Evapotranspiration covers; Potential biomass feedstock in Kingston, Ontario, Canada

Jaconette Mirck[1,*] and Warren E. Mabee[1,2]
[1]Queen's University, Department of Geography
[2]Queen's University, School of Policy Studies

*Presenting author, email: jmirck@gmail.com

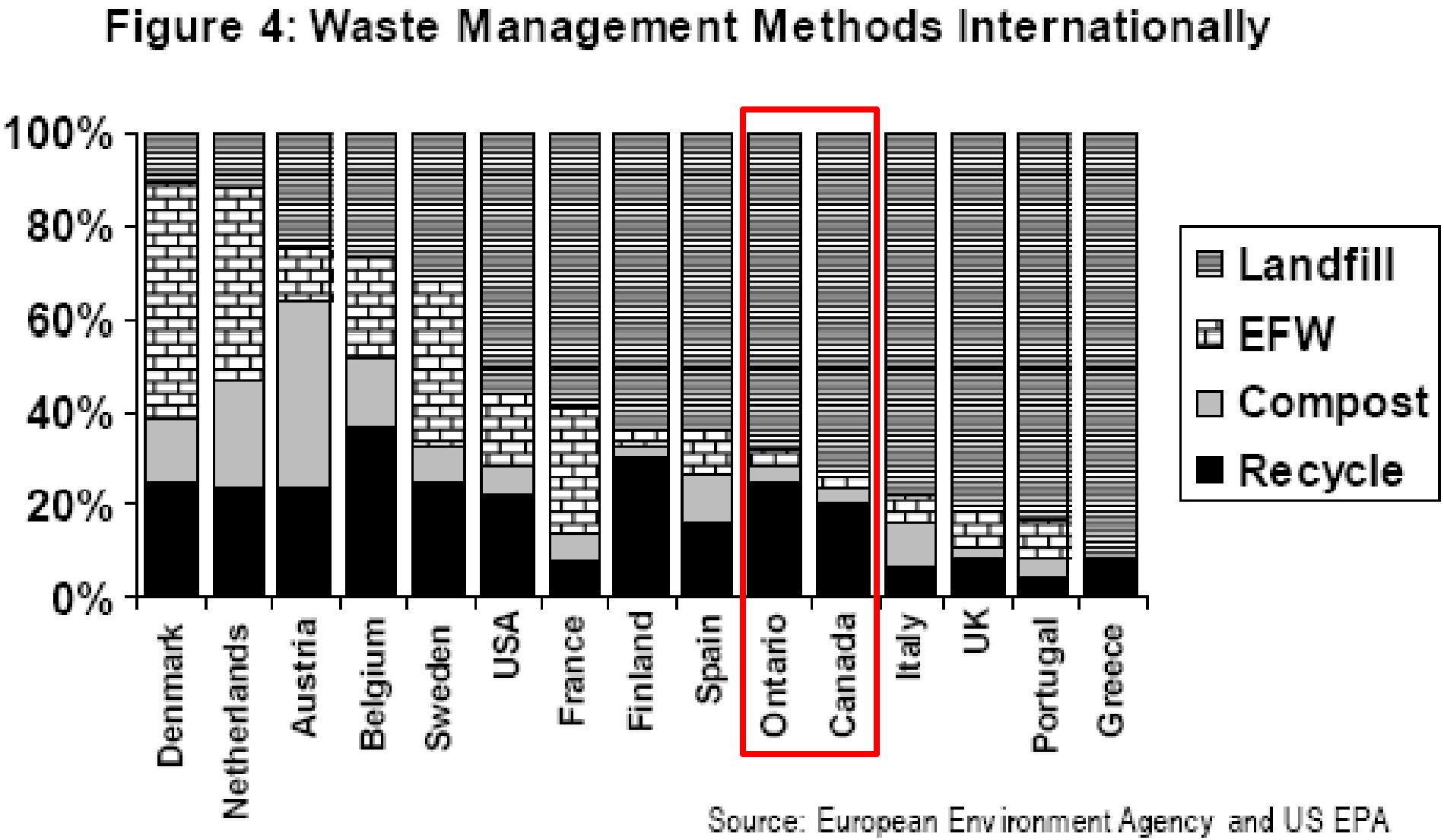
Queen's University

Institute for Energy & Environmental Policy

Objectives

- Designate landfills that have potential for evapotranspiration (ET) cover projects
  - Site history, pollutants, underlain substrate.
- Develop a Geographic Information System (GIS) to map these landfills
- Predict bioenergy production of potential shrub willow ET covers

