

Thermal Desorption of Hydrocarbon Contaminated Soil -How to Successfully Use this Technology



By Cal Faminow, CTech



Presentation Outline

1. Introduction
2. Site Summary
3. Assessment
4. Remedial Options
5. Thermal Desorption
6. Remediation
7. Treatment and Site Reinstatement
8. Lessons Learned



INTRODUCTION

Who is Ghostpine?

- Ghostpine Environmental Services Ltd. is a full service mid-size environmental planning company dedicated to providing a full range of environmental services to meet the diverse needs of each project
- Based in Calgary with offices in Medicine Hat, AB and Fort St. John, BC
- +50 employees

Project Description

- Client divesting a drilling completions chemical supply company
- Required to assess and remediate environmental liabilities prior to property transfer



SITE SUMMARY

Located in North Central Alberta

Drilling Completion Chemicals

- 2 Tank Farms (8 ASTs)
- 2 Barrel Storage Areas
- Chemical Storage Bay
- 2 Dry Chemical Storage Sheds
- Chemical Barrel Storage Area
- Liquid Chemical Storage Area (6 – 1 m³ Cubes)

PCOC

- Condensate, methanol, acids, solvents, gasoline, diesel, waste oil

ASSESSMENT



Phase I and II ESA

- Combined Phase I and II ESA completed
- Tank farms, chemical storage areas, waste transfer areas considered primary APECs
- 8 BHs with 5 Groundwater Monitoring Wells
- Full suite of analytical tests: BTEX, F1-F4, VOCs, PAH, Metals, Salinity
- Benzene above Alberta Tier 1 Guidelines in soil
- BTEX, F1 and Naphthalene above Tier 1 guidelines in GW
- Auger drilling affected sample quality. Expect contaminant plume to be larger than indicated

Delineation Drilling

- 17 BHs drilled to delineate lateral and vertical extent of contamination
- Targeted discrete sample collection in soil units above / slightly below water table and determining bedrock depth
- Total BTEX up to 1,275 ppm near chemical storage cubes
- Estimate of 7,500 m³ of soil requiring treatment

Chemical Storage Area



BH Locations



REMEDIAL OPTIONS

Key Issues to Consider

- Operating Facility
- Ample Space
- Timing – Fall/Winter
- Tight Time Constraints for Property Sale
- Light-end Hydrocarbon contamination (BTEX/F1)

REMEDIAL OPTIONS

Options

1. In Situ
2. Ex Situ Bioremediation
3. Dig and Dump
4. Thermal Desorption

In Situ Remediation

Options

1. Soil Vapour Extraction
2. Air Sparging
3. Combination of the above
4. Pump and Treat
5. Phytoremediation

Pros

Less Disturbance, cost, destroys contaminant, smaller carbon footprint

Cons

Time, uncertainty of success

Ex Situ Bioremediation

Pros

Less cost, effective, destroys contaminant

Cons

Time, weather dependent– requires $>+15^{\circ}\text{C}$ to be effective

Dig and Dump

Pros

Effective, level of certainty, meets project timeline

Cons

Cost, distance to landfill, cost of fill, compaction issues related to winter project, does not destroy contaminant, liability for landfilled soil remains for client

