Landfill Leachate Treatment

Engineered Wetlands

Parc d'entreprises St-Charles, Montreal

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and

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RemTech 2007

Types of Wetlands

- Free Water Surface (FWS)
  - "surface flow"

- Horizontal Subsurface Flow (HSSF)
  - "vegetated submerged bed" (VSB)

- Vertical Flow (VF)
- Engineered Wetlands
  - aerated, fill-and-drain, reactive media, geometric configurations, etc

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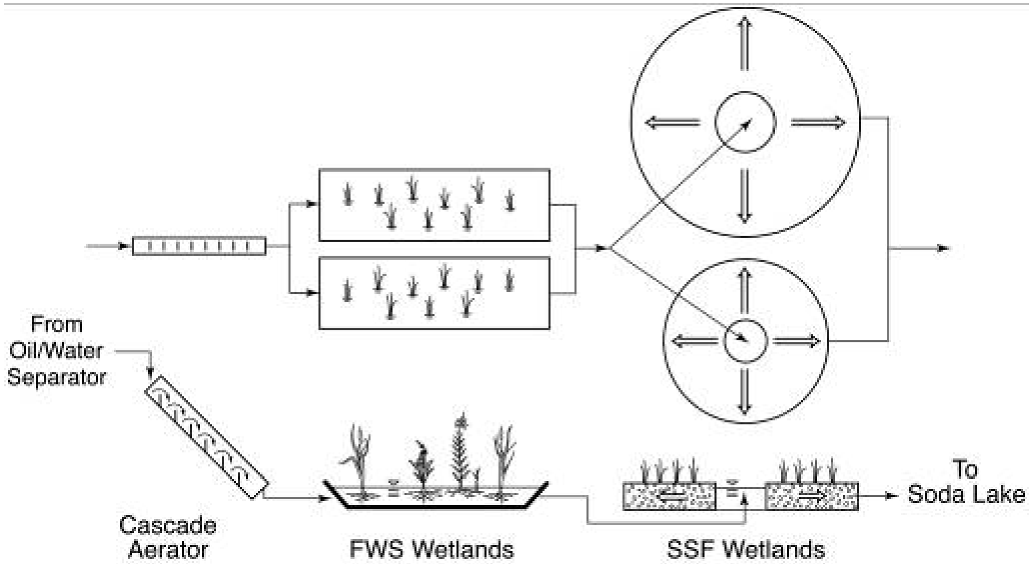
Engineered Wetlands
"A little less passive"

- **Engineering Tools**
  - **Wetland Geometry**
  - **Aeration**
  - **Gravel type and size**
  - **Insulation**



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Typical Applications For Engineered Wetlands

- Petroleum Hydrocarbons
- Chlorinated Solvents
- Landfill Leachate
- Industrial Wastewaters
- Glycols (aircraft deicing)
- Mining Waste (sulfides and metals)
- Municipal Wastewaters

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Engineered Wetlands for Landfill Leachate Treatment

Landfill Treatment Goals

- What are the goals?
  - Simple and robust
  - Minimize environmental impacts
  - Minimize costs
  - Long life
- What will it be like in 100 years?
  - What legacy do you leave
  - What impact does it have
  - Aesthetics (How does it fit the site?)

