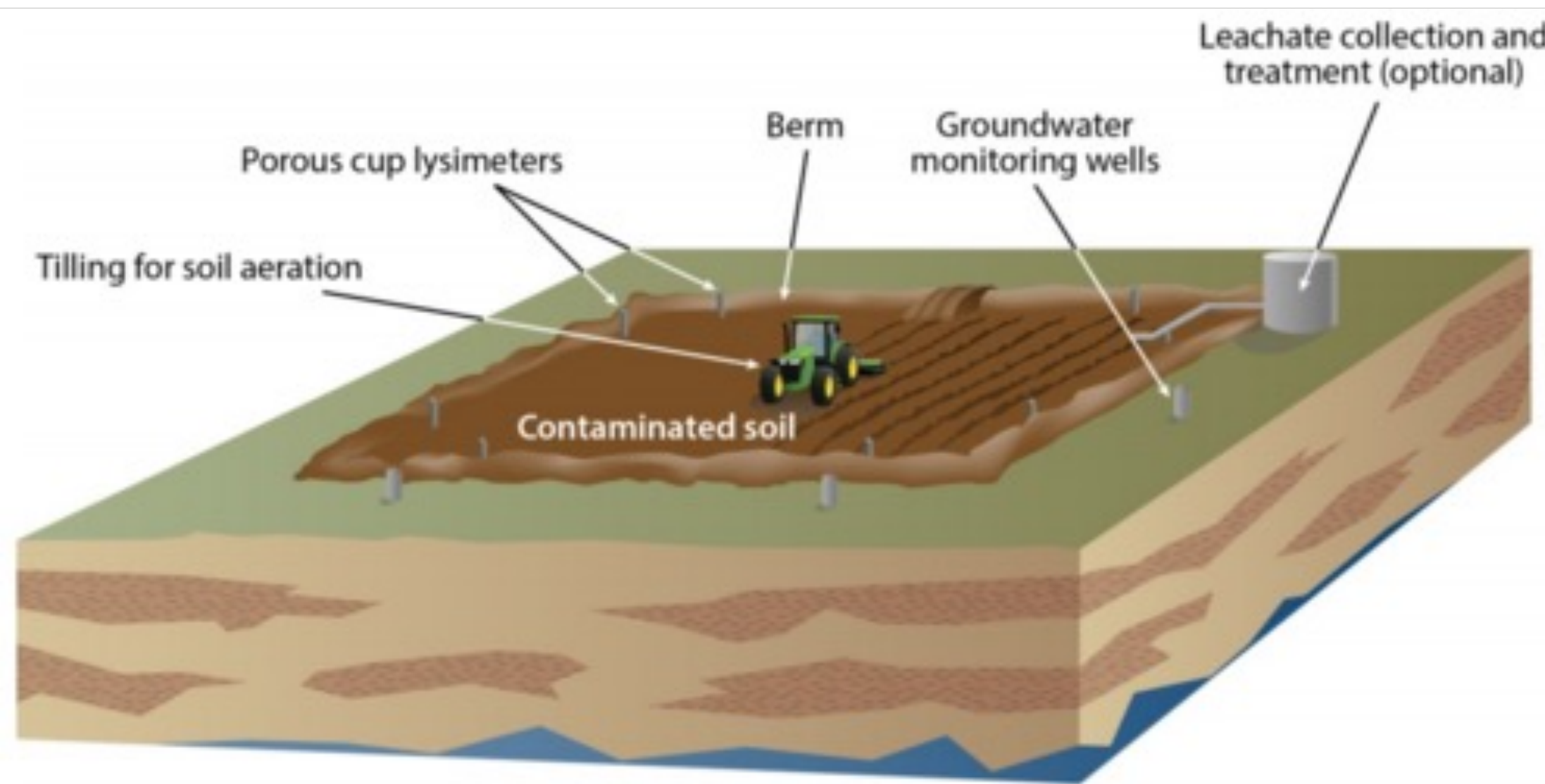


Emily Gibel, Andrew Towill, Weijie Cai, Emma Rivard, Dr. Lei Liu PhD  
Dalhousie University, Environmental Engineering Department

## Landfarming Introduction

The purpose of the project was to design a treatment system for oily solid waste created from marine oil spills. The project takes place in British Columbia, specifically dealing with the ports of Vancouver and Prince Rupert. Although many types of oily solid waste is generated from marine oil spills, this project deals exclusively with contaminated soils and sands. The treatment design chosen was landfarming, and an LP Model was created to minimize total costs.