Waste Management Comparison

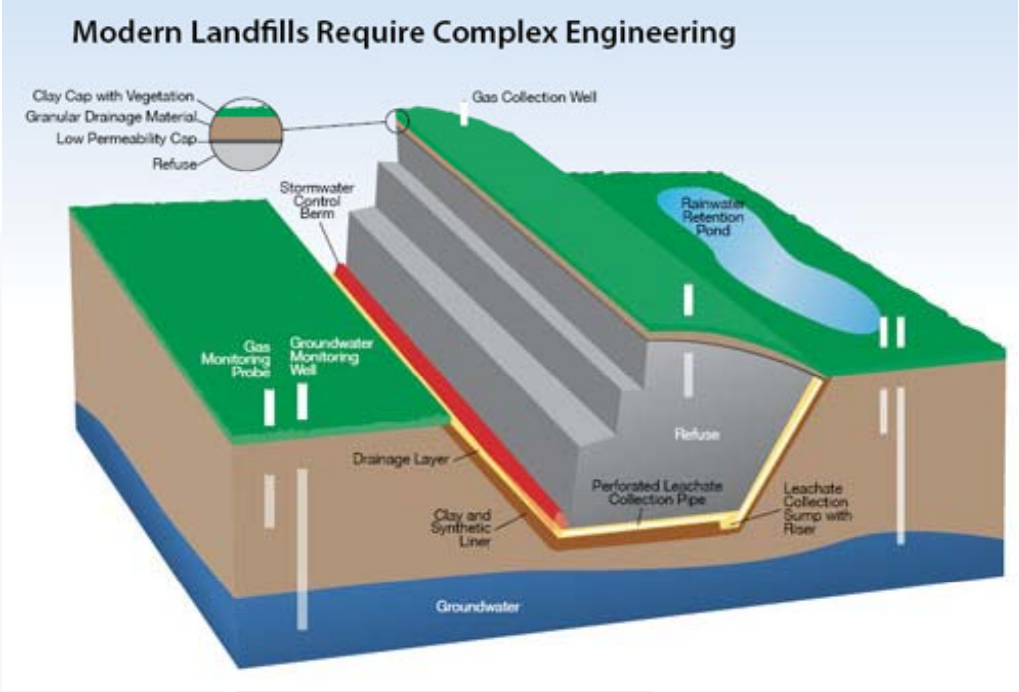


Queens University

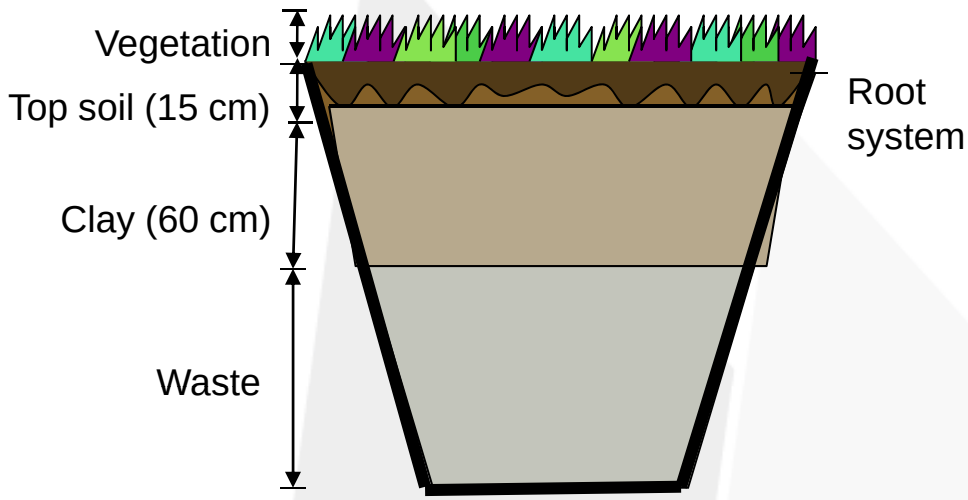
Institute for Energy & Environmental Policy

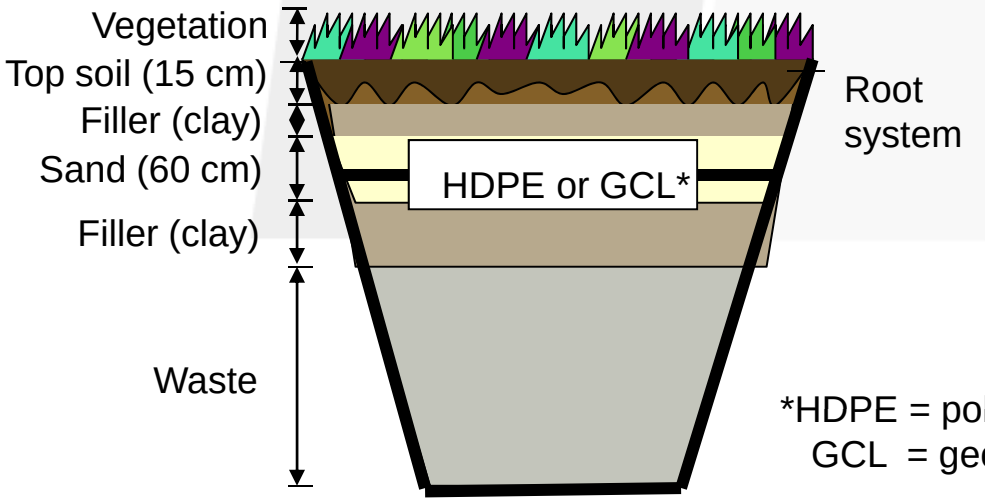
Landfill cover regulations Ontario

- Conventional cover: low permeability soil (clay) + vegetative cover
- Requirements for conventional cover:
  - 60 cm cover material
  - 15 cm top soil
  - Vegetative cover (fully grown in 3rd season)
- Alternative (e.g. ET) covers can be considered
  - ET cover fully developed in 3rd season
- Conventional cover → short approval time
- Alternative cover → more monitoring requirements to show effectiveness