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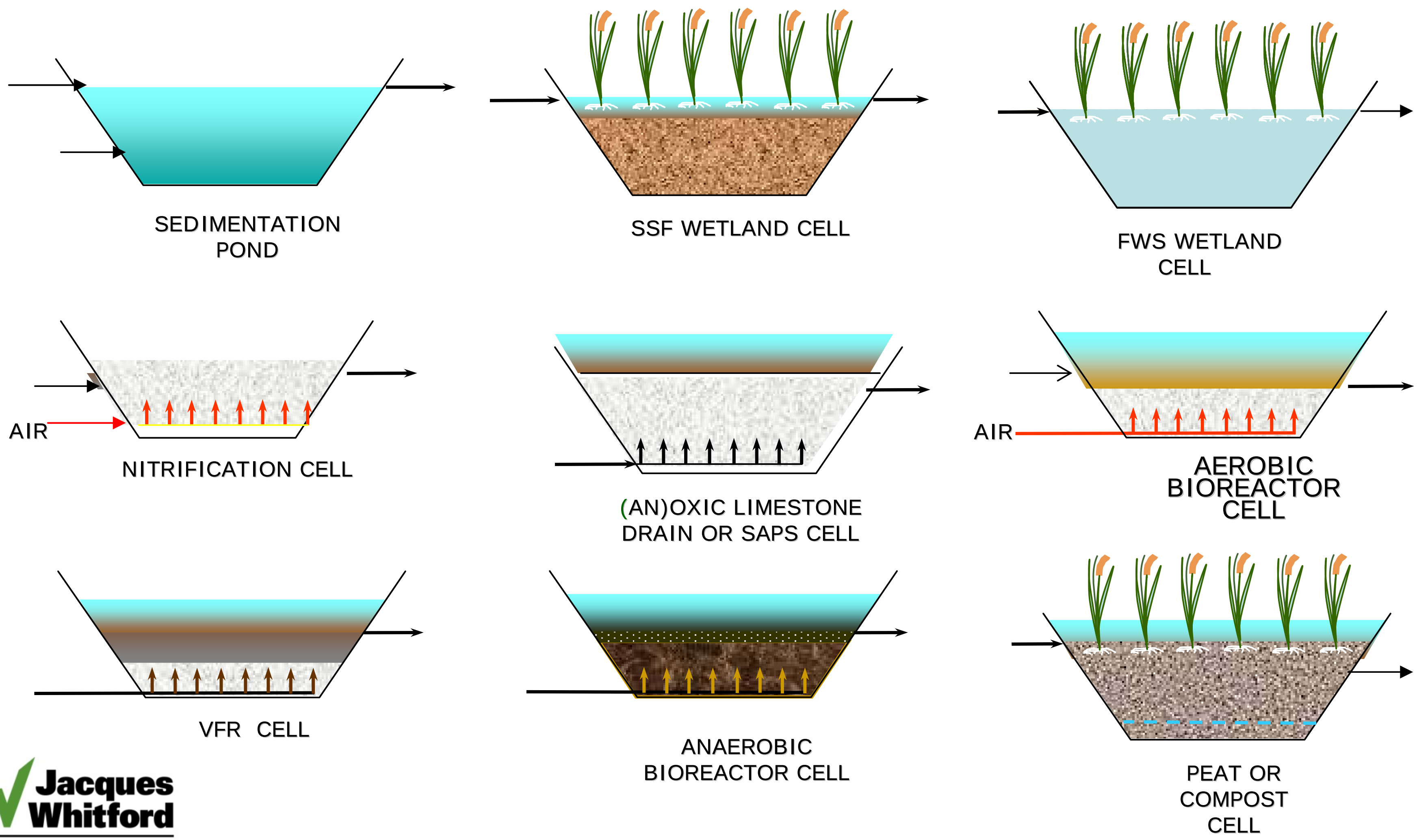
Landfill Leachate

- What does an engineer need to know?
  - Flow
  - Influent composition
  - Effluent limits
- For leachate, we know:
  - Flow is variable
  - Composition is complex and ever-changing
  - Effluent limits are based on means of disposal

Engineered Wetlands

- Engineered wetlands are flexible
  - Physical
    - Solids removal by filtration and sedimentation
  - Chemical
    - Precipitation of metals
  - Biological
    - Aerobic/anaerobic bacterial degradation
    - Plants: enhance microbial growth and evapotranspiration

Engineered Wetland Cell Options



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Aerated Wetland Systems

Aerated Vertical SSF Engineered Wetland Cell

Benefits of Wetland Aeration

- Low Energy Input (About 10% Of Activated Sludge Processes)
- 10-Fold Increase in Nitrification
- Much Smaller Wetland Footprint
- North Glengarry, ON,