Source: USEPA 1994

## Site Investigation

The site located in Chilliwack, British Columbia was chosen because of the location practicality and qualification under the Federal Contaminated Sites Landfarming Guidelines. Located just outside of Vancouver the site would be easily accessible from the Trans Canada Highway. Surrounding the site is traditional farms crops which would allow the operation disturbances to blend in with ones caused by nearby farming.

### Federal Siting Guidelines:

A landfarm should be sited...

- greater than 500m from a residential boundary.
- greater than 500m from a permanent surface water body. This restriction applies to both potable and non-potable surface waters.
- greater than 500m from a potable groundwater well.
- taking into consideration sensitive areas restrictions such as, Migratory Birds Convention Act and Species at Risk. There should also be sensitivity toward the protection areas important to aboriginal peoples.
- taking into consideration the underlying Geology/Native Soils.
- where the groundwater table is greater than 3m below the surface.

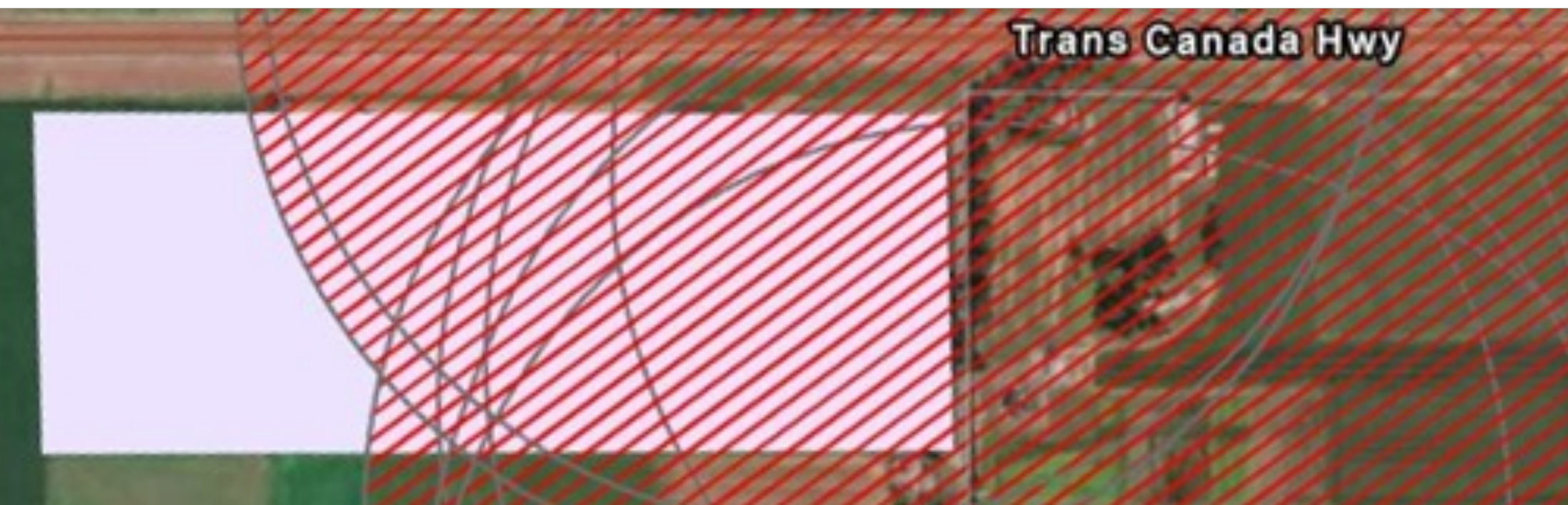


Figure: Chilliwack site with 500m residential boundry buffer zones

## Landfarm Design

Our goal is to design a landfarm that can hold 3000 cubic meters of oil sludge. The size of Landfarm is a square with a side length of 82 meters and a depth of 0.45 meters. A landfarm consists of the following components:

- Berm
- Trench
- Leachate Collecting system
- Drainage Layer
- Liner System
- Windrow
- Monitoring System

