ECH 4102

ENVIRONMENTAL HEALTH ENGINEERING

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WATER POLLUTION

1. WASTEWATER CHARACTERISTICS
2. WATER BODY POLLUTION
3. SOURCES OF POLLUTION
4. WASTEWATER TREATMENT
5. SLUDGE TREATMENT & DUMPING
6. EFFECT TO HEALTH & ENVIRONMENT
7. GOVERNMENT & PUBLIC ROLE

Learning Outcomes

1. *Explain characteristics of water pollutant*
2. *Apply and choose best methods in wastewater treatment*
3. *Plan treatment and sewage disposal*
4. *Analyze and generalize government and public roles in wastewater control*

WHAT IS WASTEWATER?

- wastewater is sewage, stormwater and water that has been used for various purposes around community.
- unless properly treated, can harm public health & environment.
- generated by most communities from residential & nonresidential

RESIDENTIAL WASTEWATER

- *SEWAGE – generated from every room at home, not only from toilet!*

- *VARIES REGIONALLY AND FROM HOME TO HOME DEPENDS ON NO. & TYPE OF WATER-USING FIXTURES & APPLIANCES, NO. OCCUPANTS, AGES, HABITS.*

- *SHARES SIMILAR OVERALL CHARACTERISTICS*

RESIDENTIAL WASTEWATER

- 2 TYPES OF DOMESTIC SEWAGE:

BLACKWATER – FROM TOILETS.
GRAYWATER – FROM OTHER SOURCES

- DIFFERENT CHARACTERISTICS BUT BOTH CONTAIN POLLUTANTS & DISEASE-CAUSING AGENTS

- REQUIRE TREATMENT

NONRESIDENTIAL WASTEWATER

- generated by such diverse sources (e.g. offices, stores, industrial entities, hospitals, etc.)
- stormwater – carries trash, pollutants from streets, pesticides & fertilizers from yards
- thus, different wastewater characterstics – communities need to assess each source individually or compare similar types of sources to ensure adequate treatment provided

WHAT IS IN WASTEWATER?

1) ORGANISMS – some essential contributors to treatment. variety of bacteria, protozoa & worms work to break down certain carbon-based pollutants by consuming them, turning wastes into CO_2, H_2O or new cell growth

2) PATHOGEN – Disease-causing viruses, parasites and bacteria, oroginate from people & animals (infected with or carriers of disease)

3) ORGANIC MATTER – Composed of carbon-based chemicals, combination of C, H_2, O_2, N_2 & other elements, originate from plants, animals or synthetic organic compounds. Many organics are protein, carbohydrates or fats – biodegradable; large biodegradable materials - more dissolved O_2 required by organisms to break down wastes; reduce O_2 supply needed by aquatic life

WHAT IS IN WASTEWATER ?

4) **OIL & GREASE** – fatty organic materials from animals, vegetables, and petroleum – not quickly broken down by bacteria, cause pollution in receiving environment. When discharge, increase BOD, may float to surface causing unpleasing condition, also trap trash, plants, causing foul odors and attracting flies and mosquitoes.

5) **INORGANICS** - minerals, metals & compounds are relatively stable; hard to be broken down. Large amounts can contaminate soil and water, some are toxic to animal and human, and accumulate in environment.

WHAT IS IN WASTEWATER ?

6) NUTRIENTS – nitrogen & phosphorus in form nitrate and phosphate in wastewater; promote plant growth. excess nutrients, cause algae & other plant to grow quickly, depleting O_2 supply in water, aquatic life die,emiting foul odors. Also has been linked to ocean "red tides" that poison fish and cause illness in human. 'N' in drinking water may contribute to miscarriages, cause serious illness in infants called methemoglobinemia or "blue baby syndrome"

7) SOLIDS – can consist of organic and/or inorganic materials & organisms. When discharge, increase BOD and provide places for microorganisms to escape disinfection. Also can clog soil absorption fields

WHAT IS IN WASTEWATER ?

- SETTEABLE SOLIDS – certain substances such as sand, grit, & heavier organic/inorganic materials settle out from the rest of wastewater stream during preliminary treatment stage. organic materials (on the bottom of tanks/ponds) – biologically active sludge; require treatment
- SUSPENDEND SOLIDS – materials that resist settling, may remain suspended in wastewater. must be treated, or will clog soil absorption systems, or reduce effectiveness of disinfection systems
- DISSOLVED SOLIDS – small particles of wastewater materials can dissolve like salt. some are consumed by microorganisms, & some like heavy metals difficult to remove by conventional treatment – adverse effect on environment

WHAT IS IN WASTEWATER ?

8) GASES – certain can cause odors, affect treatment or potentially dangerous.

EXAMPLES:

- CH_4 GAS – byproduct of anaerobic biological treatment, highly combustible. require special precaution near septic tank or areas where wastewater gases can collect
- HYDROGEN SULFIDE & AMMONIA GASES – toxic and pose asphyxiation hazards, strong odor
- DISSOLVED AMMONIA GAS IN WASTEWATER – dangerous to fish, strong odor

OTHER CHARACTERISTICS

SYSTEM DESIGNERS & OPERATORS REQUIRE TO EVALUATE WASTEWATER:

- COLOR, ODOR & TURBIDITY – clues on amount & types of pollutants present, treatment necessary

- OTHERS THAT CAN EFFECT PUBLIC HEALTH AND ENVIRONMENT, DESIGN, COST & EFFECTIVENESS OF TREATMENT

➢ TEMPERATURE – standard 77 – 95°F; biological treatment activity accelerates in warm T, slows in cool T. hot water (byproduct from manufacturing processes – pollutant; disrupt natural balance of aquatic life

OTHER CHARACTERISTICS

- PH – standard 6 – 9 to protect organisms. Too acidity or alkalinity – affect treatment & environment

- FLOW – system must able to handle fluctuation in quantity and quality of wastewater it receives to ensure proper treatment

WATER POLLUTION

- ANYTHING IN WATER THAT IS NOT WATER
- COMES FROM:
  - INDUSTRY
  - DOMESTIC UNITS
  - AGRICULTURE
  - NATURAL SOURCES

WATER POLLUTION

FROM INDUSTRY:

- Industrial plants release water into air, onto land and into water
- Form industrial waste
  - Chemical – organic or inorganic (e.g. Hg)
  - Physical (heat)
  - Microbes – borne by employees

WATER POLLUTION

FROM DOMESTIC:

- Constitutes big portion of water pollution
- Consists kitchen & bathroom waste from:
  - Homes, schools, hospitals, nursing homes
  - & Other places where people live, work & travel

WATER POLLUTION

FROM AGRICULTURE:

- Major sources: pesticides, herbicides & fertilizers
- Washes these compounds into streams, rivers, lakes & ocean
- Difficult to control – nonpoint pollution
- Other example: livestock drinking, urinating & defecating in ponds, lakes & streams

WATER POLLUTION

FROM NATURAL POLLUTION:

- Volcanic ash
- Dust storms
- Trees
- Decomposing vegetation
- Eroded soil

WATER POLLUTION

- Every state in the U.S. has a law stating that human excrement (waste) must be disposed of in a sanitary manner
- Reasons:
  - Pollution of surface water
  - Pollution of groundwater
  - Hookworm infestation – using human waste as fertilizer on vegetables & other food
- Also – to prevent waste from being accessible to insects capable of transmitting disease