Example

30.4 ha non-aerated CW

1.4 ha aerated EW

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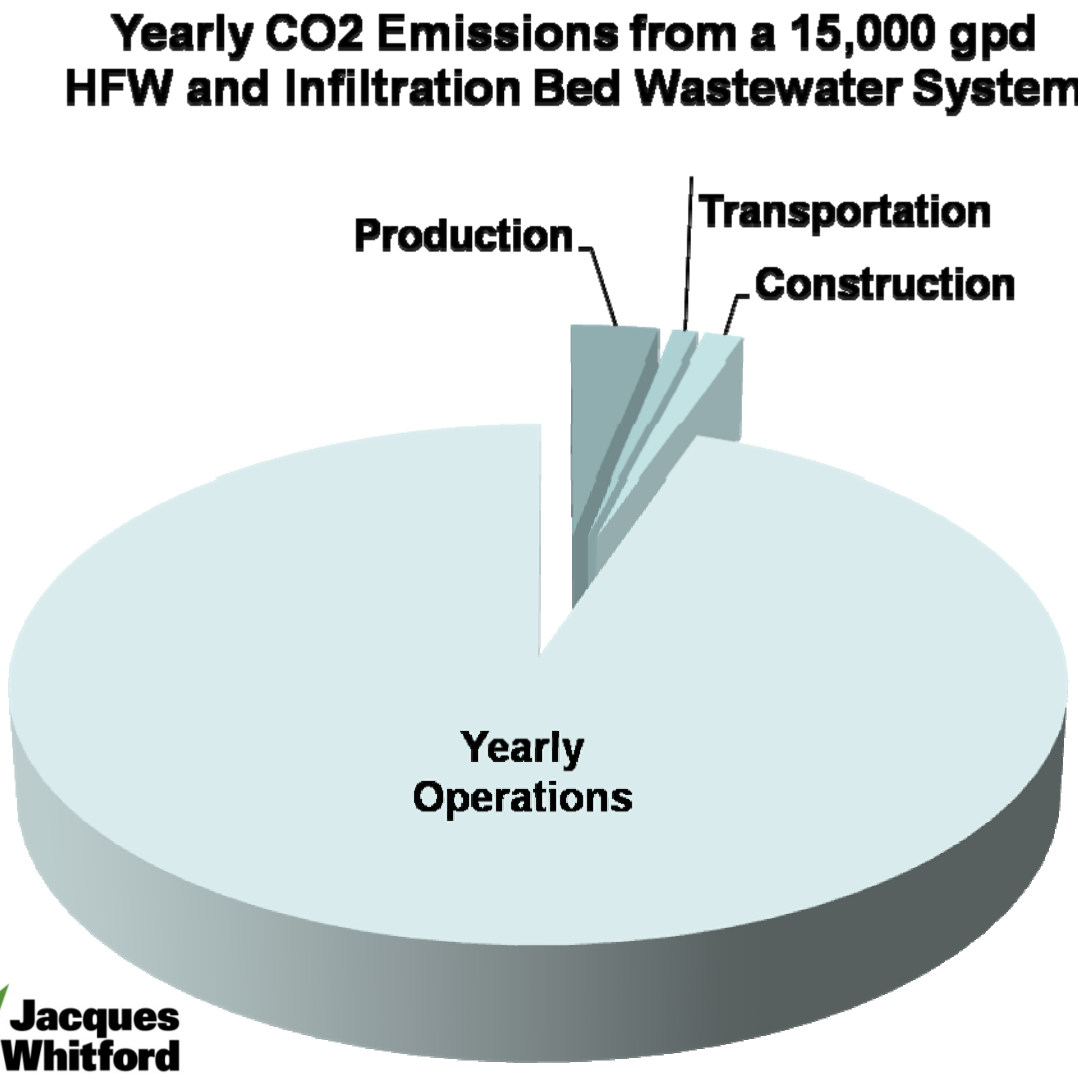
Carbon Analysis - Horizontal Flow Wetland and Infiltration Beds



CO2 Emissions (lbs)

Production	2650
Transportation	750
Construction	1170
Yearly Operations	81000
Total Yearly	*85570*

