



Ontario First Nations  
Technical Services  
Corporation



**OFNTSC**  
Environment

# Natural Attenuation Landfill Training

Presented by Stephanie Allen, OFNTSC  
and  
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NOFNEC, 2016



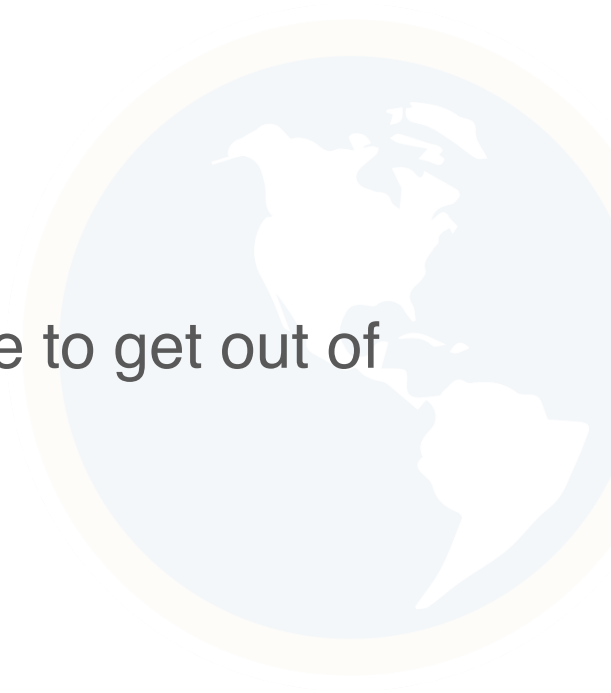




# Welcome

## Introductions

What do you hope to get out of this course?







# Agenda

- Module 1: Natural Attenuation Landfills and Contamination  
(9:00 – 10:30AM)
- Module 2: Setting Goals & Diversion Opportunities  
(10:45AM – 12:15PM)
- Module 3: O&M Part A: Design & Construction  
(1:15 – 2:45PM)
- Module 4: O&M Part B: Best Practices  
(3:00 – 4:30 PM)





# Presentation Goal

To provide you with best practices for the operations and maintenance of a natural attenuation landfill. These best practices concern:

- Environmental protection
- Operational efficiency
- Worker/public health and safety





# Course Objectives

You will be able to:

- Describe best practices for the operation and maintenance of natural attenuation landfill sites
- Apply best practices to programs in your community
- Lead you to preparing an operations and maintenance manual for your individual situation
- Share your experiences and compare your situation with others in the class





# Module 1

## Natural Attenuation Landfills and Contamination

### Module Goal

To introduce you to how a natural attenuation landfill works and to provide an overview of the components of a landfill that have the greatest potential for affecting a community's health, safety and environment.





# Module Objectives

You will be able to:

- Describe how a natural attenuation landfill works
- Describe contamination sources, pathways and receptors
- Identify best practices and legislation related to landfills
- Explain how landfills can affect the environment and human health



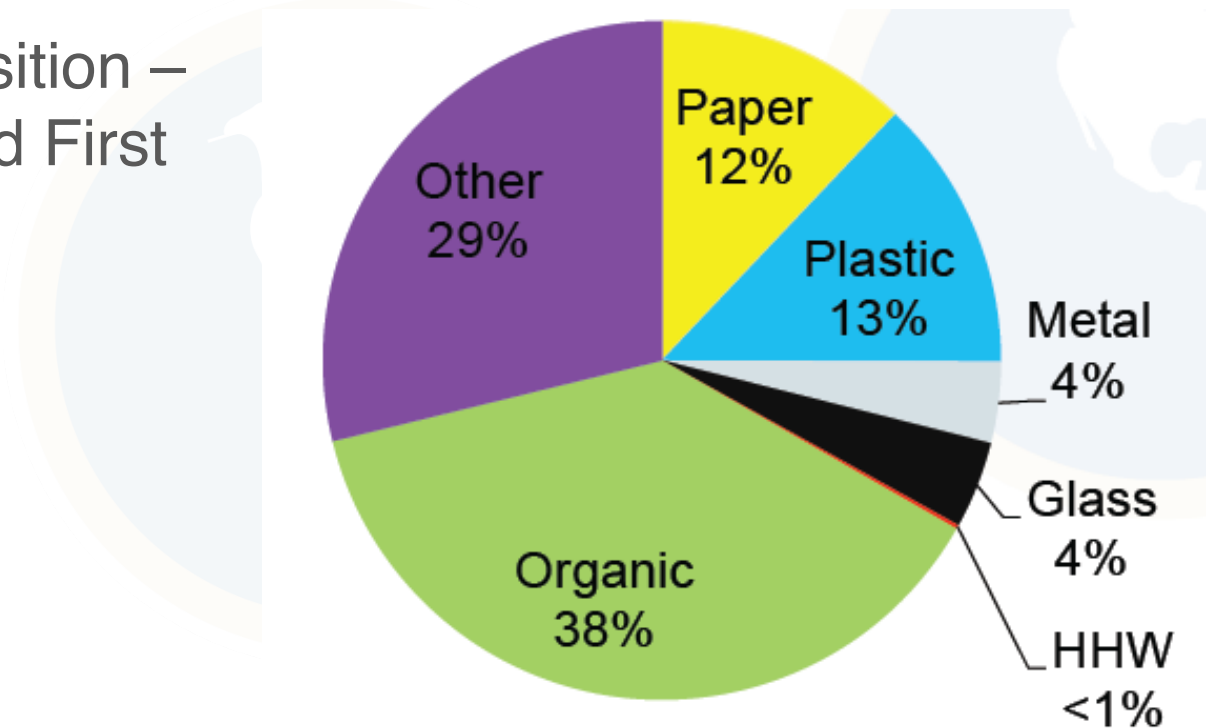
Credit: Peter Cromarty-Chapman, OFNTSC  
Engineering Student Intern, 2015