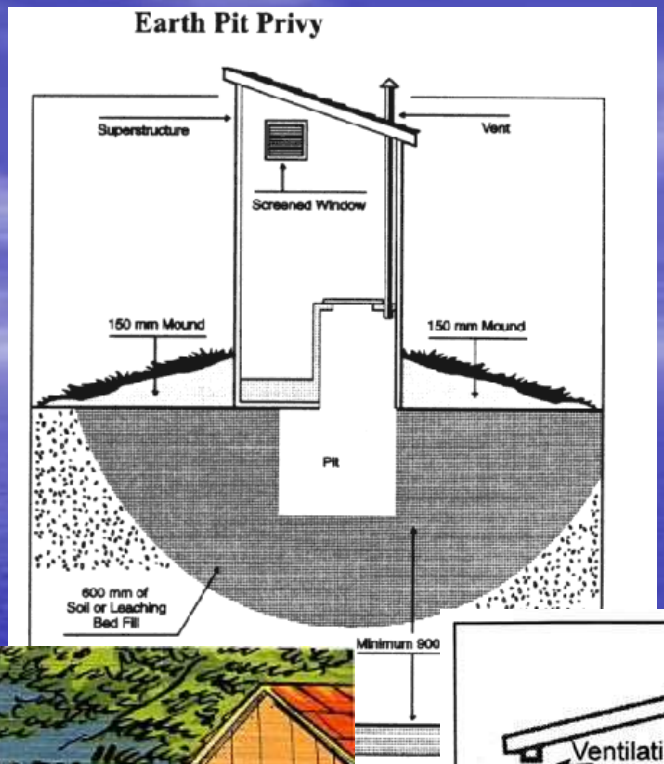
WATER POLLUTION

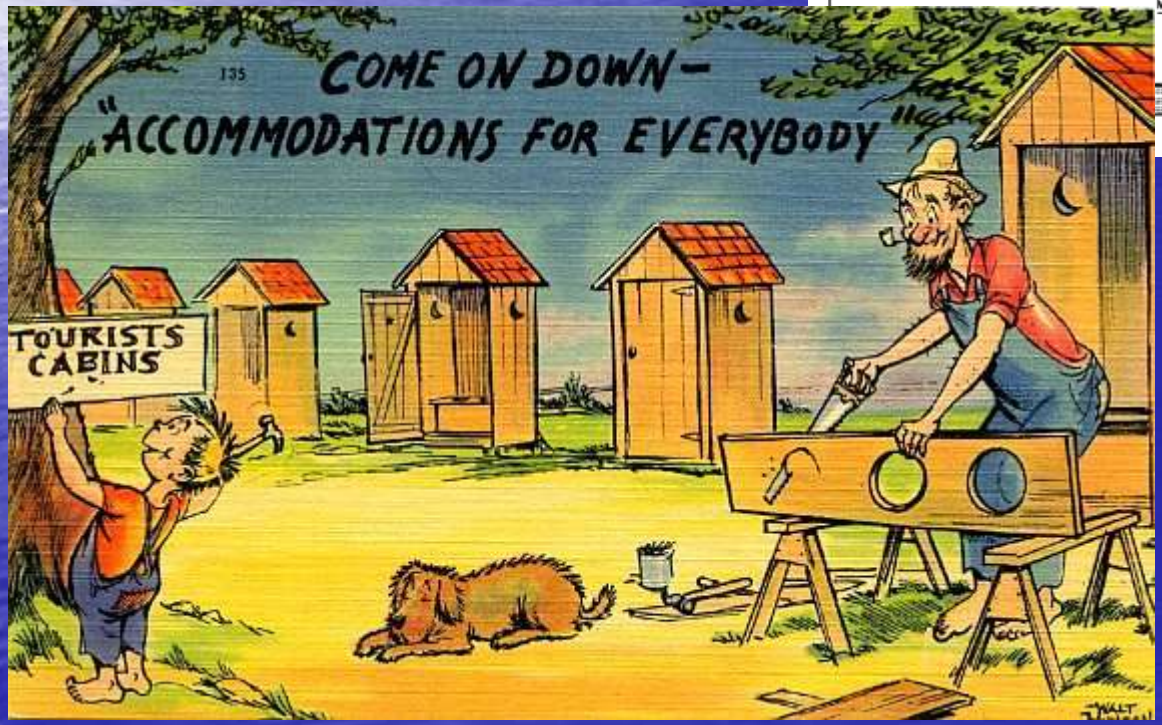
- WASTEWATER DISPOSAL – 2 MAIN TYPES
  - NON-WATER-CARRIED
  - WATER-CARRIED - DIFFERENT
    - Individual systems
    - Municipal systems

WATER POLLUTION

NON-WATER-CARRIED

- In many underdeveloped nations or areas – not equipped with indoor plumbing
- Means – no water entering, no water available to flush human waste away towards treatment
- Best example – pit privy or pit latrine
- Objective – to construct an underground area where urine & feces can be deposited & retained in a sanitary manner





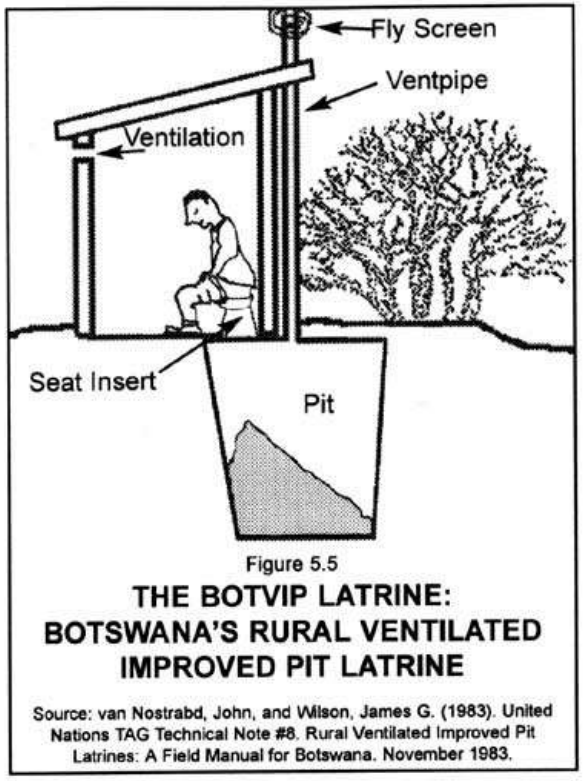


Figure 5.5

THE BOTVIP LATRINE: BOTSWANA'S RURAL VENTILATED IMPROVED PIT LATRINE

Source: van Nostrabd, John, and Wilson, James G. (1983). United Nations TAG Technical Note #8. Rural Ventilated Improved Pit Latrines: A Field Manual for Botswana. November 1983.

WATER POLLUTION

NON-WATER-CARRIED (CONT.)

- Means – pit area is sufficiently above any water table, provides a self-closing door & screens any openings, such as vents (won't allow flies, insects, etc.)
- Thus – waste is deposited directly into pit
- If & when pit becomes full, building house can be relocated to a new pit
- Old pit must be covered ~ 18 in of earth

WATER POLLUTION

NON-WATER-CARRIED (CONT.)

- Another type – box & can
- Commonly found on buses, trains, airplanes, construction sites
- 'People's waste must be contained until it can be removed for treatment'
- Often termed – portable toilets
- Have a self-contained, above-ground chamber to collect urine & feces
- Liquid chemical often is added – reduce odors, break down waste & serve as disinfectant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www.CartoonStock.com
SUPERLOO
VACANT
I'D GIVE IT TEN MINUTES IF I WERE YOU
ENGAGED
search ID: ada0016

WATER POLLUTION

INDIVIDUAL WATER-CARRIED SYSTEMS

- Where no central sewage disposal system is provided
- Called – water-carried subsurface sewage disposal system
  - Septic tank & drainfield system
- Function – to remove as many solids as possible from wastewater & filter waste through soil
- Many cases – plants draw wastewater from soil by transpiration
- Or soil's capillary action pulls it to surface to evaporate –evapotranspiration

WATER POLLUTION

INDIVIDUAL WATER-CARRIED SYSTEMS

1. SOIL EVALUATION

- CRITICAL CONCERN – Soil's capacity to absorb wastewater
- HEALTH DEPARTMENT ENVIRONMENTALIST / SANITARIAN OR SOIL SCIENTIST – Evaluate soil for appropriateness by use:
    1. A percolation test
    2. Soil maps and/or
    3. Soil color & texture evaluation

WATER POLLUTION

INDIVIDUAL WATER-CARRIED SYSTEMS

2. SEPTIC TANK SYSTEM

- From a plumbing fixture (kitchen sink), water drains through a u-trap (also called p-trap)
- Function – collect water, forming a barrier against gases backing up into house from sewer system
- From u-trap, flow continues through pipe out of house into house sewer line
- From sewer line, flow continues directly into underground septic tank

WATER POLLUTION

INDIVIDUAL WATER-CARRIED SYSTEMS

2. SEPTIC TANK SYSTEM (CONT.)

- As enters septic tank, influent is diverted downward by an inlet tee
- Serve 2 functions
  - Divert solid in wastewater towards bottom of septic tank
  - Allows gases to back up into household sewer line and exit through vent
- Vent – located on house's roof – helps wastewater flow freely through plumbing