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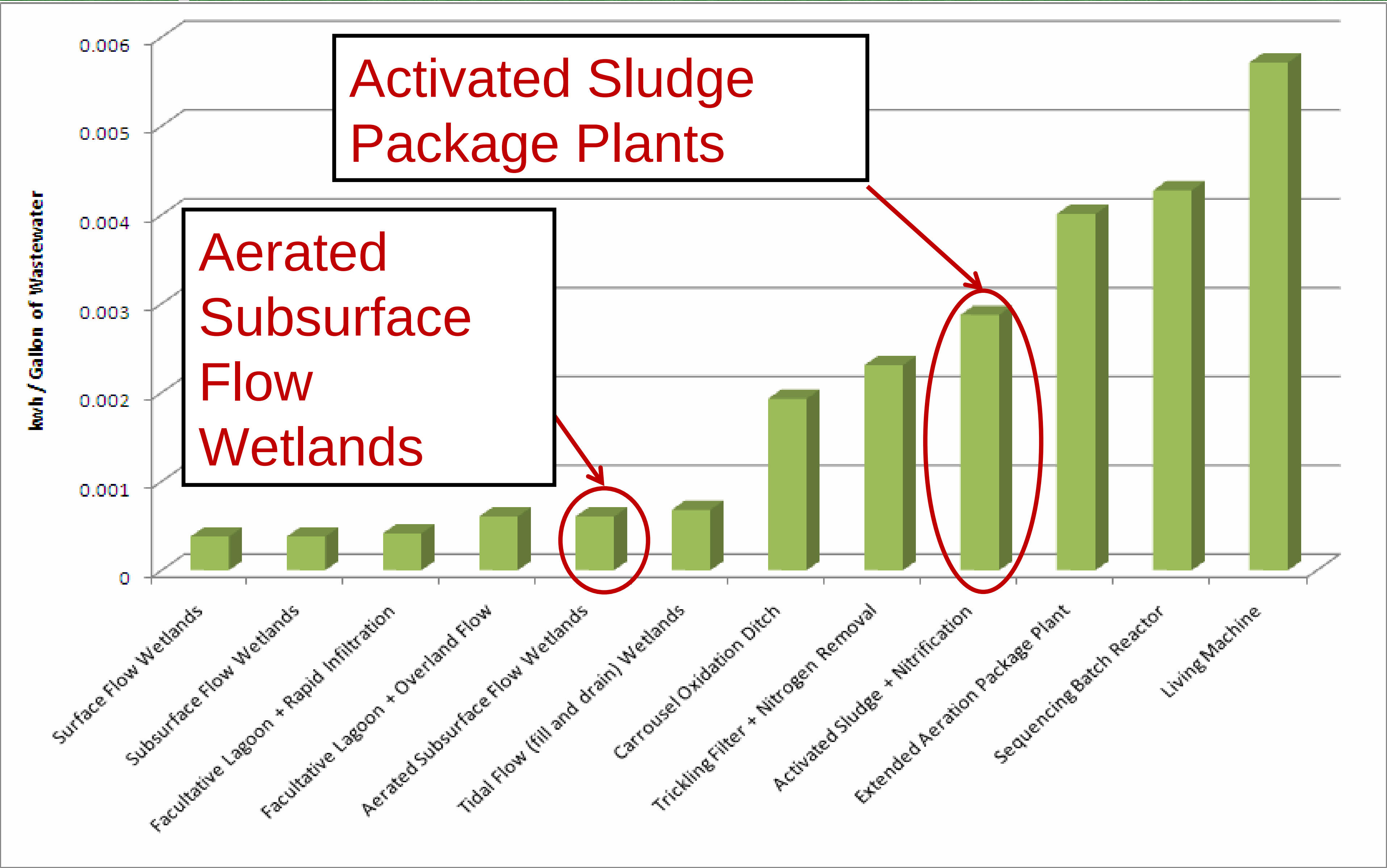
Wastewater System Energy Requirements = Carbon Emissions



Landfill Design Process

- Desk Top Study
  - Define unit processes
- Treatability Test
  - Determine sizing kinetics
- Onsite Pilot
  - Verify performance under actual site conditions
- Detailed Design

