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# IN Situ Thermal Remediation of Liquid Waste Pits

## At the Closed Martinsville Landfill

# IN Situ Thermal Remediation of Liquid Waste Pits At the Closed Martinsville Landfill

**Van Burbach, PhD, PG**
**LaBella Associates**

2021 SWANA REGION 6 CONFERENCE

**August 2021, Roanoke, VA**

## Martinsville Sanitary Landfill
## City of Martinsville, VA


**Martinsville Sanitary Landfill**

- Unlined MSW Landfill.
- Operated from 1971 – 2006.
- Two unlined disposal pits for liquid waste – mostly spent solvents, varnish, paint, etc. from the furniture industry.
- Liquid waste disposal ceased in approx. 1980.
- The pits are upgradient of the landfill.
- The facility is in a Groundwater Corrective Action Program.
- In 2016, VDEQ encouraged the City to clean up the pits.

Pit #1
Feb. 2019

Pit #2
Feb. 2019

**Solvent Pits #1 & #2**

- Operated ~1971 to ~1980.
- 2005-2006: Initial investigations:
  - Geophysical survey,
  - Soil sampling.
- June 2006: Passive soil vents installed in former solvent pits.
- December 2007: Impermeable soil cap installed on solvent pits.
- April 2016: Additional soil sampling, attempted wells in solvent pits.

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**Volume of Impacted Soil:**

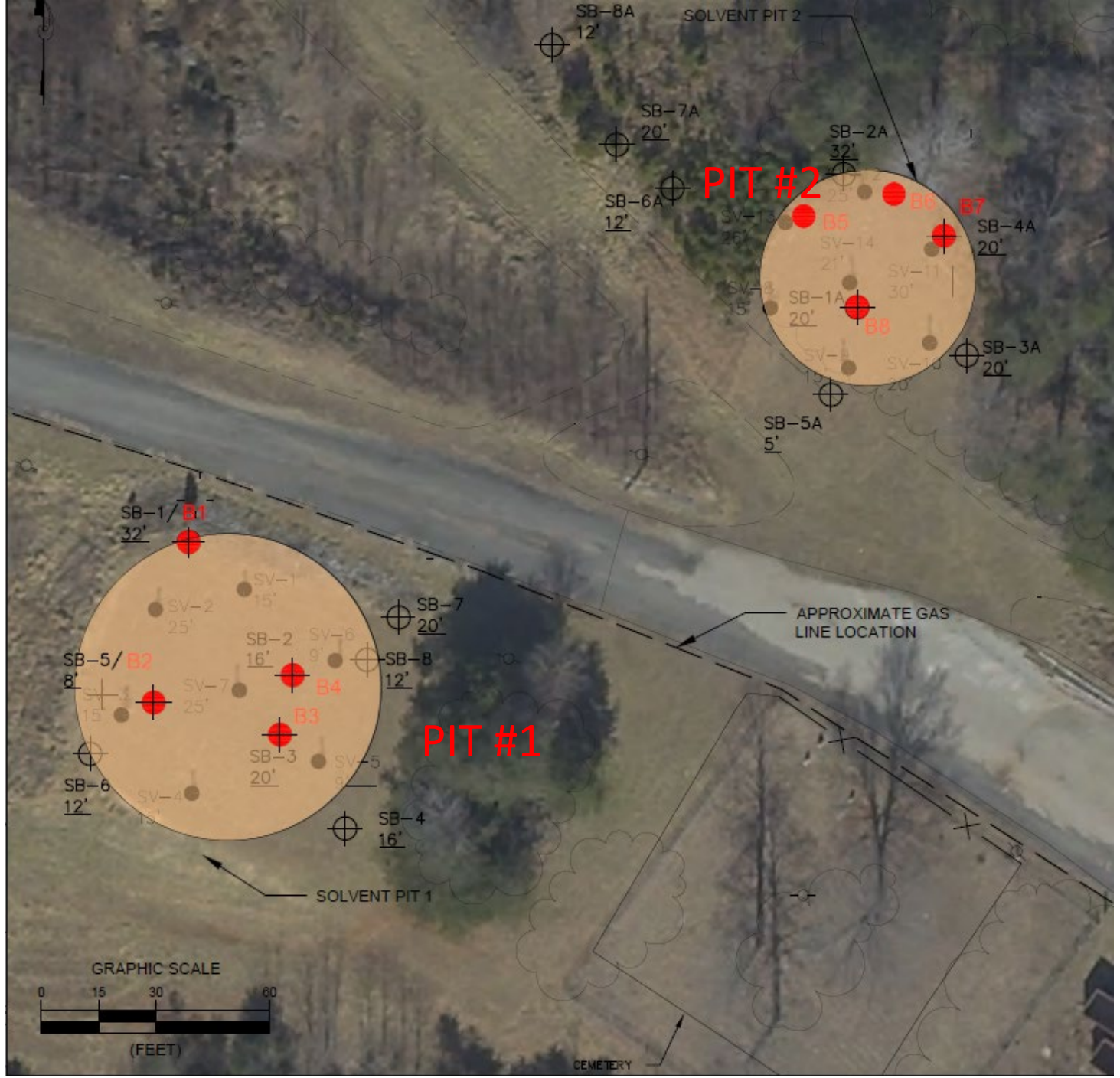
**Pit 1 = 4948 ft² x 52.5 ft = 9621 CY**

