through the bullets on slide

Evolution of ISO 14000

- Regulatory-industry cooperation
- Linking compliance problems to systemic problems
  - inadequate training
  - inadequate data
  - lack of responsibility at right level
- Shaped by
  - concept of *sustainable development*
  - success of ISO 9000 standards

WEF/CWEA/Module 6 36

Where did the idea of an EMS come from?

ISO 14000 and the EMS concept emerged from a changing climate of proactive work between regulatory regulators and industry It came from the awareness that compliance problems often originated in systemic problems such as inadequate training

(examples)

In addition, the ISO 14000 standard came out of the success of the earlier ISO 9000 product quality standards, and the philosophy of sustainable development

These are important concepts to consider, as there is a perceivable increase in international attention to corporate environmental performance records

ISO 14000 Motivators

- Financial Impacts & Cost savings
- Sustainable Development
- Global Market Competition

WEF/CWEA/Module 6 37

As we discussed, there are many reasons to adopt an environmental management system, ISO 14000 is no different than the rest

These are three of the most important reasons

SPEAKER NOTE Review bullets on slide and discuss each

ISO 14001 - Environmental Management Systems

- ISO 14001defines the overall framework for environmental management
- ISO 14001 provides the "core" requirements for developing and implementing an EMS
- ISO 14001 is considered the "specification" document to which organizations will be audited against

WEF/CWEA/Module 6 38

ISO 14000 is not a standard itself, rather, it is a family of standards all identified under the "ISO 14000" umbrella

The standard known as ISO 14001 is the only standard that defines what ISO considers to be an acceptable environmental management system This standard provides the core for developing an ISO certifiable EMS It is this standard that MUST be adopted for ISO 14000 certification

Requirements of ISO 14001

- Environmental policy
- Planning
- Implementation and operation
- Checking and corrective action
- Management review

WEF/CWEA/Module 6 39

Moving now to the nitty-gritty, what exactly is required in an ISO 14001 EMS?

These are the major elements comprising ISO 14001

We'll be discussing each of them in some detail as we go through this presentation

SPEAKER NOTE Review each bullet

Other International Standards

- Chemical Industry Initiatives
  - Responsible Care
- BS 7750
  - British standard, adopted 1994
  - base for ISO 14001
- NSF 110
  - U S , adopted 1995
- Eco-Management and Audit Scheme (EMAS)

CWEA/IHWC/Module 6 40

ISO 14000 grew out of many predecessor programs and standards, some of which are still, and will continue to be, in use, so we will describe them here briefly

One of the earliest initiatives was implemented by the Canadian Chemical Producers after the tragic Union Carbide accident in Bhopal, India

The US Chemical Manufacturers Association (CMA) adopted the same "codes of management practice" soon after This program was known as "Responsible Care", and was the chemical industry's realization that they had a somewhat tarnished image This damage to their reputation soon began seriously affecting their investment opportunities

Establishing uniform production codes was a critical move in providing damage control

Other programs, including waste minimization , emergency response, and safe materials handling and storage practices, soon followed in the tracks of the initial production codes

The British developed the BS 7750 standard, and adopted them in 1994

The BS 7750 standard has served as the base for the development of ISO 14000 Similarly, the US has an equivalent standard, the NSF 110, adopted in 1995

Probably the most widely used standard outside ISO , however, is the EMAS, the environmental standard of the European Union

ISO 14000

Using ISO 14000 as an EMS

CWEA/IHWC/Module 6 42

THIS SERVES AS A SUB-MODULE TO MODULE 6!

IF YOU FIND THE NEED TO GO FURTHER INTO ISO 14000, THIS SECTION MAY BE INSERTED AFTER THE SLIDE

"Total Quality Environmental management (TQEM)"

•Customer Focus slide #33

ISO 9000/ 14000

- Definition and role of industry in global environmental management
- Environmental legislation and enforcement
- Stakeholder pressure, awareness, image & reputation
- Competitiveness & impacts on trade

CWEA/IHWC/Module 6 43

One of the outgrowths and applications of the TQM and TQEM approaches has been the development of voluntary international standards, such as the ISO 9000 series, focused on product quality, and ISO 14000, which sets in place an environmental management system These approaches are, in fact, generally known as quality systems

I'd like to begin with a definition of ISO, then move on to how ISO 14000, in particular, affects and interacts with the following topics, so you have a sense of the impact of implementing an ISO standard

ISO: Definition

- International Organization for Standardization (ISO)
  - headquartered in Geneva, Switzerland
  - members 112 national standard-setting bodies
    - e g U S A American National Standards Institute (ANSI)
  - members 95% of world's industrial population

Let's start with definitions ISO is the International Organization for Standardization

SPEAKER NOTE Go through bullets on the slide

ISO: Role in Global Environmental Management

- Non-governmental organization formed in 1947 to develop worldwide standards to
  - improve international communication & collaboration
  - facilitate international exchange of goods and services
- Works through technical committees to establish **voluntary** standards

CWEA/IHWC/Module 6 45

SPEAKER NOTE Go through bullets on slide

(Again, it is important to note that ISO standards are voluntary standards only!)

ISO 14000

- Technical committee (TC) 207
- ISO 14001 defines components of a basic Environmental Management System (EMS)

CWEA/IHWC/Module 6 46

ISO consists of approximately 180 working committees known as Technical Committees, or TC's Each TC is responsible for the development of one set of standards

The technical committee that has developed the ISO 14000 standard, for example, is known as TC 207, which is made up of representatives from various national standard-setting organizations

The efforts of TC207 were started in June of 1993

In 1996, TC 207 finalized the first of the ISO 14000 series of standards, including ISO 14001, defining the components of an EMS, which we will be discussing in some detail later on

ISO 9000 /ISO 14000

- Emphasis on organizational rather than technical solutions
- Management of total process
- Cooperation between elements of the production chain

CWEA/IHWC/Module 6 47

ISO 14000 built on the success of ISO 9000, and contains many of the same tools and approaches, as both are, essentially, total quality management systems

ISO 9000 focuses on the quality of the product, and ISO 14000 focuses on the environmental quality, of the production process that produces it

The two systems share these common themes

SPEAKER NOTE Go through the bullets on slide

ISO 9000/ 14000

- development of quality system motivated by **external** incentives
- similar system elements
  - policy, corrective mechanisms
  - internal control, information
- similar instruments
  - policy statements, reporting
  - audits, measurements, records

CWEA/IHWC/Module 6 48

Like the underlying approaches, the implementation tools in 9000 and 14000 are very much the same The development of the system is motivated by external incentives --- as we discussed before, the customer drives the quality system, and the number and kinds of customers considered in 14000 is somewhat broader than 9000

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Evolution of ISO 14000

- regulatory-industry cooperation
- linking compliance problems to systemic problems
  - inadequate training
  - inadequate data
  - lack of responsibility at right level
- shaped by
  - concept of *sustainable development*
  - success of ISO 9000 standards

CWEA/IHWC/Module 6 49

Where did the idea of an EMS come from?

ISO 14000 and the EMS concept emerged from a changing climate of proactive work between regulatory regulators and industry It came from the awareness that compliance problems often originated in systemic problems such as inadequate training

(examples)

In addition, the ISO 14000 standard came out of the success of the earlier ISO 9000 product quality standards, and the philosophy of sustainable development

These are important concepts to consider, as there is a perceivable increase in international attention to corporate environmental performance records

ISO 14000 Motivators

- Financial Impacts & Cost savings
- Sustainable Development
- Global Market Competition

CWEA/IHWC/Module 6 50

As we discussed, there are many reasons to adopt an environmental management system, ISO 14000 is no different than the rest

These are three of the most important reasons

SPEAKER NOTE Review bullets on slide and discuss each

ISO 14001 - Environmental Management Systems

- ISO 14001defines the overall framework for environmental management
- ISO 14001 provides the "core" requirements for developing and implementing an EMS
- ISO 14001 is considered the "specification" document to which organizations will be audited against

CWEA/IHWC/Module 6 51

ISO 14000 is not a standard itself, rather, it is a family of standards all identified under the "ISO 14000" umbrella

The standard known as ISO 14001 is the only standard that defines what ISO considers to be an acceptable environmental management system This standard provides the core for developing an ISO certifiable EMS It is this standard that MUST be adopted for ISO 14000 certification

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Requirements of ISO 14001

- Environmental policy
- Planning
- Implementation and operation
- Checking and corrective action
- Management review

CWEA/IHWC/Module 6 52

Moving now to the nitty-gritty, what exactly is required in an ISO 14001 EMS?