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Results of a Typical Pilot-Scale Treatability Test:

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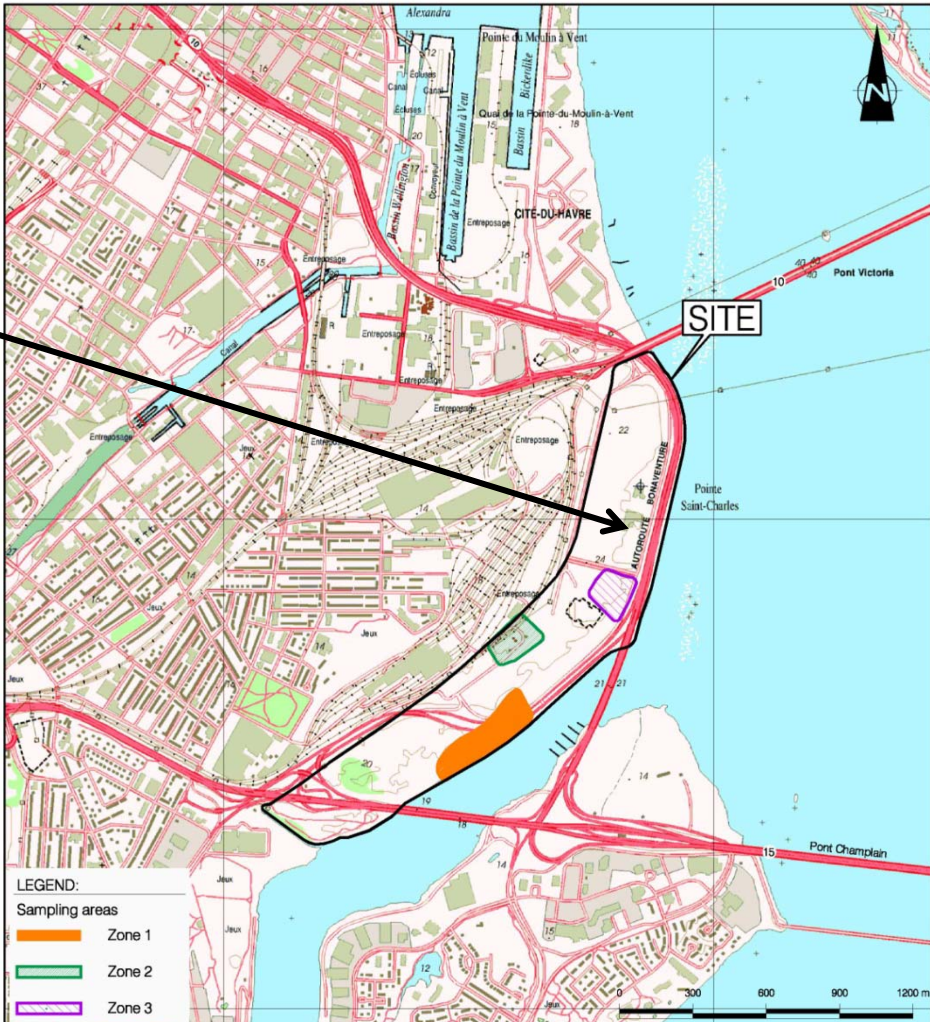
Landfill on St. Lawrence River

Area of Fill



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Pollutants of Concern

- Ammonia
- TSS
- Hydrocarbons
- Metals (Fe, Cu, Se, Sn, Zn)
- Barium
- Chronic and Acute Toxicity

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JW's Proposal was...