**Pit 2 = 3848 ft² x 24.5 ft = 3492 CY**

**Highest Total VOC Concentration:**

**Pit 1: B-2 (15-20') = 12,675 mg/kg**

**Pit 2: B-7 (20-25') = 4,745 mg/kg**



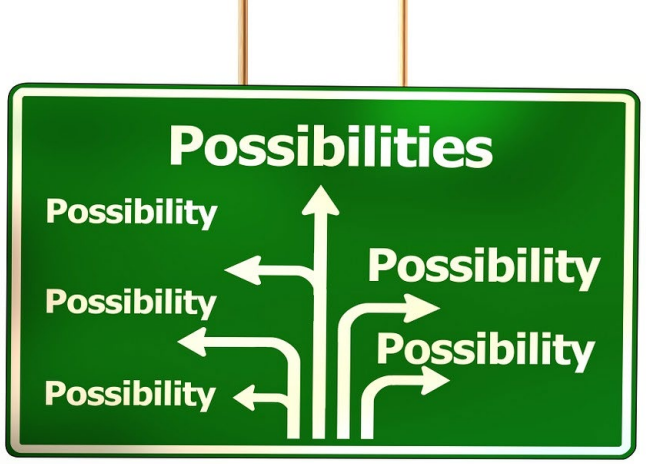

## Soil Sampling
**April 2016**

| | Pit 1 | Pit 2 |
|---|---|---|
| Average VOCs (mg/kg) | 6,027 | 3,245 |
| Volume (CY) | 9,621 | 3,492 |
| VOC Mass in Soil (tons) | 88.0 | 17.2 |

ESTIMATED TOTAL VOCs in Soil = 105.2 equivalent tons

# 2016 Preliminary Cost Estimates for Remedial Options

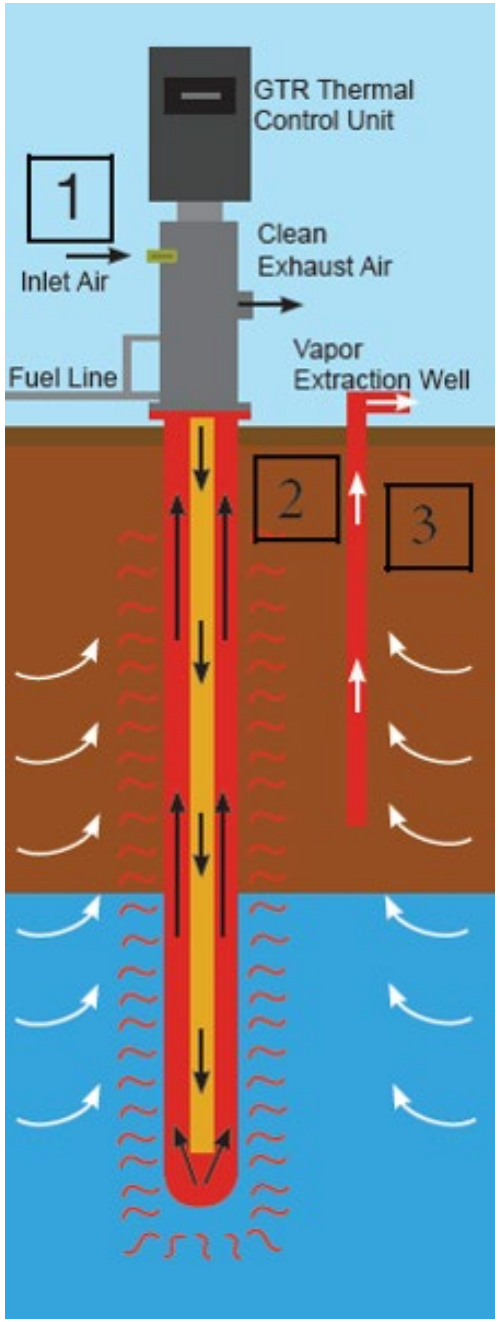
| ALTERNATE REMEDIES | Estimated Cost | Estimated Time |
|---|---|---|
| Soil Vapor Extraction (SVE) & Air Sparging (AS) | $2,088,000 | 30 years |
| Excavation & Offsite Disposal (Non-Hazardous) | $1,628,000 | 6 months |
| Excavation & Offsite Disposal (Hazardous) | $6,443,000 | 6 months |
| Excavation & Ex-situ Bioremediation | $2,863,000 | 18 months |
| Excavation & Soil Burning | $3,778,000 | 12 months |
| In Situ Soil Mixing & Bioremediation | $1,874,000 | 1-2 years |
| In Situ Enhanced Bioremediation (Injection) | $1,852,400 | 2-3 years |
| In Situ Thermal Desorption (ISTD)<br>In Situ Thermal Remediation (ISTR) | $1,570,525 | 8-12 months |




**Options Analysis**
January 2016

**ISTD Options Study**
July 2016

**Interim Measures Work Plan**
Sept. 12, 2016
VDEQ Approval:
Oct. 4, 2016




## What is ISTD?

**In Situ Thermal Desorption (aka – In Situ Thermal Remediation).**
**ISTD involves heating the subsurface to temperatures around the boiling point of the contaminants, thus fully releasing the volatile compounds in the soil and groundwater to be drawn off as steam and vapor through a vapor collection system. The vapors are then treated to remove most of the VOCs before being released to the atmosphere.**

## Why ISTD?

- **Effective in almost any geologic setting, including vadose zone and saturated zone.**
- **Effective for most organic contaminates, especially VOCs.**
- **No excavation and minimal transportation of hazardous soil.**
- **No injection of chemicals into the subsurface.**
- **It is sustainable.**
- **It is fast.**
- **It is cost effective.**

## Heating Technologies:

- **Thermal Conduction Heating** (natural gas, electrical, etc. heating elements installed in heating wells).
- **Electrical Resistance Heating** (uses the flow of alternating current electricity to heat soil and groundwater and vaporize contaminants - electric current is passed through the soil volume between subsurface electrodes).