These are the major elements comprising ISO 14001

We'll be discussing each of them in some detail as we go through this presentation

SPEAKER NOTE Review each bullet

Environmental Policy

- Management commitment
- Appropriate to nature, scale and environmental impacts of company's activities, products, and services
  - May include regulatory compliance, potential environmental liability, guiding principles from industry associations, government, public interest groups
  - Should be consistent with organization's mission and core values

CWEA/IHWC/Module 6 53

The first element of ISO 14001 is the establishment and adoption of an environmental policy by your company

We've talked a lot about management commitment in an effective EMS, and this is where it is most critical

The policy should provide a vision for the quality system, and management must support this policy completely, or any EMS will not work!

A policy should be (Review bullet 2)

Keep in mind that this policy should only covers things reasonably under a company's control However, crisis management should always be a part of any policies Contingency planning is always an important part of an EMS

You will note that the 14001 standard does not prescribe particular performance standards or technology This allows a company maximum flexibility in determining their focus

Environmental Policy

- Establish a clear "basic plan",
  - Provide periodic review and revision, reflecting a company's changing conditions
- Begin where you can achieve obvious benefits
  - Easy to accomplish

CWEA/IHWC/Module 6 54

A policy should be clear (concise!), undergo periodic review, and be revised to reflect changing conditions

Places to begin, with obvious benefits are, for example, regulatory compliance, limit liability, more efficient materials/energy use

Work in these areas can provide relatively quick successes

For instance, one company I know of, went through all its material safety data sheets for raw materials, eliminating all those that had toxic characteristics

Implementation

- Structure & Responsibility
  - Define, document, communicate roles, responsibilities and authorities
- Training, Awareness, & Competence
  - human, physical and financial resources
  - Identify training needs

CWEA/IHWC/Module 6 55

The next key component of ISO 14001 is implementation

There are seven key elements to ISO 14001 implementation This slide lists the first two

The first one, structure and responsibility, takes the important step of establishing accountability This is a key idea in ISO 14000, accountability everything must hold up to a full audit at any time!

The second, training, awareness and competence, ensures that with the responsibility and assignment of implementing some portion of ISO 14000, your staff also get the tools they need --- the resources **and** the training

The biggest mindset in a quality management system such as, ISO 14000, is that quality is everyone's responsibility

In developing a training plan and identifying training needs, keep in mind that training will differ depending on an individual or group's role in implementing the EMS

The 14001 standard does not require training for contractors and suppliers, but suggests that evidence of their training and possibly their own ISO 14000 certification be obtained prior to contract

In developing and providing training, ensure that your training also complies with regulatory and other requirements

As with all quality elements, document and continuously improve your training program with employee feedback and input

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Implementation (continued)

- Communication internal & external
  - open internal communication critical
  - required procedures for response to information requests
- ISO Documentation
  - Documentation hierarchy
    - policy manual
    - company operating procedures
    - work instructions
    - records (compliance with EMS requirements)

CWEA/IHWC/Module 6 56

Two things we will continue to emphasize throughout as critical to these processes is management commitment and communication

Open internal communication motivates employees and helps to solve problems by raising their awareness

External communication is what we sometimes call "public relations "

Establish procedures to provide information relevant to interested parties Keep in mind that full disclosure to someone unfamiliar with your plant may cause misunderstandings

While other standards, specifically BS 7750 and EMAS require a published register of significant environmental effects, ISO 14000 does not

It is not a requirement that you be in compliance to maintain ISO 14000 compliance! The only requirement is to fully implement an EMS, as defined in ISO 14001

The EMS documentation system is similar to that outlined in ISO 9000 It begins with the broad vision of the policy manual, works through the increasingly detailed levels of operating procedures and specific work instructions, and, finally, concludes with records that work was done according to the procedures, consistent with policy, and in compliance with the EMS standards

Implementation (continued)

- Required Document control
  - maintain environmental records
    - training, production process
    - inspection, maintenance, calibration
    - contract & supplier information
    - incident, emergency response records
    - regulatory records, audit results

CWEA/IHWC/Module 6 57

Documentation is a core element of a management system

Part of establishing, implementing and maintaining these procedures is documentation, so you know where to focus your efforts, have a record of achievements and justification for changing priorities Information is key

Documents should be legible, dated, orderly They should be reviewed and updated, and removed when obsolete (or kept if necessary for a legal or auditor requirement)

Implementation (continued)

- Operational control
  - leak detection, corrosion monitoring
  - preventative maintenance
  - secondary containment
- Emergency preparedness and response plans
  - for abnormal operating conditions AND potential emergency conditions

CWEA/IHWC/Module 6 58

In your everyday process operations, identify activities associated with environmental any aspects Look to see if there is anything you may need to do to get in line with your policy

This is known as performing a "gap analysis"

A gap analysis may show company management how far they are from achieving ISO 14000 compliance before actually conducting a formal ISO 14000 audit

Other simple things to implement that are likely to minimize your impacts are these activities listed here (Refer to slide)

You may also want to consider your activities, from research and development and product design, to production, marketing, and customer service

Additionally, you might thoroughly examine your product's "life cycle", and its the final point of disposal This may offer you valuable insight as to whether or not your procedures are consistent with your stated policy For example, you may be generating a product that cannot be recycled, which has the direct result of contributing to landfill usage You then might re-evaluate the products manufacturing process, carefully reviewing all aspects of its production This may go as far as reassessing your raw materials, your suppliers and contractors, your choice of packaging, any any other production related considerations

Life cycle assessment is another area covered in ISO 14000, but the standard has not been fully written at this time

The final element of implementation, your emergency response and preparedness plan, should identify the potential and response to accidents and emergency situations

The plan may include different response methods for different types of emergencies, communication structures, responsibilities, and training for employees

Planning

- Identify environmental aspects/impacts of activities, products, or services
  - Legislative & regulatory requirements
  - Significant environmental aspects
    - emissions/ releases to air, water, land
    - waste management, impact on communities
    - use of raw materials and natural resources
  - Existing environmental management practices and procedures

CWEA/IHWC/Module 6 59

Once a guiding policy is in place, you can move on to the stage of planning This involves identifying environmental aspects and impacts of your company's activities, products, or services

SPEAKER NOTES Review bullets on slide for an item to discuss or give a case study

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Checking & Corrective Action

- Monitoring & Measurement
  - track performance
  - periodic evaluation of regulatory compliance
- Corrective & Preventative Action
  - root cause analysis
  - implement procedural changes as necessary
- Records
  - inspection, incident, audits, contractors, etc
- Periodic environmental audits

CWEA/IHWC/Module 6 60

Once your systems are in place, you need to know if they're working

If a problem or any type of non-conformance is discovered through monitoring and measurement, it is important to understand the root cause of why the problem occurred This assures that it is the **problem**, and not just a resulting symptom, that is fixed

As we mentioned earlier, a core element in all monitoring is keeping good records -- complete, relevant, and accurate records on inspections, incidents, internal audits, instruments, software, etc

Finally, periodic audits should be performed on your entire environmental management system

Is it doing what you intended?

Once your performance results are collected, they should be forwarded to management to make the decisions on what needs to be altered

All employees should feel free to suggest improvements, but management must make the final decisions, consistent with company policy

The frequency of your EMS audits should be based on the environmental impact of your activity, and the results of previous audits

Management Review

- Review EMS for continuing suitability, adequacy & effectiveness
  - compare performance with objectives and targets
  - determine and correct root causes of deficiencies
  - identify further opportunities for improvement
  - establish a continuous improvement process

CWEA/IHWC/Module 6 61

Management review overlaps with what we just talked about in an EMS audit Management should take the results of the audit and review the entire system with these criteria in mind to see if the system still meets the company's needs

Things to be considered include changing circumstances, such as changes in legislation, or changing expectations from interested parties

The organizations activities or products themselves may have changed

Technology may have advanced, or marketing information may have been obtained on your customer base

Finally, you may have feedback from your responses to environmental incidents

This evaluation should be done on an ongoing basis, and not just once

Remember, it is MONITOR, EVALUATE, **and CORRECT!**

Sustainable Development

- **Definition:**
  - To satisfy economic & social needs of society without jeopardizing resources for future generations
    - global development approach
    - balancing economic growth with environmental protection
    - implementing pollution prevention, reducing use of toxic substances, slowing depletion of nonrenewable resources

CWEA/IHWC/Module 6 62

A key to the philosophy of ISO 14000, is that of sustainable development

SPEAKERS NOTE Refer to slide for definition and points

On a practical level, this means implementing pollution prevention to maintain a high quality of life for all life on Earth, and to save our natural resources for our children's children

WILL ISO 14000 Match The Success of ISO 9000?

- ISO 9000 Success
  - Standards for quality management & product quality assurance
  - > 45,000 companies registered globally
  - compliance with standard an important strategic business factor for competitiveness

WEF/CWEA/Module 6 63

Will ISO 14000 have the success of its sister ISO 9000?

Many say yes, most say it will become more successful

Over 45,000 companies received ISO 9000 registration globally, and compliance with the standard became an important strategic business factor, especially, for example, in the semiconductor and pharmaceutical industries

Perhaps the future of life on our planet will be hinged on the success of ISO 14000?