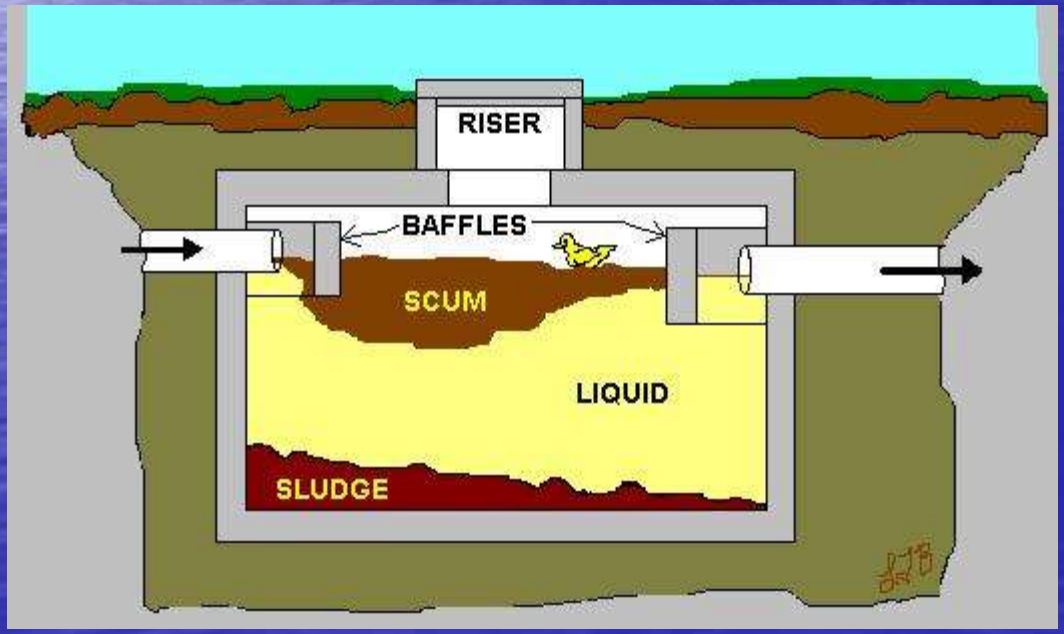
WATER POLLUTION

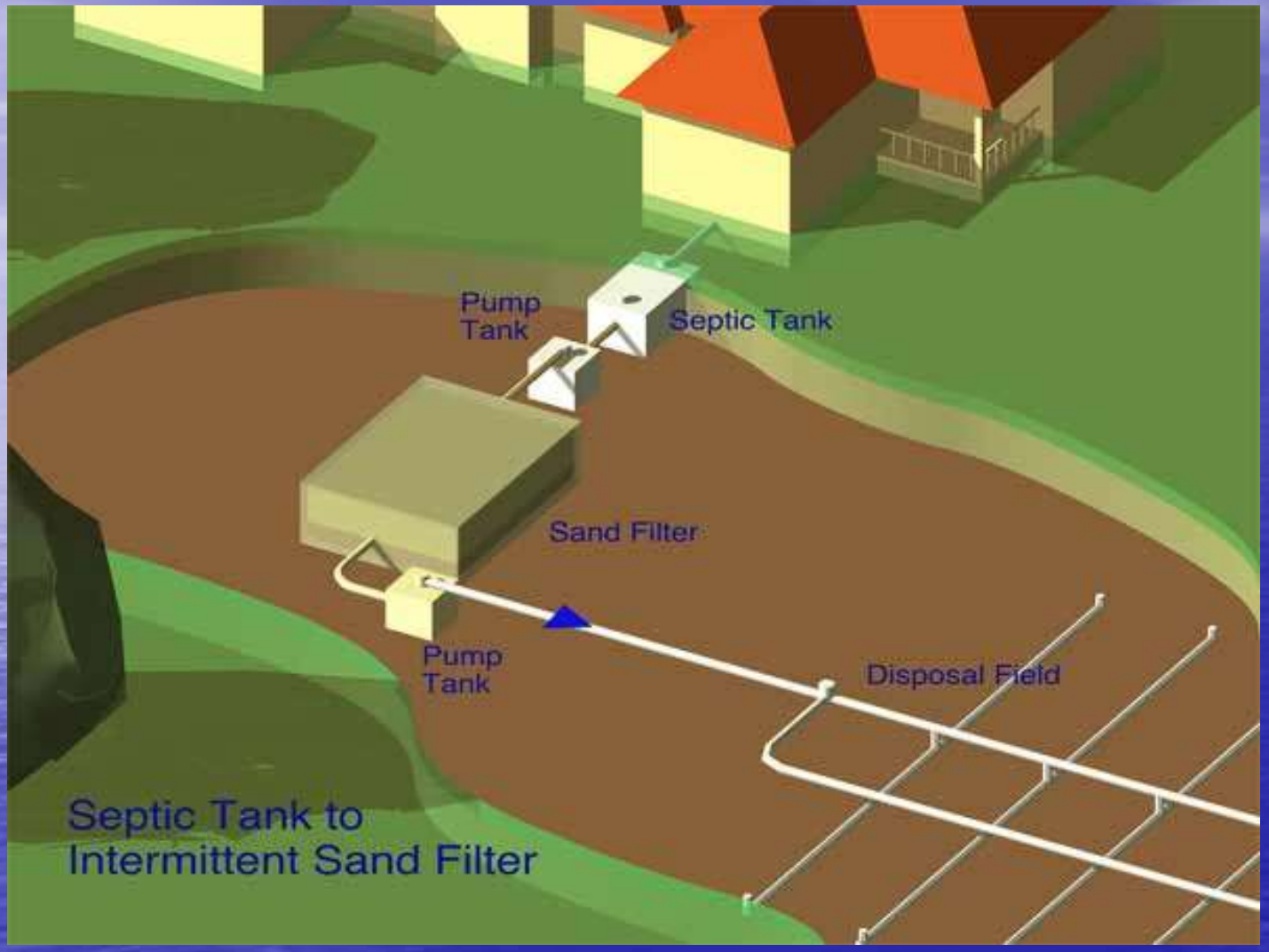
INDIVIDUAL WATER-CARRIED SYSTEMS

2. SEPTIC TANK SYSTEM (CONT.)

- Functions of septic tank
  1. A settling basin for removal of solids as sludge
  2. Stores settled sludge and scum until waste can be removed mechanically
  3. Provides a chamber for biological decomposition


Kitchen
Toilet
Fence/ Wall
Inspection Chamber
Sludge
Filter
Drain


RISER
BAFFLES
SCUM
LIQUID
SLUDGE


Pump
Tank
Septic Tank
Sand Filter
Pump
Tank
Disposal Field
Septic Tank to
Intermittent Sand Filter

WATER POLLUTION

MUNICIPAL WASTEWATER TREATMENT

- PHYSICAL, CHEMICAL & BIOLOGICAL TREATMENT PROCESSES
- WILL BE DISCUSSED LATER

POLLUTION OF WATER ORGANISATIONS

- OCCURS WHEN WATER IS ADVERSELY AFFECTED BY ADDITION OF LARGE AMOUNTS OF MATERIALS

- SOURCES CAN BE CATEGORIZED AS:

➢ POINT SOURCES – When polluting substance emitted directly to waterway

➢ NON-POINT SOURCES – When a runoff of pollutants into waterway

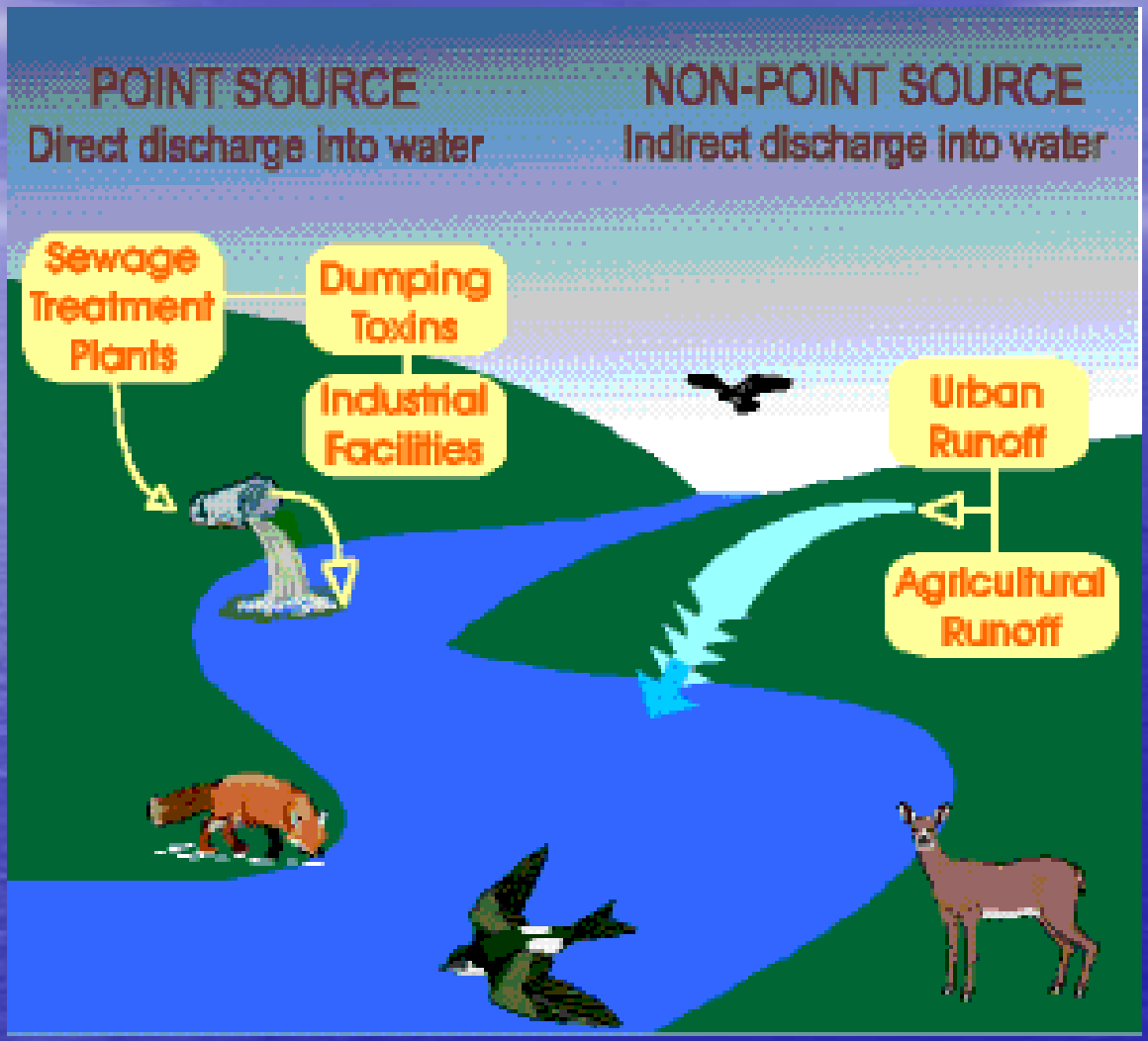

POINT SOURCE
Direct discharge into water
NON-POINT SOURCE
Indirect discharge into water
Sewage Treatment Plants
Dumping Toxins
Industrial Facilities
Urban Runoff
Agricultural Runoff

Figure 2.1 Overview of the aquatic nitrogen cycle and sources of pollution with nitrogen


oil pollution +
nuclear waste +
industrial waste
+ intensive farming
waste water
+ household waste
septic tank +
water table
pesticide
oil spill
+ animal dung
www.visualdictionaryonline.com

TYPES OF WATER POLLUTION

- *TOXIC SUBSTANCE – Chemical pollutant, not naturally occur in aquatic ecosystems. Common: herbicides, pesticides, industrial compounds*

- *ORGANIC SUBSTANCE – Excess of organic matter enters water. Common: manure, sewage. No. Decomposers increase as organic matter increase; grow rapidly & use O_2. Deplete O_2 supply, aquatic organisms die, broken down by decomposers, further deplete O_2 levels.*

TYPES OF WATER POLLUTION

- *INORGANIC SUBSTANCE – Nutrients such as nitrogen & phosphates accumulate in aquatic ecosystem, cause overgrowth of plants & algae. When die, become organic material. Enormous decay of plant/algae, deplete O_2 level.*
  - ❖ *PROCESS OF RAPID PLANT GROWTH FOLLOWED BY INCREASED ACTIVITY BY DECOMPOSERS, AND A DEPLETION OF O_2 LEVEL = <u>EUTROPHICATION</u>*

TYPES OF WATER POLLUTION

- *THERMAL POLLUTION – When water is used as coolant near power / industrial plant, then returned to aquatic environment at higher T than original. Lead to decrease in dissolved O_2 level, also increase aquatic organisms' BOD.*
- *ECOLOGICAL POLLUTION – When chemical/ organic/ thermal pollution cause by nature (not human activity). Ex.: Increased siltation rate after landslide –increase sediments in runoff water.*

SPECIFIC SOURCES

- FARMING

- Often use large amt. herbicides & pesticides, both toxic pollutants, dangerous to life in rivers, streams & lakes where toxic substances build up over period of time.
- Frequently use large amt. chemical fertilizers, washed into waterways & damage water supply & life within. Also increase amt. nitrates & phosphates – lead to eutrophication.

SPECIFIC SOURCES

- FARMING (CONT.)

- Allowing livestocks graze near water sources often results in organic waste products being washed into waterways. Sudden intro. organic materials increase amt. N in water, lead to eutrophication.

- Great deal of siltation because of runoff from exposed soil of agriculture fields. Excessive amt. sediment in waterway lead to sunlight blocking, preventing aquatic plants from photosynthesizing, & suffocating fish by clogging their gills.

SPECIFIC SOURCES

- BUSINESS

- Clearing of land lead to erosion of soil into river.
- Waste & sewage generated by industry can get into water supply, organic pollutants into ecosystem.
- Many industrial & power plants use river/ stream/ lakes to dispose waste heat, cause thermal pollution. Disastrous effect on aquatic life as T ↑, O_2 level ↓, animals to survive ↓.