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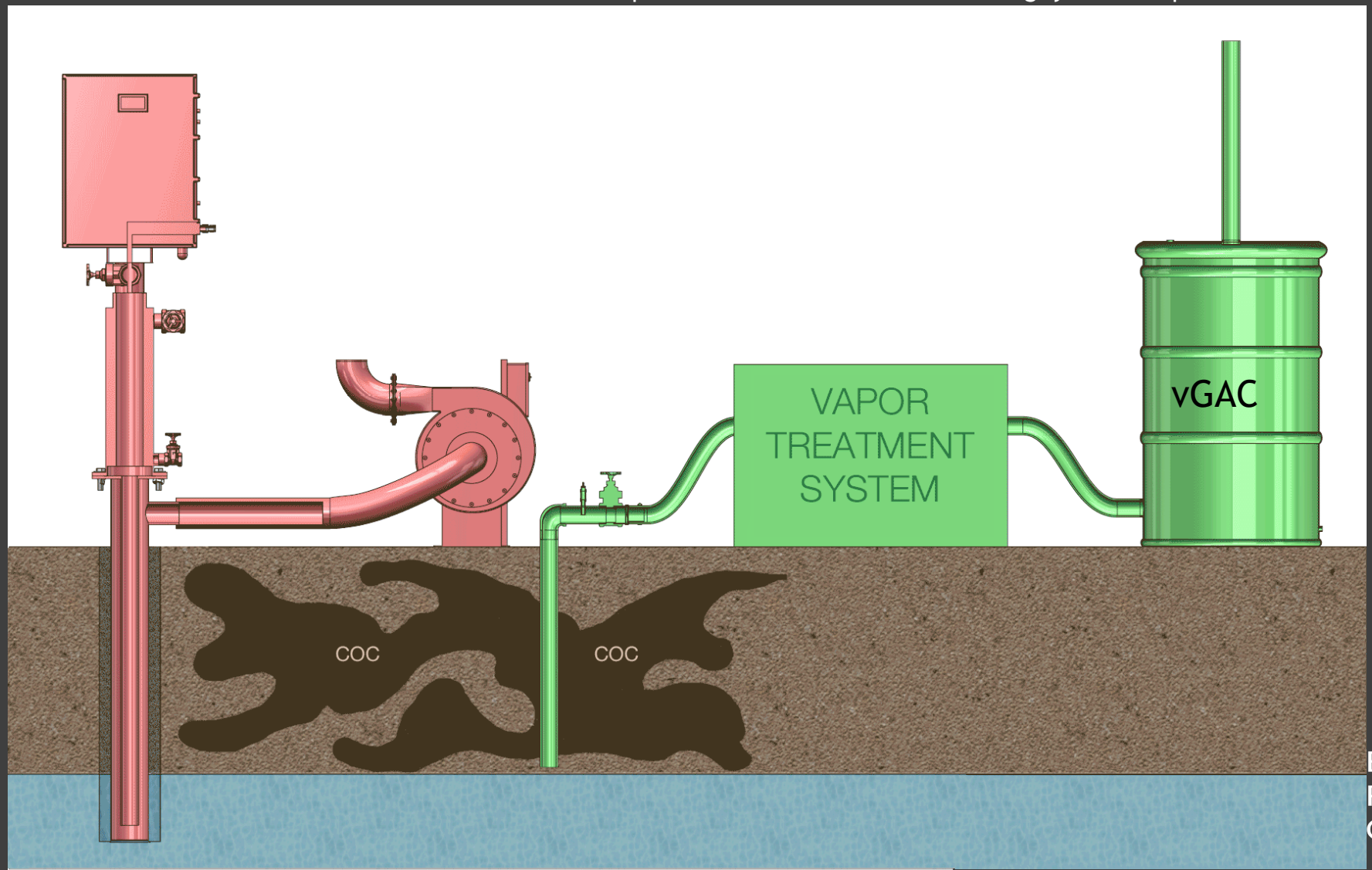
# What is GTR

GTR= Gas Thermal Remediation

- Propane/Natural gas/Diesel as fuel to heat the thermal conduction heater wells.
- Soil and groundwater are heated indirectly through conduction. Treatment temperatures from **~100°C** to **>400°C.**
- Vaporized contaminants collected from extraction wells are routed to the appropriate vapor treatment module.
- Closed-loop in-situ thermal conduction heating system. No pollution emission




Environmental Remediation Company

# Results of ISTD Bids - Oct. 2017

| TECHNICAL APPROACH: | TCH - Gas | TCH - Electric | ERH |
|---|---|---|---|
| CONSTRUCTION PHASE: | $1,036,807 | $648,260 | $1,524,502 |
| OPERATION PHASE: | $285,886 | $948,433 | $602,320 |
| END PHASE: | $74,760 | $276,600 | $104,682 |
| **Contractor Project Total:** | **$1,397,454** | **$1,873,293** | **$2,231,503** |