END

Implementing an Industrial Effluent Management Program

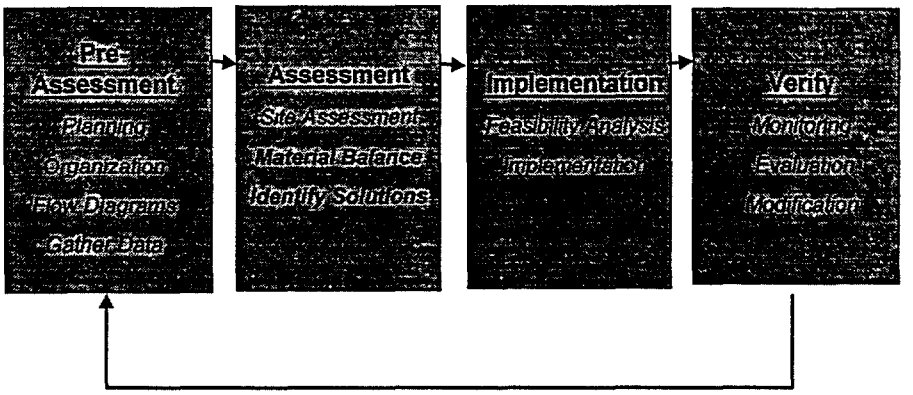
Presented by

The Water Environment Federation(WEF)

and

The California Water Environment Association(CWEA)

Effluent Management Phases



Barriers to Implementing Effluent Management

- Financial Barriers
- Informational Barriers
- Technical Barriers
- Institutional Barriers

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3

Notes

While some barriers are in fact real Many times these barriers are often perceived, as much, or more, than they are real

Often the rest of the barriers are tied to the **lack of information** barrier Once information or education is provided the other barriers may lose some of their impact

Elements of an Effective Effluent Management Program

- Planning and Organization
- Assessment
- Feasibility Analysis
- Implementation
- Monitoring, Evaluation, and Modification

Elements of an Effective Effluent Management Program - Element 1

Planning and Organization

- Get management commitment
- Determine company's overall effluent management goals
- Develop policy statements and program objectives
- Select effluent management task force team members

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Notes

To provide good and quick illustrative examples for this overhead you may want to draw from results from the Resort exercise or other examples brought out in the course

Review the list on the screen - should not need to go into detail as this information was already covered earlier in the course at length

Elements of an Effective Effluent Management Program - Element 1

Planning and Organization (continued)

- Gather pre-assessment phase information
- Create flow diagram
- Gather and review all pertinent information

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Notes

Review the list on the screen - should not need to go into detail as this information was already covered earlier in the course at length

Elements of an Effective Effluent Management Program

- Planning and Organization
- Assessment
- Feasibility Analysis
- Implementation
- Monitoring, Evaluation, and Modification

Elements of an Effective Effluent Management Program - Element 2

Assessment

- Conduct a site assessment
  - Identify all waste streams
  - Identify the causes of all generated wastes
  - Identify pollution prevention or pollution control practices already in place
- Collect and review additional data
- Calculate material balance
- Identify possible solutions

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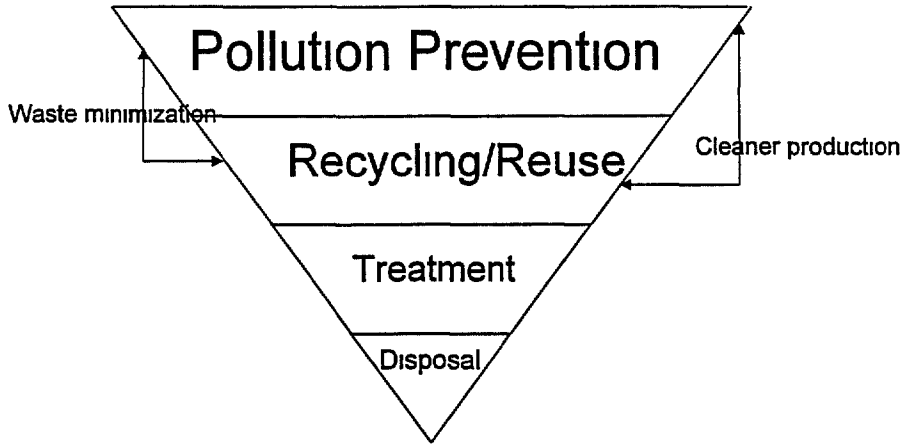
Notes

Review the list on the screen - should not need to go into detail as this information was already covered earlier in the course at length

Solutions



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Elements of an Effective Effluent Management Program

- Planning and Organization
- Assessment
- Feasibility Analysis
- Implementation
- Monitoring, Evaluation, and Modification

Elements of an Effective Effluent Management Program - Element 3

Feasibility Analysis

- Screen and select options for further consideration
- Conduct technical evaluation
- Conduct economic evaluation

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Notes

Because in the brainstorming or idea gathering phases, there is no such thing as a bad idea the ideas must be reviewed and put in some sort of priority

First identify which option should be further considered, AT THIS TIME There is still not a bad idea, just those that may not be appropriate at the time

Two ways that ideas are often screened is by technical feasibility and by economic feasibility

Be careful to not quickly dismiss an idea because you think it is not economical or technically feasible, an evaluation will need to be conducted to evaluate their true feasibility

Screening and Selecting Options for Further Study

- Identify those options that offer potential to minimize waste and reduce costs
  - Informal evaluation
  - Formal evaluation methodologies
- Consider barriers
- Develop written report

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Notes

The importance having a written report is to document how and why options where eliminated or selected

As changes take place, within company, country, access to technology, access to funding, etc it may be advantageous to review options that were originally eliminated to see if they have become feasible and desirable at a new point in time

Because it is important to begin the implementation process and to achieve successes -- the reality is that there may be some true barriers that will be difficult to overcome, quickly

To ensure success, when prioritizing you will need to be a realistic about barriers that exist, real and perceived

Barriers to be Addressed in Decision Making

- Financial Barriers
- Informational Barriers
- Technical Barriers
- Institutional Barriers

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Notes

While some barriers are in fact real Many times these barriers are often perceived, as much, or more, than they are real

Often the rest of the barriers are tied to the **lack of information** barrier Once information or education is provided the other barriers may lose some of their impact

Technical Evaluation

- Will option work in a specific application?
- Will option involve equipment change or process change?
- Will there be facility constraints and product requirements?

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Notes

These are some technical evaluation to consider, there may be others

Answering YES to any of these questions does not mean that the organization should not move forward with that option, but rather that there may be additional items that need to be factored in when making the evaluation

Decisions for implementing pollution prevention ideas, even great ones, can not be made in a vacuum

Of course with any change there will be trade-offs That is why "evaluation" is truly what must take place Balancing the pros with the cons

Economic Evaluation

- Capital costs
- Equipment costs
- Raw and other input materials costs
- Indirect capital costs
- Working capital
- Total capital investment
- Operating and maintenance costs and savings
- Profitability analysis

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Notes

Industry is in the business to make products which in turn will hopefully make money They are not in the business to make a clean environment

However, these two ideas need not be at opposite ends What a business need to evaluate is how they can continue to make money and at the same time have the added benefit of a cleaner environment

As we have discussed throughout the course industry can actually save money or make additional money with waste minimization

We have already looked at (and depending on the course) actually calculated mass balance to look at real costs

In the evaluation process you will want to look at how the costs and savings compare (both short range and long range) in deciding with which options the industry will begin

Decision Making Methods

- Ranking
- Rating
- Criteria Matrix

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Notes

While an organization may come up with their own way to evaluate and prioritize effluent management options we are going to take a closer look and three "formal" prioritizing methodologies -- ranking, rating, and the criteria matrix

Ranking Method - Example

- Best/Worst
- Most/Least workable
- Most/Least Reliable
- Most/Least tested and proven
- Most/Least risky
- Most/Least able for staff to make it work
- Best/Worst chance for success

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Notes

When using the Ranking approach the organization will "rank" the possible alternatives comparing them against pre-determined goals or ideals

On the overhead are some possible items against which the ideas will be ranked

The review team will look at all of the possible alternatives and rank them against the others choosing which item(s) are the "best" The group may decide to rank the ideas from "worst" to be "best"

Obviously this process is very subjective and people will be coming to the process with their own ideas and backgrounds Coming to a consensus in a group may be a lengthy and difficult process

If more than one goal or ideal is being used to rank the alternatives you may come up with sever "the best" in various categories

Rating Method - Example

- Rate and tabulate each item
  - 5 - Top preference
  - 4 - High preference
  - 3 - OK
  - 2 - Maybe
  - 1 - Slim chance
  - 0 - No way

