Pilot Project: Soil Farm Design for Mosaic Potash Belle Plaine

Josephine Craig Penner (joso.cp@gmail.com), Tommy Lien (t_lien@live.com), Justin Peterson (justin.peterson1638@gmail.com)

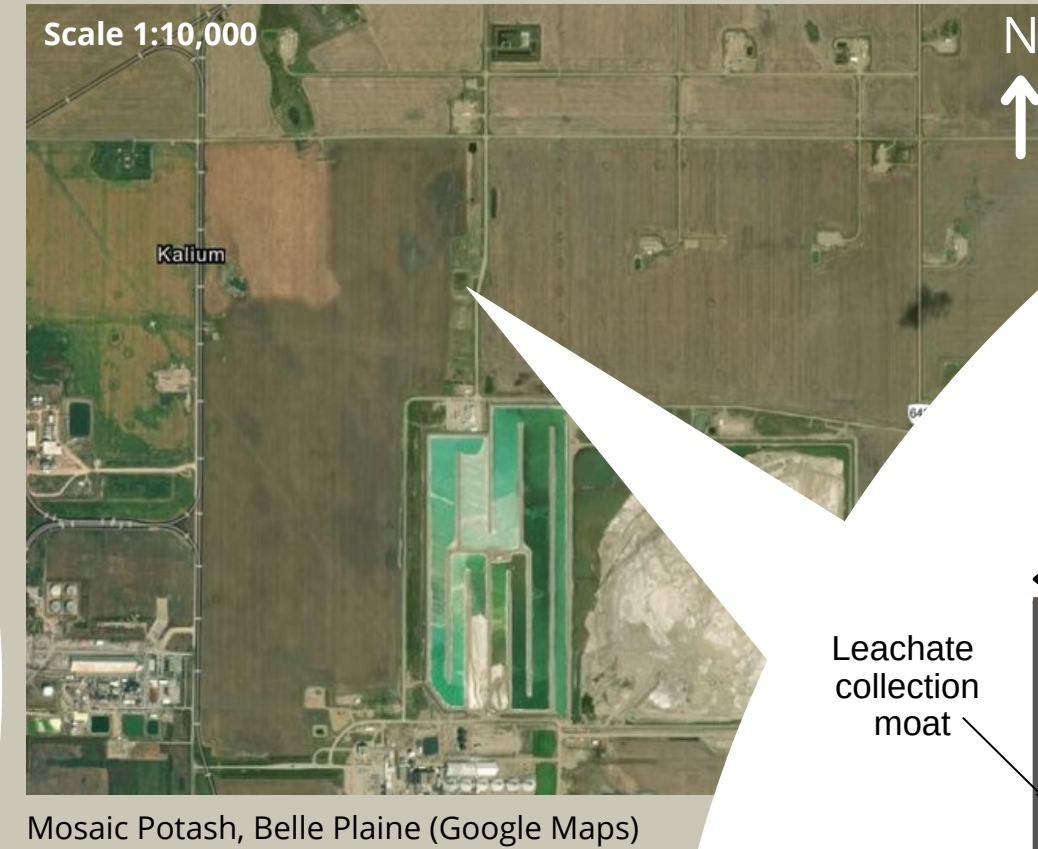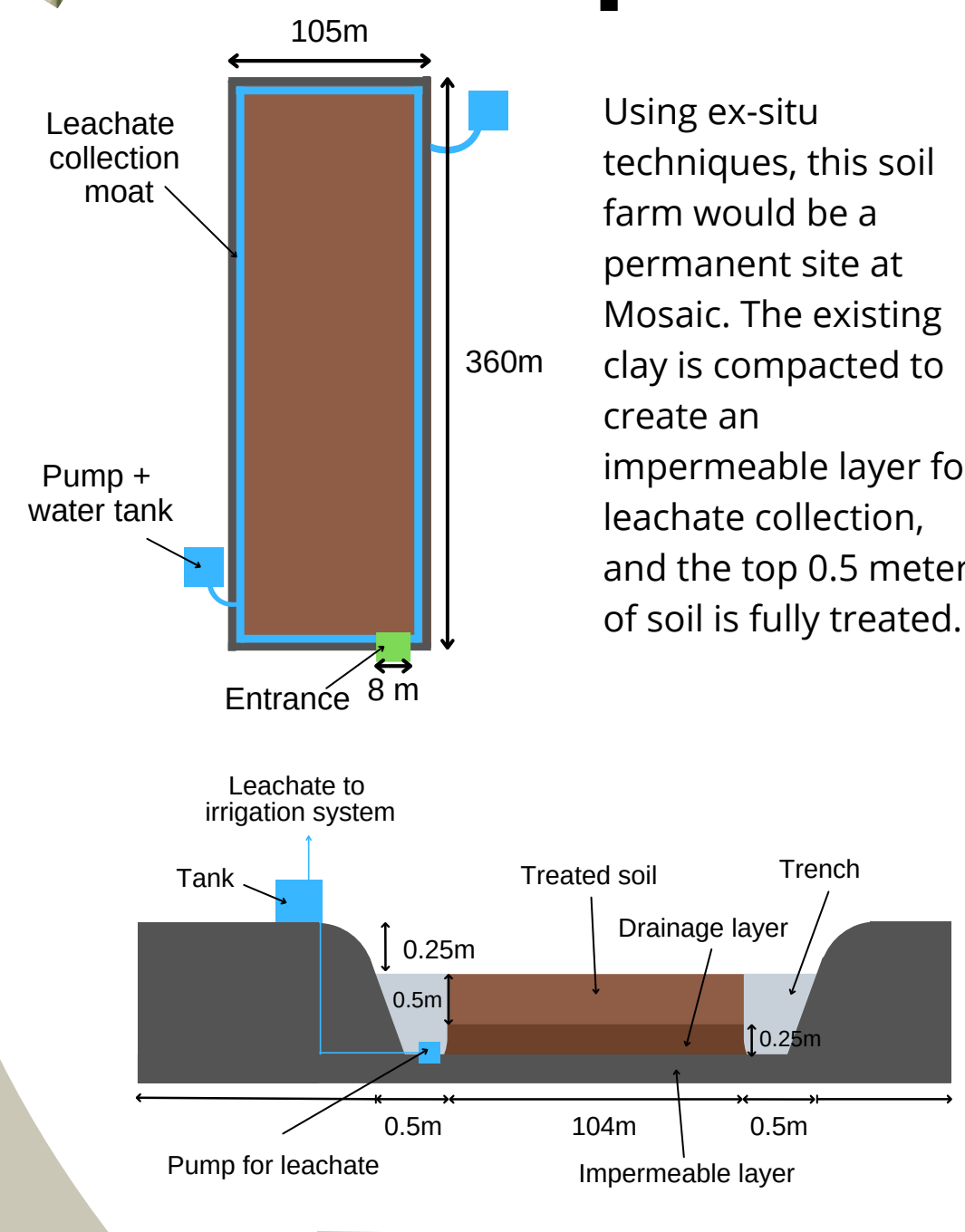Supervisers: Dr. Kelvin Ng (UofR), Erik Wilmot (Mosaic)