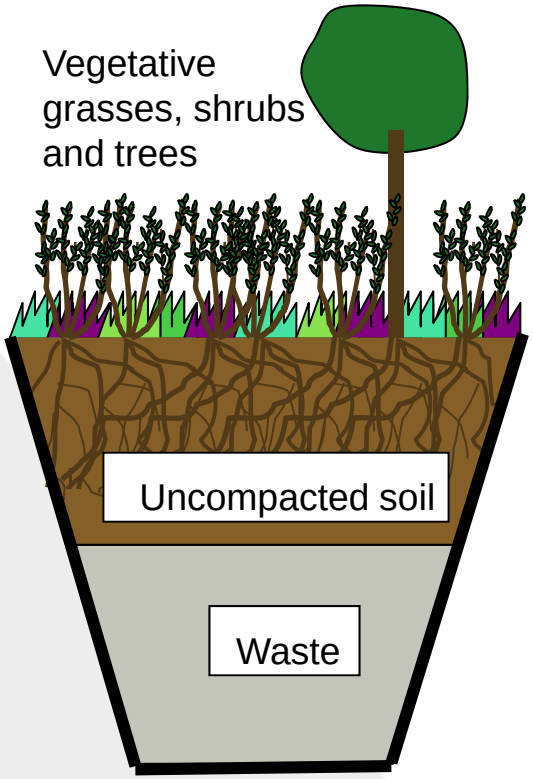


Cover options Ontario





Conventional Covers



Evapotranspiration Cover

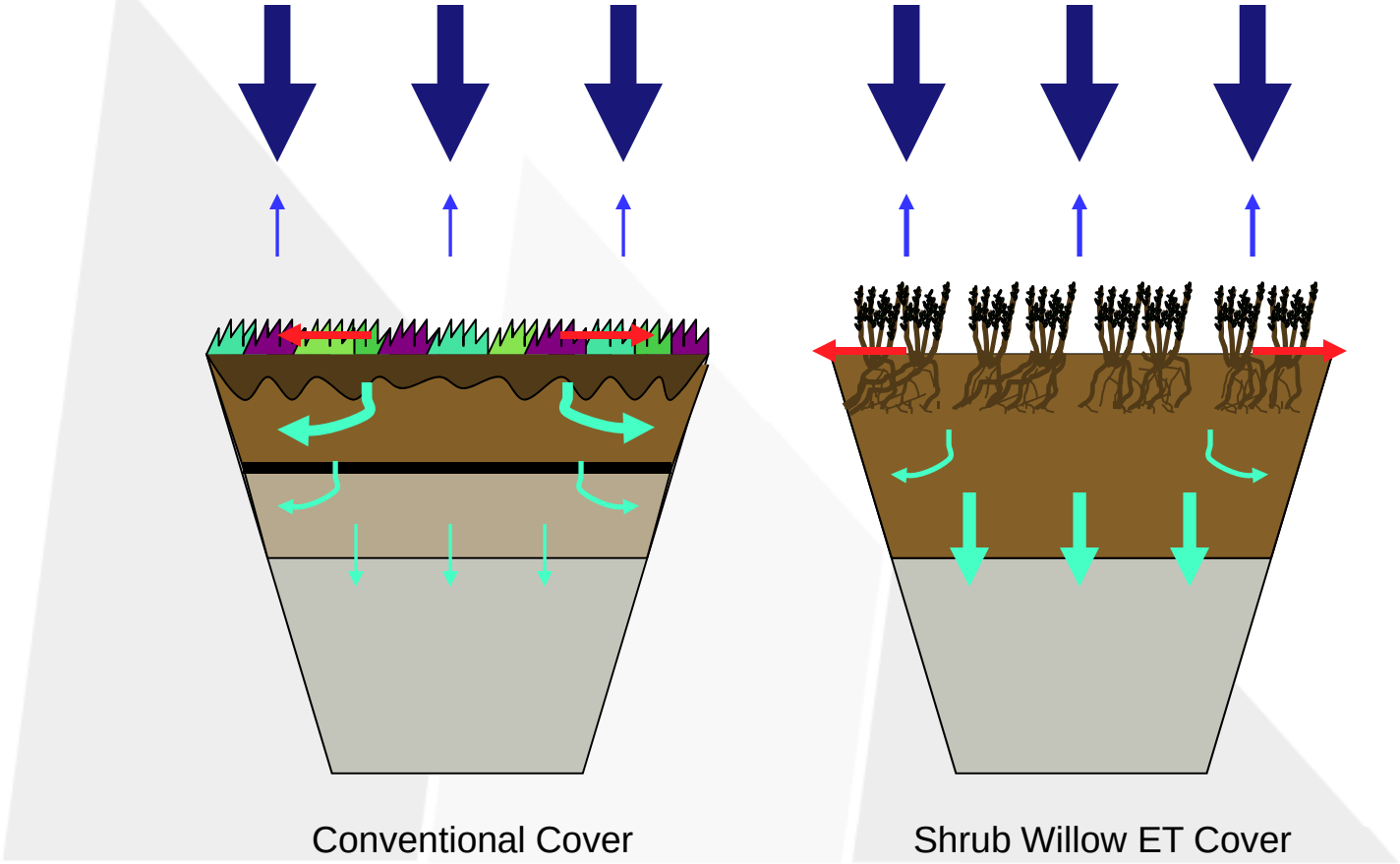
*HDPE = polyethylene liner
GCL = geosynthetic clay liner

