Thermal Conduction Heating (TCH) Removed Over 400,000 Pounds of Jet Fuel Contamination from Former Bulk Fuel Source Area

Jim Galligan, Steffen Griepke, Nikole Huard, Tim Mahoney - TerraTherm, Inc.
Mac Walling, Nicholas Largent - Amentum Environment & Energy
Barry Kline, Sean Lorden - TRC Companies
Tom Roesch – Federal Aviation Administration

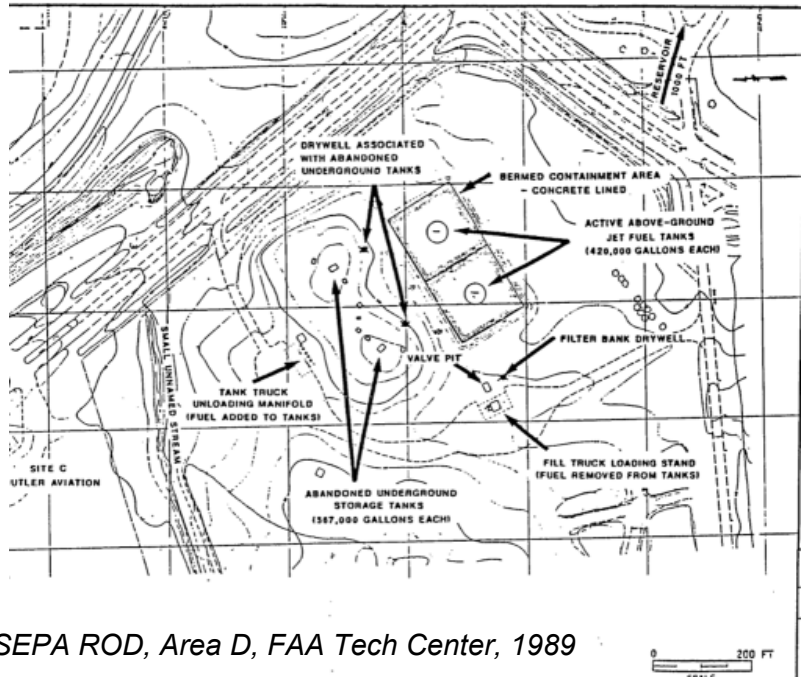
FAA Tech Center - Area D Thermal Remediation

Agenda

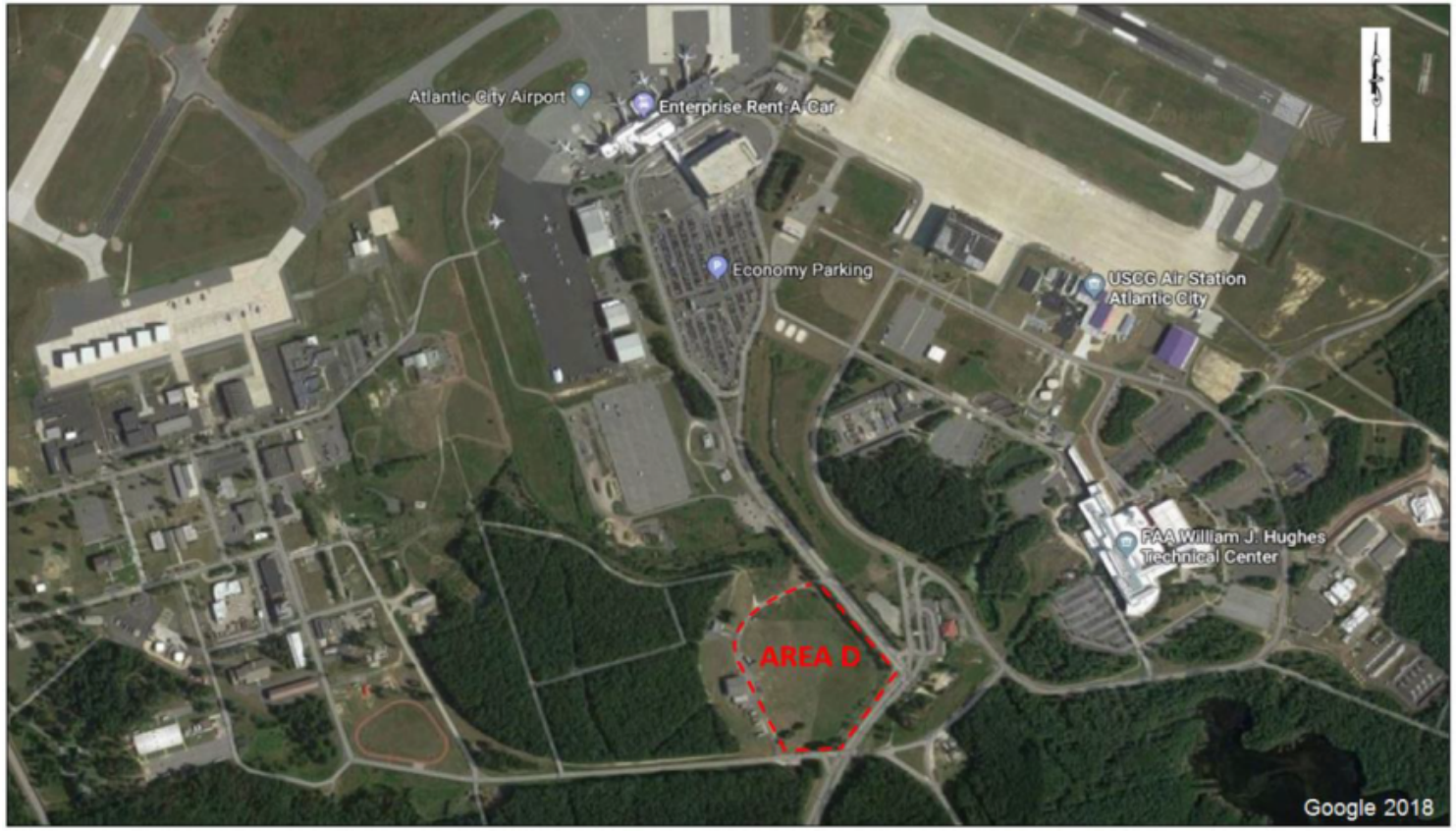
- Site History
- Thermal Treatment Zone Definition
- Treatment Goals
- TCH Operation (2 phases)
- Lessons Learned
- Results
- Questions