Objectives

1 Evaluate and choose a **method of bioremediation** to use at Mosaic's site (Cluster 2) in Belle Plaine.

2 Identify the level of **contamination** within soil located on the site and create an **ArcGis map** to interpolate the 8 hydrocarbon contaminants.

3 Create **designs** of the soil farm alternatives to demonstrate their **dimensions**, **operations**, and **costs**.
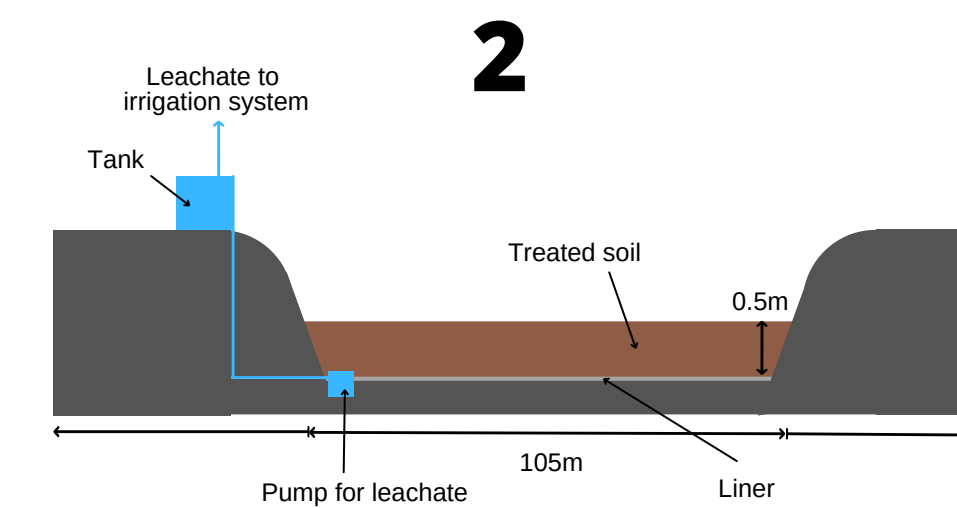
Scale 1:10,000

Mosaic Potash, Belle Plaine (Google Maps)

Contamination Assessment

Hydrocarbon Surface Contamination

Petroleum Hydrocarbons	Guideline (mg/kg)	Average Contamination Level (mg/kg)	Maximum Contamination Level (mg/kg)
Benzene	0.046	0.03	1.2
Toluene	0.12	0.33	12
Ethylbenzene	0.073	0.82	25
Xylenes	0.99	3.57	120
F1-BTEX	30	169	4000
F2	150	3197	58000
F3	300-600	6902	57000
F4 / F4-HTG	2800	654	5700

Cluster 2 Surface Contamination Points

Scale 1:3,400

F3 Contamination Interpolation Map
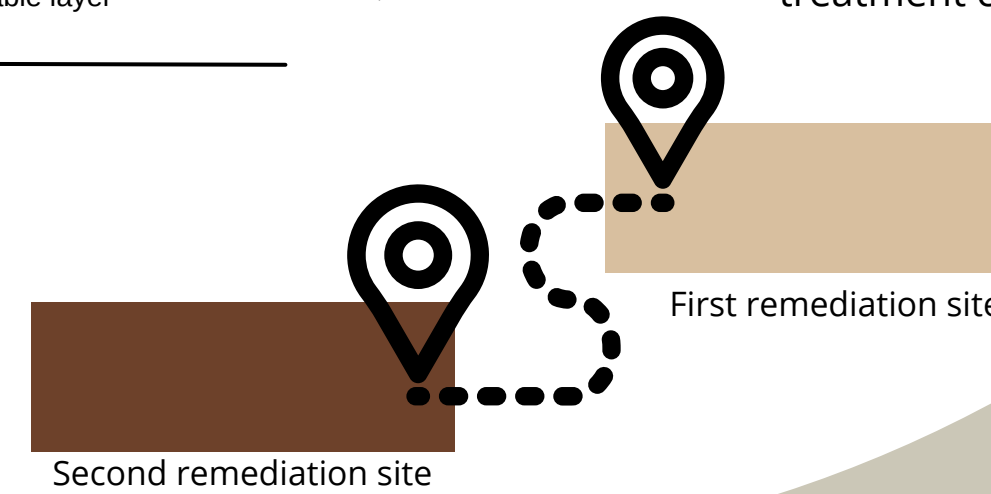
Scale 1:3,400