Source: Mirck, 2009

Queens University

Institute for Energy & Environmental Policy

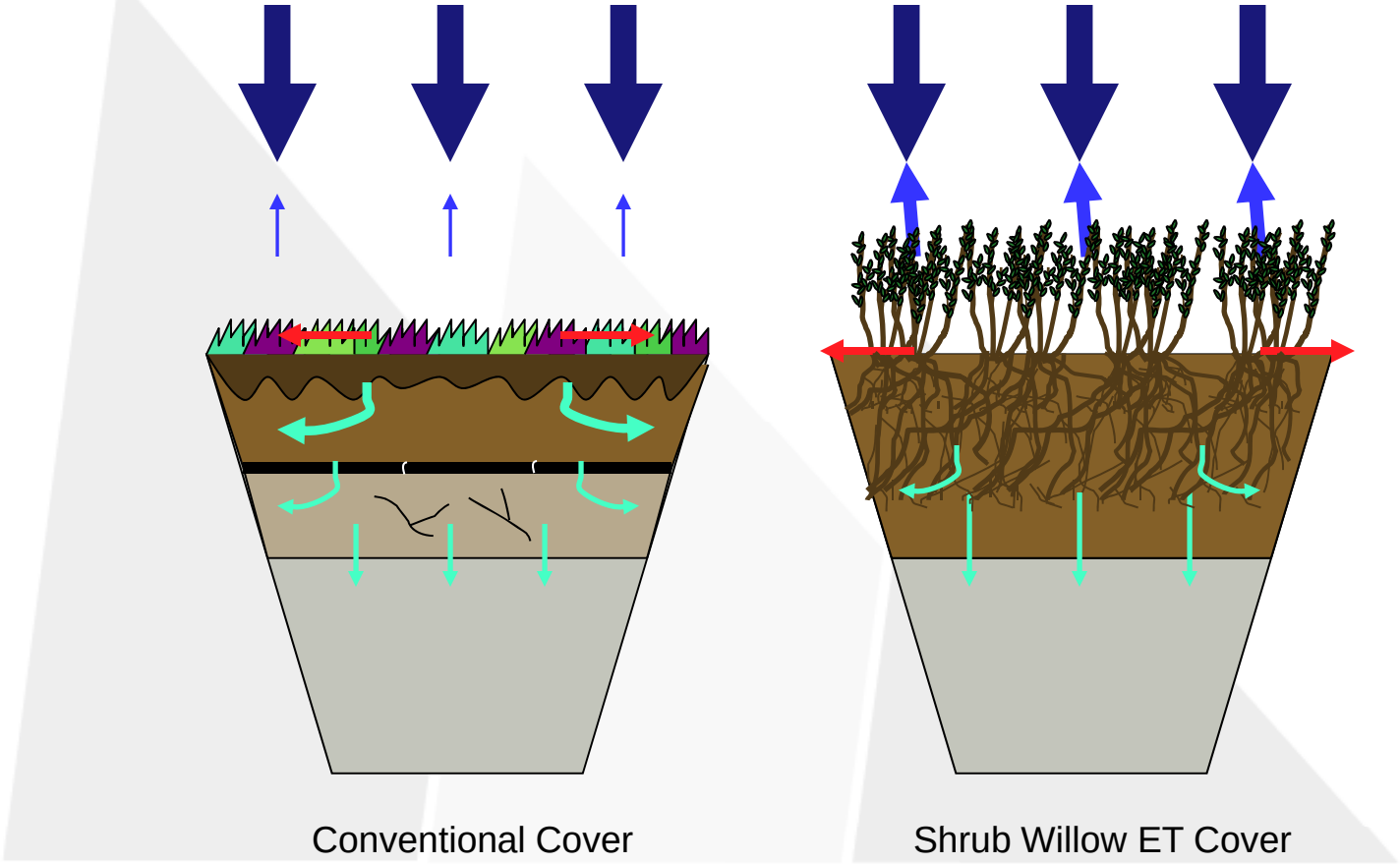
Long-term Performance



Year 1

Source: Mirck, 2009

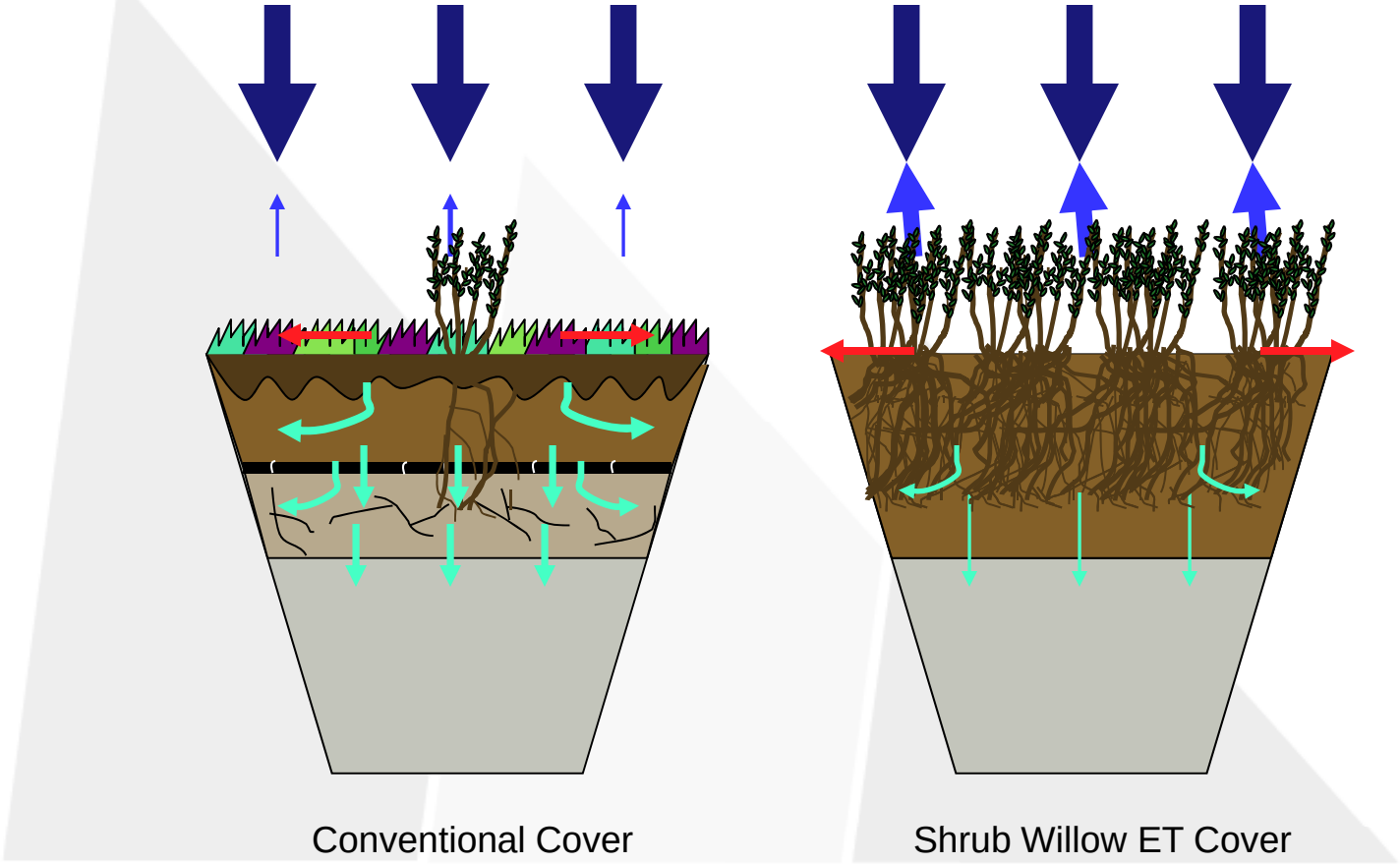
Long-term Performance



Year 4

Source: Mirck, 2009

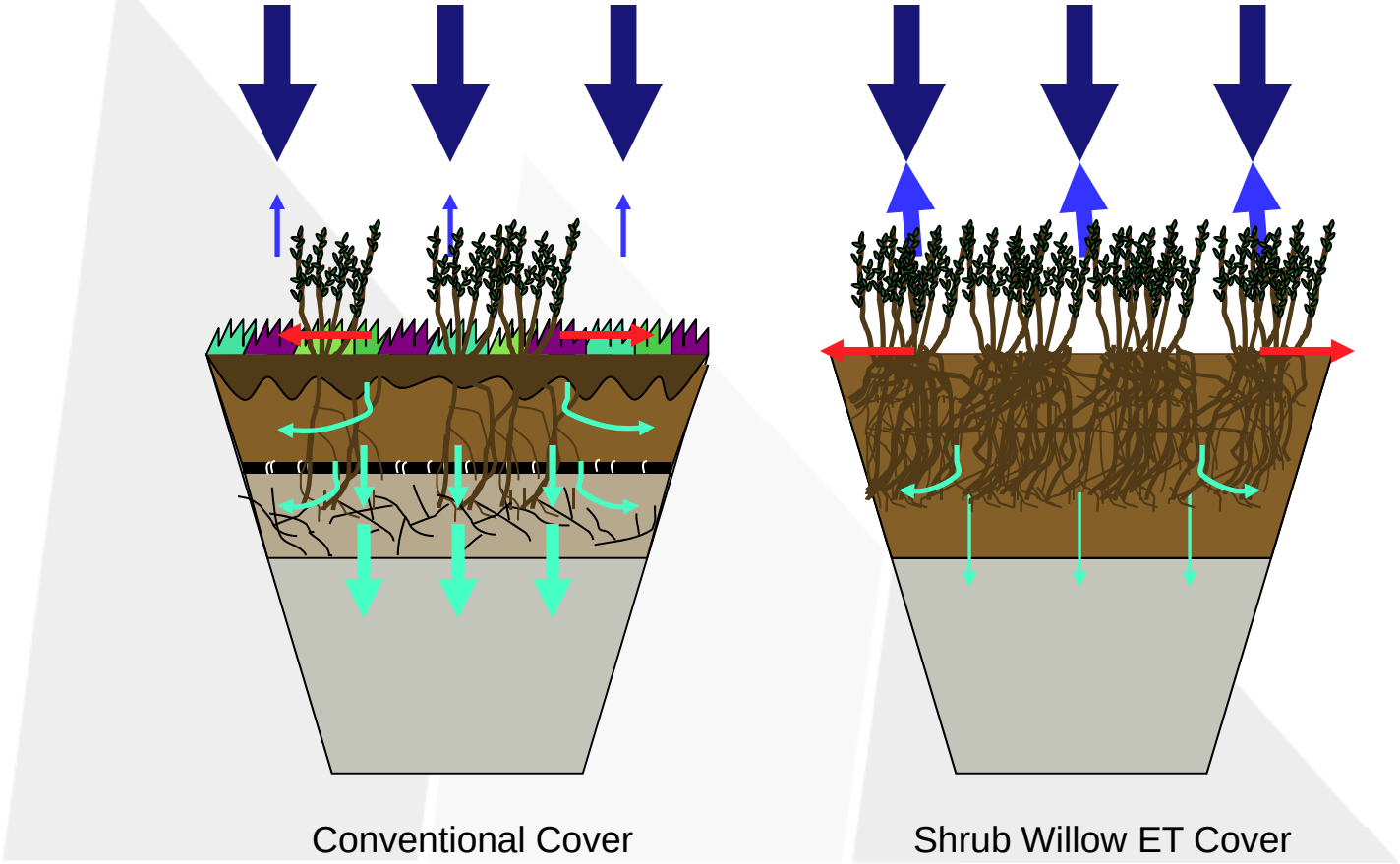
Long-term Performance



Year 10

Source: Mirck, 2009

Long-term Performance



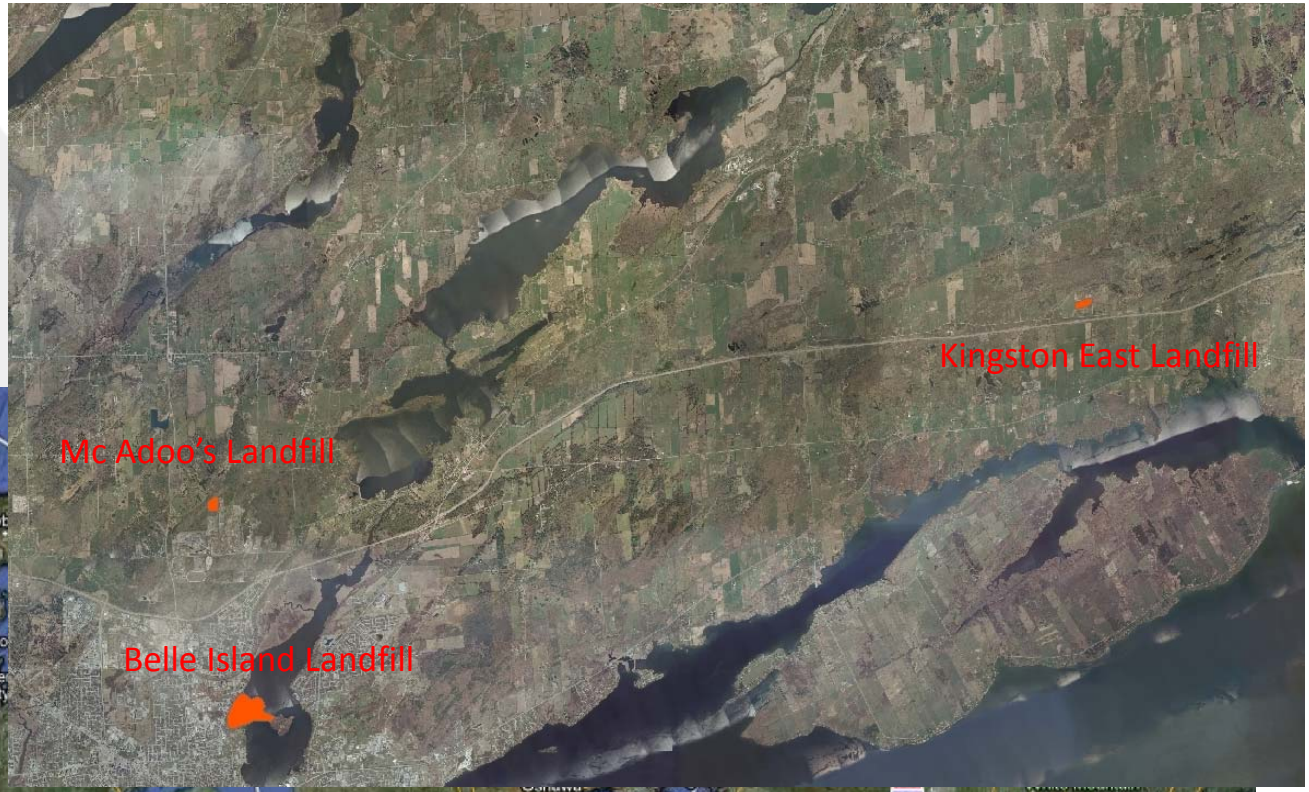