GREENPEACE

SPECIFIC SOURCES

- BUSINESS (CONT.)

- Contaminated with toxic / radioactive materials from industry, mine sites & abandoned hazardous waste sites.
- Fossil fuel burning emits SO_2 into atmosphere. SO_2 reacts with H_2O, creating rainfall containing H_2SO_4 – acid precipitation. Falls into lakes, streams & ponds, ↓ overall pH, killing plant life, affecting food chain. Also leach heavy metals from soil, killing fish/ aquatic organisms.

$$SO_2 + H_2O + \tfrac{1}{2}O_2\,(ATMOSPHERE) \rightarrow H_2SO_4$$

SPECIFIC SOURCES

- *HOMES*

- *Sewage generated by houses or runoff from septic tanks into nearby waterways, introduce organic pollutants – cause eutrophication.*
- *Fertilizers, herbicides & pesticides used for lawn care can runoff & contaminate waterway – lead to eutrophication of lakes & rivers.*

S26 AHAD 15 OGOS 2010 • sinarharian

Limpahan najis tiada kesudahan

15 keluarga tanggung derita

TAMAN BANGI PERMAI – Bau busuk dari sistem kumbahan dan limpahan najis dari longkang perumahan yang tersumbat setiap kali hujan sudah menjadi kebiasaannya dialami kira-kira 15 keluarga dari Taman Bangi Permai, Pekan Bangi.

Keadaan ini diibaratkan mencurahkan air ke daun keladi kerana pelbagai aduan telah dikemukakan kepada pihak bertanggungjawab menyelesaikannya namun sehingga kini masih belum ada sebarang tindakan positif yang diterima.

Rata-rata penghuni masyarakat India mengharapkan permasalahan ini segera diselesaikan kerana ia memberi kesan terhadap persekitaran dan juga mendorong kewujudan penyakit demam denggi dan sebagainya disebabkan persekitaran yang tidak sempurna.

M Mahendran (empat, kiri) bersama penduduk menceritakan masalah mereka kepada Abdul Rahim (tiga, kiri).

SPECIFIC SOURCES

- HOMES (CONT.)

- Improper disposal of hazardous chemicals down drain - toxic material into ecosystem, contaminate water supply.
- Leaks of oil & antifreeze from car on driveway, can wash off by rain into nearby waterways, polluting it.

OTHER SOURCES

- Cl_2 – Added at water treatment works (oxidizing agent); kills some bacteria, but taints & degrades taste.
- HAZARDOUS CONTAMINANTS – Leak from tank & seep from refuse & disposal landfills.
- ALUMINIUM SULPHATE (ALUM) (COAGULANT) – Added at water treatment works; aggravate health problem.
- LEAKY OLD LEAD DISTRIBUTION PIPEWORK – Mainly Victorian; further & unwelcome contribution to water pollution.

WASTEWATER TREATMENT

- SEWAGE – Wastewater released by residences, businesses & industries in a community.
- TYPICAL, CONTAIN 99.94% WATER % ONLY 0.06% DISSOLVED WASTEWATER & SUSPENDED SOLID MATERIAL.
- CLOUDINESS – Cause by suspended particles (untreated sewage = 100 – 350 mg/L)
- STRENGTH OF WASTEWATER – Measure by BOD
- BOD – Amt. O_2 microorganisms require in 5-days to break down sewage.

WASTEWATER TREATMENT

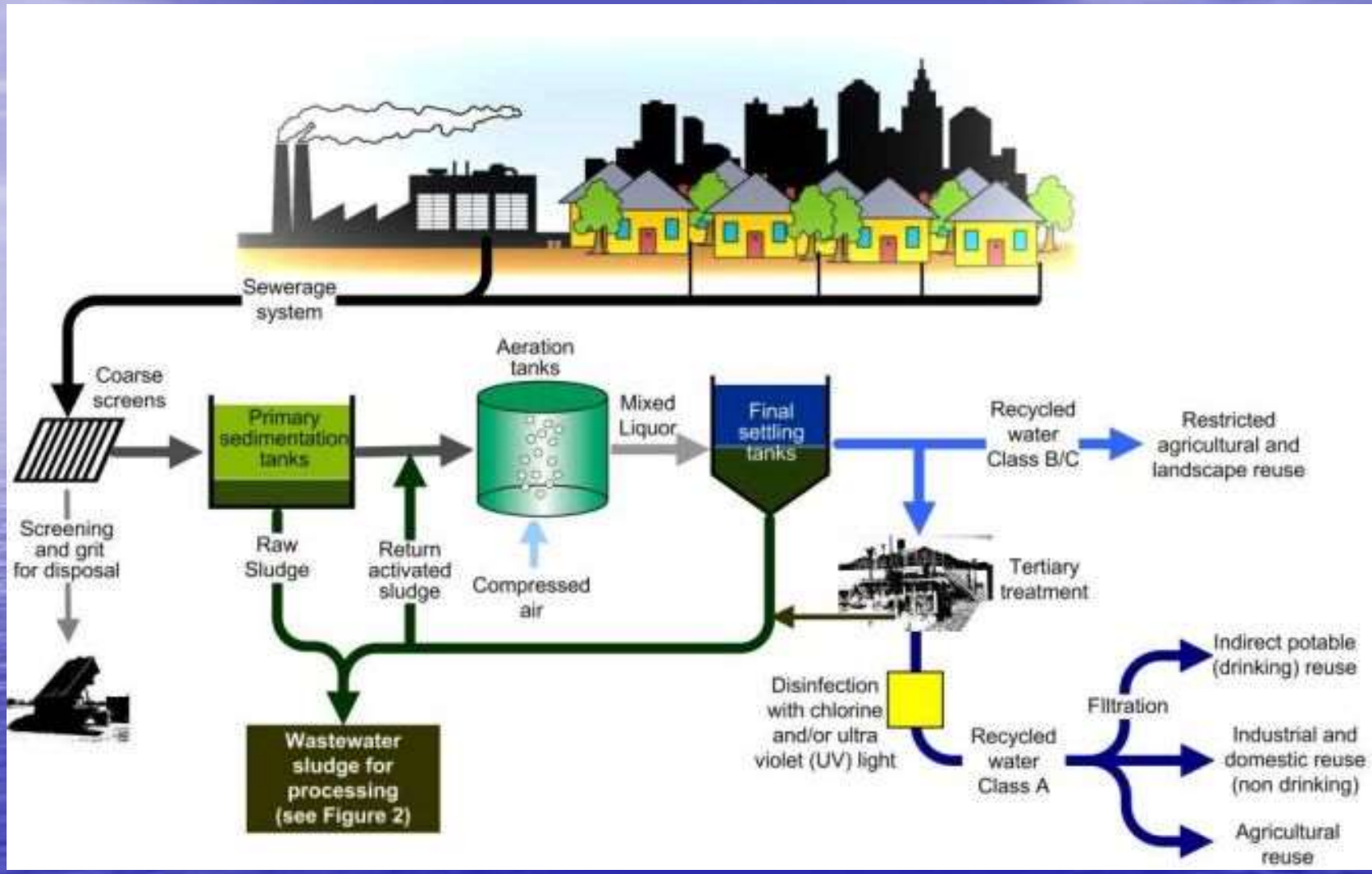
- UNTREATED SEWAGE – BOD (100 – 300 mg/L)
- PATHOGENS - Disease-causing organisms present in sewage
- COLIFORM BACTERIA – Used as indicator of disease-causing organisms
- ALSO CONTAIN NUTRIENTS (NH_3, P), MINERALS & METALS
- NH_3 – Typical 12 – 50 mg/L; P – Typical 6-20 mg/L