# What is Solid Waste?

- Typical composition – Georgina Island First Nation





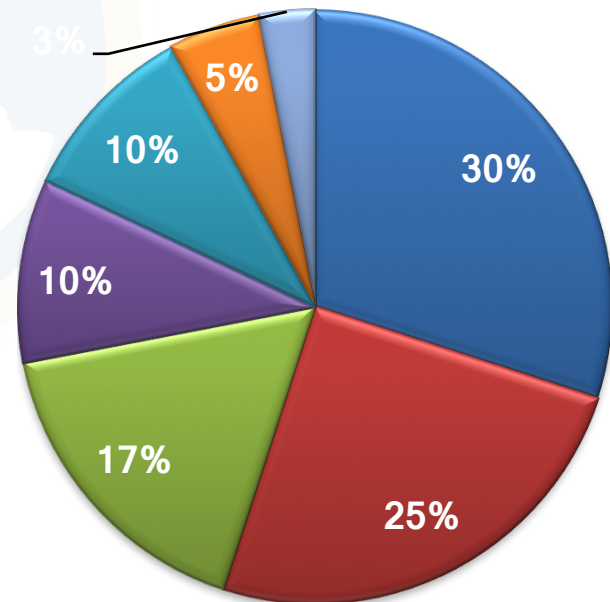


# Waste Management Costs

- Integral part of Community - political and \$\$
- Small communities \$100,000 - \$400,000
- 4% - 10% of annual municipal budgets

**Summary of Waste Management Costs**

	Total	Percent
Wages	\$30,000	30%
Equipment	\$25,000	25%
Consulting/Monitoring	\$17,000	17%
Material/Supplies	\$10,000	10%
Hauling	\$10,000	10%
Repairs/Maintenance	\$5,000	5%
Tipping Fees	\$3,000	3%
Total	\$100,000	







# Legislation

- Federal
  - Canadian Environmental Assessment Act
  - Canadian Environmental Protection Act
  - Fisheries Act
  - Federal regulations are very limited e.g. Indian Reserve Waste Disposal Regulations, CRC, c 960
- Provincial
  - Environmental Protection Act (EPA)
  - Ontario Environmental Assessment Act (EAA)
  - Ontario Regulations don't apply on reserve lands but are referenced as best practice
  - New Waste Free Ontario Act





# Waste Disposal Types

- Three types of facilities:
  - Dump
  - Engineered landfill
  - Natural attenuation landfill







# DUMP

- Usually remote or isolated
- Small waste quantities and serviced population
- Large buffers manage impacts to groundwater, surface water and air quality – including landfill gas.





# Engineered Landfill

Landfilling facility with design features typically includes: berms, drainage ditches, liners, covers, pumps, leachate control system, landfill gas control system