Thermal Desorption

Pros

Effective, level of certainty, meets project timeline, destroys contaminant

Cons

Typically Cost - However, due to unit in area cost/tonne less than dig and dump

REMEDIAL OPTIONS

Final Determination

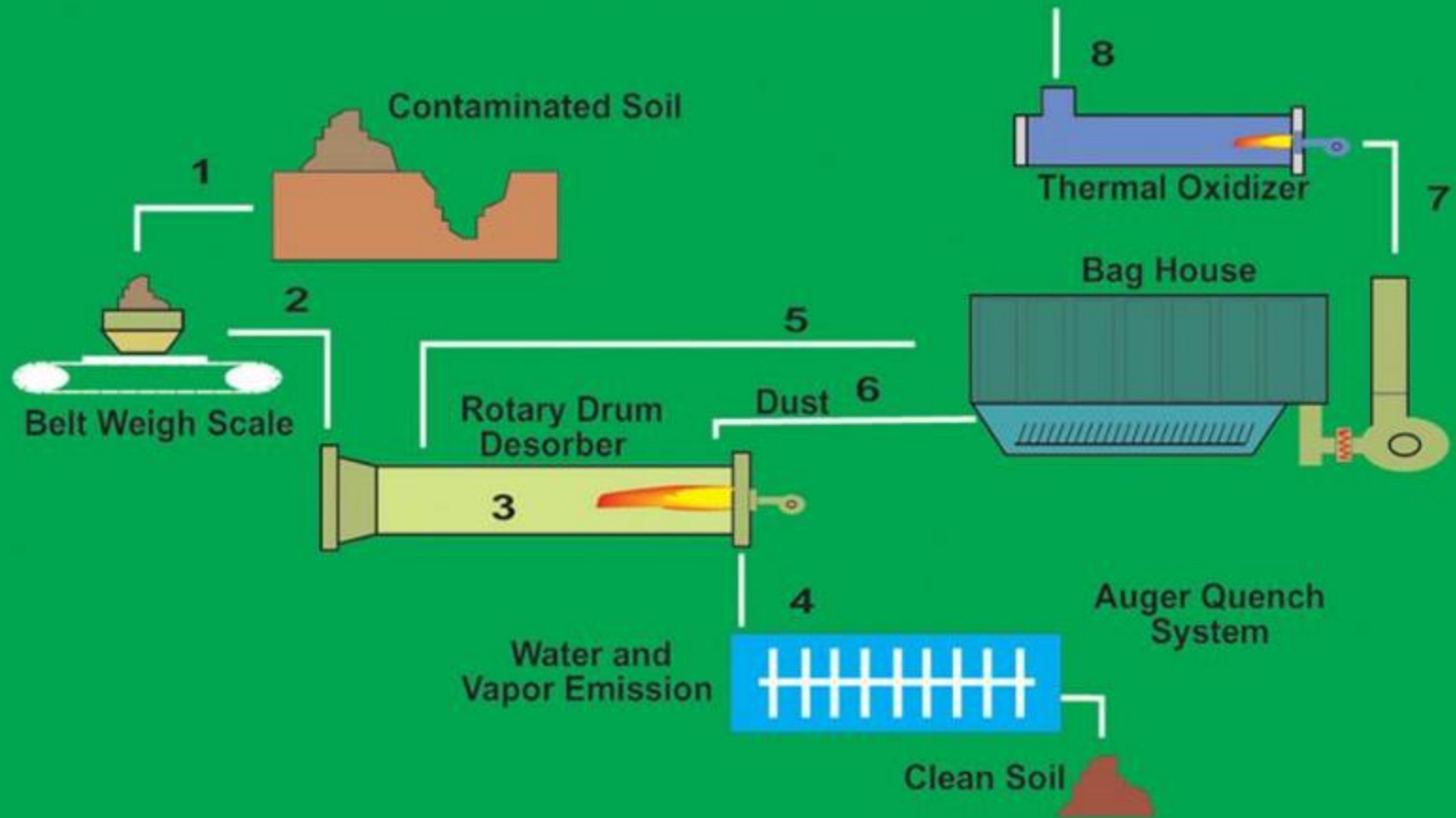
1. In Situ – Not possible for timeline
2. Ex Situ Bioremediation – Not possible for timeline
3. Dig and Dump – Possible but high cost/tonne
4. Thermal Desorption – Possible, lower cost per tonne

THERMAL DESORPTION



Thermal Remediation Cycle

Thermal Desorption Unit - (TDU)



Plant Setup and Logistical Considerations

- Space Management – Is there enough room for the plant, dirty and clean soil stockpiles, excavation?
- Local Fuel Source – can offset costs if a local cheap fuel source can be found, e.g. Gas from a wellhead
- Permits – any local bylaws that might prohibit operation
- Noise – plant operates 24/7 and can impact residential areas
- Prevailing wind direction – emissions from stack

Issues Affecting Soil treatment

- Grain size of soil – sands easier to treat than clay
- Moisture Content – wet soils require higher operating temperature/higher cost
- Contaminant – lighter end hydrocarbons easier to treat than heavy ends. Key to have adequate soil chemistry characterization
- Frozen soil and cohesive soils – need to break up soil into manageable sizes <150 mm dia.