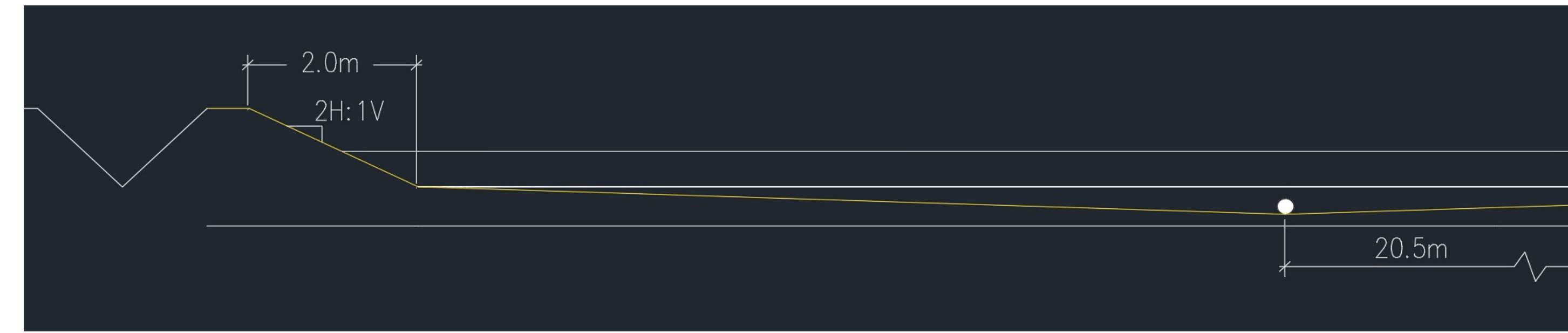


Figure: Berm & Trench

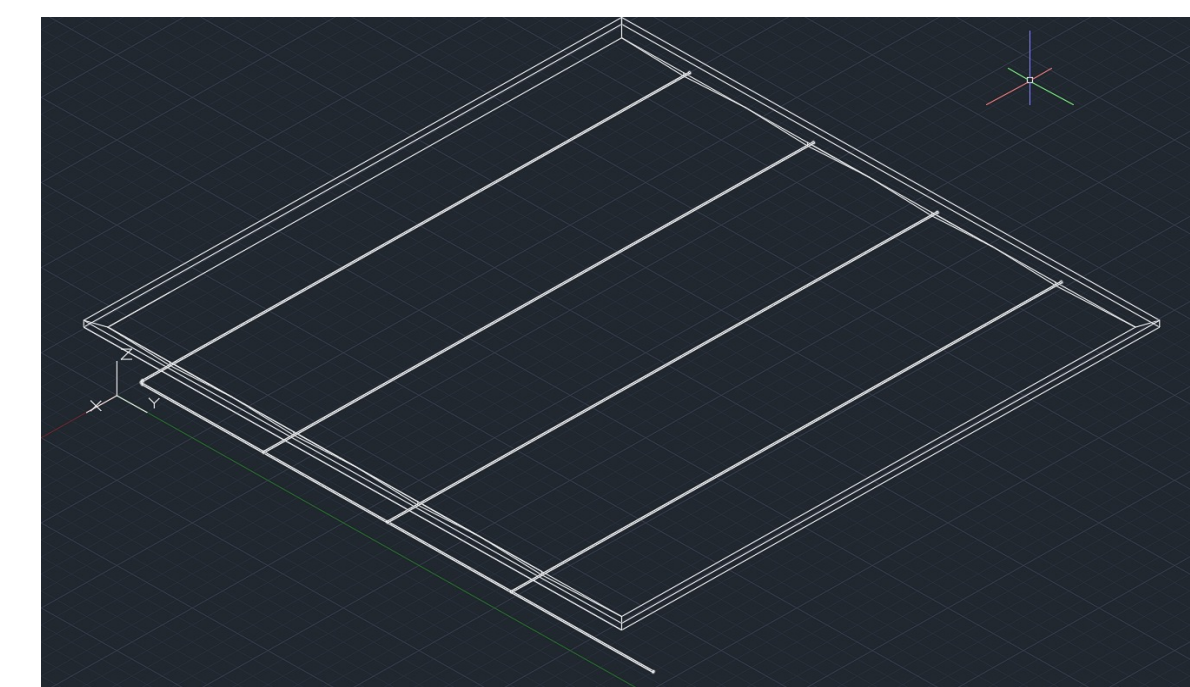


Figure: Leachate Collecting Pipes

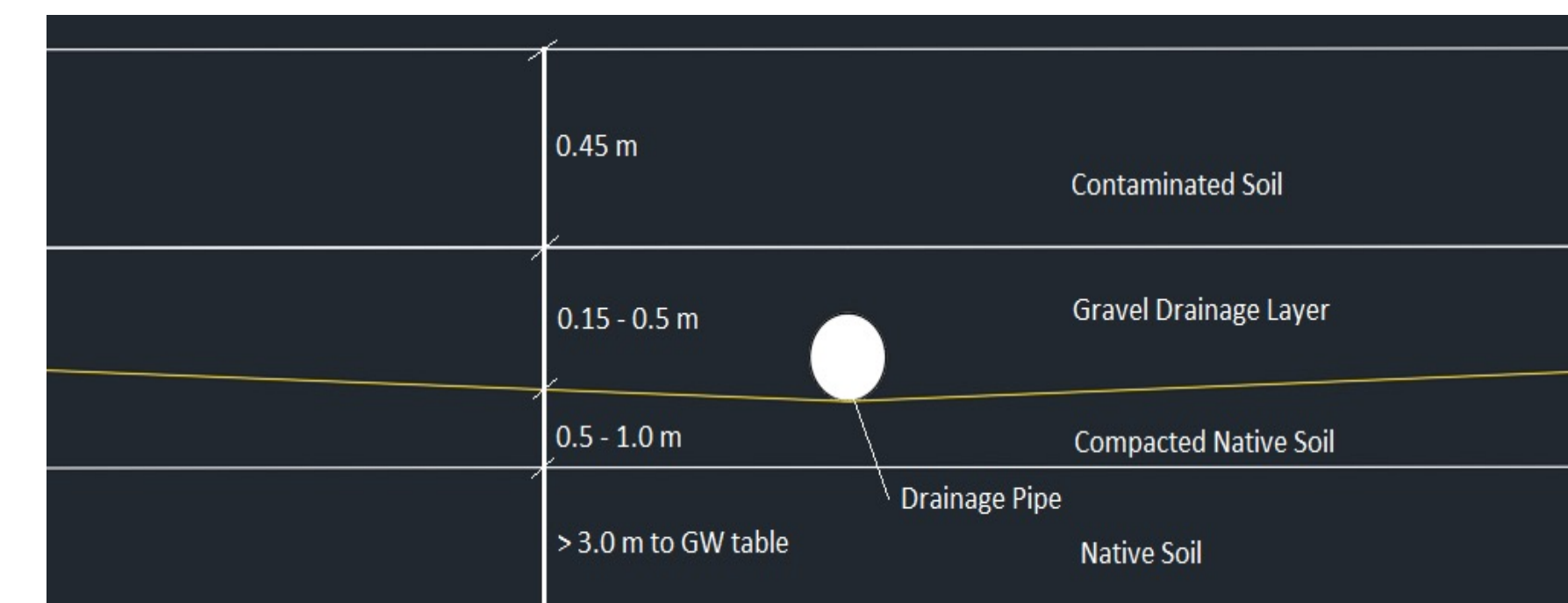


Figure: Drainage Layer & Liner

Landfarming is a bioremediation technique whereupon oily sludges are scattered and mixed into the reactive soil layer in a controlled manner for the microbiota in the ground to act as a degrading agent.

Optimum Conditions for Landfarming:

HC concentration: 1%-5% by weight in dry soil.

PH: 6 – 8.5

Aeration/Tilling: every 2-4 weeks

Moisture Content: 60%-80%

Nutrients:

1. Total Nitrogen 250-500 ppm
2. Phosphate: 125-250 ppm



Figure: Soil at Landfarm

## LP Model

The LP Model created for the Oily Solid Waste Disposal utilizes 3 landfarming sites with varying capacities, 2 ports where the material can be delivered and Clean Harbors as a processing and transportation facility.