Area D Fuel Farm - Historic Sources

- Airport built in 1940s
- (2) USTs (Abandoned), 567,000 gal each
- (2) ASTs in conc. berms 420,000 gal each



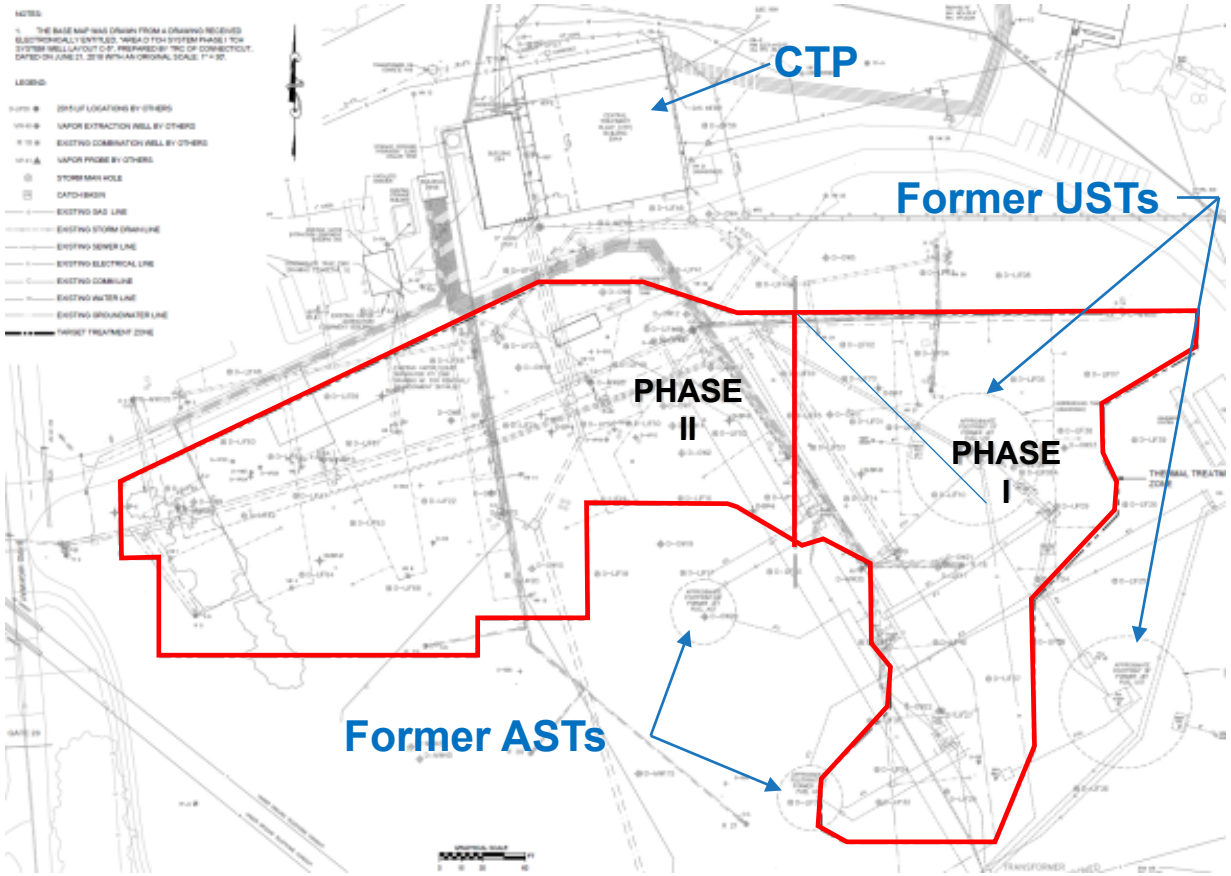
USEPA ROD, Area D, FAA Tech Center, 1989



Area D – Pre-Thermal Remediation

- 1989: ROD
- 1998: Free product extraction
- 1994: Vapor Extraction Sys. (VES), Cat-ox off gas treatment; Pump & treat with effluent reinjection
- 2009: Central Treatment Plant (CTP) replaced Area D GWTP
- 2012: Upgrade Cat-ox, 36 new VES, Solar powered LNAPL skimmers, and 5-acre recharge bed
- 1995-2015:
  - Over 89,000 gal NAPL (~580,000 lb) recovered
    - Pumping/skimming: >56,500 gal NAPL [63%]
    - VES System: >33,200 gal, as NAPL [37%]