Low — High

Design Alternatives

1

Using ex-situ techniques, this soil farm would be a permanent site at Mosaic. The existing clay is compacted to create an impermeable layer for leachate collection, and the top 0.5 meter of soil is fully treated.
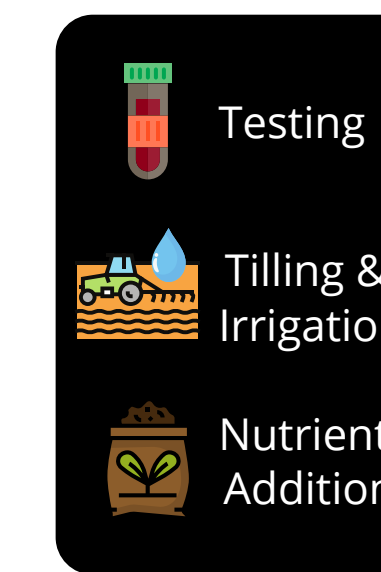
105m

Leachate collection moat

360m

Pump + water tank

Entrance 8 m

Leachate to irrigation system

Tank

Treated soil

0.25m / 0.5m

Drainage layer

Trench

Pump for leachate

0.5m / 104m / 0.5m / 0.25m

Impermeable layer

2

Leachate to irrigation system

Tank