The following variables and constraints are described below:

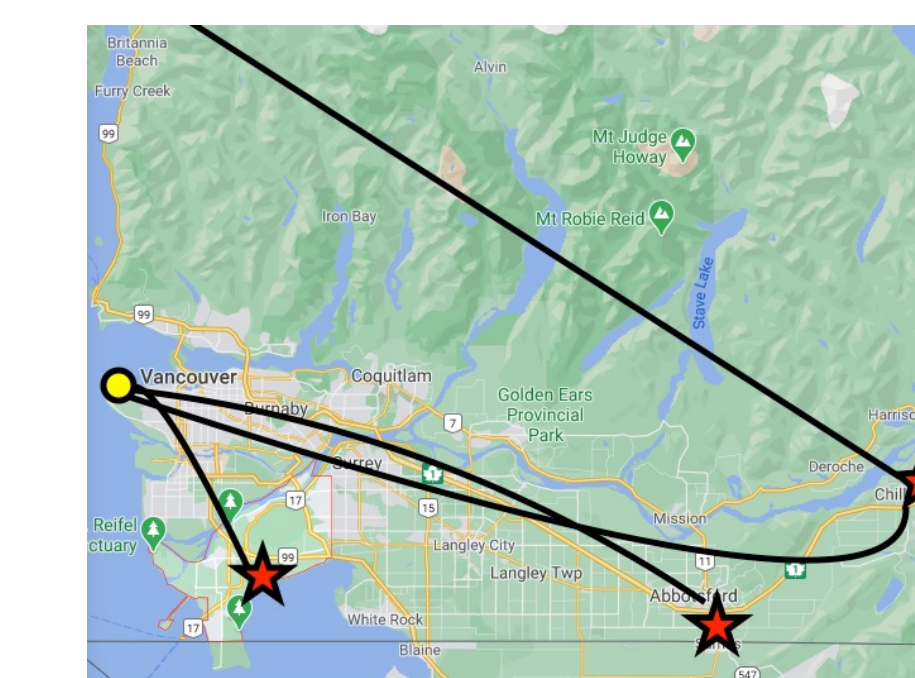
Variables used in Xij format where:

Port location represented as i= 1, 2 where 1= Vancouver and 2= Prince Rupert

Landfarm location represented as j= 1, 2, 3, 4 where 1=Chilliwack, 2= Clean Harbours, 3= Delta, and 4= Abbotsford

The objective of the LP Model was to minimize total cost, where each Xij combination was made into an equation. These equations included the disposal costs, the operation cost, the transportation cost, and the total landfarm cost.

The constraints on the system dealt with the capacity of each landfarm, and the total capacity of the oil spill. In this case, the landfarms each had a different capacity and all had to hold a minimum of 3 tons, the average amount of contaminated sand from a spill.