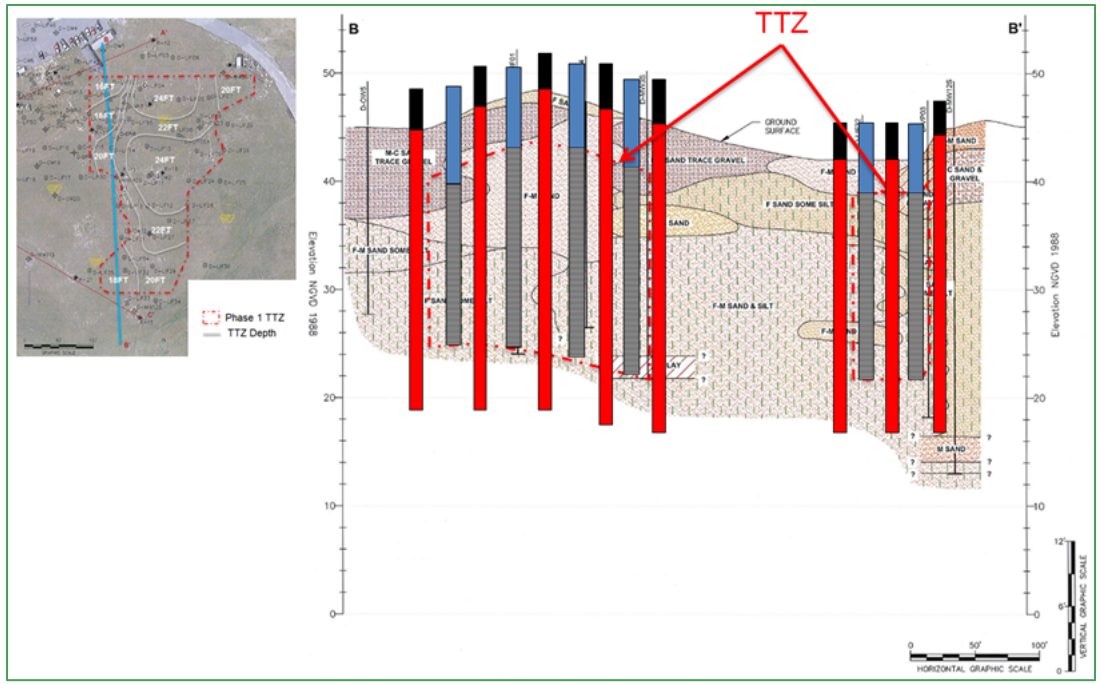
Area D - Thermal Treatment Zone



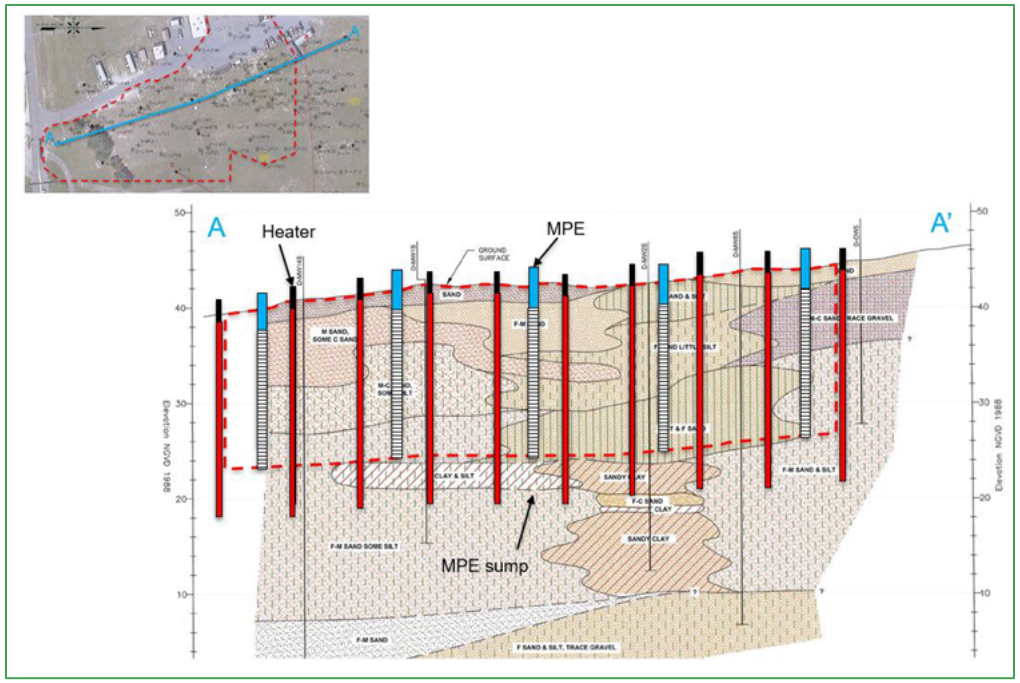
- Final TTZ > 4 acres (1.7 ha)
- Target depth varied
  - Top: 5 - 9 ft bgs
  - Bottom: 16 - 24 ft bgs
  - 8 ft average thickness
- Contaminants: JP-4, BTEX
  - Estimated 500,000 lbs
- Obstructions
  - Buried tank foundations (20’ bgs)
  - Active roadway
  - Central Treatment Plant (CTP)
  - Active UG utilities
  - Buried SVE lines

Hydrogeologic Setting

Area 1



Area 2



Geology	Silty/clayey fine sand w/some coarse sand/gravel Intermittent clay stringers
Water Table	10-15 ft bgs, unconfined
Hydraulic Conductivity (k)	Varies, $1x10^{-4}$ to $1x10^{-5}$ cm/sec (0.283 – 0.0283 ft/day)
Topographic Relief:	6 to 8 ft elevation change across site