- Conduct Pilot-Scale Treatability Testing - JW Campus D'Alfred Test Unit
- All 3 Technoparc Groundwaters
- High & Low Temperatures

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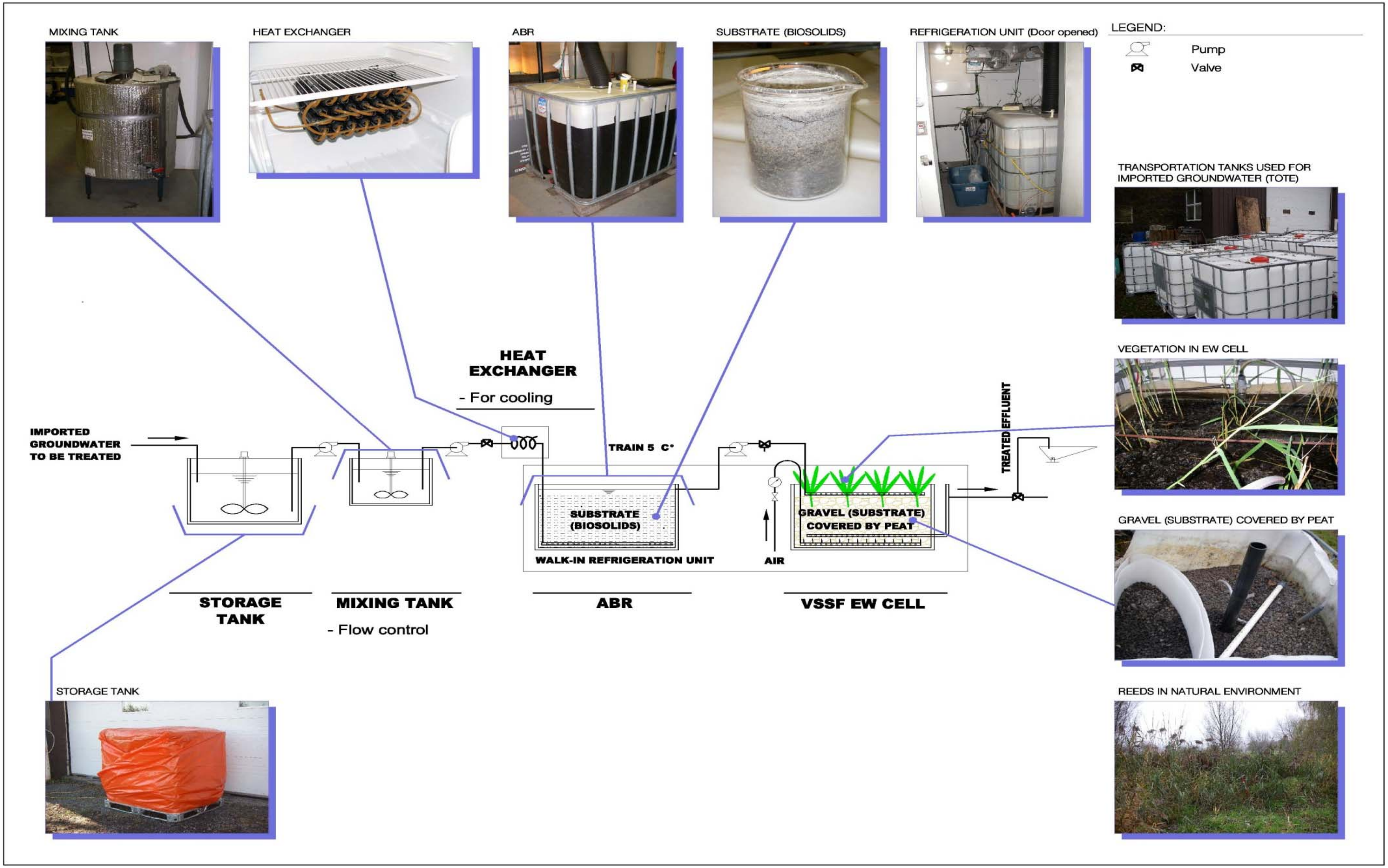
Pilot Test



MIXING TANK
HEAT EXCHANGER
ABR
SUBSTRATE (BIOSOLIDS)
REFRIGERATION UNIT (Door opened)
LEGEND:
Pump
Valve
TRANSPORTATION TANKS USED FOR IMPORTED GROUNDWATER (TOTE)
VEGETATION IN EW CELL
GRAVEL (SUBSTRATE) COVERED BY PEAT
REEDS IN NATURAL ENVIRONMENT
STORAGE TANK
HEAT EXCHANGER
- For cooling
IMPORTED GROUNDWATER TO BE TREATED
TRAIN 5 C°
TREATED EFFLUENT
SUBSTRATE (BIOSOLIDS)
GRAVEL (SUBSTRATE) COVERED BY PEAT
WALK-IN REFRIGERATION UNIT
AIR
STORAGE TANK
MIXING TANK
- Flow control
ABR
VSSF EW CELL