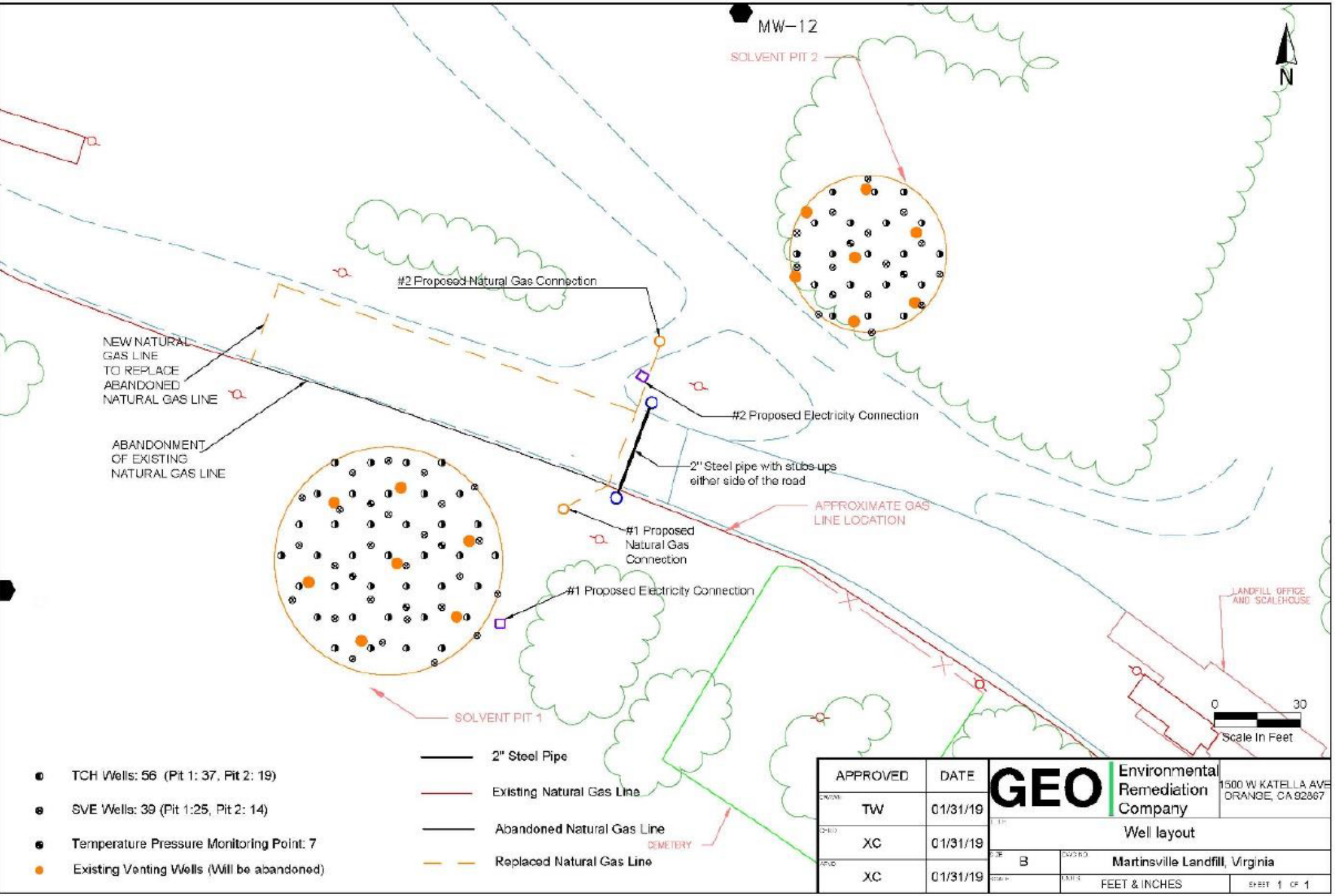
**The winner…**

GEO Environmental Remediation Company

**TCH – GTR**
**(Gas Thermal Heating)**

**RFP for ISTD Implementation: Aug. 2017**
**Bids Received: Oct. 2017**

**TCH = Thermal Conduction Heating**
**ERH = Electrical Resistance Heating**




## Well Layout:

- **56 THC Wells**
- **39 SVE Wells**
- **7 Temp/Pres**

## Project Implementation:

1) **Abandon PSVs - 2/25/2019**
2) **Begin Well Installations - 2/26/2019**

## Hazardous Soil Cuttings:

Approx. 60 CY of cuttings
D-Listed Hazardous Waste

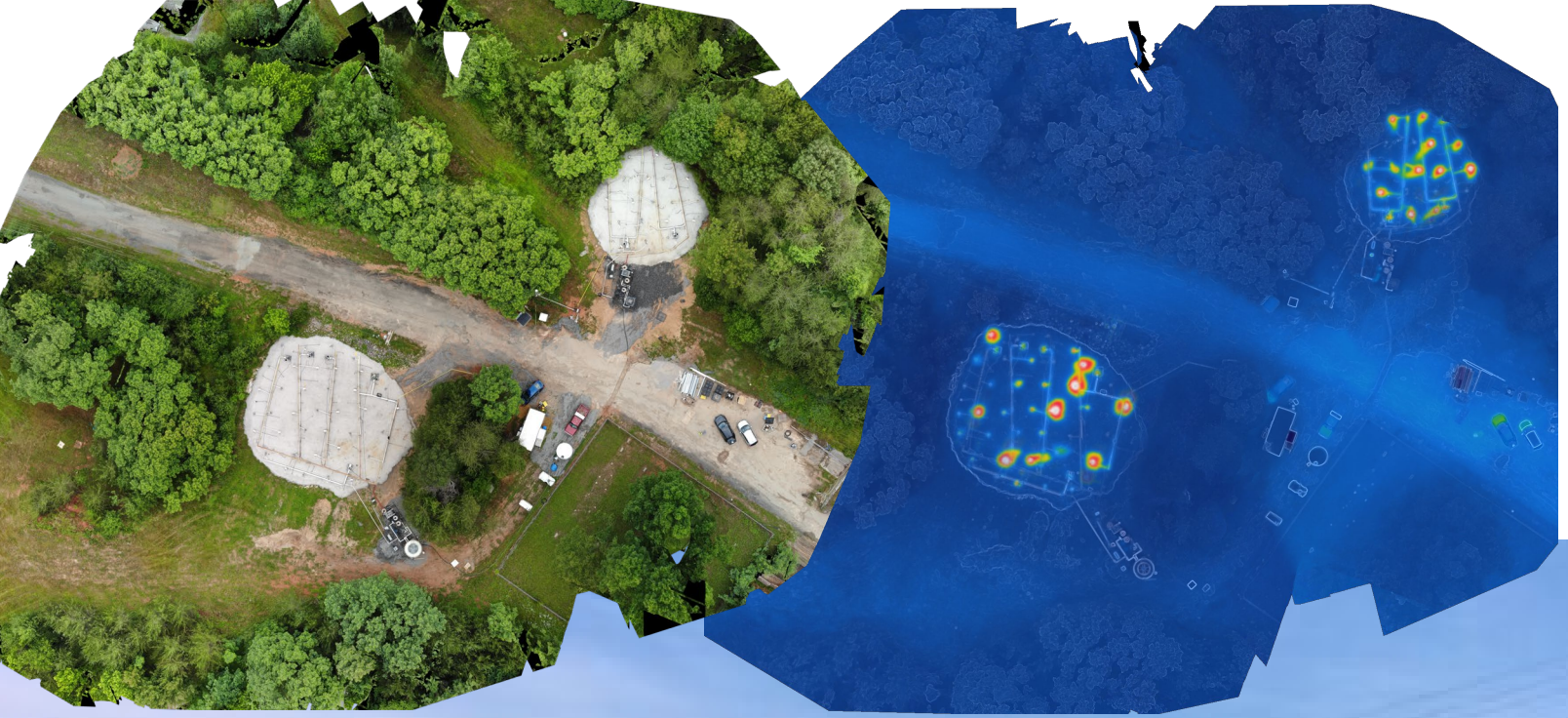
Applied to top of Pit #2 and Remediated on site as part of the ISTD remediation.