Treatment Goals

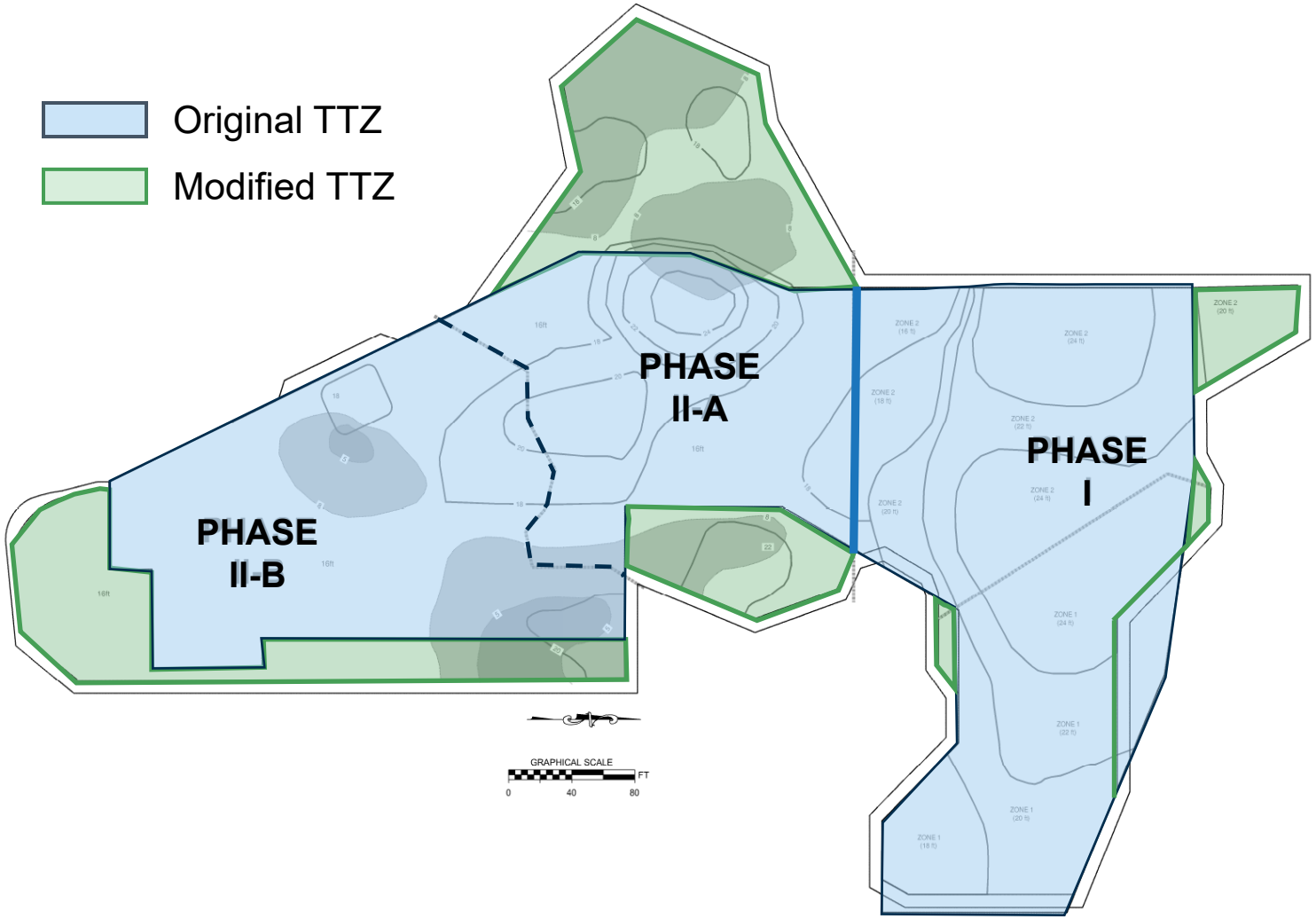
- Remove JP-4 NAPL
- Target Temp: 100ºC (+/- 3ºC)
  - 90% of TCs > 97ºC
  - Minimum 65 Days at Target
  - Contract specified # of days
- Reduce Contaminant Mass
  - Diminishing Returns

Thermal Treatment Zone

Design Parameters

Modified Thermal Treatment Zone

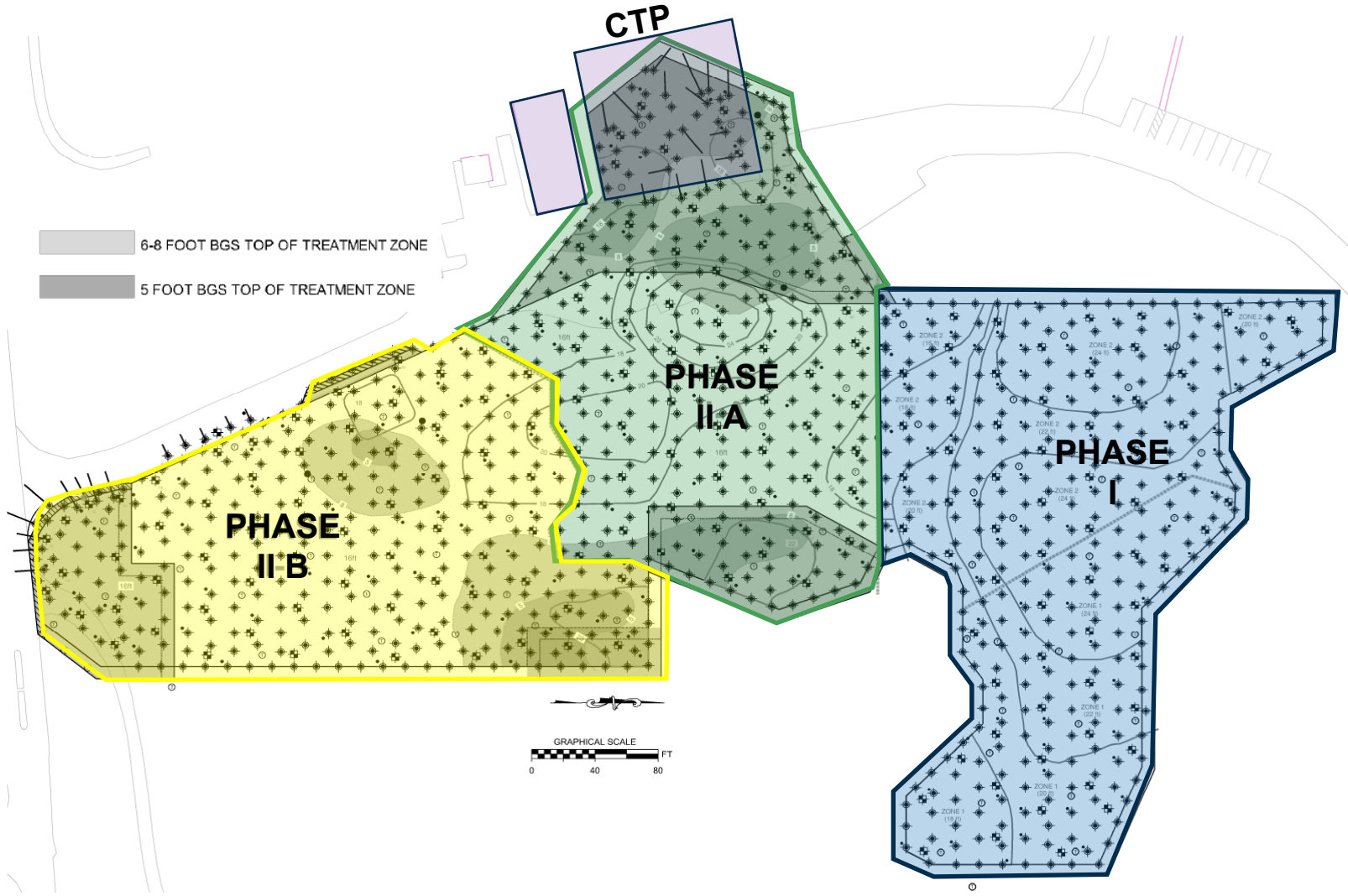
Pre-design final delineation modified original treatment zone