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Notes

In the rating process each option is rated individually

For example on a scale from 1 to 5 each item is given its own rating A rating of 5 would be mean that the item was a top preference item,, while a rating of 3 meant that it was "OK"

If the group can not agree on a specific numerical value you do have the option of each person rating and then averaging these together to come up with a rating (As is done by judges when rating in the Olympic Games)

After the group has rated the option they may find that they have a couple of items that are rated as a 5 This should indicate that these are the groups top preference for moving forward into the implementation stage

The rating process may be more easily managed and require less negotiating than the ranking method

Criteria Matrix Method

- Use for top rated alternatives
- Forces examination of issues to be addressed during implementation
- May not have enough differentiation in scores for initial prioritization

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Notes

This decision making method may take the most time Therefore the decision making group may want to use another method, first, to perform the matrix against their top choices

This method build on the rating method Rather than evaluating options in a "stand alone" mode each option is prioritized against a variety of goals, ideas and issues that will factor into the implementation

Criteria Matrix Method - Example

- Effectiveness
- Implementability
- Costs

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Notes

These are just some examples of the goals by which the group may want to prioritize each item

The following overheads will show more detailed examples of the issues that the group might consider for each of these three items - effectiveness, implementability, and cost

Criteria Matrix Method - Example Effectiveness

- Potential for minimization/elimination
- Potential for recovery of valuable by-products
- Compliance with current and future regulations
- Reduction in Hazardous properties
- Benefits of employee safety
- Reduction in materials use

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Notes

Review list

Criteria Matrix Method - Example Implementability

- Well documented cases available
- Variety of vendors available
- Risk of media transfer is low
- Quality of reference provided
- Management/employee support
- Engineering sophistication of option

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Notes

Review list

Criteria Matrix Method - Example Costs

- Cost savings
  - Direct and indirect
- Potential environmental and safety liability
- Availability of internal funding
- Availability of external funding
- Payback potential and time period

Notes

Review list

Criteria Matrix Table - Example

Alternative Solution	Ef	Impl	Cost	Total
Use displacers to reduce bath ratios	4	4	3	11
Apply countercurrent washing	5	4	5	14
Use appropriate holding tanks to implement bleach bath reuse	3	4	5	12
Use flow control valves & restrictors on washers & cooling water	3	4	4	11
Use horizontal or inclined washers	5	5	4	14
Install moveable water meters to document water use and evaluate improvement	3	3	4	10
Optimize salt use individually for each dyeing	4	3	3	11

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Notes

This is an example of what a completed criteria matrix would like

As in the Rating method the group must determine what their scale will be, for example 1-5 or 1-10, with the high end number being the best rating

Each of the alternative solutions are listed and rated individually for each of the categories (individually)

After each alternative has been rated for each category, the scores should be added together to create a grand score

Once all of the alternatives have been completed the group will be able to determine which of the options have the overall best rating

EFFLUENT MANAGEMENT

Presented by
Water Environment Federation (WEF)
and
California Water Environment Association
(CWEA)

Why Segregate Wastestreams?

- Improved removal effectiveness
- Specific Treatment Technologies
- Possible recycling of recovered materials

Notes

Segregating waste streams allows you to enhance removal effectiveness & enable you to reuse recovered materials

Depending upon the cost of treatment or value of recovered material, the treatment system payback could will be dramatically shortened and ultimately increase facility income

Types of Wastes Generated

- solids
- BOD/COD
- fats, oils, and grease (FOG)
- acid/alkaline
- heavy metals
- nutrients
- toxic organics

Types of Solids

- Screenable
  - Large >25 mm
- Non-Screenable
  - Grit sand or small gravel
- Settleable remove by sedimentation
- Suspended remains dispersed
- Colloidal very fine particles

Notes

Solid or suspended material in wastewater is classified according to its size and the technique used for removal The types of solids produced are either large, grit, settleable or colloids Large solids are at least 25 mm in diameter Grit includes sand, gravel, and other dense materials Setleable solids are particles that have diameters between 0 001 mm and 25 mm Colloids are very small particles (0 00001 mm) and do not settle if unaided

Sources of Solids

- Grinding, Chopping, Polishing and Washing in
  - Food Processing
  - Pulp and Paper Facilities
  - Timber Products Processing
  - Iron and Steel Manufacturing
  - Metal Finishing and High Tech Industries

Notes

Suspended materials are generated from, grinding, chopping, polishing and washing operations conducted at pulp and paper manufacturing facilities, timber processors, and the food processing industry Pickling operations at iron and steel manufacturing facilities also generate solid material, similar to grit

Settleable solids and colloidal materials may be either organic or inorganic, depending upon the type of industrial processing operation The use of dispersing agents (surfactants) may stabilize the wastestream and make solids removal more difficult

Solids Removal

Removal Depends On:

- Type of solids generated (size, settleability, thickening, density)
- Final concentrations of solids desired in treated water
- Initial concentration of solids in wastewater

Notes

The type of treatment method used to remove solids from your wastestream depends on three factors the initial concentration of solids in wastewater, the desired concentration of solid material in the wastewater after treatment and the type of solids generated in your process

Types of Solids Removal

- Screening
- Gravity Settling /Floatation
- Filtration

Notes

Three common techniques are used for solids removal These include passing wastewater through a strainer to remove large solids, using gravity for solids to settle or filtering wastewater through different type of media

In treatment plants handling domestic and industrial sewage, the incoming water is first screened, then combinations of floatation and gravity settling treatment applied

For finer particles more settling and perhaps even filters are used

Solids Removal

- **Screening**
  - Coarse and Fine Screens
- **Gravity Settling/ Floatation**
  - Grit Removal
  - Sedimentation
  - Flocculation/Coagulation
  - Dissolved air flotation separation

Notes

As water passes through the screens, the large solids are captured The screens can either be coarse (to remove large particles and solids that may damage equipment downstream of the waste source) or fine to remove smaller or noncolloidal particles

Suspended solids in the wastestream can be removed by gravity Depending on the particle's specific gravity, the material will either settle or float under the influence of gravity Gravity can remove the suspended materials in your wastestream The influence of gravity is used to remove grit, and occurs in sedimentation, coagulation and flotation processes

Solids Removal (continued)

Filtration

- cartridges and bags
- multi-media (ie sand)

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Gravity Settling
Grit Removal - WHY?

- Grit can damage equipment and collect in tanks and pipes
  - Fruit and Vegetable processing facilities (dirt)
  - Iron and Steel Industry (mill scale)
  - Grinding and polishing
  - precipitation by-product

Why remove grit??? Grit is inorganic solids with a settling velocity greater than that of organic solids and it should be removed from your wastewater Otherwise, the grit may damage your downstream equipment, or accumulate in process or treatment tanks and your pipes Large amounts of grit are generated at fruit and vegetable processors (dirt from washing produce) and the iron and steel industry (mill scale) Grinding and polishing operations generate grit

Diffused air can be used in the grit chamber to enhance removal Heavy particles settle and lighter organic particles are suspended by air and carried out With velocity controlled grit removal, a constant velocity is developed and designed in downstream channel and heavy grit settles However, lighter organic particles tend to resuspend

Gravity Separation
Grit Removal

- **Two methods of removal:**
  - Aeration
  - Velocity control
- **Rate of solids settling depends on:**
  - Size
  - Specific gravity of grit particle
  - Temperature of wastestream
  - concentration of suspended solids

Gravity Separation
Settling

- **Settling**
  - circular, rectangular, and inclined plate clarifiers
- **Considerations**
  - surface area of tank, detention time
  - tank depth, surface area over flow rate
  - settling velocity, weir overflow rate
  - shape, design and wind

Notes

The second type of gravity separation process used to remove solid materials is settling If the wastewater is held long enough, solids will naturally settle Design parameters for a sedimentation tank include surface area, detention time (time water will be held), tank depth, surface overflow rate and weir overflow rate Tanks can either be circular, rectangular or square shape

Solids Removal
Coagulation/Floculation

➢**Chemical Coagulation**

- promotes particle settling
- makes particles larger
- promotes flocculation
- dry feed and liquid feed systems

Chemicals can be added to enhance gravity separation Coagulant aids are added to the wastewater to promote flocculation Particles cling together and grow in size, making them heavier, and more amenable to settling by gravity Some chemicals can be dry feed, but most fed as liquid feed systems If dry, the chemicals are in solid form and converted to a solution or slurry before they are introduced into the wastewater

Types of Coalgulants

- Organic
  - Polyelectrolytes (low doses)
- Inorganic
  - alum, lime, ferric chloride
  - ferrous sulfide, sodium aluminate
- Natural
  - chiten (byproduct of shrimp and crap processing)
  - carrageen (seaweed)

Notes

Gravity separation can be enhanced with coagulatants and coagulant aids which promote flocculation such as iron, aluminum and calcium salts Coagulants aids also include long chain molecules with characteristics of polymers and electrolytes