REMEDIATION



Soil Profile



Soil Profile

- 0 – 1.0 m Topsoil Unit: SAND, silty, dark grey
- 1.0 – 2.5 m Medium Brown SAND
- 2.5 – 3.0 m Coarse Grey SAND
- >3.0 m Soft Sandstone BEDROCK
- GW present in Grey Sand unit/lower portion of Brown Sand unit
- Fill
- 25 mm Crush gravel in roadway areas
- Clayey silt in some traffic areas

Contaminant Zones

- Highest Concentrations in vicinity of the Chemical Tank Storage area with Total BTEX >1,000 ppm and toluene/xylenes ranging from 400 to 600 ppm
- Extends from 0.5 m to bedrock depth
- Further away from source, contamination confined to lower portion of Medium Brown Sand unit and Coarse Grey Sand unit
- Curiously, only benzene present at leading edge of contaminant plume

Excavation Issues

- Some groundwater seepage into excavation
- Frozen soil - stripping uncontaminated gravel for reuse and clay fill very difficult
- Solution – Grizzly asphalt miller used to remove gravel from excavation footprint



Confirmatory Sampling

Followed Alberta Environmental Site Assessment Guidelines (Draft 2008)

- discrete samples must be collected from each excavation face (i.e., walls and base);
- samples must not be collected from the exposed wall face. The sample must be collected from within a 0.2 metre perpendicular distance from the excavation surface;
- discrete confirmatory samples must be collected and analyzed such that there is at least one sample within a grid based on 10-metre increments (5-metre increments for hazardous waste); and
- more closely-spaced confirmatory sampling is required where there are thin identifiable soil layers that are suspected to be contaminated.

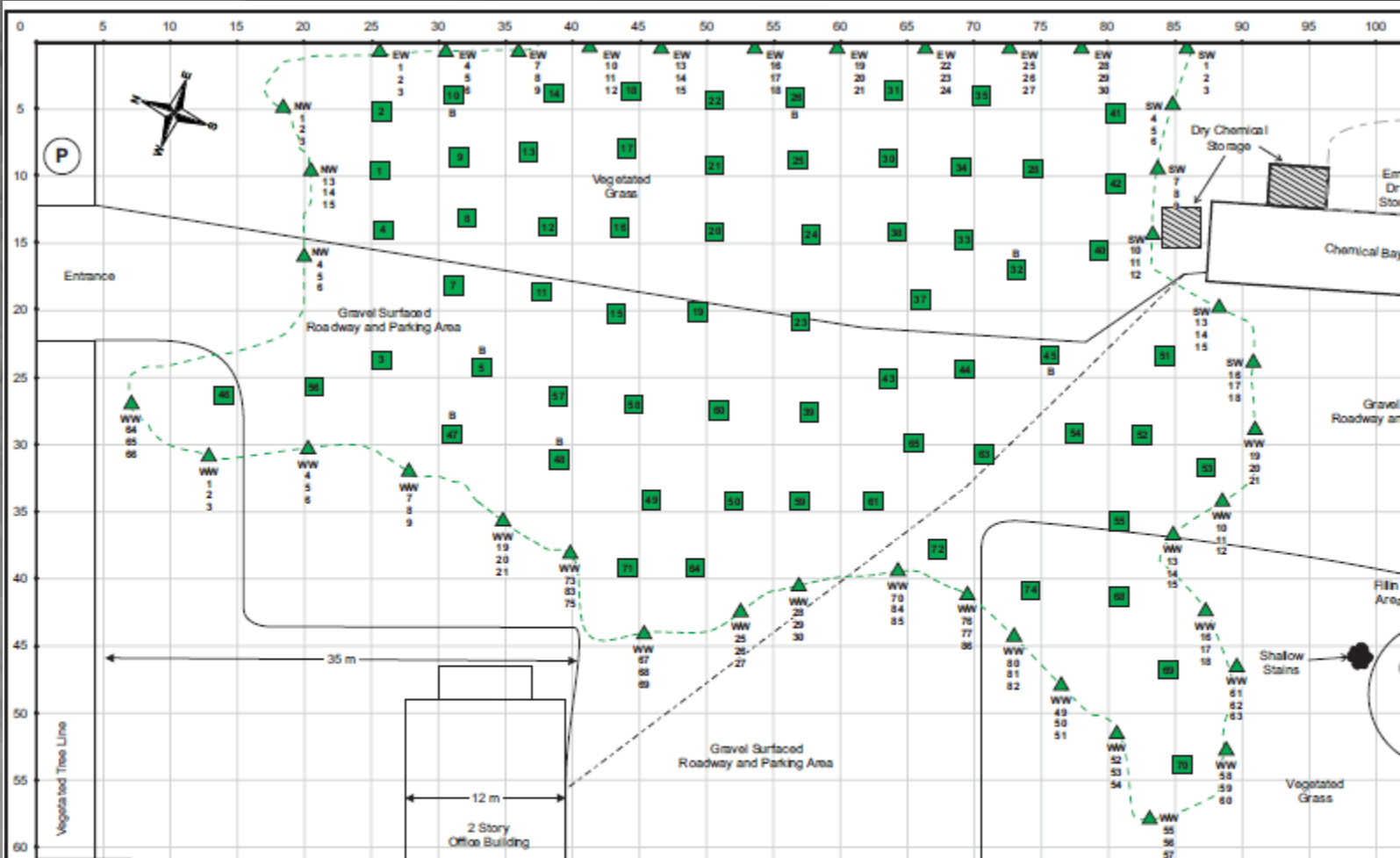
Confirmatory Sampling (cont.)