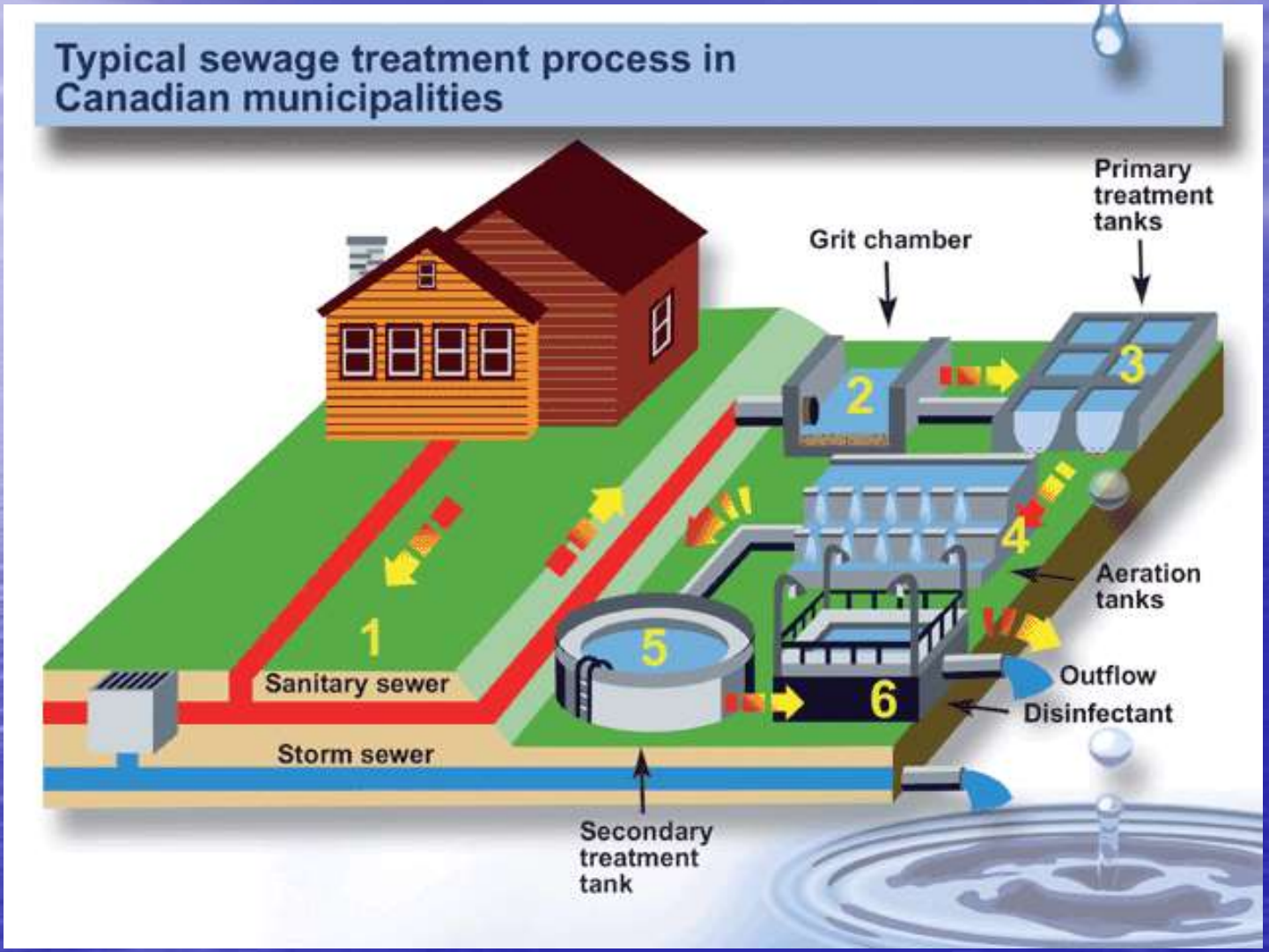
WASTEWATER TREATMENT

- SEWAGE TREATMENT – Multi-stage process to renovate wastewater before re-enter body of water, apply to land, or reuse
- GOAL – Reduce / remove organic matter, solids, nutrients, pathogens & other pollutants from wastewater
- Each receiving body of water has limits to amt. Of pollutants it can receive w/o degradation
- Thus, each sewage treatment plant must hold permit listing allowable BOD levels, SS, Coliform bacteria & other pollutants

WASTEWATER TREATMENT-STAGE PROCESSES

- PRELIMINARY TREATMENT
- PRIMARY TREATMENT
- SECONDARY TREATMENT
- FIXED FILM SYSTEMS
- SUSPENDED FILM SYSTEMS
- LAGOON SYSTEMS
- FINAL TREATMENT
- ADVANCED TREATMENT
- SLUDGES & TREATMENT


Sewerage system
Coarse screens
Primary sedimentation tanks
Aeration tanks
Mixed Liquor
Final settling tanks
Recycled water Class B/C
Restricted agricultural and landscape reuse
Screening and grit for disposal
Raw Sludge
Return activated sludge
Compressed air
Tertiary treatment
Disinfection with chlorine and/or ultra violet (UV) light
Filtration
Indirect potable (drinking) reuse
Recycled water Class A
Industrial and domestic reuse (non drinking)
Agricultural reuse
Wastewater sludge for processing (see Figure 2)


Typical sewage treatment process in Canadian municipalities
Primary treatment tanks
Grit chamber
1
2
3
4
5
6
Aeration tanks
Outflow
Disinfectant
Sanitary sewer
Storm sewer
Secondary treatment tank

WASTEWATER TREATMENT- STAGE PROCESSES

1. PRELIMINARY TREATMENT

- FIRST STEP: Screen out, grind up, or separate debris, sticks, rags, large food particles, sand, gravel, toys, etc. Are removed to protect the pumping & other equipment in treatment plant. Equipment: bar screens, comminutors (large version of garbage disposal), & grit chambers – are used as wastewater first enters a treatment plant collected debris – usually disposed off in landfill.

WASTEWATER TREATMENT-STAGE PROCESSES

2. PRIMARY TREATMENT

- SECOND STEP: Separate SS & greases from wastewater. Wastewater is held in a quiet tank for several hours, allowing particles to settle at bottom, & grease to float at top. Solids drawn off the bottom & skimmed off the top receive further treatment as sludge. Clarified wastewater flows to next stage of treatment. Clarifiers & septic tanks – usually use to provide primary treatment.

WASTEWATER TREATMENT - STAGE PROCESSES

3. SECONDARY TREATMENT

- Biological treatment process to remove dissolved organic matter. Sewage microorganisms are cultivated & added to wastewater – absorb organic matter from sewage as their food supply. 3 approaches are used: fixed film, suspended film & lagoon systems.

WASTEWATER TREATMENT- STAGE PROCESSES

A. FIXED FILM SYSTEMS

- Grow microorganisms on substrates such as rocks, sand or plastic. Wastewater spread over substrate, allowing wastewater to flow past the film of microorganisms fixed to substrate. As organic matter & nutrients are absorbed from wastewater, film of microorganisms grow & thicken. Examples of fixed film systems: trickling filters, rotating biological contactors, sand filters.

WASTEWATER TREATMENT- STAGE PROCESSES

B. SUSPENDED FILM SYSTEMS

- Stirs & suspend microorganisms. As microorganisms absorb organic matter & nutrients from wastewater, they grow in size & number. After microorganisms have been suspended in wastewater for several hours, they are settled out as sludge. Some sludge is pumped back into incoming wastewater to provide 'seed' microorganisms. Remainder is wasted & sent to sludge treatment process. Examples: activated sludge, extended aeration, oxidation ditch, sequential batch reactor systems.

WASTEWATER TREATMENT- STAGE PROCESSES

C. LAGOON SYSTEMS

- Shallow basins which hold wastewater for several months – allow for natural degradation of sewage. These systems take advantage of natural aeration & microorganisms in wastewater to renovate sewage

WASTEWATER TREATMENT-STAGE PROCESSES

4. FINAL TREATMENT

- Focuses on removal pathogens from wastewater. Treated wastewater can be disinfected by adding Cl_2 and/or using UV light (Redox process). High levels of Cl_2 may be harmful to aquatic life in receiving streams. Treatment systems often add a Cl_2-neutralizing chemical to treated wastewater before stream discharge.

WASTEWATER TREATMENT- STAGE PROCESSES

5. ADVANCED TREATMENT

- Necessary in some treatment systems to remove nutrients from wastewater. Chemicals are sometimes added during treatment process to help settle out or strip out P or N. Some examples of nutrient removal systems: coagulant addition – P removal; air stripping – NH_3 removal.

WASTEWATER TREATMENT- STAGE PROCESSES

6. SLUDGES

- Generated through sewage treatment process.
- Primary sludge – material that settles out during primary treatment; often have strong odor & require treatment prior to disposal.

WASTEWATER TREATMENT - STAGE PROCESSES

6. SLUDGES (CONT.)

- SECONDARY SLUDGES – Extra microorganisms from biological treatment processes.
- GOALS:
  - Stabilize sludge & reduce odors;
  - Remove some water & reduce volume;
  - Decompose some organic matter & reduce volume;
  - Kill pathogens & disinfect sludge.

WASTEWATER TREATMENT - STAGE PROCESSES

6. SLUDGES (CONT.)

- Untreated sludges ~ 97% water.
- After settling sludge & decanting off separated liquid, removes some water – reduce volume: 96 – 92% water.
- More water can be removed: sand drying beds, vacuum filters, filter presses & centrifuges – 80 – 50% water.
- Dried sludge - called sludge cake.

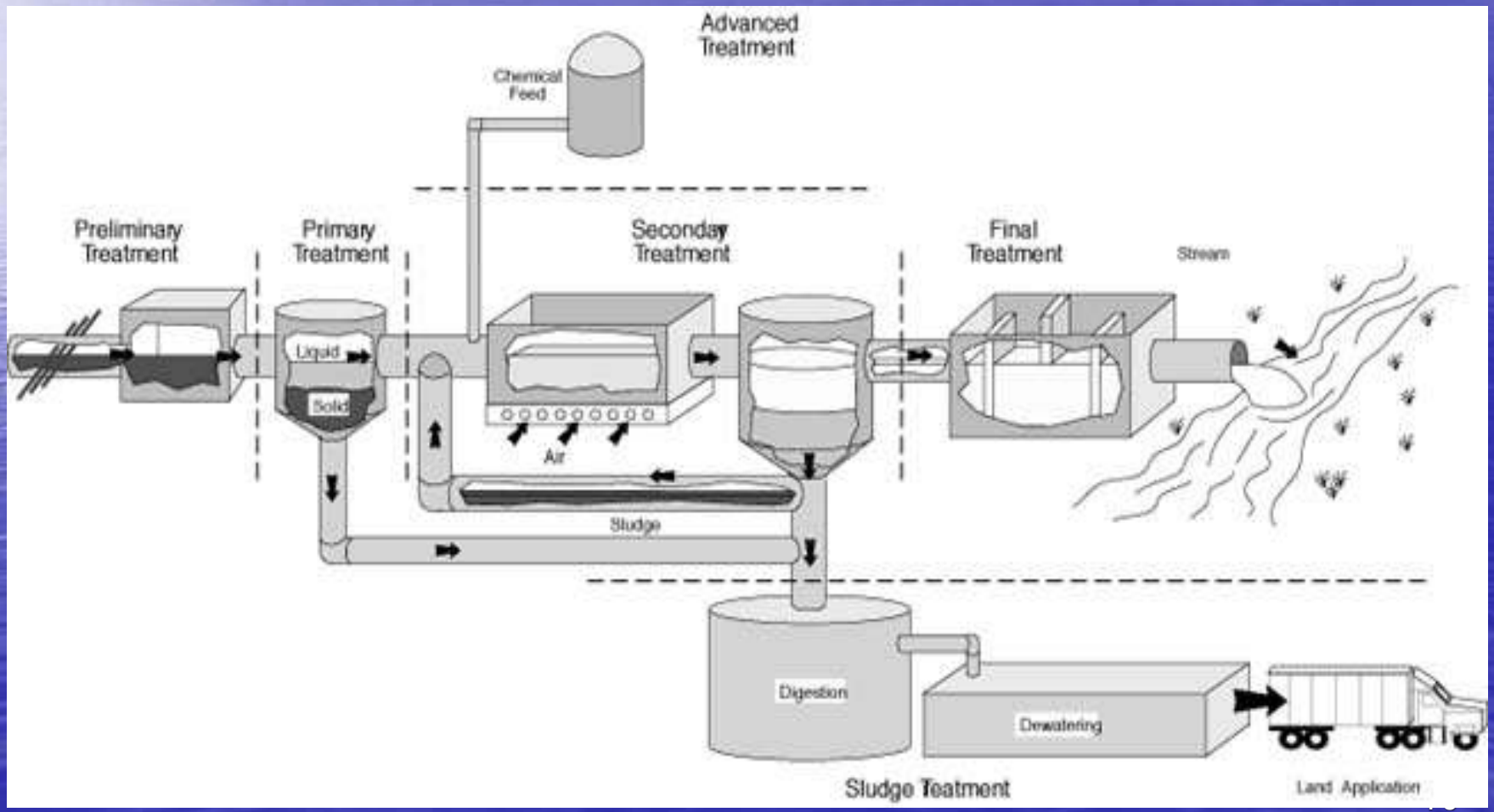
WASTEWATER TREATMENT - STAGE PROCESSES

6. SLUDGES (CONT.)

- AEROBIC & ANAEROBIC DIGESTION – use to decompose organic matter to reduce volume.
- DIGESTION - also stabilize sludge to reduce odor.
- Caustic chemicals can be added to sludge or may be heat-treated to kill pathogens.
- Following treatment, liquid & cake sludge are usually spread on fields, returning organic matter & nutrients to soil.