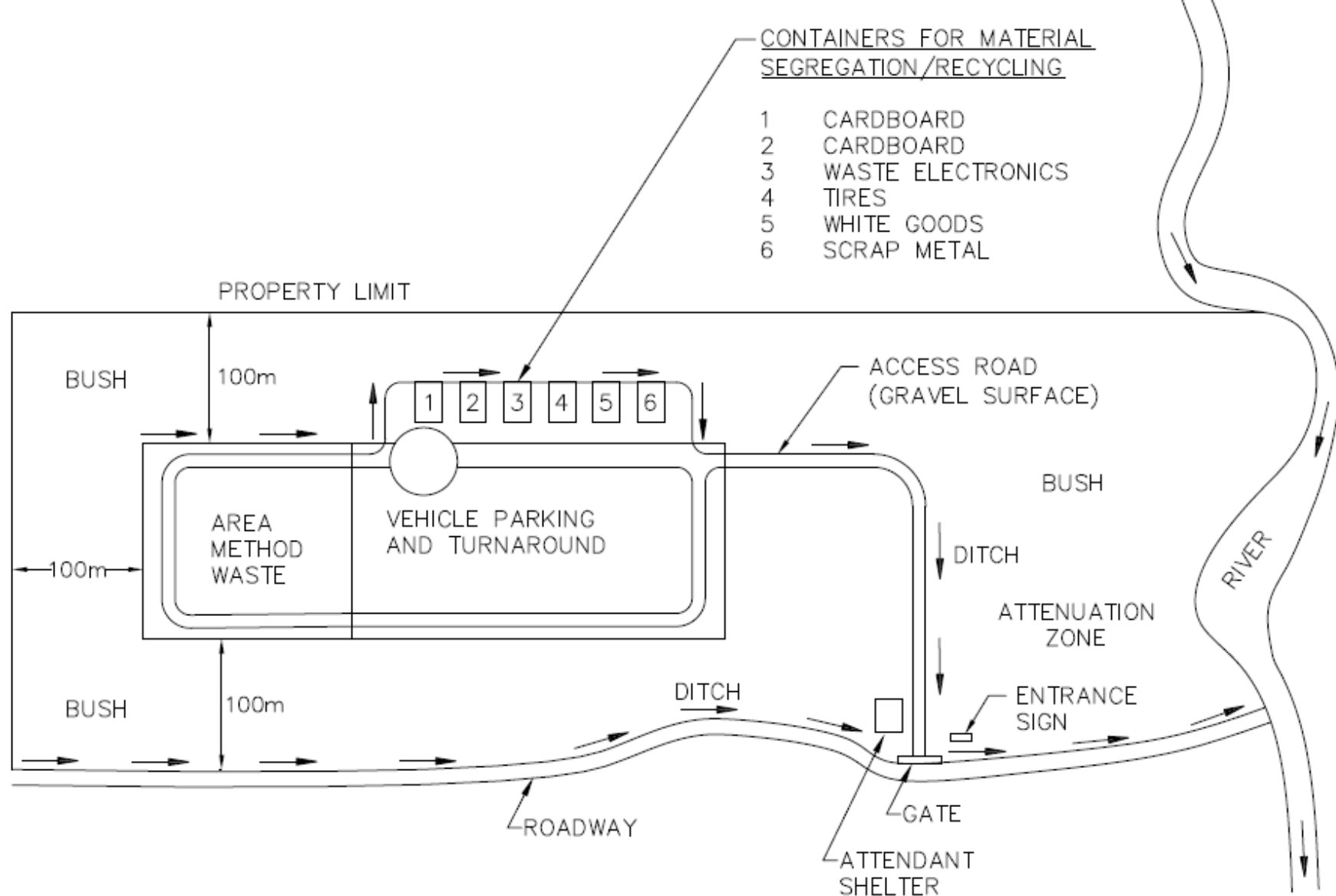


# Natural Attenuation Landfill

- Natural attenuation is the most common form of landfill found on reserve in Ontario.
- Natural Attenuation: The process by which a compound (i.e., leachate) is reduced in concentration over time, through absorption, adsorption, degradation, dilution and/or transformation

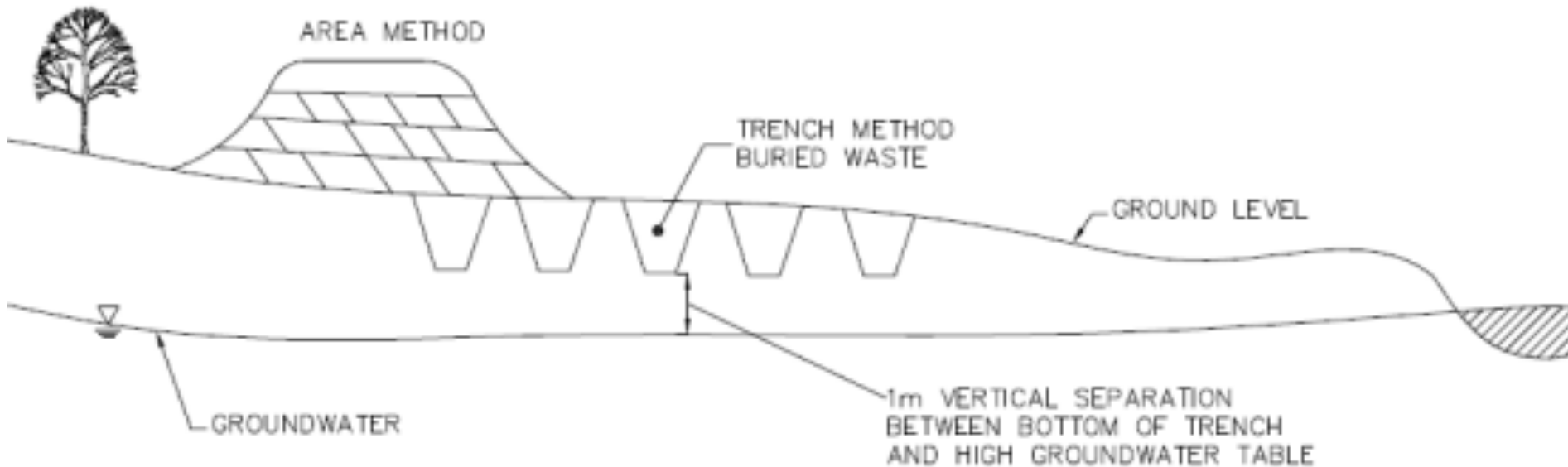






**Typical Natural Attenuation Landfill  
Site Layout - Plan View**





## Site Layout - Section View

Waste can be placed in the following ways:

- Above existing ground (area method)
- Below ground in trenches (trench method)
- Combination of both (modified area method)





# Methods of Waste Placement

- Trench Method
- Area Method



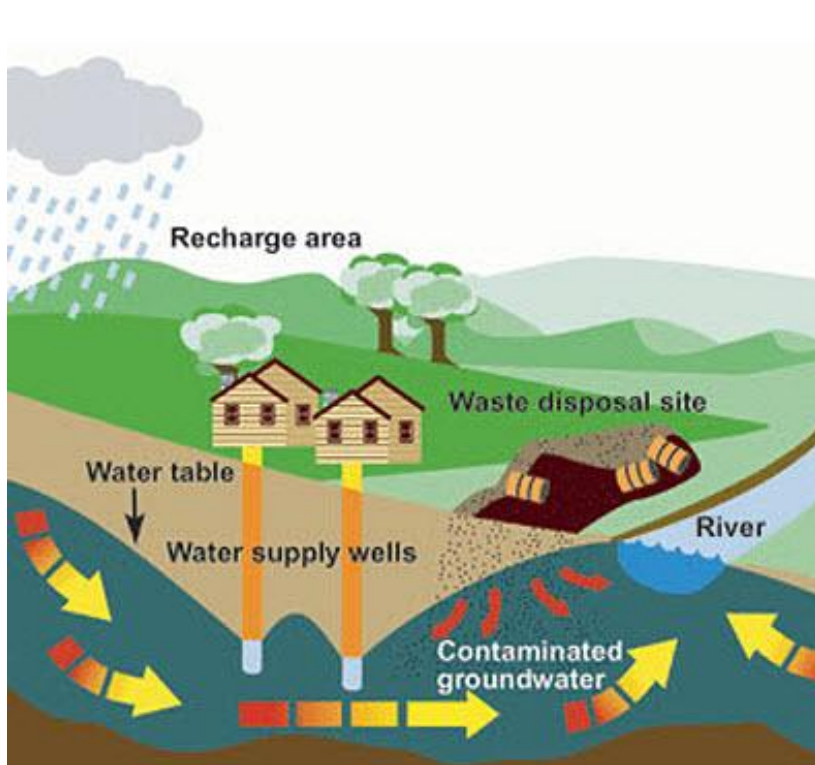
Which method do you use?