Final TTZ Configuration

	Area (SF)	Treatment Volume (CY)	Heated Volume (CY)
Phase 1	**63,563**	**38,609**	**62,150**
Phase 2A	*59,848*	*19,433*	*46,247*
Phase 2B	*59,913*	*19,454*	*46,297*
Phase 2 Total	**119,761**	**38,887**	**92,544**
Combined	**183,324**	**77,496**	**154,694**

Thermal Wellfield

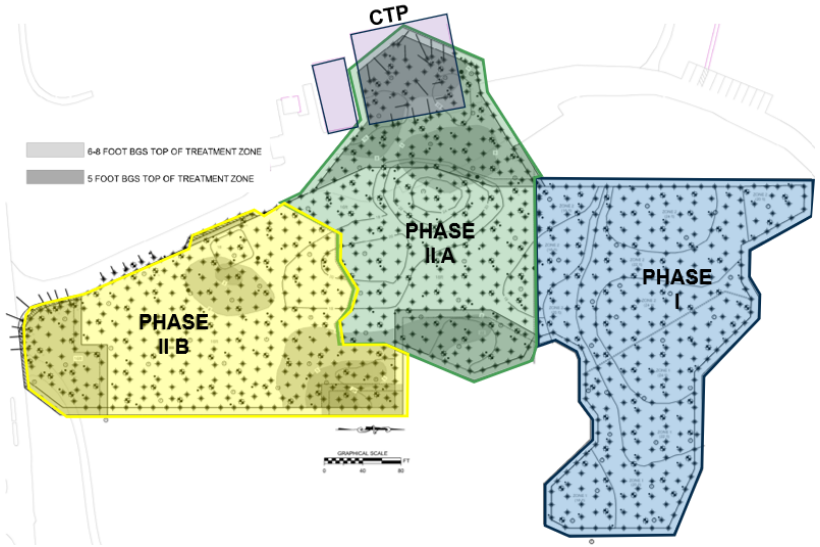


Final TCH Wellfield

	Phase 1	Phase 2
TCH Heaters	307	595 ** 27 angled*
Shallow TCH Htrs	*13*	*0*
MPE	66	129 ** 2 angled*
TMP	28	44
Shallow TCs	0	4

Design Parameters

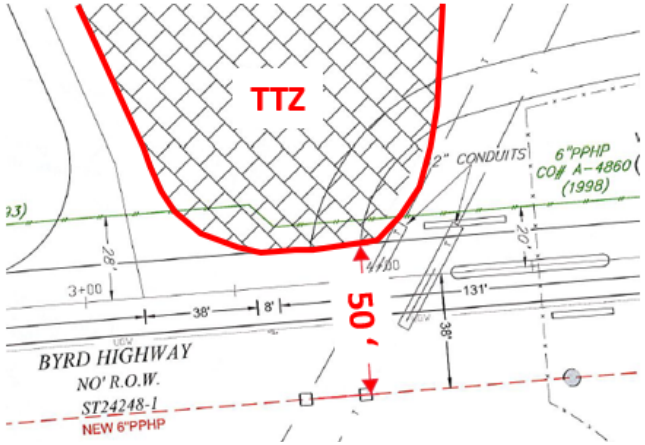
	Heater Spacing (ft)	Heating Duration (Days)	Power Use, in ground (kW)	Power Demand (kW)	Est. Power Use (kW-hr)
Phase 1	17' interior 15' perimeter	**256**	**2,231**	**3,250**	**15,021,000**
Phase 2A	For top of TTZ at 9' bgs: 17' interior 15' perimeter For top of TTZ at <6' bgs: 15' interior 15' perimeter + insulation	**400**	1,223	1,651	12,145,000
Phase 2B			1,320	1,599	13,116,000
Phase 2 Total			**2,543**	**3,250**	**25,261,000**
Combined		**656**	**4,774**	**6,500**	**40,282,000**