WASTEWATER TREATMENT-STAGE PROCESSES

TREATMENT PROCESSES



WASTEWATER TREATMENT- STAGE PROCESSES

TESTS

- By system operators, designers & regulatory agencies – evaluate strength of wastewater & amt. Of treatment required, quality of effluent at different stages of treatment, & quality of receiving water at point of discharge.
- Also determine whether treatment is in compliance with state, local, & federal regulations.

WASTEWATER TREATMENT- STAGE PROCESSES

FEW IMPORTANT TESTS

- BOD – Measures amt. dissolved O_2 organisms need to degrade wastes in wastewater; evaluate how much treatment require & potential impact on receiving water.
- TSS – Estimate amt. SS in wastewater helps to complete overall picture of how much secondary treatment required.
- TOTAL COLIFORMS & FECAL COLIFORMS – Determine whether wastewater has been adequately treated & whether quality is suitable for drinking & recreation.

WASTEWATER TREATMENT-STAGE PROCESSES

TYPICAL MUNICIPAL WASTEWATER CHARACTERISTICS (mg/L)

	WEAK	MEDIUM	STRONG	MIN. TREATMENT REQUIREMENTS
BOD	110	220	400	30
TSS	100	220	350	30
N	20	40	85	Variable
P	4	8	15	Variable

WHAT IS SLUDGE ?

- SOLID MATERIAL remaining after sewage treatment facilities purify wastewater from homes, businesses & industries.
- OBTAINING CLEANER WATER FROM TREATMENT FACILITIES – Producing more sludge.
- PAST PRACTICE – Sewage sludge was dumped to sea, buried in landfills or burned in incinerators.

WHAT IS SLUDGE ?

- PRESENT – Reassess sludge management practices
- WHY ?
  - INCREASE LANDFILL TIPPING FEES & CLOSURE COSTS
  - MORE STRINGENT ENVIRONMENTAL STANDARDS
  - INCREASED PUBLIC CONCERN ON AIR, LAND & WATER

NEW PROBLEMS ?

- STRICTER WATER QUALITY STANDARD – upgrade treatment facilities
- CLEANER EFFLUENT – lower quality sludge: more impurities are removed
- SLUDGE QUALITY – depends on how clean the incoming wastewater & which treatment methods applied
- PROCESSING SLUDGE – best considered at early stages of planning & design wastewater treatment facilities

TYPES OF SLUDGE

- *PRIMARY SLUDGE – from primary wastewater treatment; remove 40 – 50% solids in water by bar screens, grit chambers & primary sedimentation tanks; contains solid organic material*

- *SECONDARY SLUDGE – generated after wastewater travels thru aeration tank & allowed time to settle; consists microscopic material remaining after biological processes have removed dissolved organic matter*

TYPES OF SLUDGE

- *TERTIARY SLUDGE – generated at third stage wastewater treatment by advanced processes (e.g. chemical treatment, filtration)*

- *EACH TREATMENT (1°, 2°, 3°) adds purification process cost*

→ *MAKING WATER CLEANER – MORE EXPENSIVE*

SLUDGE PROCESSING: GOALS

- MUST BE TREATED / STABILIZED TO MAKE THEM SAFE FOR USE OR DISPOSAL
- TYPICAL GOALS : reduce water content & sludge quantity; destroy pathogens; control odors
- TO ACHIEVE – various treatment & stabilization methods are used : anaerobic / aerobic digestion; lime treatment; composting; heat drying
- EACH METHODS – reduces pathogen levels & odor potential of sludge

SLUDGE MANAGEMENT

- BEGINS with generation of sludge during wastewater treatment
- CONTINUES thru sludge processing & stabilization
- ENDS with either use of disposal of processed sludge

➔ SUITABILITY FOR VARIOUS USE / DISPOSAL – generator must know what in sludge ?

➔ HIGHER QUALITY SLUDGE – contain smaller amt. metals, toxic chemicals & pathogens – safer for environment & can be marketed ?

SLUDGE PRODUCTION

- INCREASE as additional municipalities complied with stringent regulations
- INCREASE as more sophisticated processing systems are developed & installed

SLUDGE AS A RESOURCE

- Most municipalities agree that it is IMPORTANT TO RECYCLE OR REUSE what they can from their wastewater
- PRESENT FOCUS – sludge's potential as a valuable resource
- HIGH CONTENT OF ORGANIC MATTER & PRESENCE OF NUTRIENTS – potentially valuable addition to soils
- OBSTACLE: public resistance to use it & new facilities with great expense to produce it

SLUDGE CHARACTERISTICS ?

- 3 FACTORS IN DETERMINING SLUDGE QUALITY:
  - Whether it originates from residential homes, businesses or industries
  - What processes are used to treat wastewater
  - Seasonal or daily fluctuations in composition of wastewater

SLUDGE CHARACTERISTICS ?

- MUST BE TAKEN INTO ACCOUNT:

- how much water & solid matter does it contain ?
- how many different metals & nutrients does it have & how much of each ?
- what potentially toxic organic chemicals are contained in sludge ?
- what pathogen reduction process was used ?

SLUDGE CHARACTERISTICS ?

- MOST WASTEWATER COMES FROM residential homes, industries, schools & businesses
- SOME ADDITIONAL FROM ROADS, PARKING LOTS & LAWNS RUNOFF – may contain petroleum products & pesticides
- CHEMICALS & OTHER TOXIC WASTES DISCHARGED BY FACTORIES & BUSINESSES – affect sludge quality
- HUMAN & HOUSEHOLD WASTES – contain fewer harmful chemicals but increased human pathogens

SLUDGE CHARACTERISTICS ?

- TYPICALLY CONTAIN :
  - 1 – 7 % SOLID MATERIAL
  - 93 – 99 % WATER
  - pH RANGE – 4 (ACIDIC) – 12 (ALKALINE)
- pH – affects movement of heavy metals, corrosiveness of sludge & survival of pathogens contained

SLUDGE CHARACTERISTICS ?

- GOOD SLUDGE !

- sludge treated with lime (pH > 11) – contain less pathogenic bacteria

- when applied to soils (maintained at pH ~ 7), heavy metals movement (Pb, Cd, Hg) thru soil to streams & groundwater inhibited

- neutral pH soils treated with sludge – limit uptake of heavy metals by plants

MANAGING SLUDGE PROPERLY

- *RESEARCH SHOWS that adding certain iron oxides & other solid materials – cause chemical binding process*
- *INCREASE METAL- holding capacity*
- *WHEN ADDED DURING TREATMENT – believe that these materials reduce potential risks from metals in land-applied sludge*

MANAGING SLUDGE PROPERLY

- *PROPER SLUDGE USE & MANAGEMENT – necessary to ensure public & environmental health & safety*

- *TO PROPERLY MANAGE – municipalities determine amt. & types of nutrients & heavy metals, organic matter content (toxic & non-toxic) & quantity of pathogenic organisms contained*

MANAGING SLUDGE PROPERLY

- SEWAGE SLUDGE has many CHARACTERISTICS that are GOOD FOR SOILS & PLANTS, if applied properly
- ORGANIC MATTER in sludge CAN IMPROVE PHYSICAL PROPERTIES of soil
- If added properly, ENHANCES SOIL QUALITY & makes it BETTER FOR VEGETATION
- APPLIED AT RECOMMENDED VOLUMES & RATES, can supply most of N & P needed for GOOD PLANT GROWTH

PROPER APPLICATION - VITAL

- INDUSTRIAL WASTEWATER DISCHARGE – major source of metals & toxic organic chemicals
- These harmful substances can be kept out of sludge from the start BY ELIMINATING THEM FROM WASTEWATER COMING INTO TREATMENT PLANT

PROPER APPLICATION - VITAL

- TWO WAYS:

1) SOURCE CONTROL – modifying industrial process or product to reduce toxins

2) PRETREATMENT – requiring industry to treat its wastewater before it enters municipal sewer system