Treated soil

0.5m

Pump for leachate / 105m / Liner

This soil farm includes the use of a liner, instead of compacting clay. This lessens the depth of disturbed soil and increases the durability of the leachate collection system.
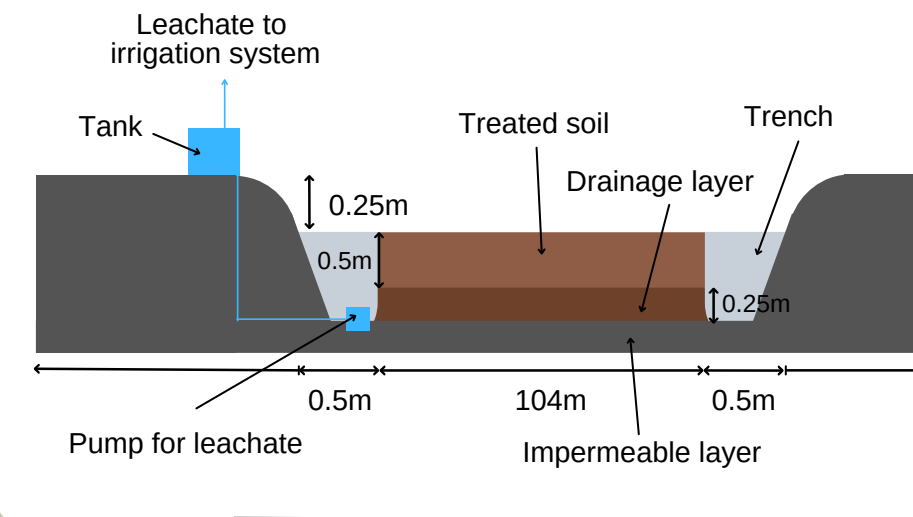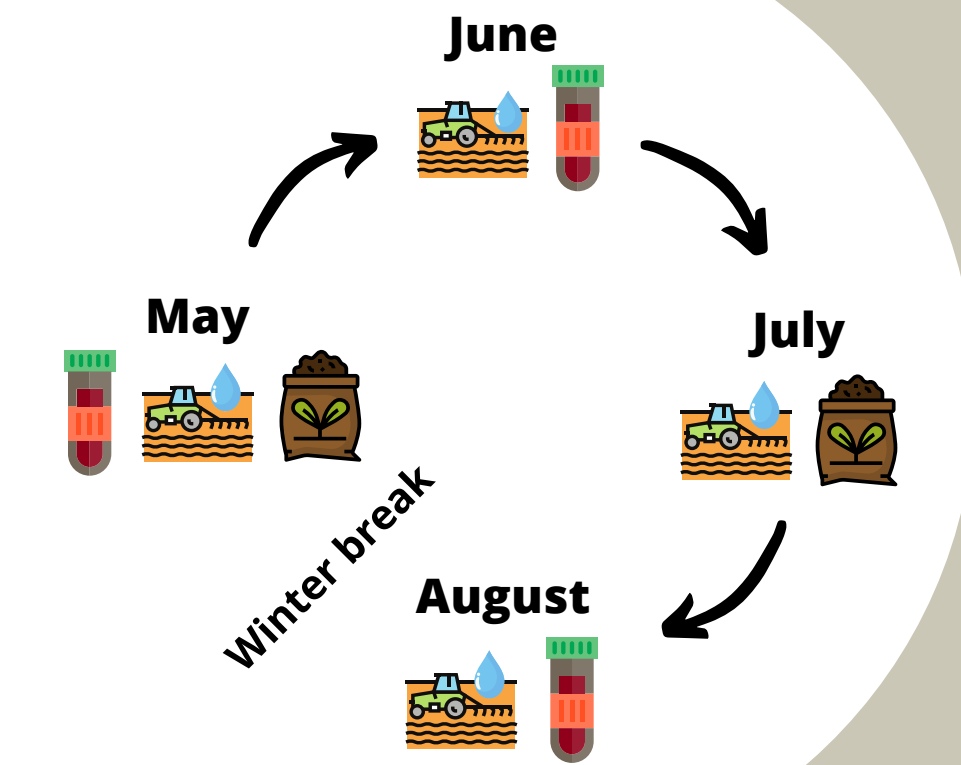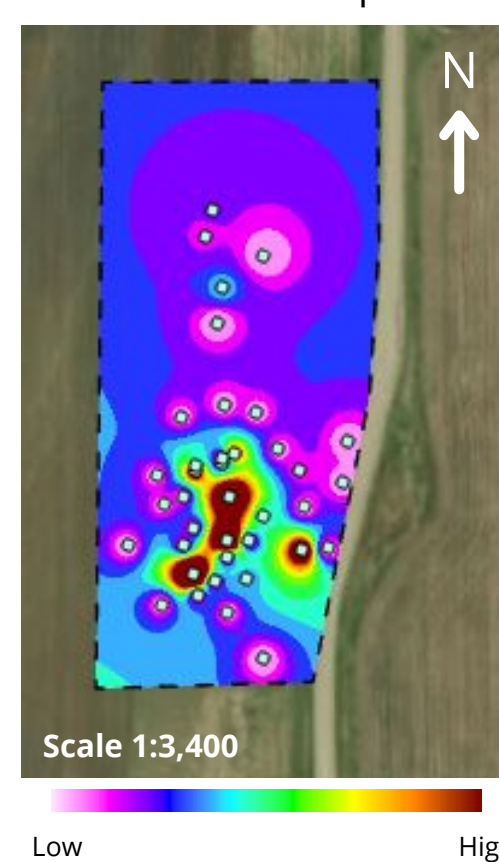
3

Design 3 is built in the same way as Design 1, however it operates with in-situ techniques. This implies that the soil farm will be moved from site to site of contaminated soil, every treatment cycle.