When product reuse or recovery is desired, naturally derived coagulants are used These include Chiten, a byproduct of of shrimp and crab processing or carrageen, seaweed, are used when metal salts would affect the quality o the recovered product

An effective way to choose a coagulant or coagulant and the best conditions to use the coagulant is to conduct a jar

Rapid dispersal of the chemical agent throughout the waste stream is important to allow sufficient agitation and mix time This is facilitated by a mixer, followed by a slow mix area that promotes flocculation

Types of Flotation

- **Purpose**
  - cause particles to separate by floatation
- **gravity flotation**
- **dissolved air flotation (DAF)**

Floatable products in the food processing industry can be recovered and sent off for rendering

Solids Removal
Flotation

➢**Factors to consider**

- operating pressures, air to solids ratio
- float detention time, surface hydraulic loading
- percent recycle flow, flow rate
- suspended solids concentration
- particle specific gravity
- polymers

Notes

Flotation is a process in which light suspended solids are separated from the liquid phase Pilot testing is required to develop reliable criteria These criteria include operating pressures, air to solids ratio, float detention time, surface hydraulic loading, and percent recycle flow Depending on the size and type of of industry, an equalization process could be required Chemical coagulation can be used to promote flocculation

Two conventional methods of flotation are gravity flotation and dissolved air flotation Gravity flotation relies on light suspended solids to float to the surface and be skimmed off, such as grease (FOG)

Dissolved air flotation techniques are the same as is used in fats, oils, and grease removal DAF incorporates air bubles which either entrap or attach to particles, casing them to float to the surface for removal DAF is used in the food industry where rapid recovery of by products for rendering desired

Solids Removal
What is Filtration?

- Practiced downstream of other treatment processes
- Neutralization/precipitation systems
- Heavy metal removal
- Biological treatment systems
- Rreduce BOD levels

Notes

Filtration is used for suspended solids removal when low concentrations are desired Treatment occurs downstream of other treatment processes, more of a final step, prior to discharge Rarely is filtration used by itself, it is usually conducted with neutralization and precipitation systems for heavy metals removal and biological treatment to further reduce the oxygen demand exhibited by a wastestream

Types of Filtration

- Depth
  - Granular Media
  - straining
- Pre-coat Filtration
- Cartridges
- Bag Filters

Notes

Four types of filtration systems are used These include granular media filtration systems (depth filtration)and straining filtration systems Granular media filters use anthracite, sand or gravel for solids removal Straining filtration systems are used for wastewater with fine or gelatinous solids that require very fine filtration and frequent backwashing Filter media are coated with a porous material and filtered solids are backwashed off Other types of straining filters are disposable cartridge filters and disposable cartridges

Solids/Residuals Handling

- **Why?**
  - Allow solids to be removed for disposal (recycled)
  - Reduces sludge volume for disposal
- **Processes May Include:**
  - conditioning, thickening
  - stabilization, dewatering
  - heat drying, reduction

Notes

So you have removed the solids or most of the solids from the wastewater you generate Now you need to consider how to manage the solids that have been removed Commonly known as sludge, (a liquid/solid mixture), reducing the amount of liquid in the sludge will reduce the volume of waste you need to manage and in turn, the cost associated with disposal Sludge is reduced in volume by conditioning, thickening, stabilization, dewatering, heat drying, and reduction Not all may be required, it depends on the characteristics of the sludge generated and method of disposal

Solids processing and disposal can account for 50% of treatment costs

Solids/Residuals Handling

- **Conditioning**
  - add chemicals before thickening and dewatering
- **Thickening**
  - reduce volume before dewatering
    - gravity, DAF, centrifugation, gravity belt
- **Dewatering**
  - reduce moisture content
    - centrifugation, vacuum filtration, drying beds, filter presses, heat

Notes

most sludge requires some sort of conditioning prior to thickening and dewatering Conditioners cause the solids to separate from the water add volume of the solids being generated

Thickening processes are used to reduce solids volume before dewatering or disposal The better the thickener performs, the less amount of sludge that has to be dewatered A variety of thickeners can be used, including gravity thickeners, dissolved air flotation, centrifuges, and belt thickeners

Dewatering reduces the moisture content in the sludge Dewatering methods include centrifugation, vacuum, belt and pressure filtration, screw presses and drying beds Presses, specifically, recessed plate filter presses are used by industries generating sludges with metal contaminants Screw presses are used to dewater sludge generated by paper manufacturers Drying beds are used at industries who generate small quantities of sludge Climactic conditions may prevent the use of drying beds

Solids/Residuals Handling

➢**What to do with Thickened and Dewatered Solids?**

- Reuse
- Recycle
- Land Application
- Disposal

Notes

You've treated your wastewater and solids was produced You then thickened and dewatered the soilds to reduce the amount generated But there is still some left and it must be managed properly What do you do with it????

Sometimes the thickened and dewatered solids can be reused If the sludge contains high level of metals, a raw material for certain types of industries, the metals can be removed from the sludge and sold as a raw material Solids generated in the food processing industry can be mixed with wood chips or sawdust and allowed to decompose Composting the solids biological stabilization process, geneates heat, further reduces sludge volumes, and makes an excellent soil conditioner

Oily solids can be centrifuged and the recovered oil can be reused for fuel blending or further refining If generated from food processing, may be sold to a rendering facility If the solids generated is non-hazardous, it may be applied to land as a soil conditioner

Sometimes the coagulants used to enhance dewatering can be recovered for reuse Again, centrifugation aids in this method of reuse

BOD/COD-Definitions

- BOD
  - Biological oxygen demand is measured as oxygen demand resulting from aerobic bacteria and chemical reduction
- COD
  - Chemical oxygen demand is measured as equivalent oxygen demand by dichromate

BOD/COD-
Sources

- Fats, Oils and Grease
- Sugars
- Food Wastes
- Organic Acids
- Fatty Acids

BOD/COD Removal- WHY?

- Causes rivers, bays and oceans to experience oxygen depletion
- Reduced oxygen kills fish
- Organic materials must be stabilized

BOD/COD-
Types of Treatment

- Aerobic
  - oxidation
  - destruction
  - activated sludge/trickling filter
- Anaerobic
  - Decomposition
  - Reduction
  - Anerobic digestion

Fats, Oil and Grease (FOG)-Types

- Materials of vegetable, animal and mineral origin
- Present in water either as an emulsion or free floating

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Notes

Fats, oils and grease or FOG includes materials of vegetable, animal, and mineral (petroleum, hydrocarbon) origin and can be present in water either as an emulsion or free floating Fats are mixtures of triglycerides and are commonly found in both plants and animals and are components of our diet (lard and butter fat) Common oils, those which are edible, include palm, olive and soybean Grease includes fats, oils, waxes and soaps

Fats, Oil and Grease (FOG)-Sources

- Food Processing Industry
- Tanneries
- Metal Working Industry
- Petroleum Industry
- Organic Chemical Manufacturing
- Landfill Leachate
- Auto Manufacturing and Repair

Notes

Fats, Oil and Grease are introduced into the wastestream produced in a variety of processes at industrial facilities Such types of industries include food processing, metal working, and petroleum-related industries

Types of food processing includes

-vegetable oil refining, soap manufacturing, milk and dairy processing
-rendering

Metal Working Industry includes machining and rolling-- not metal plating

Although Fats, Oils, and greases are generated in these facilities, the fog produced varies according to the processes and raw materials used FOG generated in metal working plants is from cutting fluids (coolants, lubricants) and contains mineral oils derived from petroleum and coal FOG from the petroleum industry is generated from leaks and spills and the products of chemical treatment Fuels and tars (crude oils, diesel oils) may also be present in the waste generated from the petroleum industry

FOG Removal- Why?