FEDERAL & STATE REGULATIONS FOR MUNICIPAL SLUDGE USE / DISPOSAL - PROTECT HUMAN HEALTH AND ENVIRONMENT

SLUDGE - LAND APPLICATIONS

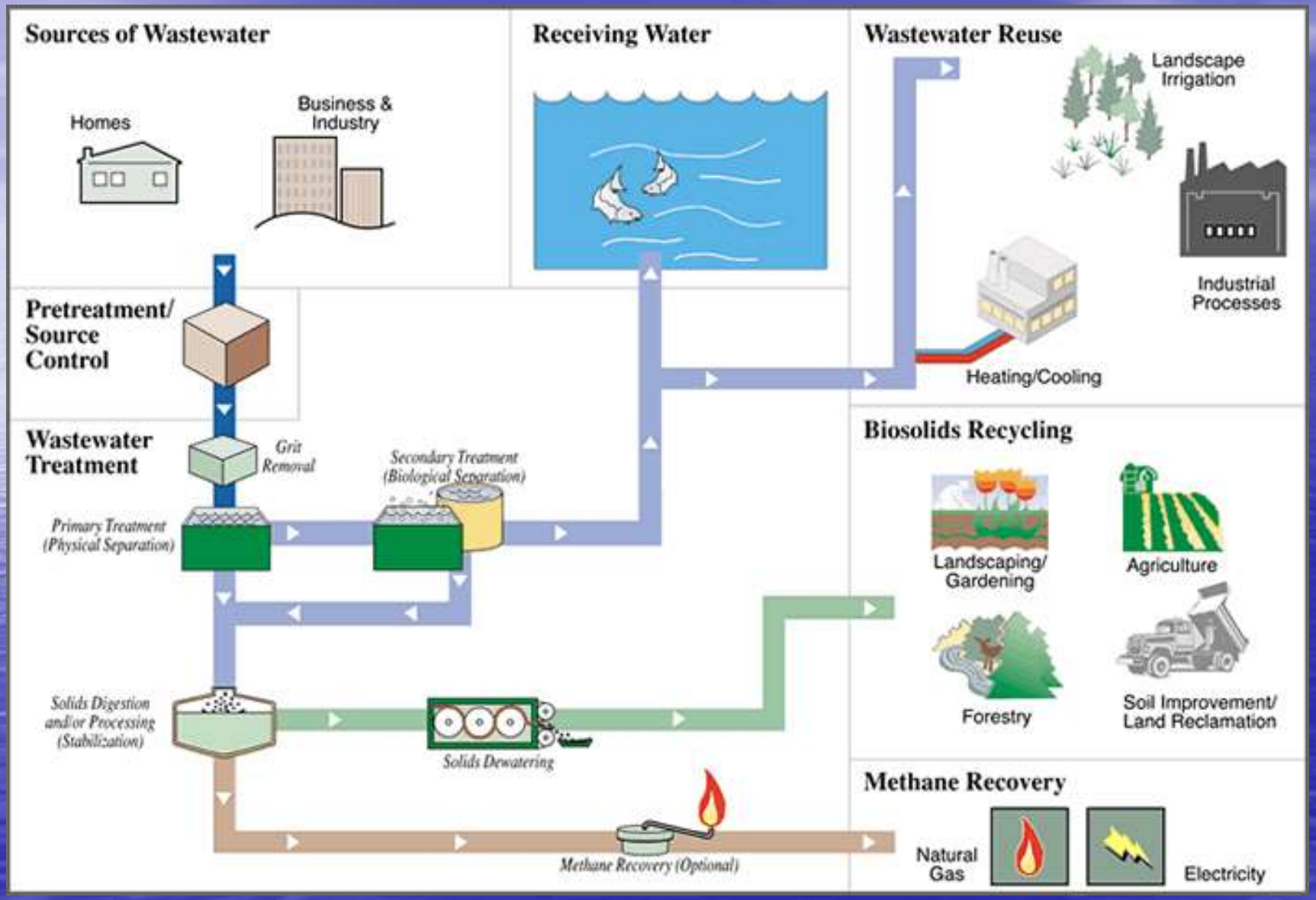
- LARGEST BENEFICIAL USE
- Since municipal sludges are A BY-PRODUCT OF FOODS WE EAT, they contain NUTRIENTS (N, P, Ca)
- PROPER LAND APPLICATION – provides a way to recycle these nutrients & return them safely to soil
- Also can be processed into HEAT-DRIED PELLETS that are marketed as FERTILIZERS & SOIL CONDITIONERS

SLUDGE - LAND APPLICATIONS

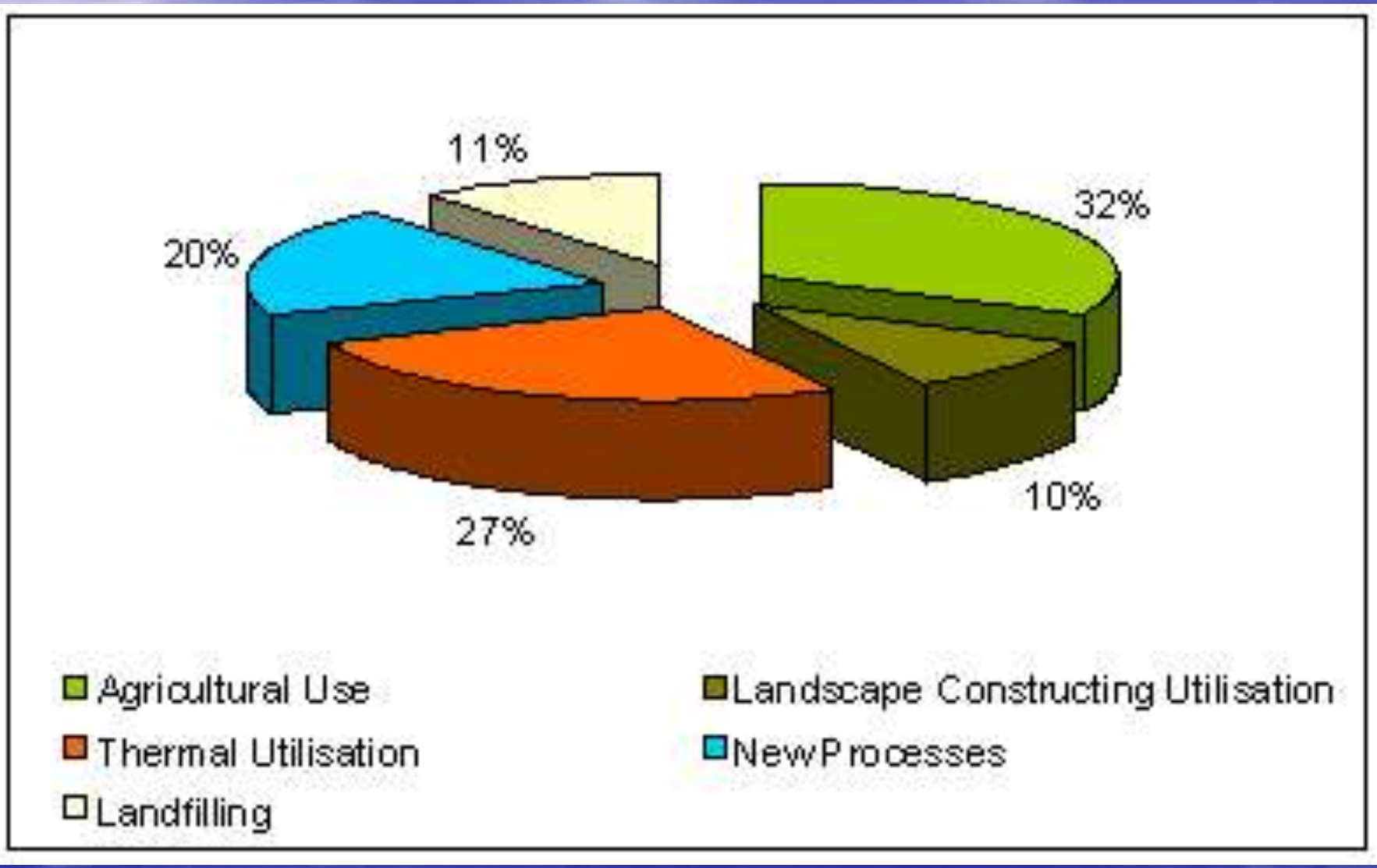
- *PELLETIZATION PROCESS – also reduces disease-causing organisms*
- *PELLETIZED SLUDGE PRODUCT MARKET - golf courses, parks, cemeteries, nurseries, & municipal landscaping projects*
- *COMPOSTING – another way to recycle nutrients & organic matter*

SLUDGE - LAND APPLICATIONS

- BENEFITS OF SLUDGE COMPOSTS
  - Increased water & nutrient-holding capacity
  - Increased aeration & drainage of soils
  - Provide soil with low levels of plant nutrients
  - Also can be used along roadsides to establish vegetation & reduce erosion; uses which require a single or infrequent permit application


Sources of Wastewater
Homes
Business & Industry
Receiving Water
Wastewater Reuse
Landscape Irrigation
Industrial Processes
Heating/Cooling
Pretreatment/ Source Control
Wastewater Treatment
Grit Removal
Secondary Treatment (Biological Separation)
Primary Treatment (Physical Separation)
Biosolids Recycling
Landscaping/ Gardening
Agriculture
Forestry
Soil Improvement/ Land Reclamation
Solids Digestion and/or Processing (Stabilization)
Solids Dewatering
Methane Recovery
Methane Recovery (Optional)
Natural Gas
Electricity

Sludge Use


11%
32%
20%
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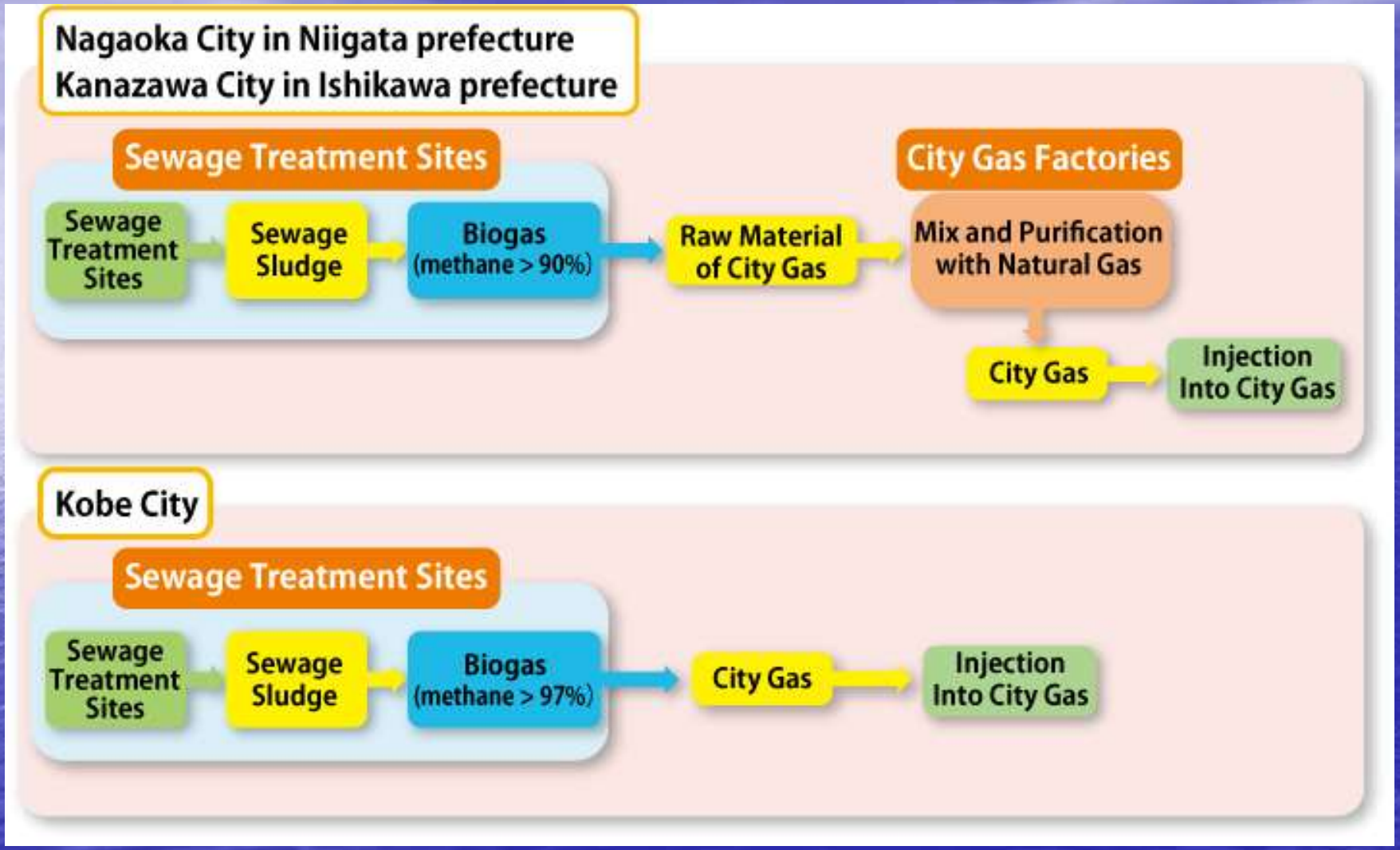
27%
Agricultural Use
Landscape Constructing Utilisation
Thermal Utilisation
New Processes
Landfilling