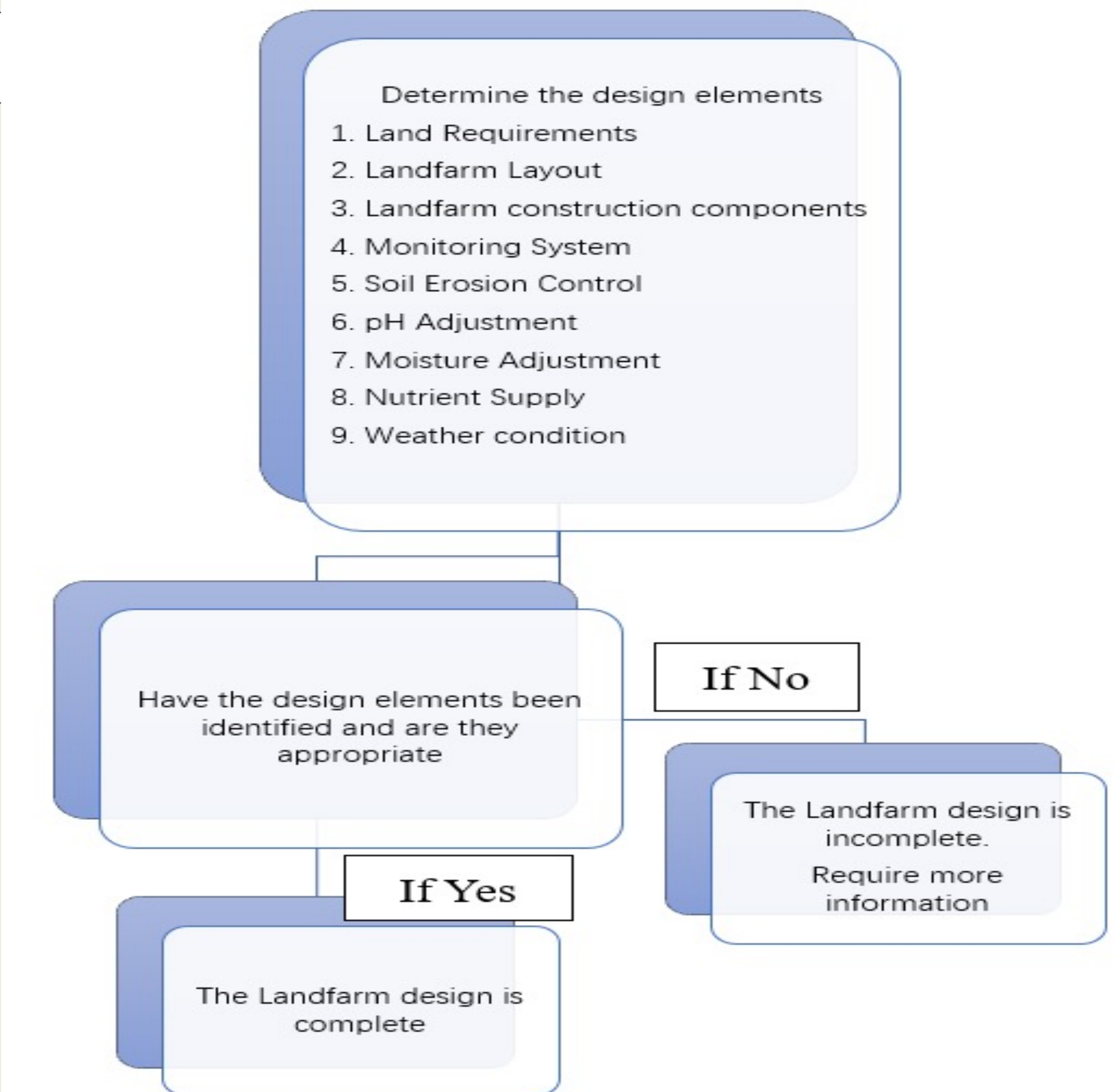


Location/Destination transportation map

Parameter	Values	Hours	Operation	Transport Cost	Landfarm Total Cost
Distances					
Port of Vancouver - Chilliwack	120 km	3	205	\$180	\$71,180
Port of Vancouver - Clean Harbours Storage	35 km	1	260	\$60	\$80,000
Port of Vancouver - Delta	36 km	1.1	295	\$66	\$67,000
Port of Vancouver - Abbotsford	86 km	1.6	175	\$96	\$77,000
Port at Prince Rupert - Chilliwack	1500 km	16.8	205	\$1,008	\$72,008
Port at Prince Rupert - Clean Harbours Storage	1600 km	17.2	260	\$1,032	\$80,000
Port at Prince Rupert - Delta	1490 km	16.6	295	\$996	\$67,000
Port at Prince Rupert - Abbotsford	1420 km	16.3	175	\$978	\$77,000
Cost					
Transportation	\$60 /hr				
Storage	\$115/tonne/month				
Disposal	Pay to B.C. \$30/tonne Incineration Disposal \$530/tonne Landfarm Cost \$71,000/tonne Operations \$205/tonne				
Constraints					
Capacity	Site 1 - Chilliwack 1.6 tonnes Site 2 - Abbotsford 1.2 tonnes Site 3 - Delta 0.8 tonnes Clean Harbours 0.5 tonnes				

LP Model variables, constraints and costs

## Design Process



## Budget

Design Budget - 1 Site

1. Set-Up Costs: Including land acquisition, labor, materials, equipment, approvals/permits \$615,000

2. Operating Costs: Labor, chemical, utilities, expendables, \$20,000

3. Extraneous Costs: Transportation, Disposal & Storage Fees, Upgrades \$645,000

**Total Budget: 1.4 million.**

Overarching Totals	Rate	% of Total
Set-up	815,196.00	55.06%
Operating	20,128.00	1.36%
Transportation - Extraneous	645,300.00	43.58%
<b>Total</b>		

Master Budget

Rate of Return: The operating costs account for less than 2% of the total landfarm costs. The design accounts for an operating life of 10 years, before irrigation and maintenance materials will need to be replaced.

## Conclusion – LP Model Answer

The LP Model concluded that the minimized model cost is \$212096.10. This is achieved by sending 1.6 tons from Vancouver to Chilliwack, 1.2 tons from Vancouver to Delta and finally, 0.2 tons from Vancouver to Abbotsford. This meets all the required needs and satisfies the system.

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