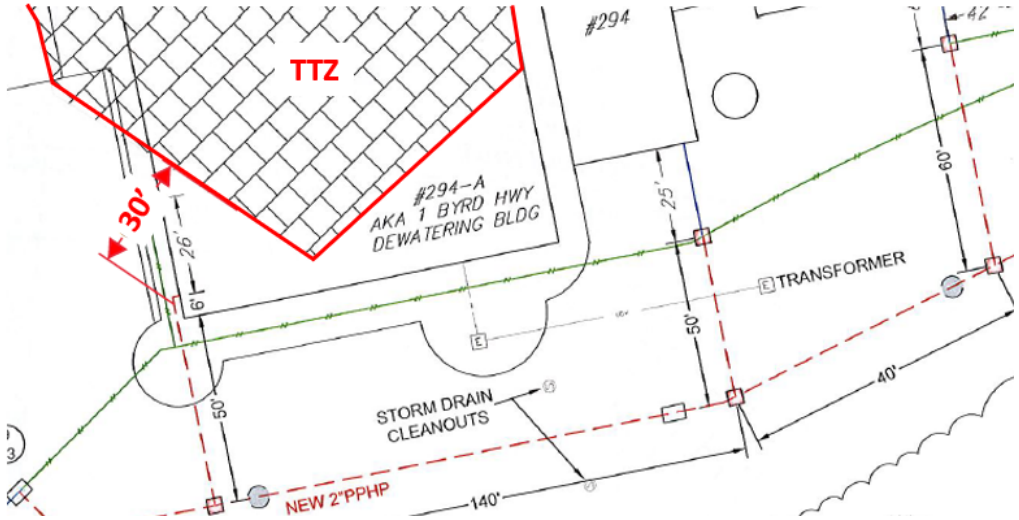
- HDPE cover in Ph. 1 & 2
- Ph. 2 added insulation & concrete cover where top of TTZ <6 ft bgs
- Ph 2 A/B staggered start
  - Reduce peak power demand
  - Reduce peak COC mass load