- Obstruct flow in sewers (collection systems)
- Interfere with biological treatment
- Fire and explosion hazards
- Visible in effluent
- Odors

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Notes

When FOG is present in the wastewater you generate, it is necessary to remove the FOG prior to discharge to a receiving stream, the sanitary sewer, or other wastes generated at the facility Large FOG globules, if not removed, may obstruct flow in sewers or collection pipes at your facility If discharged to the sanitary sewer, the presence of petroleum oils may affect the aerobic treatment processes employed at the sewage treatment plant - related to the low rate of biodegradation of oils Similarly, high levels of petroleum oils can also present fire and explosion hazards in the sanitary sewer system or at your facility

FOG Removal

- **First Stage Treatment**
  - Floatable FOG removal
- **Second Stage Treatment**
  - Emulsified FOG removal

Notes

If generated, FOG can be removed by either first or second stage treatment As a general rule, FOG should be removed and recovered as close to the source generating the FOG to reduce the amount of waste to treat and size of the treatment unit To prevent emulsification of free FOG, reduce agitation of the wastestream

First stage treatment removes non-emulsified FOG Non-emulsified FOG may float to the surface and agglomerate and the FOG may be mechanically skimmed or lifted of the surface

Normally, gravity separation is inadequate and a coalesce device will be required

Emulsified FOG stays in suspension and is difficult to separate Second stage treatment must be employed to break the emulsions and remove emulsified FOG

First Stage Treatment - Floatable FOG Removal

Examples

- gravity separation
- oil interceptor
- grease trap
- coalescing separator
- chemically enhanced separation
- dissolved air floatation

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Notes

First stage treatment is used to separate floatable FOG from water and emulsified substances The simplest form of treatment is an oil interceptor or grease trap and is commonly used in restaurants and hotels preparing and serving food Interceptors or traps are installed downstream of the source producing waste prior to mixing with other wastes and should be placed in areas easily accessible for cleaning and maintenance Belt or tube type skimmers are used to remove floating

In some instances, gravity separation can be enhanced with coalescing media or the addition of chemicals The media should have a high affinity for oil and also ensure that it will not produce the recovered material to be unusable (if intended for animal or human consumption) Chemical treatment is employed to destroy any emulsified agents that are present which limit the amount of material to be recovered

Advanced Treatment
Emulsified FOG Removal

Examples

- Dissolved Air Flotation
- Destruction of the emulsion
- pH control
- Settling/Floatation
- Flitration (fatty acids)

Notes

When chemicals are used to destroy emulsified agents, the FOG is concentrated and can be removed by a physical process The most widely used is dissolved air flotation Air is added to the wastestream under pressure and the oil and solids present in the wastestream cling to the air charged stream and float to the surface where they are skimmed off

Centrifugation may be employed if the floc particles created with chemical treatment do not separate well Centrifuges are used if space at the facility is an issue but require more maintenance and energy than other types of separation techniques Wastestream containing FOG can also be filtered with the addition of coagulants (to create larger particles)

Biological treatment and ultrafiltration are two other treatment technologies that may be used to remove FOG Ultrafiltration, for the recovery of fatty acids or machine oils in metal working shops

FOG Recovery and Reuse

- Use in Animal Foods
- Refinery Feed Stock or Fuel
- Asphalt Manufacturing

Notes

Oil recovered by gravity floatation of industrial wastes from edible oil refiners, soap makers, and rendering plants can be salvaged and used in animal foods FOG from restaurants can be sold to rendering plants and purified to be used in animal foods or tallow

Recovered petroleum hydrocarbons can be used in refinery feed stock or for fuel Similarly, waste motor oil from vehicles can be sold to waste oil refiners

In addition to refineries, other types of industrial facilities can reuse recovered FOG

FOG Disposal

- Recycle
- Landfill
- Incineration

Notes

Disposal of FOG should be considered as a last resort Typically, treatment systems which use chemical addition to break emulsions generate sludge Once dewatered to reduce the volume of material requiring disposal, the FOG can be placed in a landfill Other FOG materials, preferably dry FOG from gravity separation technologies can be incinerated at low cost due to the heat value of the recovered FOG Sludge generated by chemical addition may not be incinerated due to metal or salt contents

Acid and Alkaline Wastes-Sources

- Acid
  - Plating
  - Pickling
  - Food processing
  - Metal working/plating
  - Leather tanning
  - Mining
- Alkaline
  - Chlorine generation
  - Scrubbers
  - Paint
  - Organics
  - Cleaning operations

Acid and Alkaline Removal-Why?

- Protect employees and operators
- Protect treatment plant and equipment
- Protect downstream operation
- Protect sewers/concrete (corrosion)
- Control the release of sulfides, cyanide (acid) and ammonia (base)

Acid and Alkaline Wastes- Types of Treatment

- Neutralization by pH adjustment
- Detention
  - alkalinity
  - acidity
  - buffering capacity
- Run Titration Curve

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Notes

When generating acid or alkaline wastes, common method of treatment is to neutralize the waste Roughly, this means bringing the solution to approximately 6-8 standard units However, limits will vary if discharging to the sewer or directly to a stream However, neutralizing a waste just does not mean adding acid to an alkaline waste nor adding caustics to acidic wastes One needs to determine the capacity of the waste solution to be neutralized

Controlling pH

- Wastewater flow rate
- Reactor/Mixing intensity
- Acidity and alkalinity
- Buffering capacity
- Neutralizing agent

Notes

Being able to control the pH of the waste generated depends upon a variety of factors Reiterate info in overhead If variations in flow rate, pH of wastes, or buffering capacity of the solutions to be neutralized exist, an equalization process upstream of neutralization process will decrease the effects of variability and enable the pH of the solution to be controlled

Controlling pH (continued)

- Type, strength, and application of agent
- Precision of required pH control
- System layout and variability in pH system
- Probe standardization (calibration)
- Probe design and placement

Neutralization

- **Acidity of Wastewater**
  - is a measure of its capacity to neutralize a strong base to a designated pH
- **Alkalinity of Wasetwater**
  - is a measure of its capacity to neutralize a strong acid to a designated pH
- **Buffering Capacity of Wastewater**
  - capacity of a solution to resist changes in pH

Notes

The acidity of a solution is it's capability to neutralize a strong base The alkalinity of a solution is it's ability to neutralize a strong acid In other words, strongly acidic solutions can neutralize strong basic solutions and vice versa However, it's not always that simple Treated solutions need to be able to withstand changes in pH and the ability of a solution to resist pH changes is termed the buffering capacity of the solution Such a resistance to changes in pH results from the presence of weak acids and their salts or weak bases and their salts Buffers can either be added as the solution is treated, be a product of the neutralization process or be added after the solution is neutralized The addition of a buffering agent to the wastestream may result in a more economical and controllable neutralization system

Neutralizing Agents

- **Neutralizing acidic wastes**
  - sodium carbonate
  - lime
- **Neutralizing alkaline wastes**
  - sulfuric acid
  - hydrochloric acid
  - carbon dioxide
  - flue gas

Selecting Neutralizing Compounds

- safety and overloading
- availability
- purpose
- pH required
- cost and dosage
- sludge generated
- equipment costs
- off gas consideration

Notes

When selecting neutralizing compounds, criteria should be considered These include the type of agent required, the unit cost of each chemical and required dose, equipment costs (tanks, mixers, pumps), the time required for the neutralization reaction to take place, and the amount of dissolved solids and sludge produced

One must also consider the type of neutralizing agent used and the potential hazards associated with the neutralizing agent chosen Precautions should be taken to reduce skin contact, eye contact and the amount of vapors that may be inhaled from reactions taking place With some neutralizing agents, pH excursions can occur if too much agent is used, so overdosing should be avoided Impacts on other facility treatment processes, as a result of overdosing, should also be a factor when considering a neutralizing agent Also consider the availability of the agent selected You don't want to choose a neutralizing agent that is not readily available

Solicit audience

Additional Considerations

- raw materials handling and safety
- process control
- annual cost
- side reactions and byproducts
- scale formation
- equipment and structural effects
- experience with handling

Notes

As you know, before you consider using neutralizing agents general guidelines should be followed when handling and using the agent you have chosen Always remember to wear appropriate personal protective equipment (PPE) when handling chemicals and consult the material safety data sheet to determine the attire to wear In addition, certain types of agents may affect the processes employed at your site Scale deposits form because of oversaturation conditions and may create problems in pipes, valves, mixers, etc Annual costs of neutralization systems are associated with chemical and equipment maintenance costs and savings should be realized with proper chemical dosages In the event production changes occur, side reactions may take place and these byproducts may effect the treatment system Monitor your system for the production of insoluble and soluble salts, gases, and changes in the quality of effluent generated

Heavy Metals-
Sources

- Automotive Industry
- Pharmaceuticals and Cosmetics
- Printing Industry
- Tanneries
- Electronics
- Corrosion
- Plating
- Film Manufacturing
- Mining
- Textiles
- Pulp and Paper
- Petroleum Refining
- Organic Chemicals
- Plastics
- Photo Labs
- Hospitals/Dental

Notes

As shown in the slide, heavy metals are present in a variety of wastestreams generated from numerous different types of industries (reiterate info in overhead) Such metals commonly found in wastewater from these industries include copper, cadmium, lead, mercury, nickel, selenium, silver and zinc While it is true that metals are an important part of our diet and our body needs certain levels of some of these metals for good health, the presence of these metals in our foods or water at certain concentrations is hazardous to our health Therefore, they must be removed from the wastewater you generate Aside from health reasons, their presence, without removal, can damage your facility infrastructure or the product you produce

Heavy Metals-
Control/Minimization

- Process modifications to eliminate metals
- Improve segregation
- Improve product
- Reduce dragout of contaminated process water