## Project Implementation:

1) Abandon PSVs - 2/25/2019
2) Begin Well Installations - 2/26/2019
3) Install Vapor Cap - 4/06/19
   - Vermiculite
   - Gravel
   - Concrete

## Project Implementation:

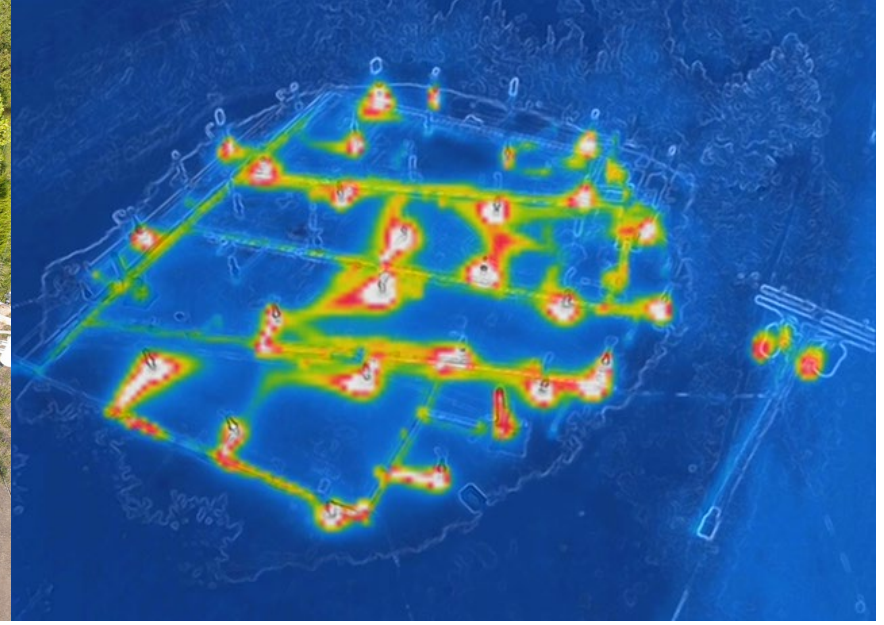
1) Abandon PSVs - 2/25/2019
2) Begin Well Installations - 2/26/2019
3) Install Vapor Cap - 4/06/19
4) Install Inner Heating Sleeves - 4/20/2019
5) Install Piping & Equipment - 4/13/2019



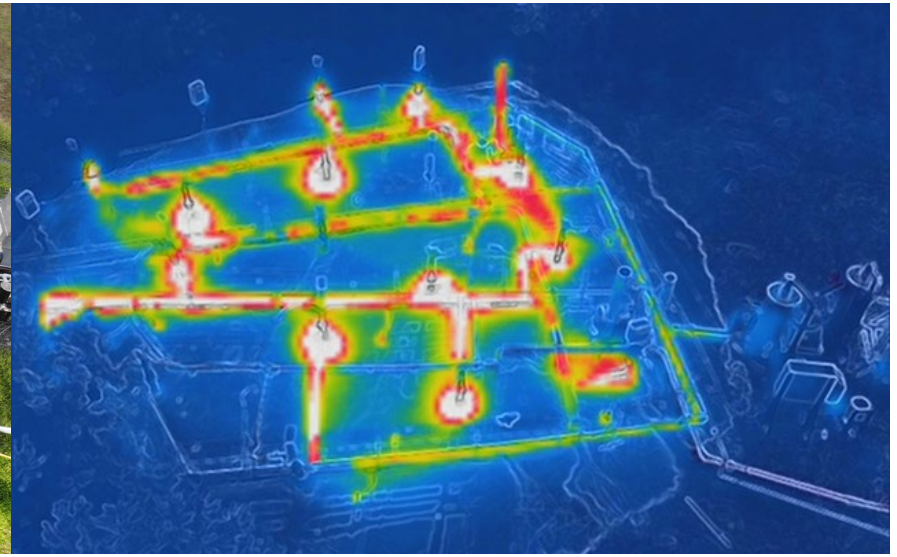
## Project Implementation:

1) Abandon PSVs - 2/25/2019
2) Begin Well Installations - 2/26/2019
3) Install Vapor Cap - 4/06/19
4) Install Inner Heating Sleeves - 4/20/2019
5) Install Piping & Equipment - 4/13/2019
6) Start Heating / 5/24/2019