Year 22

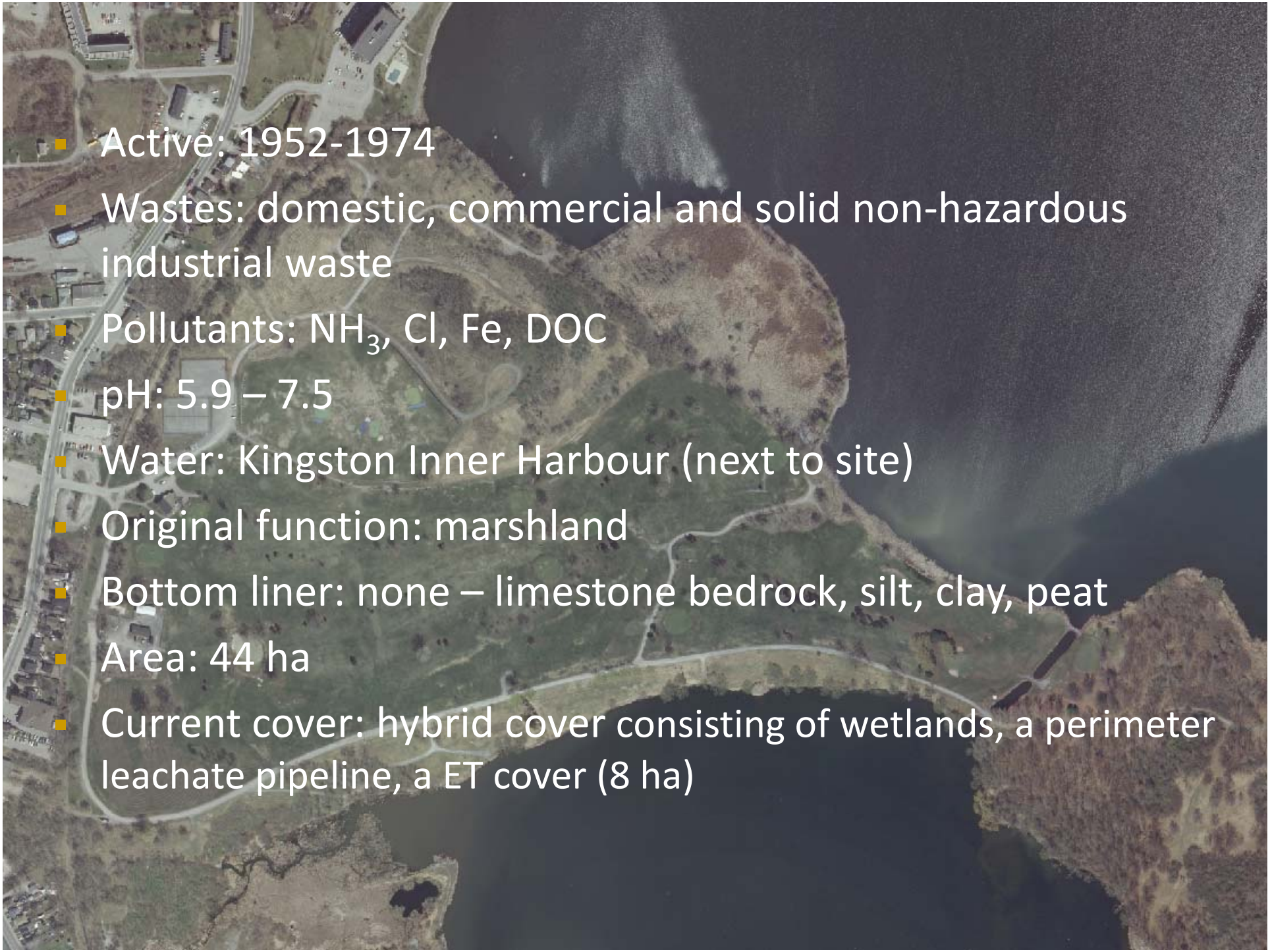
Source: Mirck, 2009

Pros and Cons Conventional and ET Covers

Source: DOE/EM-0558, 2000; Dwyer, 2003	**Conventional Cover**	**ET Cover**
Durability	Insufficient for long-term	Good for long-term
Construction	Difficult	Easier
Cost	High	Lower

Potential Landfills Kingston





- Active: 1952-1974
- Wastes: domestic, commercial and solid non-hazardous industrial waste