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Notes

O K , so you've generated a wastestream that has metals present and you wish to treat the discharge Before considering a treatment technology, have you considered modifications to your process that will minimize the quantity of waste to be treated or decrease the amount of metals present in the waste that must be treated? Have you considered reducing the amount of chemicals/metals you use or installing a closed loop system? Why Not?? These are important concepts to consider before you embark on installing a treatment technology Considering these two ideas before you purchase a treatment system can save you time and money

Heavy Metals Removal- Process Modifications

Reduce water usage

- Inspection program
- Counter-current rinses
- Spray rinses
- Flow restrictors
- Reuse contaminated rinse waters
- Practice dry clean up methods
- Automatic close nozzles on all hoses

Notes

As shown, there are a variety of ways to reduce the amount of water you use and in turn, the amount of water that must be treated Simple methods of reducing water usage at your site may include adopting an inspection program to check for leaks, using counterflow rinses or spray rinses, and reusing contaminated rinse water for rinsing operations that do not require "cleaner" water Better yet, if possible, don't use water when cleaning If dry methods are available, adopt them and you'll see a change in the amount of water you use

Example - Lockheed Martin- aeronautical space - used etching process rinses, regenerate a etching process, final rinse tank, cost of installation was $59K, reduced treatment costs by $68K, sludge costs by $75K

Also, Lockheed monitored solution (rinse) disposal, thus extending life of solution, better inspection program, saved $33k a year in wastewater treatment and disposal costs

Heavy Metals Removal- Reduce Water/Chemical Usage

- Inspection program
- Recycle rinse water
- Reuse spent solutions for other processes
- Use only minimum amount of chemicals needed
- Recovery systems

Notes

As stated earlier, another way to reduce the amount of waste you generate is to reduce the amount of chemicals you use in your processes Implementing an inspection program that focuses on maintenance will reduce the amount of chemicals you use for maintenance purposes - use only what you need when you need to Reusing rinse waters or spent solutions re-supply the chemicals that you used for another process This will save you money Installing a recovery system to reclaim chemicals from rinse waters is another effective way to reduce chemical usage

Heavy Metals Removal- Closed Loop System

- Evaporation
- Reverse Osmosis
- Electrodialysis
- Electrolytic Recovery
- Ion Exchange

Appropriate for difficult or expensive wastes to treat

Notes

Closed Loop systems is a third way to reduce the waste generated that must be treated before discharge And such systems may be appropriate for wastes that are difficult or expensive to treat These systems include (reiterate info in overhead) Prior to purchasing such a system, conduct a cost analysis of each option This will aid in selecting the most appropriate process modification for your operation Consider the capital and operating costs and compare them to the total benefits realized from reducing raw material losses, wastewater treatment capacity, and sludge disposal fees Then you are ready to make the right decision

Closed loop systems are commonly used by facilities to recover expensive process solutions such as gold plating baths

Heavy Metals Removal-Treatment Technologies

- Precipitation/Coagulation
- Membrane Processes
- Ion Exchange
- Evaporation
- Adsorption

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Notes

So you've considered all process modifications and adopted quite a few You've reduced the amount of chemicals you use and the waste you generate Some of you may have installed a closed-loop system and no longer have any wastes that require treatment Congratulations to you, but still pay attention with those that are less fortunate You may need some of this information as your company grows and operation change

Don't despair if you still have a wastestream requiring treatment before discharge There are many technologies that can meet your needs Some common technologies employed to remove metals from wastewater include (reiterate info in overhead) We'll talk about each of these in the slides to follow

Heavy Metals Removal-Precipitation/Coagulation

- Typically, Metals are Dissolved in Acidic Conditions
- Precipitate under Alkaline Conditions
- The specific pH at which a metal is least soluble depends on other components in the solution
- Coagulation to aid in settling
- Complexation makes removal difficult

Notes

The conventional method of removing heavy metals from solution is chemical precipitation of the metal as a hydroxide followed by coagulation of the metal particles into a larger particle which separates from the wastestream Typically, the metals in your wastewater will be in a dissolved state if the water is acidic Raising the pH of the wastestream will precipitate the metals out of solution However, metals may redissolve at high pH conditions and the pH at which a particular metal is least soluble (most likely to precipitate) is characteristic of the metal and your solution (temperature, other components in solution) Therefore, laboratory experimentation is necessary to determine the pH at which most metals are least soluble When the optimum overall pH is determined, metal hydroxides will precipitate and coagulants are added to increase the particle size and enhance settling

Heavy Metals Removal-Precipitation/Coagulation

- **Lime precipitation**
  - common but not always effective
- **Sulfide precipitation**
  - used if complexing agents are present
  - more care (excess sulfides in in alkaline solution will form hydogen sulfide, a toxic gas)
- **Carbonate precipitation**
  - not as effective but simpler system
  - adds buffering capacity

NotesB

Although the conventional method of removing heavy metals is the chemical precipitation of the metal as a hydroxide, using lime as a precipitate, when low metal concentrations are required or if the metals are complexed with chelating agents (cyanide, ammonia) sulfide or carbonate precipitation may be an alternative form of treatment In general, metals have lower solubilities as sulfides than as hydroxides, particularly in the neutral and alkaline pH ranges

In addition metal hydroxides tend to redissolve as pH increases, while metal sulfides continue to precipitate with increasing pH Carbonate precipitation is not as effective at removing metals from solution but does have advantages - metals can be precipitated while holding the pH with a narrow range (simpler control system) and it adds buffering capacity to your treated solution

Heavy Metals Removal- Ion Exchange

- **Concept**
  - Exchange of selected ions in solution for ions of less impact on resin
- **Reality**
  - Effectively removes metals but initial cost and O&M requirements make it more applicable to certain types of situations and wastestreams
  - not sufficiently selective to be cost effective

Notes

As state earlier, other treatment technologies can be used to remove metals from your wastewater Although ion exchange, adsorption and membrane processes can be used at end-of-pipe, it is more economical to use these treatment systems in-line

Ion exchange systems exchange desirable ions from the resin for undesirable ions of similar electrostatic charge dissolved in wastewater It's a very effective technique for metals removal but it has its disadvantages- high initial cost and high O & M costs

Ion exchange is used in metal finishing facilities and the effluent can be used as rinse water in other manufacturing lines Photolabs also use ion exchange to recover silver from the waste solutions

Heavy Metals Removal-Adsorption

➤Adhesion of dissolved particles to the surface of solid particles

- activated carbon
- soluble sorbent clarification

Notes

Adsorption is the adhesion of dissolved substances to the surface of solid particles One technology utilizing adsorption is activated carbon While successful for the removal of organic substances, its application for metals removal is relatively recent Wastewater is usually pretreated by sedimentation or filtration to remove precipitated metals The dissolved metals that remain in the solution are passed through activated carbon and the dissolved metals adhere to the carbon When all available sites in the carbon column are exhausted, the spent carbon must be replaced or regenerated

Soluble sorbent clarification uses a specific chemical sorbent that is soluble at low pH and insoluble at high pH The pH of the wastewater containing the dissolved sorbent is increased to precipitate hydroxides At the higher pH, the remaining dissolved metals adsorb to the now insoluble sorbent, causing it to settle with the hydroxides

Heavy Metals Removal-Membrane Processes

- Ultrafiltration
- Reverse Osmosis
- Electrodialysis

Notes

Ultrafiltration requires pumping energy to force liquid through a membrane Large particles are retained and concentrated in the liquid portion that does not pass through the membrane

Reverse osmosis concentrates dissolved materials from dilute solutions and the large metallic ions do not pass through the membrane Like ultrafiltration, reverse osmosis requires pumping energy to force the liquid through the membrane from the lesser to the more concentrated solution The pressure must overcome the osmotic pressure between the solutions

Electrodialysis, the third type of membrane process treatment technology makes use of the inabilty of some chemicals to pass through a charged membrane Direct current electricity is applied to the wastewater and the charged impurities move through positive and negative membranes that remove the ionic impurites from the water

Heavy Metals Removal-Evaporation

- Recover useful byproducts from solution
- Concentrate wastes before additional treatment

Notes

During evaporation, a solution is concentrated when a portion of the solvent (water) is vaporized, leaving a concentrated liquor that contains all the dissolved solids Evaporation may be carried out naturally (weather permitting) or via mechanical evaporators Air quality considerations must be considered

Nutrient Types

- Phosphorus
- Nitrogen

Notes

The term nutrients, for the purposes of this discussion, pertains to phosphorus and nitrogen compounds A common treatment technique for phosphorus removal is precipitation For nitrogen removal, ion exchange systems, ammonia stripping, biological oxidation, reduction, and breakpoint chlorination have been utilized with limited success and a high cost But we'll talk about these more later in our discussion

Nutrient Sources

- **Phosphorus**
  - human waste
  - household detergent
  - fertilizer
- **Nitrogen**
  - human waste
  - fertilizers
  - rendering

food processing

ammonia

Nutrient Removal- WHY?