5/31/2019



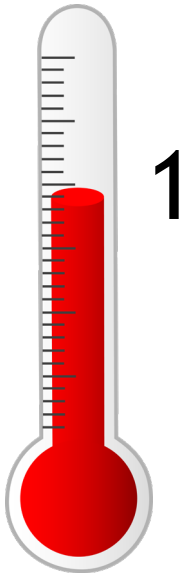
Pit 1  Sept. 2019



Pit 2  Sept. 2019

## Project Implementation:

1) **Abandon PSVs - 2/25/2019**
2) **Begin Well Installations - 2/26/2019**
3) **Install Vapor Cap - 4/06/19**
4) **Install Inner Heating Sleeves - 4/20/2019**
5) **Install Piping & Equipment - 4/13/2019**
6) **Start Heating / 5/24/2019**
7) **Reach Target Temperature - 8/13/2019**



100 °C


# Vapor Treatment

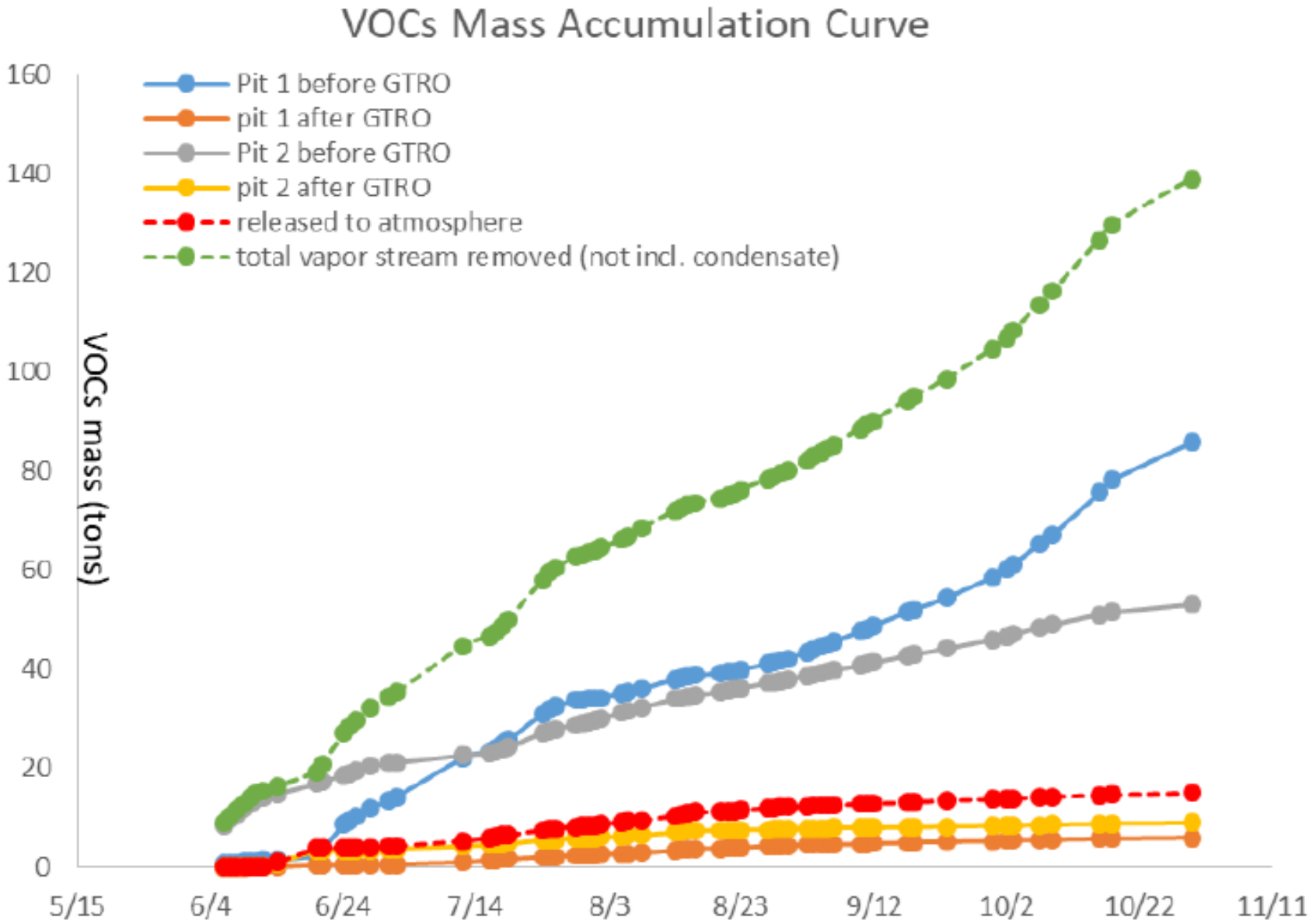
**Treatment of Off-Gas from Extraction Wells:**

- Vapor-liquid separators;
- Cooling of off-gas in heat exchangers;
- Condensate recovery;
- 720 gal. LNAPLs incinerated;
- Remaining liquid GAC filtered.
- Treatment of contaminated off-gas achieved >95% efficience.

**GTR+O vapor treatment system:**

The BTU value of the off-gas was used as a supplemental fuel for in situ heating, resulting in the thermal destruction of contaminants in the off-gas.