Ph 2 Design Consideration: Gas Lines

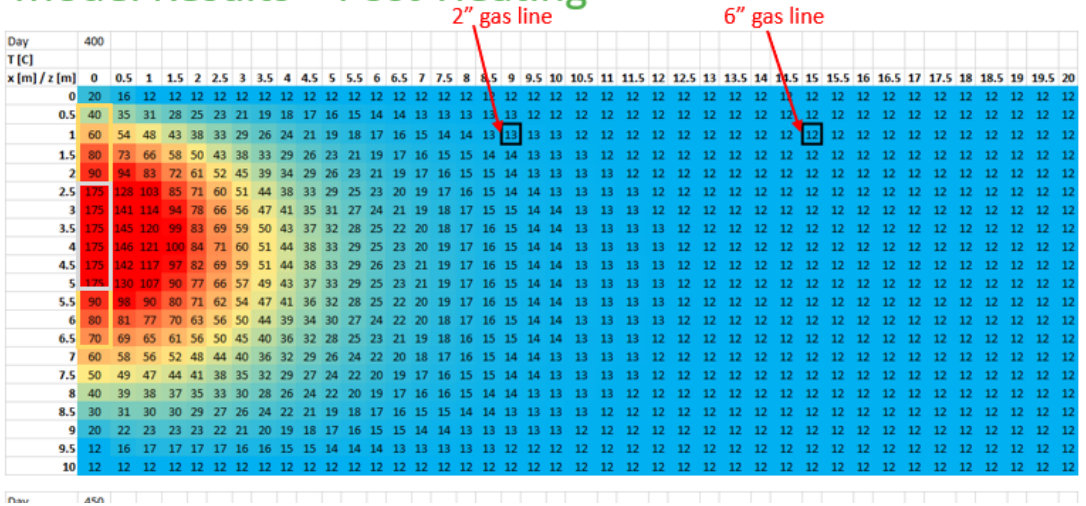
6” Gas Line Location



2” Gas Line Location



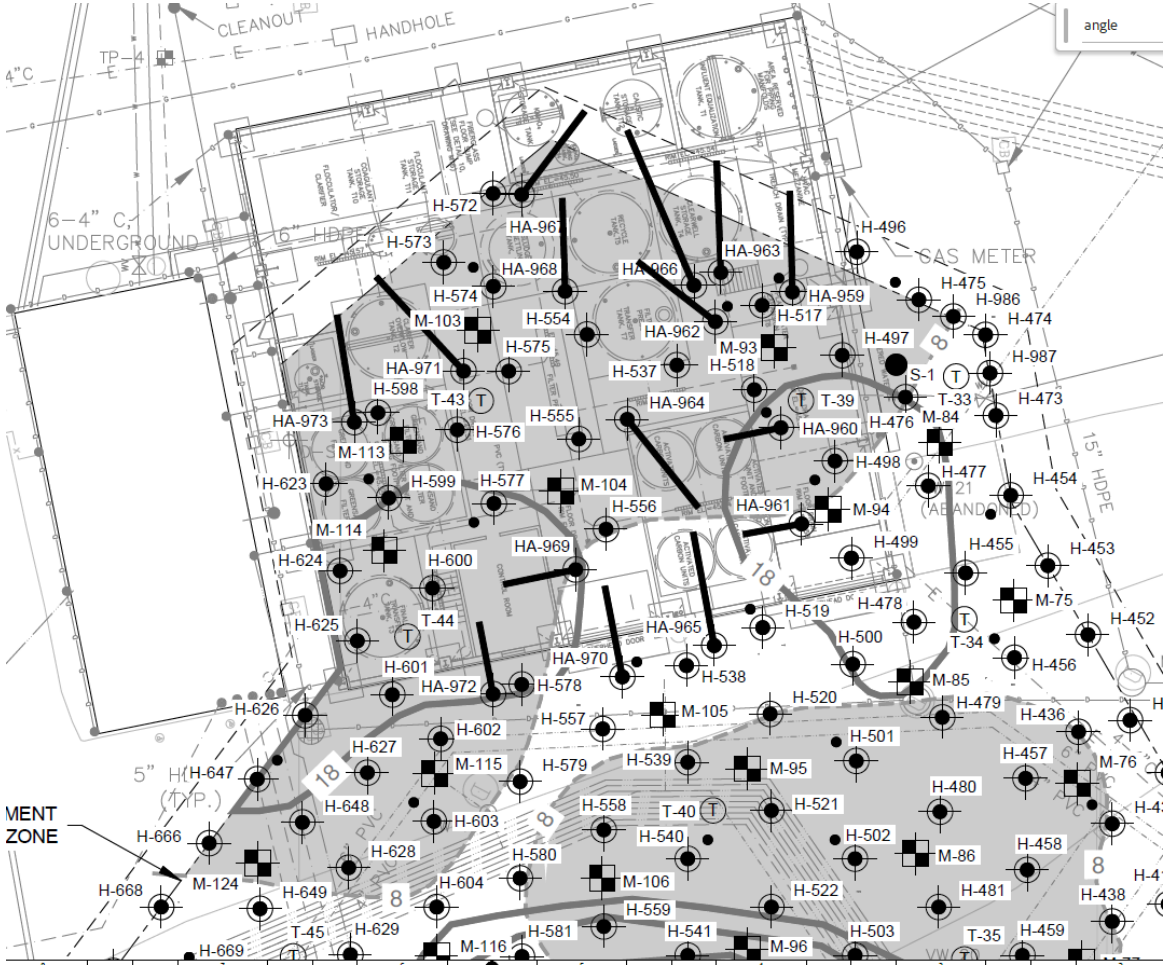
Model Results – Post-Heating



Model Results

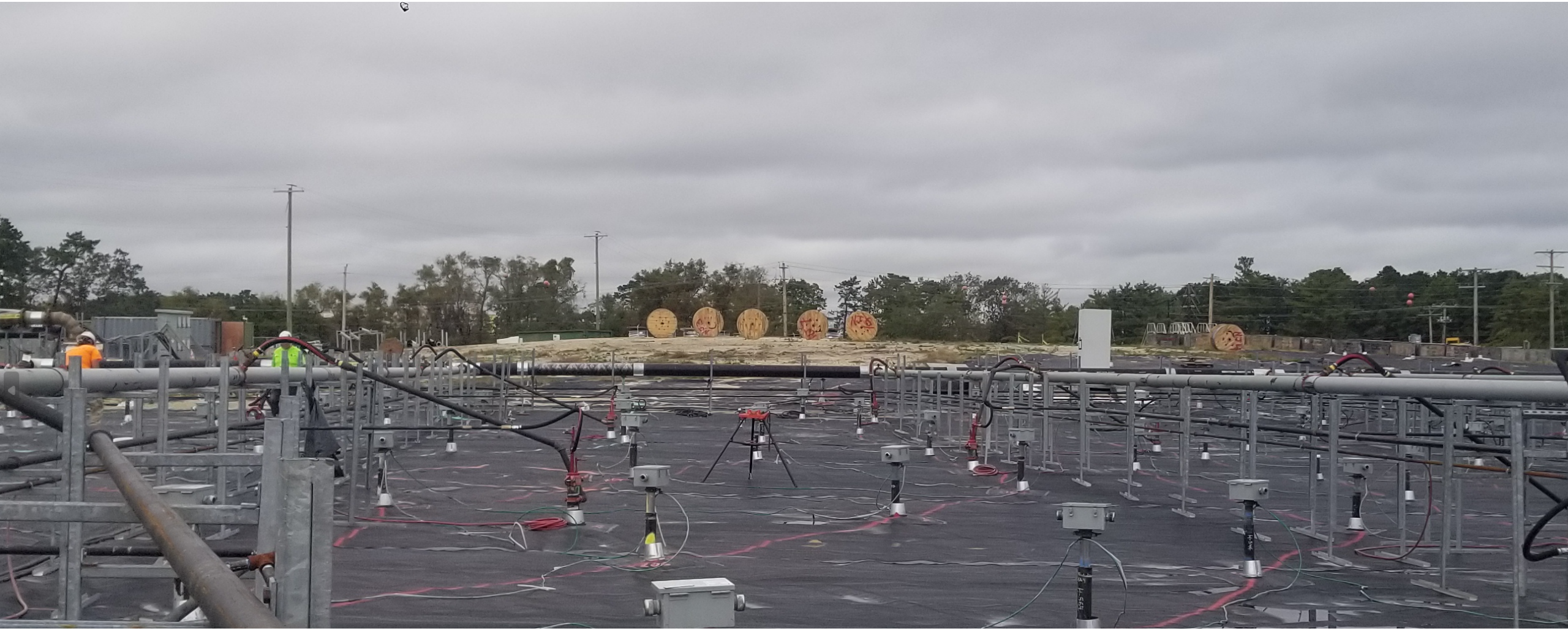
Modest heat-up of approximately 1°C at the 2” gas line and no heat-up observed at the 6” gas line.