- **Phosphorus**
  - may form precipitates which require additional maintenance
- **Nitrogen**
  - under specific pH and temperature conditions, ammonia may form, which is toxic effect on water organisms
  - create algae blooms in receiving streams which deplete oxygen supply in water

Notes

Phosphorus and nitrogen may need to be removed from the wastewater you generate High levels of phosphorus may react with other compounds in the wastewater and form precipitates Although not typically harmful, the precipitates will have to be removed from your treatment systems or facility process lines This additional maintenance wastes resources Nitrogen on the other hand could pose toxic effects to water quality if in the form of ammonia Also, increased nitrogen levels in receiving streams promotes the formation of algae Algae, an organism utilizes oxygen and may deplete the dissolved oxygen in a receiving stream Lack of oxygen in the water does not permit other aquatic species to thrive and survive

Nutrients Removal-Phosphorus

- Coagulation
- Precipitation
  - iron
  - calcium
  - aluminum

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Notes

Coagulation and precipitation typically offers the most practical method of phosphorus removal However, chemical addition produces large quantities of sludge But you'll learn how to reduce the sludge you generate later in our training seminar

Depending upon the nature of waste generated and the temperature and pH of wastewater requiring phosphorus removal, different types and quantities of chemicals are used Three cations are used for precipitation to occur These include iron, aluminum, and calcium

Nutrients Removal-Nitrogen

- Complex and Costly
- Byproducts may cause air pollution
- Typically three forms of nitrogen requiring Treatment
  - ammonia
  - nitrate
  - organic nitrogen

Notes

Treatment for removal of nitrogen compounds is complex and costly Byproducts that may be released could cause air pollution problems because of ammonia released to the atmosphere or alkaline solution condensation deposits in the immediately surrounding area

Salt or chemical brines generated from the treatment process require elaborate disposal techniques Investigate the treatment processes that are proposed and if possible, reuse any byproducts that may be generated

Nitrogen occurs in three forms that may require treatment - ammonia, nitrate and organic nitrogen Since organic nitrogen may be converted to ammonia, we will limit our discussion of nitrogen removal to only ammonia and nitrate

Nutrients Removal

- **Nitrogen - Ammonia**
  - air or steam stripping
  - ion exchange
  - breakpoint chlorination
  - biological oxidation
  - pH adjustment to reduce toxicity
- **Nitrogen - Nitrate**
  - biological denitrification
  - ion exchange

Notes

Ammonia can be removed from your wastewater via three common treatment technologies These include air or stream stripping, ion exchange, and breakpoint chlorination

Each type of technologies has its advantages and disadvantages both in economics and environmental considerations Consider all three and research the pros and cons associated with each before installing a system to remove ammonia from your wastewater

Nutrients Removal

- Nitrogen - Organic Nitrogen
- Anerobic digestion
- Evaporation
- Sulfuric acid digestion

Toxic Organics
Types

- Solvents
  - alcohols
  - chlorinated
  - hydrocarbons
  - ketones

Toxic Organics-
Types (cont)

- Oils/PCBs
- Plasticides
- Pesticides
- Phenols
- Gycols

Toxic Organics-
Sources

- Cleaning
- Degreasing
- Cutting
- Industries
  - metal finishing electronics
  - plastics pesticides
- Segregation is critical
- Product substitution

Toxic Organics Removal- WHY?

- Health issues
- Environmental concerns
- Safety/Fire
- Odor
- Toxicity

Toxic Organics- Types of Treatment

- Volatiles
  - air stripping
  - carbon adsorption
  - steam stripping
- Semi Volatile
  - steam stripping
  - carbon adsorption

Toxic Organics- Types of Treatment (cont)

- **Pesticides/Phenolics**
  - oxidation
  - carbon adsorption
- **Gycols**
  - distillation

Implementing an Industrial Effluent Management Program

Presented by

The Water Environment Federation(WEF)

and

The California Water Environment Association(CWEA)

Elements of an Effective Effluent Management Program

- Planning and Organization
- Assessment
- Feasibility Analysis
- Implementation
- Monitoring, Feedback and Modification

Action Plan Form

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Notes

An Action Plan will break down a task into smaller manageable steps

It is important to not put too many things into one step To keep momentum moving forward in the implementation process it is important to be able to check items off as completed and celebrate successes

Each of these steps will then have corresponding items, for example

Who is responsible?

What is the goal?

How will you know (verify) if the item is done - what is the measure?

When (date) should it be completed?

Elements of an Effective Effluent Management Program - Element 4

Implementation

- Create Action Plans for
  - Operations and procedures
  - Maintenance
  - Training
  - Promotion
  - Installation of equipment
  - Monitoring and evaluation plan

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Notes

To help illustrate what might be included in a detailed Action Plan we will use some of these examples listed on the overhead

Many people might be tempted to think that each of these items are examples of the steps that might be listed on an Action Plan However each of these these items are to big and complex At a minimum, each of these items should have their own actions plan

For example, if several changes Effluent Management changes are being implemented in an industry, each change will have its own set of steps for the Operations and Procedures section Or for training, there may be several different groups within the industry that will need to be trained differently Each will need their own set of Action plans

Don't forget that even before any of these "implementation" items, you may need to develop an Action Plan for finding more information on a type of equipment or procedure being considered for change Rather than just assuming it will happen you should still have a plan that will outline who, how, and when, to know that you will be making the best decisions

Speaker Note

Use one of the alternatives off of one of the groups priority list and demonstrate how that priority might be broken down into several actions plans or several steps

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Elements of an Effective Effluent Management Program - Element 5

Monitoring, Evaluation & Modification

- Establish program evaluation criteria
- Set up appropriate system feedback mechanisms
- Perform modifications to the program
- Implement a master schedule to monitor, evaluate, and correct the program as needed

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Note

Refer to overhead

Why is Monitoring Important?

- Measures the efficacy of a given effluent management method or technology
- Allows the periodic examination of both the quantity and quality of all wastes generated
- Helps in assessing whether or not a program is operating in a cost effective manner
- Allows a mechanism for correcting or improving even the most practical effluent management program

Note

Refer to overhead

Program Evaluation Criteria Should Include:

- A measurement of the program's reduction in the quantities of waste generated
  - Measured both before and after the Program being implemented
- A ratio of waste to production rate
  - Measured both before and after the Program being implemented
- A program's effect on the companies costs and savings

Note

Refer to overhead

What Kind of Data and Tracking System Should be Used?

- Depends on the size and formality of the company
- Should be as simple as possible
- Data should be gathered in a systematic and clearly documented manner
- Must be able to gather <u>all</u> necessary data

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Note

Refer to overhead

Evaluation Systems Should:

- Perform on-going material balance analyses
  - Become more simplified and accurate as more are completed
- Reflect any changing financial considerations
  - Cost and savings
- Gather data that may be easily obtainable by and from the relevant personnel
  - Formal and informal

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Note

Refer to overhead

Verify Results

Benefits and effects of an effluent Management program can only be evaluated if measurables are used throughout the process

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Notes

To know the success of effluent management changes an organization must have baseline data to begin so they may compare after implementation

This need not be a separate step as much of this information will have been gathered in preparing for an assessment and in conducting a mass balance However, if only guesses, rather than real data are use, it will be impossible to quantify the real benefits

Program Modification

- On-going process
- Reasons for modifications include
  - Benefits realized from earlier implementations
  - Changes in financial considerations
  - Environmental regulations
  - New technologies
  - A change in product line or product formulation
  - Market demands

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Notes

The fact that this is an on-going process can not be stressed enough And hopefully the reasons will be obvious

However, human nature does not often adapt to change so readily Just as there has been an action plan for the other phases of implementation so should there be one for the on-going review and enhancement of your effluent management system

Some reasons for modification are listed on the overhead Also remember that in the prioritization process you probably narrowed down the choices that you were going to implement to get started You may still have many very good options that have not been implemented for one reason or another

However you should not just restrict yourself to those idea already brought forward The initial changes may have created an whole new set of opportunities

Celebrate Successes !!!!!

- Reward employee input
- Publicize achievements
- Promote through marketing strategies
- Participate in awards programs

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Notes

As benefits and successes of your Effluent Management process are obtained don't forget to celebrate Another reason to have small quatifiable steps in your action plans

Celebrating can take many forms but the important concept is that as people within and outside of the organization are made aware of the positive steps that the organization is making, they should feel good about what is happening so they will be supportive and encouraging of future advances

Throughout the course we have discussed how important the employees are to the success of a program Reward them for their input It may be monetary or take other forms such as awards, recognition among their peers, time off, etc

Publicize you r success, both internally and when appropriate externally

You may find that you may want to include you successes in you marketing an outreach strategies

Participate in awards programs of governments or other organizations or of they don't exist encourage them to develop them