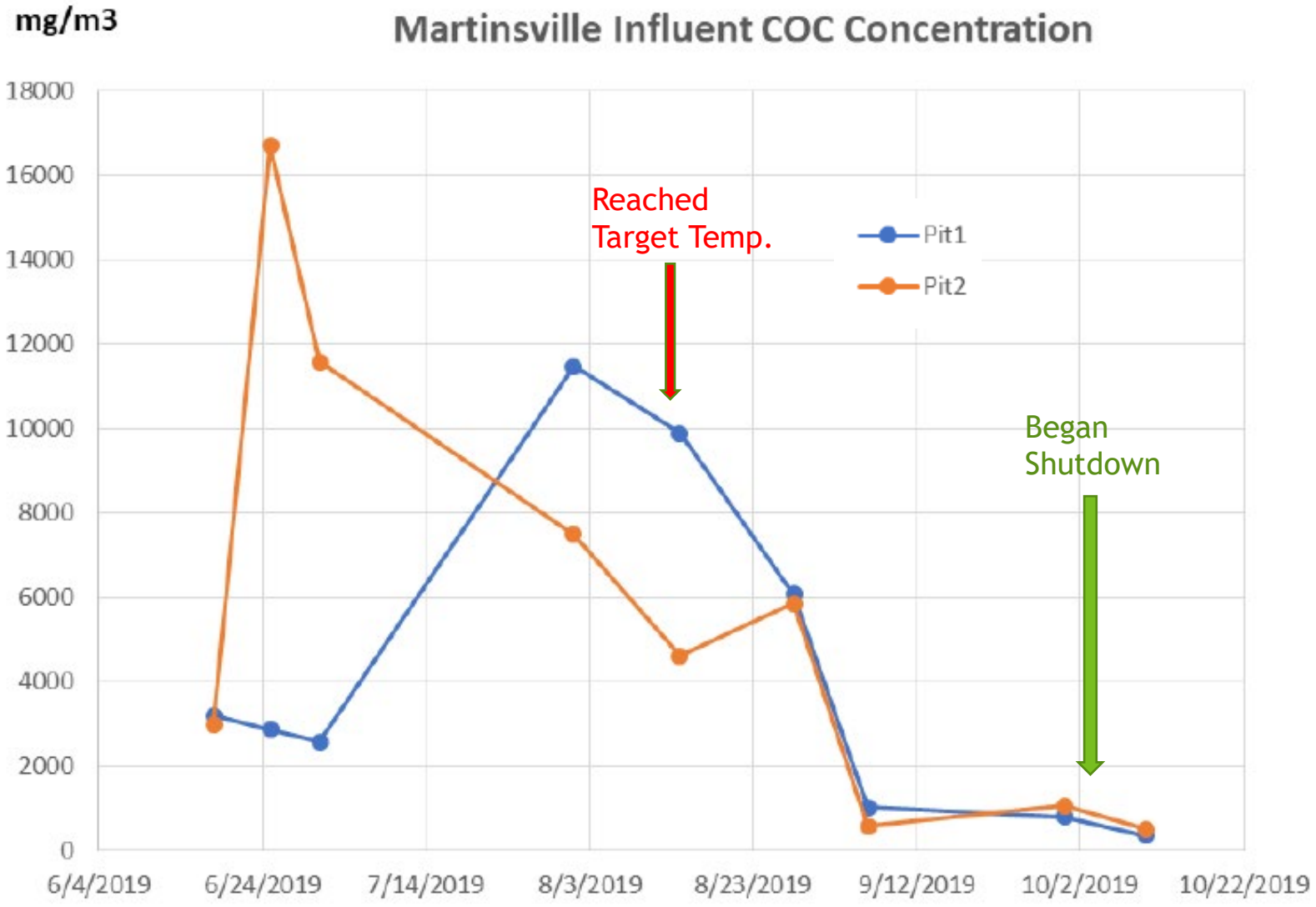
# Vapor Treatment




Volatile Organic Compounds (VOCs) Removed as Vapors:

**141.5 tons**

**(equivalent tons)**




## Project Implementation:

1) **Abandon PSVs - 2/25/2019**
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6) **Start Heating / 5/24/2019**
7) **Reach Target Temperature - 8/13/2019**
8) **Turn off heaters in Pit 2 & reduce heaters in Pit 1 – 10/07/2019**
9) **All heaters and SVE system turned off – 11/05/2019**





## Project Implementation:

1) Abandon PSVs - 2/25/2019
2) Begin Well Installations - 2/26/2019
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5) Install Piping & Equipment - 4/13/2019
6) Start Heating / 5/24/2019
7) Reach Target Temperature - 8/13/2019
8) Turn off heaters in Pit 2 & reduce heaters in Pit 1 – 10/07/2019
9) All heaters and SVE system turned off – 11/05/2019
10) Confirmatory Soil Sampling – 11/05/2019