- Pollutants: NH_3, Cl, Fe, DOC
- pH: 5.9 – 7.5
- Water: Kingston Inner Harbour (next to site)
- Original function: marshland
- Bottom liner: none – limestone bedrock, silt, clay, peat
- Area: 44 ha
- Current cover: hybrid cover consisting of wetlands, a perimeter leachate pipeline, a ET cover (8 ha)

McAdoo's Landfill

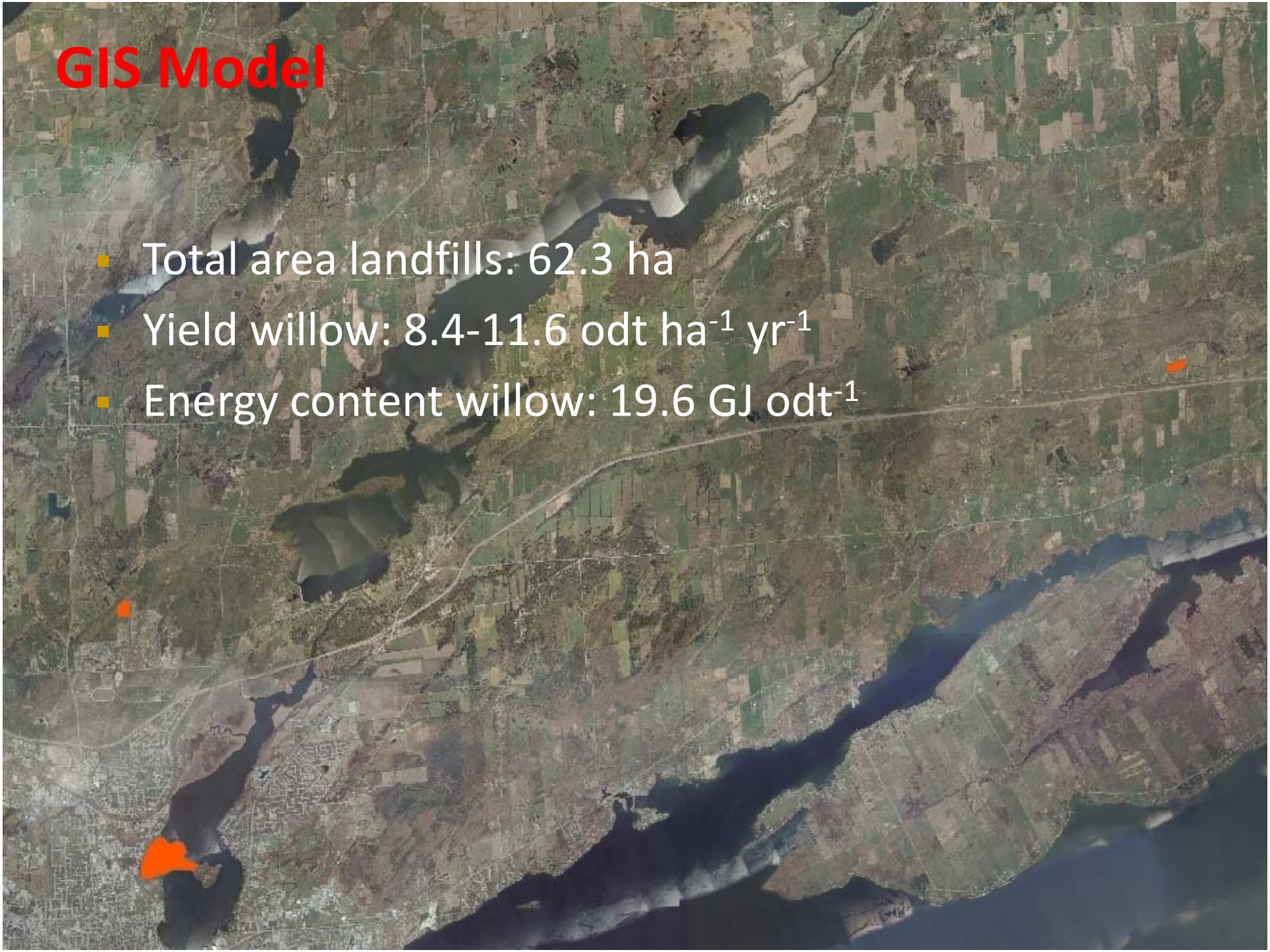
- Active: 1962-1970 (open dump) and 1970-1987 (licensed)
- Wastes: domestic, commercial and solid non-hazardous industrial waste
- Pollutants: $CaCO_3$, DOC, Tot. N, Mg , Chloroform , bromodichloromethane
- pH: 5.4 - 8
- Water: Kingston pond (150 m), Galanis pond (180 m), Little Cataraqui Creek (500 m)
- Original function: swamp
- Bottom liner: none – limestone bedrock, clay, sand, gravel
- Area: 6.3 ha
- Current cover: Clay cap, installed in 1991