Specific Objectives

- To demonstrate the technology is effective.
- To determine components of the system and its potential implementation.
- Verify that applicable standards can be met i.e. toxicity

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Results

- **Contaminated groundwater was successfully treated by engineered wetlands.**
- **Ammonia can be treated at low temperatures (<5 ºC) even lower than anticipated on-site.**

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Results

- **No detectable concentrations of PCBs, nor Petroleum Hydrocarbons (C_{10}-C_{50}) were found in the groundwater to be treated.**
- **Previous pilot tests revealed that those compounds could be easily treated through an Engineered Wetlands.**

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Results

- PAH Compounds can be easily treated
- Metallic compounds will precipitate as mental salts through the use of anaerobic bio reactors.

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Results

- No compounds identified in the groundwater from the site had any negative impacts on the bacteria metabolism.
- After acclamation, the effluent is non-toxic.
- No environmental impact is anticipated for residuals generated after treatment.

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Results - % of Removal

- Physico-chemical Parameters
  - Ammonia: 98%
  - PAHs: 99%
  - Metals: up to 98%
- Ecotoxicological Parameters
  - Non-toxic

Advantages of Engineered Wetlands

- Low Maintenance
- Low Energy Requirements
  - Solar Powered!
  - Gravity Powered!
- Applicable In Remote Locations Without Utility Access.
- Decreased Emissions And Sludge Production Compared To Conventional WW Treatment Plants

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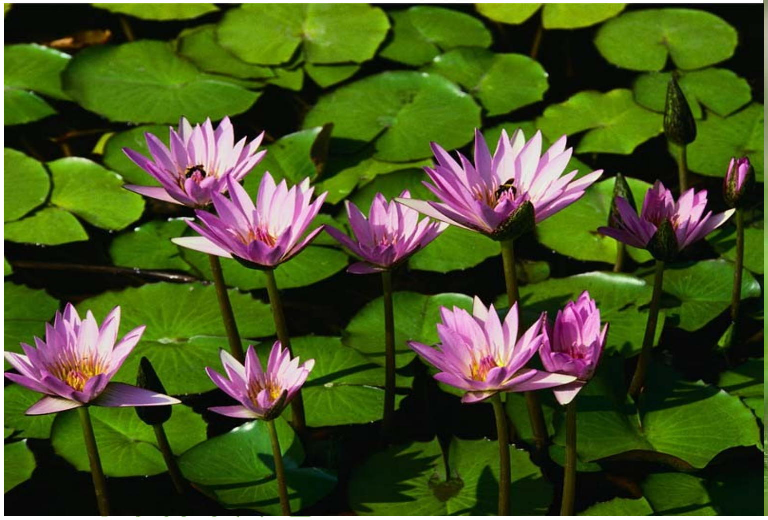
More Advantages…

- Effective Reliable Treatment
- Inexpensive To Construct
- Economical To Operate Due To Low Labour Requirements
- Can Accept Varying Loads
- Tolerant Of Fluctuating Hydrological Conditions
- Able To Remediate Sites With Multiple Or Mixed Contaminants




…Added Benefits

- **Habitat Creation**
- **Favorable Public Perception, Increased Aesthetics and Lower Noise Than Mechanical Systems**
- **Increasing Regulatory Acceptance And Standardization**
- **Lowest Greenhouse Gas Footprint**



Why Engineered Wetlands?

- Plants And Bacteria Work For Free, People And Machines Don’t
- Trade Land for Mechanical Complexity
- Sites with Very Long Time Horizons
- Remote, Difficult to Access Sites
- Life Cycle Cost Savings Due to Low O&M

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Questions?



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