# Natural Attenuation Landfill

What are potential impacts from a landfill?

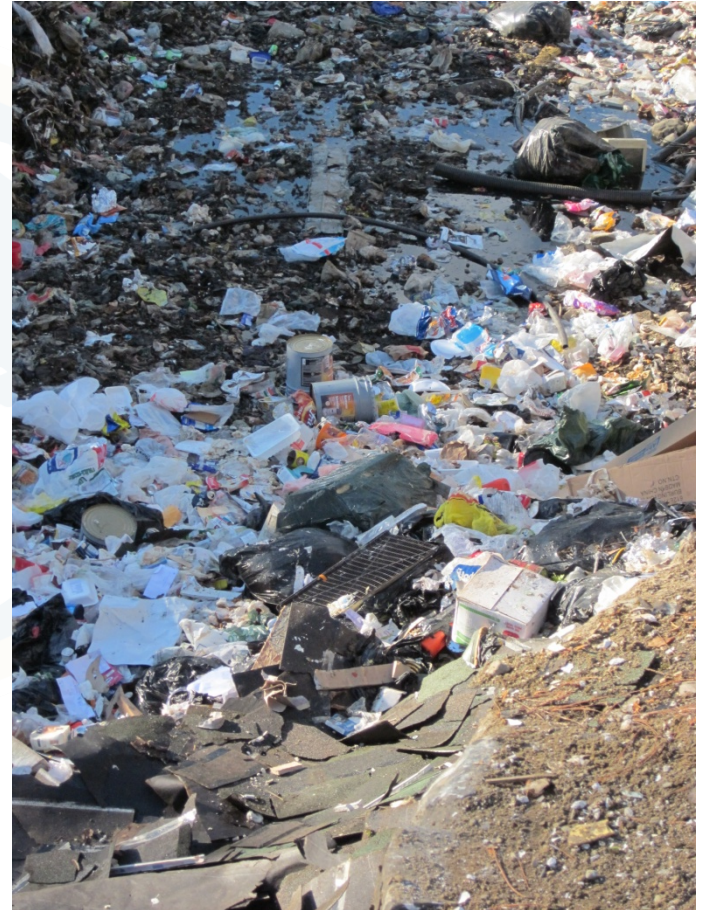






# Potential Landfill Impacts

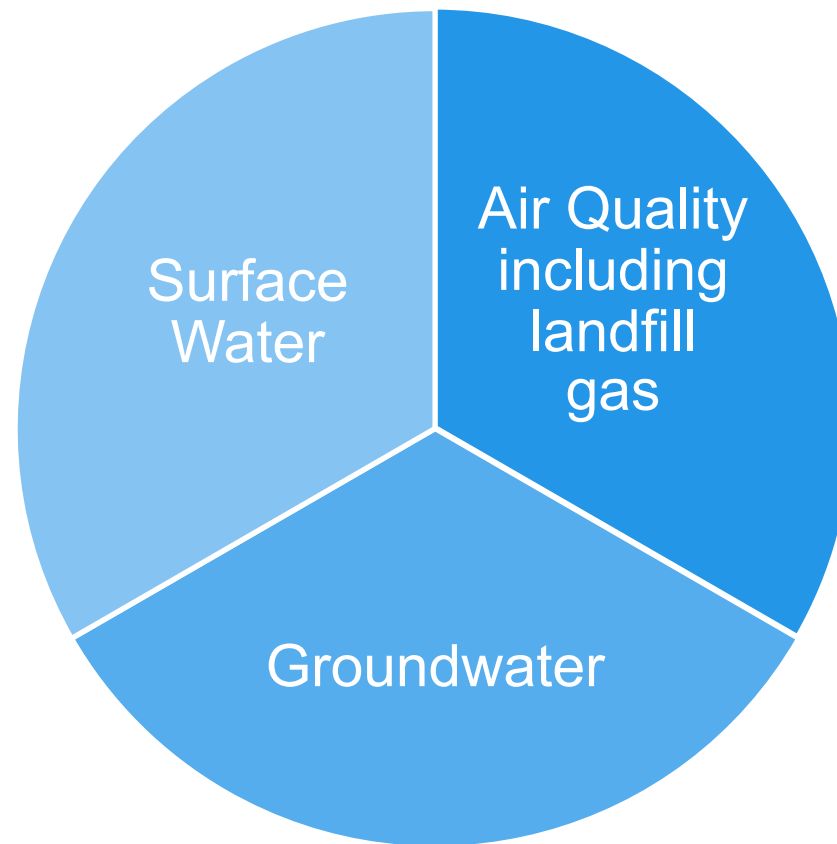
- Contamination of surface water
- Leachate creation and contamination of groundwater
- Landfill gas creation
- Litter, odours, noise
- Disease-causing pests
- Public & worker health & safety







# Contamination Pathways







# Surface Water



Runoff from landfills, if improperly diverted, can enter naturally occurring streams, lakes, or other waterways. This causes harm to local ecosystems and human health through the spread of bacteria, toxic chemicals, and heavy metals.