Kingston East Landfill

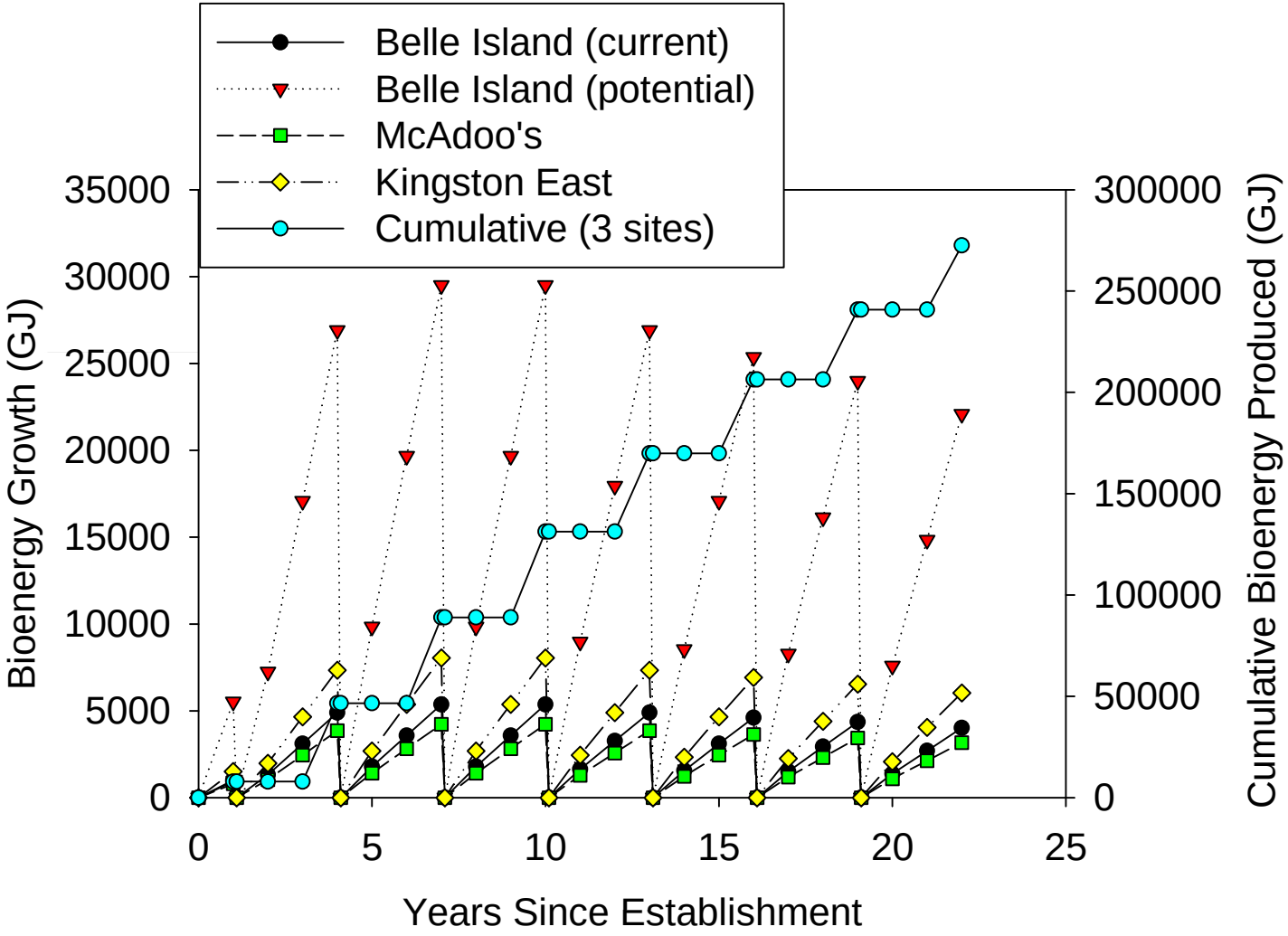
- Active: 1970 - present (near closing)
- Wastes: domestic, commercial and solid non-hazardous industrial waste
- Pollutants: Fe, Mn, P, VOC (could be a concern)
- pH: 6.1-7.8
- Water: North Creek (234 m), beaver pond (onsite)
- Original function: pasture
- Bottom liner: none – limestone bedrock, silt, clay, sand, gravel
- Area: landfill 12.0 ha
- Current cover: None (planned cover: clay, with phased ET cover)

GIS Model

- Total area landfills: 62.3 ha
- Yield willow: 8.4-11.6 odt ha^{-1} yr^{-1}
- Energy content willow: 19.6 GJ odt^{-1}



Bioenergy Production



Queens University

Institute for Energy & Environmental Policy

Conclusion

- Biomass produced in 22 years (life span ET cover):
  - Belle Island Landfill current: 34,496 GJ; potential: 224,224 GJ.
  - McAdoo's: 27,166 GJ
  - Kingston East: 51,744 GJ
  - **Cumulative: 272,518 GJ**
- Energy consumed by one household: 120 GJ yr^{-1}
- Cumulative bioenergy produced can supply about 100 households with electricity or 325 households with heat for 22 years.

Acknowledgement

- I would like to thank the Natural Science and Engineering Research Council of Canada (NSERC) and the Queen's Institute for Energy and Environmental Policy (QIEEP).

Questions?

QUEEN'S INSTITUTE FOR ENERGY & ENVIRONMENTAL POLICY

Queens University

INSTITUTE FOR ENERGY & ENVIRONMENTAL POLICY