# Confirmatory Soil Sampling Results

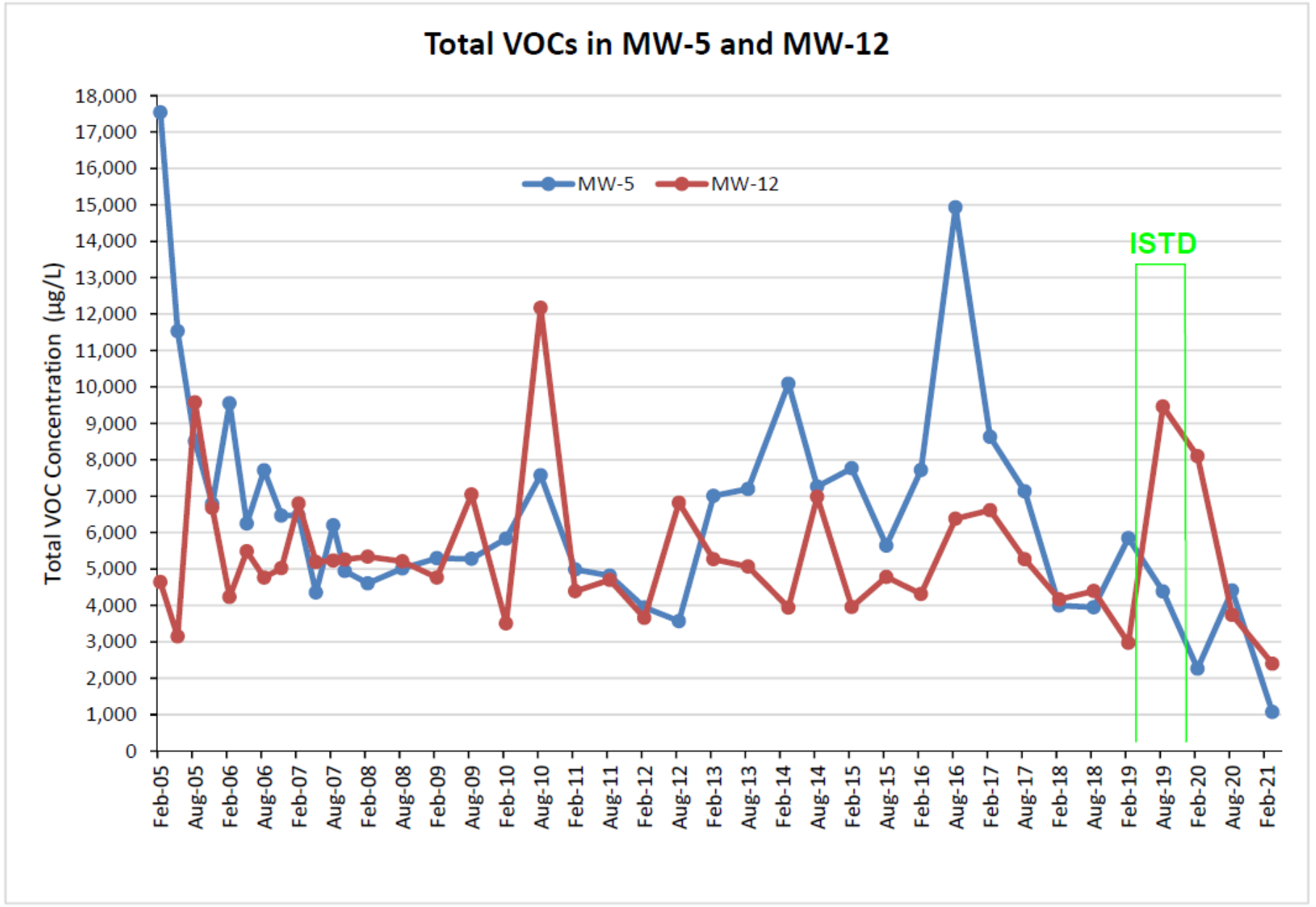
| Pre-ISTD Soil Sampling Results | Solvent Pit #1 | | | | | Solvent Pit #2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| April 14, 2016 Soil Samples | B1<br>10-15' | B2<br>15-20' | B2<br>30-35' | B3<br>15-20' | B4<br>15-20' | B5<br>25-30' | B7<br>20-25' | B6<br>25-30' | B8<br>10-15' | B8<br>15-20' |
| Total VOCs (mg/kg): | 655 | 12,675 | 836 | 7,746 | 8,222 | 1,902 | 4,745 | 4,277 | 3,118 | 2,185 |

| Post-ISTD Soil Sampling Results | Solvent Pit #1 | | | | | Solvent Pit #2 | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| November 12, 2019 Soil Samples | B-1<br>12-13' | B2<br>12-13' | B2<br>30-35' | B3<br>15-20' | B4<br>12-13' | B5<br>27' | B7<br>17-18' | B6<br>25' | B8<br>10-15' | B8<br>15-20' |
| Total VOCs (mg/kg): | 105.8 | 384.6 | 5.621 | 21.91 | 17.25 | 6.537 | 2.440 | 119.8 | 459.7 | 4.510 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Percent Reduction for Corresponding Samples: | 83.86% | 96.97% | 99.33% | 99.72% | 99.79% | 99.66% | 99.95% | 97.20% | 85.26% | 99.79% |
| Average Reduction in each Pit | 95.93% | | | | | 96.37% | | | | |
| **Over-all Average Reduction in Total VOCs** | 96.15% | | | | | | | | | |

## Project Implementation:

1) Abandon PSVs - 2/25/2019
2) Begin Well Installations - 2/26/2019
3) Install Vapor Cap - 4/06/19
4) Install Inner Heating Sleeves - 4/20/2019
5) Install Piping & Equipment - 4/13/2019
6) Start Heating / 5/24/2019
7) Reach Target Temperature - 8/13/2021
8) Turn off heaters in Pit 2 & reduce heaters in Pit 1 – 10/07/2019
9) All heaters and SVE system turned off – 11/05/2019
10) Confirmatory Soil Sampling – 11/05/2019
11) Equipment Disassembled & Removed from Site – November 2019
12) Heating Wells Abandoned – December 2019 – SVE wells left in place.




# Effect on Groundwater Concentrations

# Actual Costs of the Martinsville Landfill In Situ Thermal Remediation Project

| | GEO | LaBella | Total |
|---|---|---|---|
| **FY-2019:** | $951,292.57 | $57,203.19 | $1,008,495.76 |
| **FY-2020:** | $268,970.00 | $21,187.95 | $290,157.95 |
| **PROJECT TOTAL:** | $1,220,262.57 | $78,391.14 | $1,298,653.71 |

| | | | |
|---|---|---|---|
| **Orginal Budget:** | $1,397,453.50 | $107,500.00 | $1,504,953.50 |
| **Savings:** | $177,190.93 | $29,108.86 | $206,299.79 |
| **% Savings:** | 12.68% | 27.08% | 13.71% |

## SOURCES of SAVINGS

- **Innovative Air Effluent Treatment**
- **Lower Fuel Costs**
- **On-Site Remediation of Drill Cuttings**

# Martinsville Landfill ISTD Project Summary:

- The ISTD system operated for a total of 165 days.
- More than 141.5 tons of volatile organic compounds (VOCs) were removed as vapors.
- The GTR-O treatment system achieved >95% average removal efficiency for off gasses.
- 720 gallons of LNAPL were recovered and destroyed.
- 96% reduction of VOC concentrations in the soils.
- Promising reductions in groundwater VOCs.
- Finished under budget.

# QUESTIONS

**Van Burbach, PhD, PG**

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**LaBella Associates - Greensboro, NC**

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