# Landfill Gas

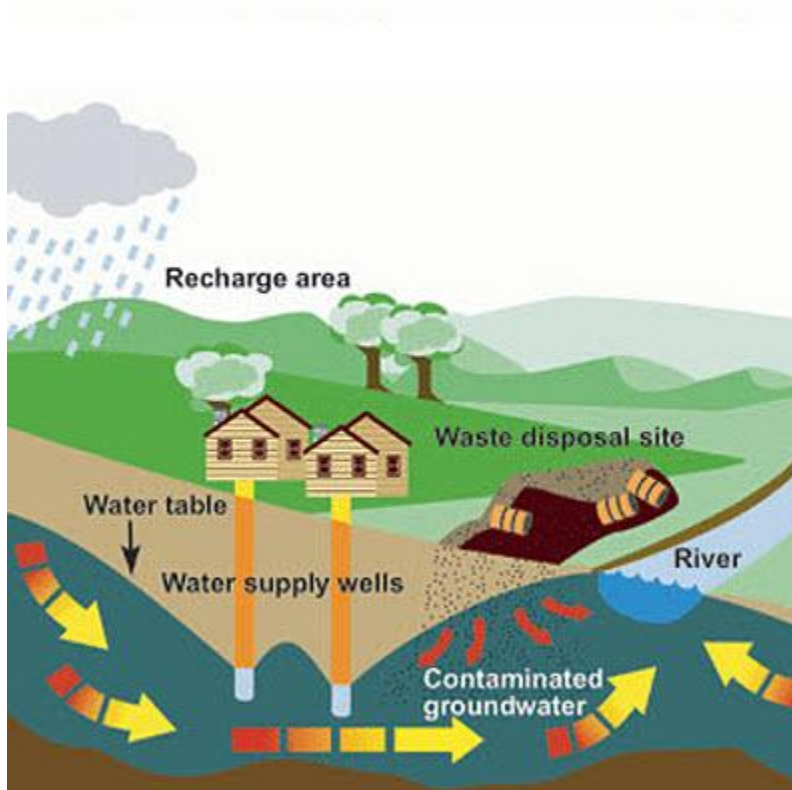


Decomposition of organic wastes in landfills causes the formation of landfill gas, which is mostly methane and carbon dioxide. Landfill gas migrates through waste and the surrounding soil, and if a buildup of gas occurs, can asphyxiate humans, animals and vegetation, and can even cause explosions.





# Groundwater



Leachate from landfills can seep underground and contaminate the underlying groundwater. Depending on how the groundwater is being used, there could be serious long-term health hazards that affect the community. Any plants, animals, birds or fish that depend on that groundwater source can also be threatened by the contamination.





# For Natural Attenuation Landfills, leachate is the most significant consideration



- Formed when water contacts waste
- May spread harmful bacteria
- Can contain toxic chemicals
- May carry heavy metals
- Depletes waterways of oxygen





# Risk Assessment



Source

Pathway

Receptor





# Groundwater Sampling

Do you have monitoring wells at your landfill?

Do you regularly sample the groundwater?





# Leachate

## Typical water quality indicators for leachate:

- pH (5.3 – 8.5, typical 6)
- Electrical conductance (e.g. chloride 100 – 3,000)
- BOD (5-day BOD 2,000 – 30,000)
- COD (3,000 – 45,000)
- TSS (200 – 1,000)
- Ammonia (10 – 800)

\*\*many parameters vary by age of landfill





# Which boreholes show evidence of leachate impact ?

Parameters

Alkalinity

Chloride

Ammonia

Total Kjeldahl Nitrogen  
(TKN)