Reference Grid

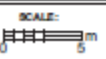
- Used property lines as grid origin with 0 m/0 m at northeast corner of property
- Sample locations referenced south and west of this origin
- Grids are a necessity to allow for reproducible sample locations
- Discussions with AENV recommended a 7 m lateral sample distance instead of 10 m

QA/QC

- Blind duplicates were collected at a frequency of 1 per 10
- Overburden soil stockpiled and sampled at a frequency of 1 per 125 m³. 1,500 m³ reused as backfill

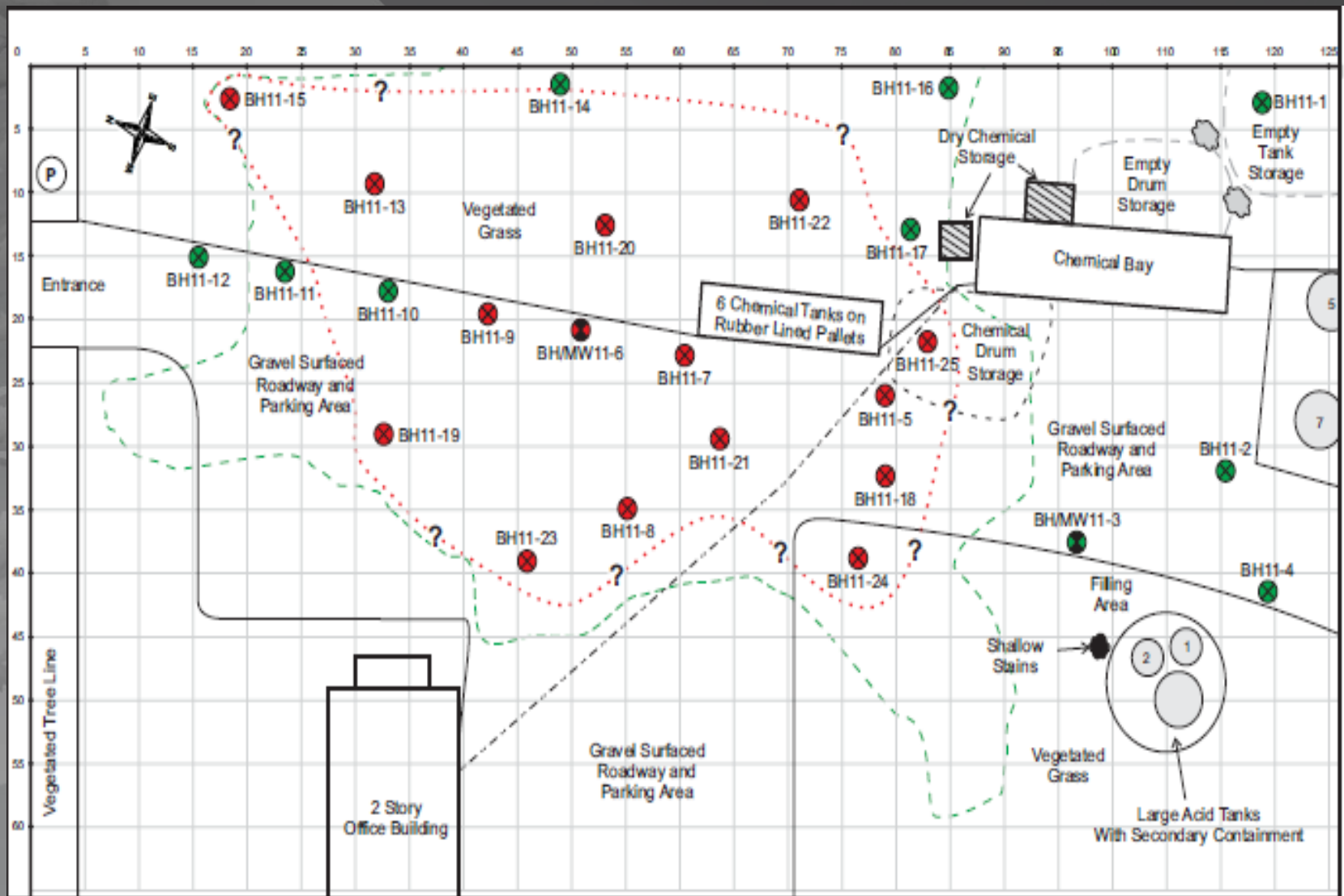


Sample No.	Date	Depth	Result
1	12/15/01	0.15m	1
2	12/15/01	0.30m	1
3	12/15/01	0.45m	1



LEGEND

- Wall Sample (WW - West Wall, NW - North Wall, EW - East Wall, SW - South Wall)
- Floor Sample (FL 1)
- Power Pole
- Stain
- Dead Vegetation
- Tank
- Standing Structure
- Shed
- Buried Electrical Line
- Excavation Limit
- Indicates Confirmatory Soil Sample Below AENV TER 1 Surface Soils Industrial Areas Criteria.



SOIL TREATMENT

Plant Setup – 5 to 7 days

- During this time contaminated soil was stockpiled

Batch Testing To Establish Plant Operation Parameters

- Need to run contaminated soil through plant at various temperatures to determine operating parameters to achieve remediation target
- Typically 4 different temperatures but more may be needed if soil conditions/contamination warrants additional test batches
- Each soil stockpile created from the test treatment temperature requires analytical testing
- Once operating temp. determined, full treatment can commence

Soil Treatment (cont.)

- We ran soil at temp. of 288 °C, 320 °C, 343 °C and 371 °C. First 2,500 tonnes treated at 343 °C and remainder treated at 371 °C to 427 °C. Due to cold temp/frozen soil.
- Through-put varies depending on the unit used but typically ranges from 25 - 30 tonnes/hour or 600 – 720 tonnes/day



Treated Soil Sampling

- Daily soil sampling was completed on the treated soil stockpiles
- Discrete samples were collected
- 39 samples tested from treated soil stockpiles



SITE RESTORATION

- Operating facility with heavy truck use
- Excavation primarily in high traffic area; therefore excavation needed to be compacted
- Treated soil was hot and allowed for compaction to be completed in frozen conditions down to -25°C



LESSONS LEARNED

1. **Characterize your site properly before selecting remediation method!**
2. Manpower/Equipment Needs
3. Plant Setup
4. Treated Soil Sampling
 - Allow soil piles to sit at least 24 hours before sampling to allow for residual off-gassing to occur
5. Plan to wash a few cars/buildings at end of program

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