Nagaoka City in Niigata prefecture
Kanazawa City in Ishikawa prefecture
Sewage Treatment Sites
Sewage Treatment Sites
Sewage Sludge
Biogas (methane > 90%)
Raw Material of City Gas
City Gas Factories
Mix and Purification with Natural Gas
City Gas
Injection Into City Gas
Kobe City
Sewage Treatment Sites
Sewage Treatment Sites
Sewage Sludge
Biogas (methane > 97%)
City Gas
Injection Into City Gas


THIS MODERN WORLD by TOM TOMORROW
IT'S TIME FOR YET ANOTHER LOOK AT HOW THE NEWS WORKS...STEP ONE: A CORPORATION WHICH HAS BEEN CAUGHT ENGAGING IN SOME ILLEGAL OR UNETHICAL ACT HIRES A PUBLIC RELATIONS FIRM...
PEOPLE ARE UPSET BECAUSE WE'VE BEEN DUMPING TOXIC SLUDGE INTO THE WATER SUPPLY!
WELL--BY THE TIME WE'RE THROUGH, THEY'LL THANK YOU FOR IT!
STEP TWO: THE P.R. FIRM PROCEEDS TO MANIPULATE PUBLIC OPINION IN A VARIETY OF DEVIOUS, UNDERHANDED WAYS-- SUCH AS ANONYMOUSLY PLANTING OP-ED PIECES IN THE NATION'S NEWSPAPERS...
What's So Bad About Toxic Sludge?
by Joe Pundit
...AS WELL AS SENDING OUT SLICKLY-PRODUCED "VIDEO NEWS RELEASES" WHICH MANY CASH-STRAPPED LOCAL NEWS DEPARTMENTS AIR VIRTUALLY UNEDITED...GIVING CORPORATE PROPAGANDA THE APPEARANCE OF OBJECTIVE REPORTING...
...AND SO YOU SEE, TOXIC SLUDGE IS ACTUALLY QUITE GOOD FOR YOU!
STEP THREE: PUBLIC OPINION IS SWAYED BY THIS ONSLAUGHT OF MEDIA MANIPULATION MASQUERADING AS NEWS...SINCE, AS P.R. FIRMS WELL UNDERSTAND, ANY LIE REPEATED OFTEN ENOUGH BECOMES TRUE...
I CAN'T IMAGINE WHY WE EVER WORRIED ABOUT TOXIC SLUDGE!
YES--HOW SILLY WE WERE!
©TOM TOMORROW

CONCERNS ABOUT SLUDGE USE

- *LAND APPLICATION OF SLUDGES – result in increase of pathogenic bacteria, viruses, parasites, chemicals & metals in drinking water reservoirs, aquifers & food chain*
- *CUMULATIVE EFFECTS of metals in cropped soils*
- *RESEARCH – IF METALS (Zn, Cu, Pb, Ni, Hg & Cd) are allowed to build up in soils due to many applications over the years, COULD RELEASE AT LEVELS HARMFUL TO CROPS, ANIMALS & HUMANS*

CONCERNS ABOUT SLUDGE USE

- SOME ARE NECESSARY MICRONUTRIENTS, BUT AT HIGHER LEVELS – may be harmful to plants, particularly those grown on acid soils (soil with low pH)
  - Cd – suspected carcinogen
  - Hg – toxic effects on animals & humans
  - SYNTHETIC ORGANIC COMPOUNDS (DIOXINS & PCB) – ecological & human health impact

CONCERNS ABOUT SLUDGE USE

- *FATE OF SLUDGE COMPONENTS – also influenced by factors:*
  - *CLIMATE – rainfall & temperature*
  - *SOIL MANAGEMENT – irrigation, drainage, liming, fertilization, & addition of amendments*
  - *COMPOSITION of sludge*

CONCERNS ABOUT SLUDGE USE

- In the past, success of land application has been hurt by mismanagement of important factors such as soil pH
- Uptake of many metals (e.g. Cd) – related to soil pH. if pH drops below certain level, heavy metals will be released, increasing chances of leaching & plant uptake
- Nutrient contamination of surface water through nonpoint source pollution needs to be carefully monitored – odors associated with poorly managed sludge application

EFFECT - DRINKING WATER

- LEAD (CURRENT EU LIMIT – 50 μg/L)

- General toxicant that accumulates in skeleton
- Normally from old plumbing system; blood lead levels are commonly used as index of recent exposure
- Possibility of neuro-physiological effects influencing learning ability & general behavior in children
- Pregnant women & infants considered sensitive group

EFFECT - DRINKING WATER

- NITRATE (WHO STANDARD – 50-100 mg/L)

- Normally from nitrogenous fertilizers

- Also from changes in land use (conversion of pasture into arable land) & increased sewage effluent recycling in lowland waters

- Effect - blood disease in bottle fed infants

- Cause by bacterial reduction of ingested nitrate to nitrite in stomach; nitrites combines with blood haemoglobin to produce methaemoglobinaemia – reduce oxygen carrying capacity

EFFECT - DRINKING WATER

- ALUMINIUM (< 10μg/L)

- ALUM – widely used as cougulants in water treatment for public supply
- INEFFICIENT TREATMENT – lead to breakthru into water distribution system
- EFFECT – brain tissue alzheimer's disease

EFFECT - DRINKING WATER

- *SODIUM* (< 50 mg/L)

- Normally present in drinking water; intake from this source will represent no more than 1-2 % of total dietary intake

- ONLY GROUP CONCERN – bottle-fed infants

- INFANT KIDNEY IS LESS EFFECTIVE THAN ADULTS AT SODIUM ELIMINATION – danger of hypernatraemia if cow's milk is fed

- COW'S MILK - 3X > HUMAN MILK

EFFECT - DRINKING WATER

- PESTICIDES

- CARCINOGENIC SUBSTANCES – CANCER RISK

COMPOUND OR GROUP OF ISOMERS	μg/L
DDT	2
ALDRIN & DIELDRIN	0.03
CHLORDANE	0.2
HEXACHLOROBENZENE	1
HEPTACHLOR & HEPTACHLOR EPOXIDE	0.03
LINDANE	2
METHOXYCHLOR	20
2.4-D	30

WHO GUIDELINE VALUES (1993) FOR CERTAIN PESTICIDES

EFFECT – WATER POLLUTION

- EUTROPHICATION

- Release nutrients during breakdown of organic matter stimulates aquatic plants overgrowth; lead to die sooner; depleting O_2 level

- ACIDIFICATION

- Major source from burning fossil fuels, releasing oxides of sulfur and nitrogen to atmosphere; rain falls with high acidity; effect to aquatic life

EFFECT – WATER POLLUTION

- TOXIC CHEMICALS – MAJOR TYPES
- Metals (Zn, Cu, Hd, Cd)
- Organic compounds (pesticides, herbicides, PCB, phenols)
- Gases (Cl_2, NH_3)
- Anions (cyanide, sulfide, sulfite)
- Acids & alkalis

EFFECT – WATER POLLUTION

- REGULAR USE TERMS IN STUDY TOXIC EFFECT

- ACUTE – causing an effect (usually death) within a short period

- CHRONIC – causing an effect (lethal or sub-lethal) over a prolonged period of time

- LETHAL – causing death by direct poisoning

- SUB-LETHAL – below the level which causes death but which may effect growth, reproduction or behavior so that population may eventually reduce

- CUMULATIVE – effect is increased by successive doses

EFFECT – WATER POLLUTION

- THERMAL POLLUTION

- Cooling water discharges from electricity generating stations are the main source – still have T

- As T increase, O_2 consumption & heart rate of fish will increase to obtain O_2 for increased metabolic processes, but at the same time, O_2 concentration of water decreased

- THUS, FISH & AQUATIC LIFE WILL EASILY DIE

EFFECT – WATER POLLUTION

- *OIL*

- *derives from petrol & oil washed from roads together with illegal discharge of engine oil*
- *also from boats & irrigation pumps & accidents involving transporters & spillages*
- *effect to eggs & young stages of animals*
- *some contaminants of oils (PCB & Pb) – accumulate in tissues*
- *emulsifiers & dispersants – used to clean up spillages are often highly toxic*
- *floating oil – threat to higher vertebrates (aquatic birds)*

ROLE – PUBLIC, GOV'T, NGOs, Industrialists, Celebrities & Medias, Academia

WHAT SHOULD WE DO ?

WHAT SHOULD GOVERNMENT DO ?

WHAT SHOULD OTHERS DO?

PREVENT WATER POLLUTION