Boron

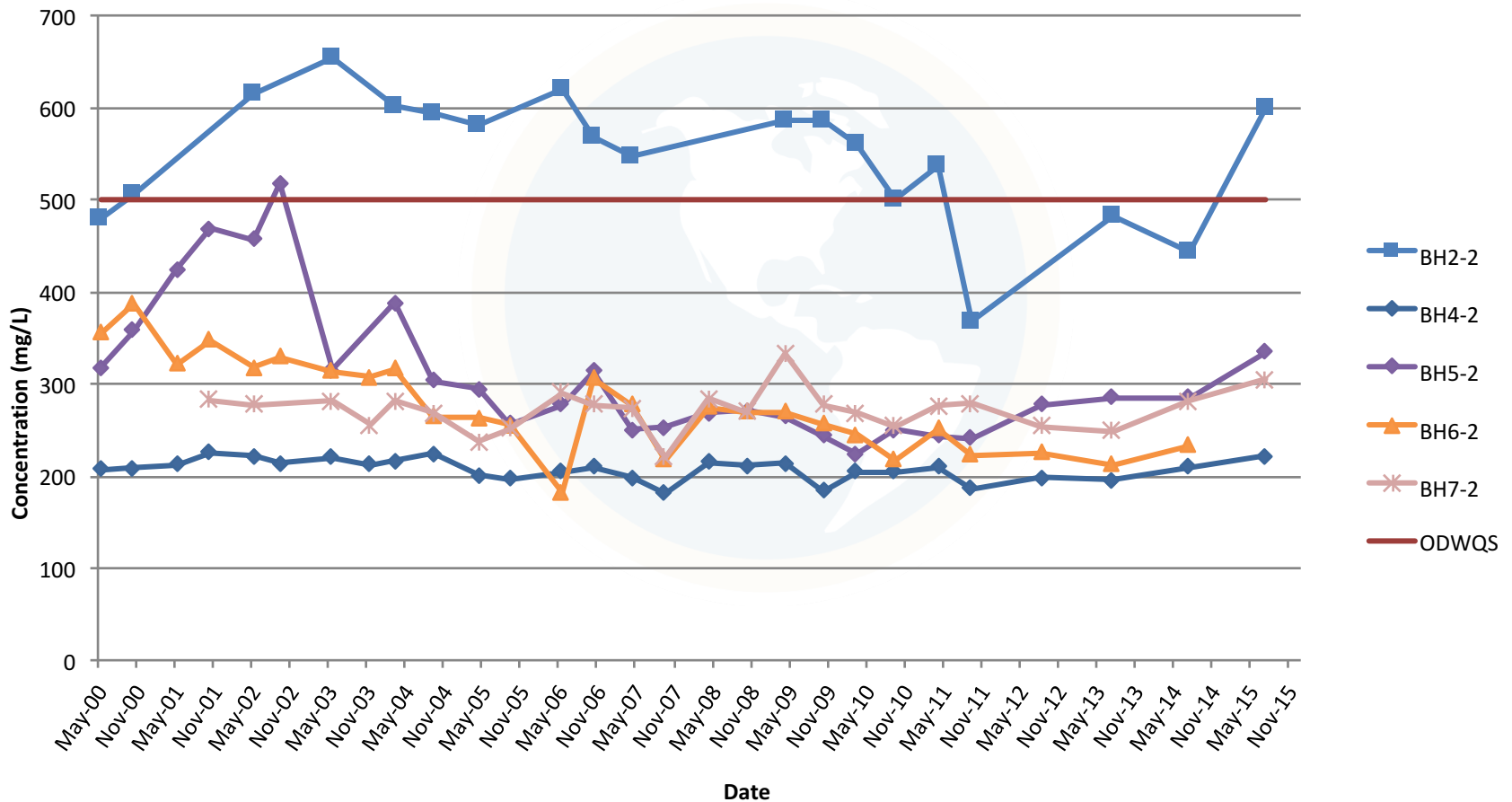
Iron

Chain of Custody Number: 100			Matrix:				
LAB ID:			838833	838834	838835	838836	838837
Sample Date:			2010-10-20	2010-10-20	2010-10-20	2010-10-20	2010-10-20
Sample ID:			BH96-1	BH96-2/2	BH96-3	BH96-4	BH07-1D
PARAMETER	UNITS	MRL					
Alkalinity as CaCO <sub>3</sub>	mg/L	5	446	279	309	81	238
Chloride	mg/L	1	97	4	<1	2	<1
Conductivity	uS/cm	5	1180	524	775	184	442
Fluoride	mg/L	0.1	<0.10	0.10	0.14	0.16	0.14
Hydrogen Sulphide	mg/L	0.01	1.40	<1	<1	1.70	<10
N-NH <sub>3</sub> (Ammonia)	mg/L	0.02	2.17	4.99	<0.02	0.04	0.39
N-NO <sub>2</sub> (Nitrite)	mg/L	0.1	<0.10	<0.10	<0.10	<0.10	<0.10
N-NO <sub>3</sub> (Nitrate)	mg/L	0.1	<0.10	<0.10	0.29	<0.10	<0.10
Sulphate	mg/L	1	46	<1	104	13	6
Total Dissolved Solids (COND - CALC)	mg/L	5	767	341	504	120	287
Total Kjeldahl Nitrogen	mg/L	0.1	3.27	5.74	<0.10	<0.10	0.68
Turbidity	NTU	0.1	100	>100	86.0	>100	>100
Hardness as CaCO <sub>3</sub>	mg/L	1	515	265	306	94	231
Calcium	mg/L	1	165	83	65	26	58
Magnesium	mg/L	1	25	14	35	7	21
Potassium	mg/L	1	6	6	6	<1	3
Sodium	mg/L	2	59	8	65	<2	8
Aluminum	mg/L	0.01	0.01	0.07	0.05	0.17	0.08
Antimony	mg/L	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Arsenic	mg/L	0.001	<0.01	<0.001	<0.001	<0.001	<0.01
Barium	mg/L	0.01	0.06	0.19	0.03	0.01	0.02
Beryllium	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Boron	mg/L	0.01	0.23	0.07	0.04	<0.01	0.02
Cadmium	mg/L	0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Chromium	mg/L	0.001	0.005	0.005	0.002	0.003	0.004
Cobalt	mg/L	0.0002	0.0049	0.0043	0.0088	0.0110	0.0011
Copper	mg/L	0.001	<0.001	<0.001	0.001	0.001	<0.001
Hexavalent Chromium (Cr(VI))	mg/L	0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Iron	mg/L	0.03	10.8	66.3	0.05	0.14	0.34
Lead	mg/L	0.001	<0.001	<0.001	<0.001	<0.001	<0.001





# Alkalinity as a Leachate Indicator







# Groundwater

Groundwater should be monitored on a regular basis.





## Equipment Used in Sampling Water at Landfill

Which field parameters are typically measured?