First remediation site

Second remediation site

Bioremediation Selection

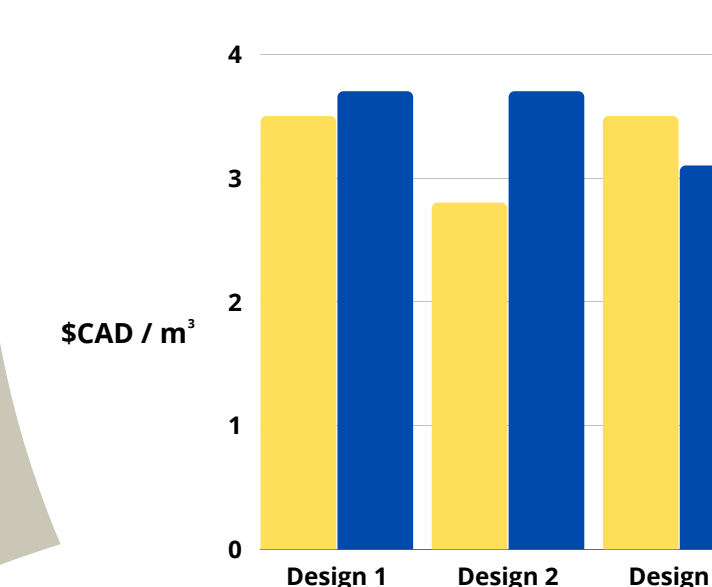|	Maintenance	Cost	Impact of Equipment	Performance	Suitability for Site
Landfarming	✓	✓	✓	✓	✓
Natural Attenuation	✓	✓	✓	✗	✗ [1]
Bioventing	✓	✗	◯	✓	✗ [2]
Phytoremediation	✗	✗	✓	◯	✗ [3]

[1] May be seen as a "do nothing" approach since no remediation efforts are currently in place
[2] Required equipment will come into contact with existing water tables
[3] Vegetation on site is not desired

Operation Cycle

Testing
Tilling & Irrigation
Nutrient Addition

May → June → July → August → Winter break

Total treatment time = 2 years = 2 cycles

Impact of Equipment

Measured by number of heavy machines times number of hours in use

Design 1
Design 2
Design 3

0 500 1,000 1,500 2,000

Costs

$CAD / m³

Design 1 Design 2 Design 3
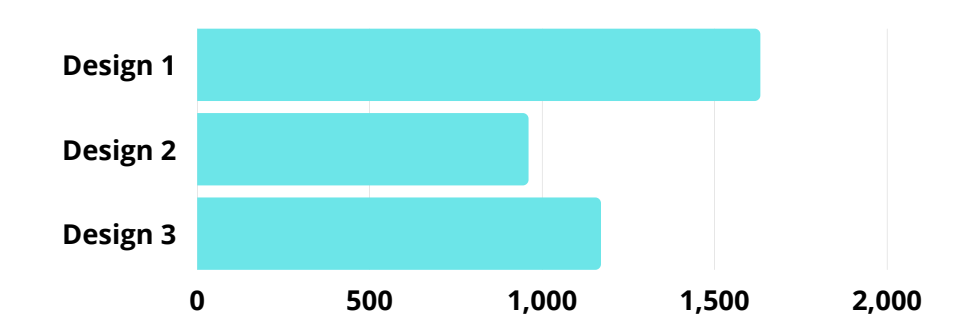
Level of Maintenance

Measured by number of labor hours

Design 1 — 816
Design 2 — 720
Design 3 — 1088
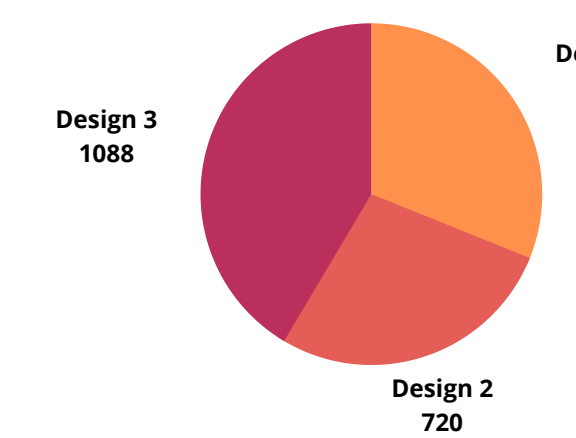
Final Recommendations

Pillars of Engineering Design

Environment	Economy	Technicality	Society
Impact of equipment	Cost	Level of Performance & Maintenance	Action towards Mosaic's social strategy

Our design criteria

Design 2 is our recommended alternative based on the design criteria which focused on analyzing environmental impact, cost, and maintenance.

This Pilot Project will fulfill Mosaic's strategy to act responsibly and "Be a good corporate citizen and contribute to the vitality of the people and the communities around us" (Mosaic, 2022).