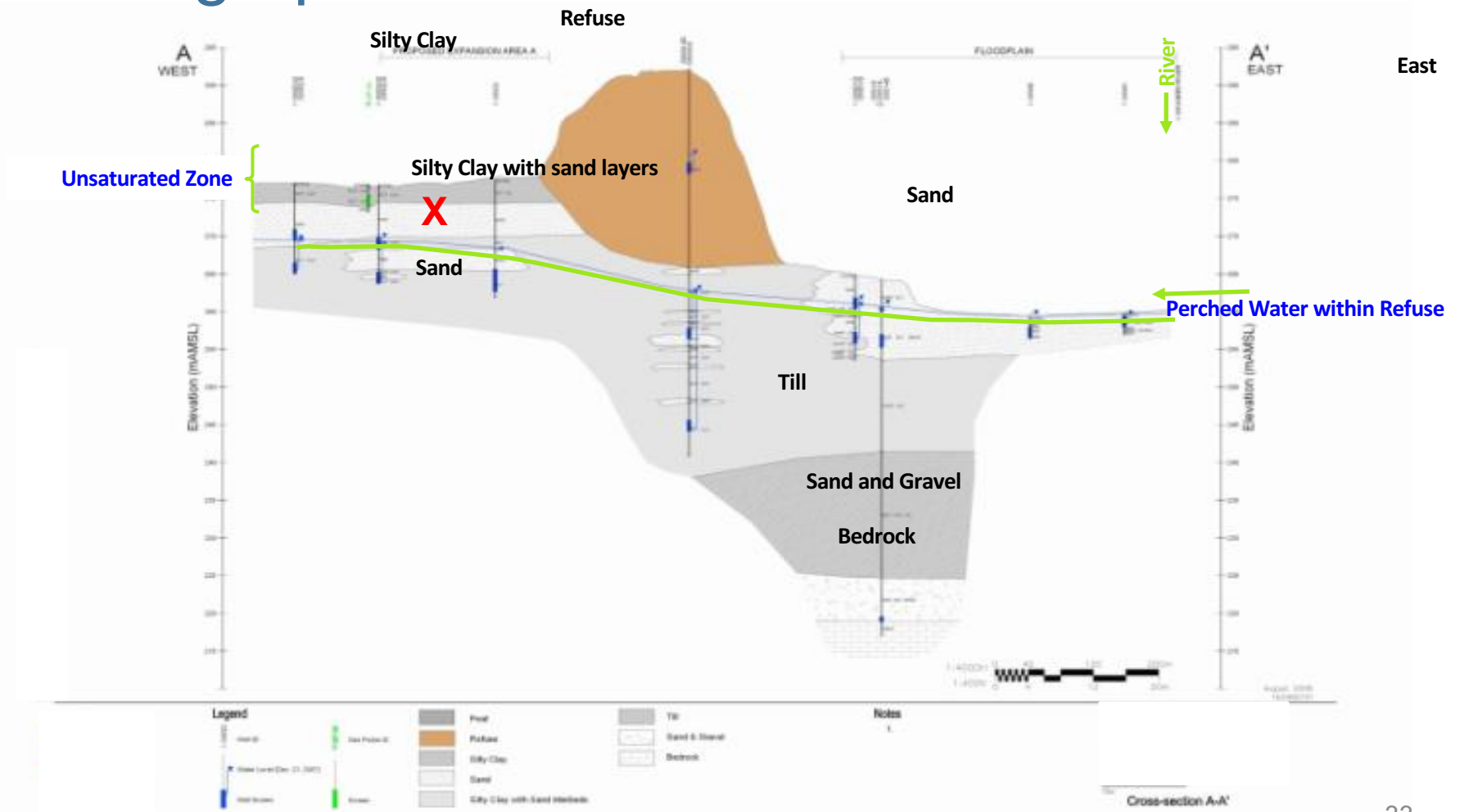
# Hydrogeological Assessment

Required to confirm groundwater flow direction and velocity, depth to ground-water table and groundwater quality.





# Stratigraphic Units – Section







## Soil beneath waste

Soils with moderate hydraulic conductivity such as clays or silts are preferred.



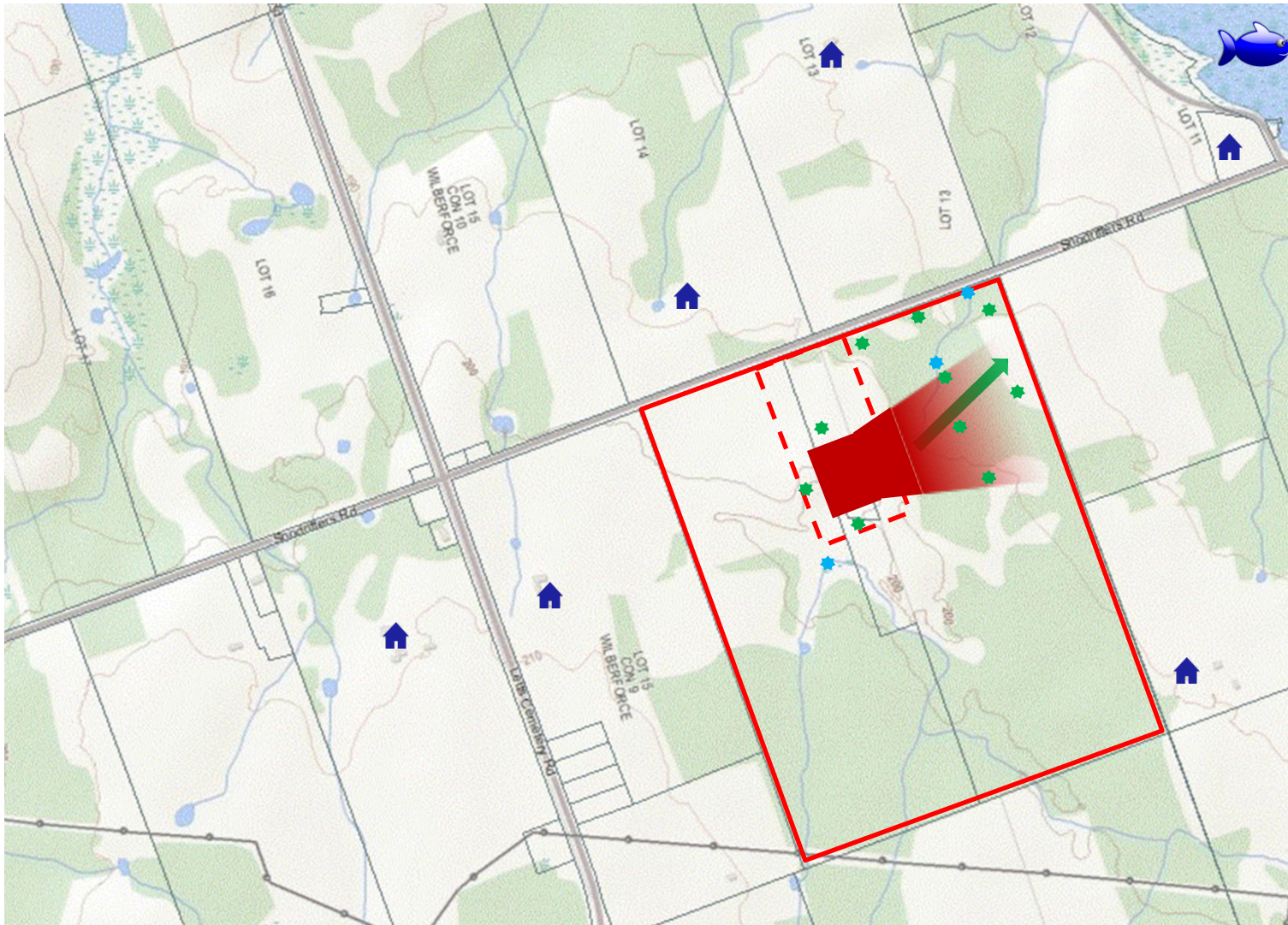


Maintain separation from dwellings, surface water courses and roadway.



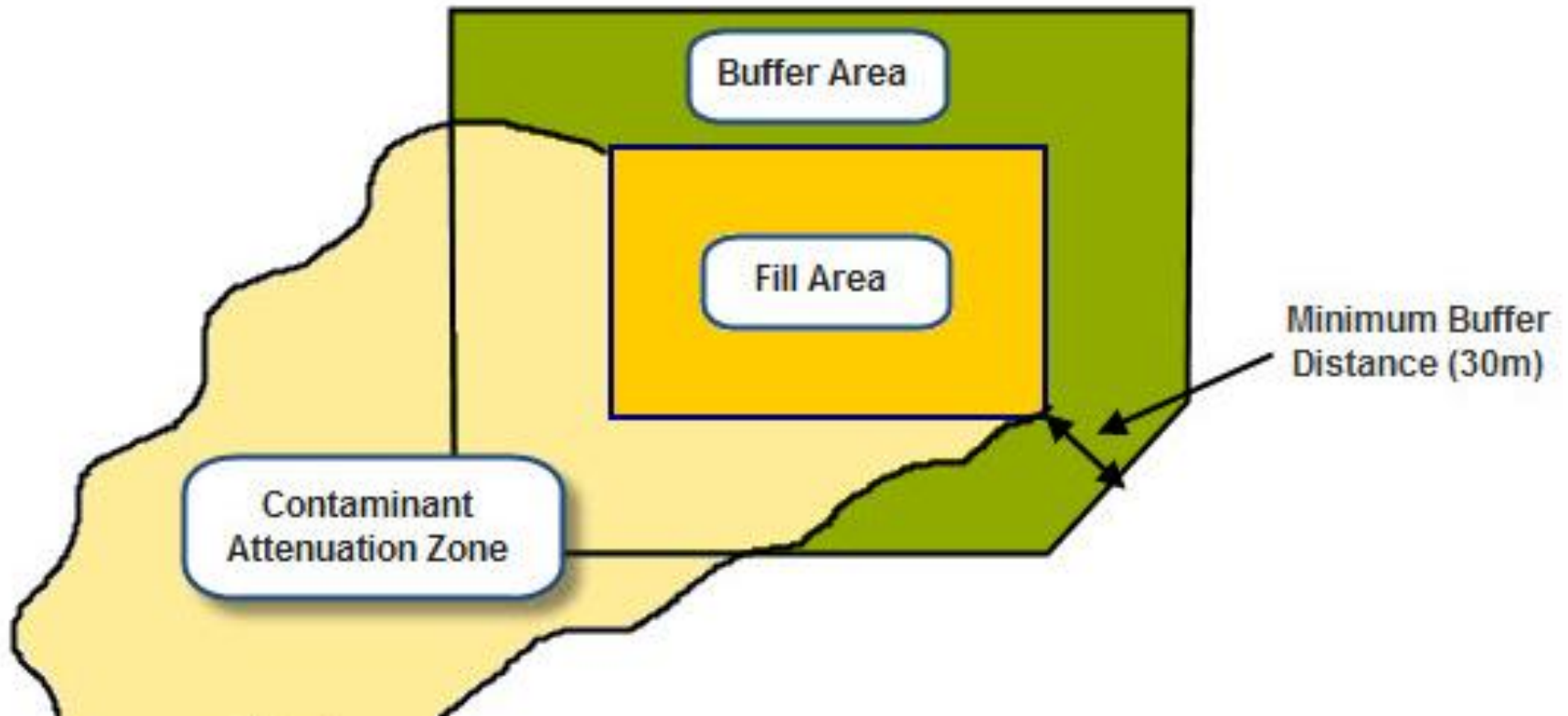


# Managing the Fill Area





## Landfill Buffer Zone



Buffer zone has to be 100m wide at every point unless special permission is granted to reduce to 30m.





# Typical Factors to Consider

- Keep receptors such as residences or other buildings away from waste
- Maintain separation distance to water wells, streams, lakes and highways
- Keep waste above groundwater table
- Waste slopes to prevent failure
- Deposit waste on gently sloping ground
- Waste to be screened from roadway
- Waste on soils with moderate **hydraulic conductivity**
- Site to accommodate large buffer zone





The active face should have a slope draining away from the waste so water doesn't infiltrate





Screened from public view by berms,  
trees or other shrubbery





Apply sufficient daily cover to minimize infiltration, reduce wind-blown debris and minimize exposure to wildlife and humans





# Module Discussion

- ✓ Waste Disposal Types
- ✓ Methods of Waste Placement
- ✓ Risk Assessment
- ✓ Contamination Pathways
- ✓ Hydrogeological Assessment
- ✓ Typical Factors to Consider in Siting