Infrastructure Challenges



Angled TCH Heaters & MPE wells around infrastructure

Phase 1 Wellfield



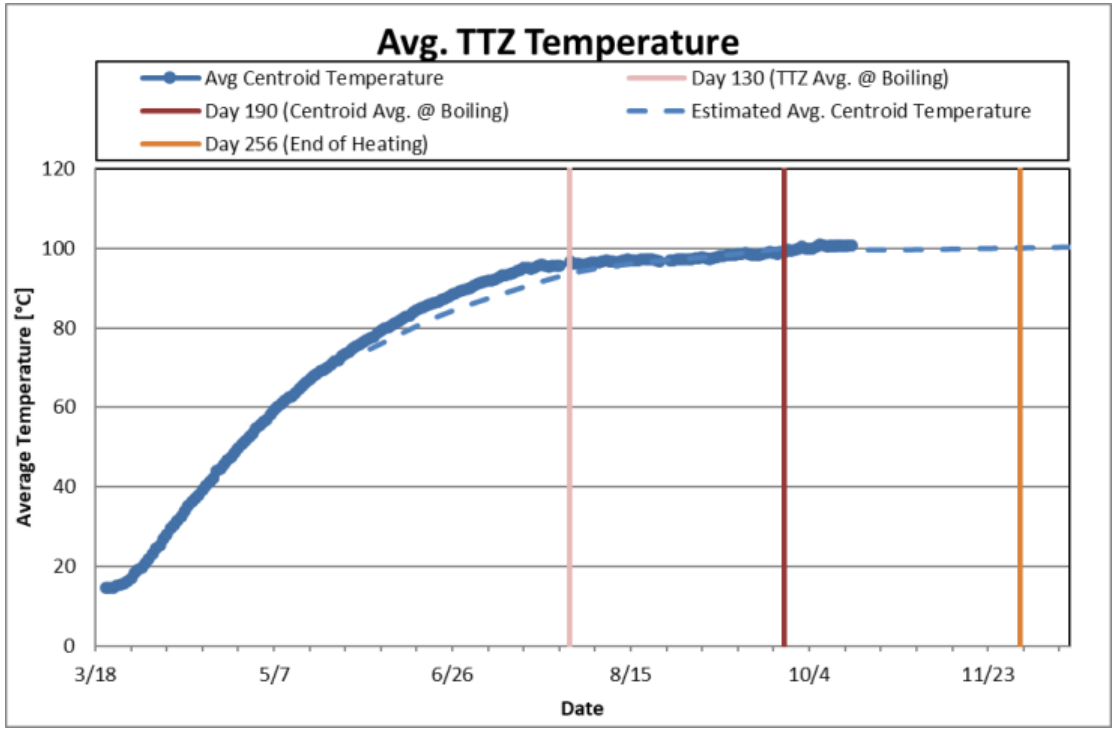
Phase 2 Wellfield

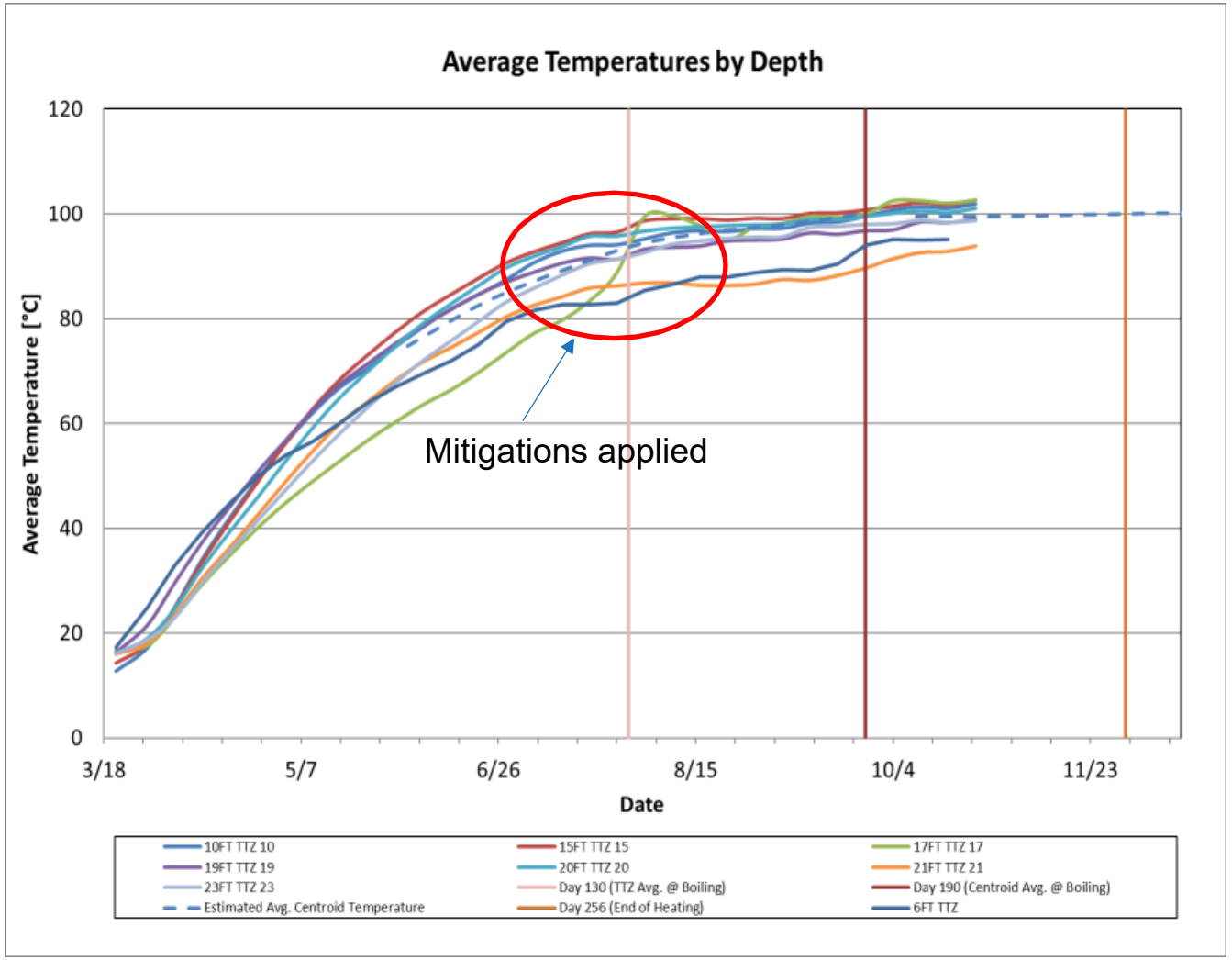
Vapor Treatment System

- Condensing front end to reduce steam load on oxidizer
- Existing Cat-ox replaced with Thermal-ox due high influent loading
  - Therm ox rated up to 134 lb/hr JP-4 (3,200 lb/day)
- Continuous real-time LEL monitoring allowed therm-ox to process vapors at up to 40% LEL
  - Warnings at 35% LEL
  - Alarm/Shut-down at 40% LEL

TCH Operations

Temperatures – Phase 1





- Average temps closely tracked model
- 6', 21', 23' intervals lagged behind Avg.
  - Mitigation measures in July/August
  - Supplemental htrs & insulation

Modifications

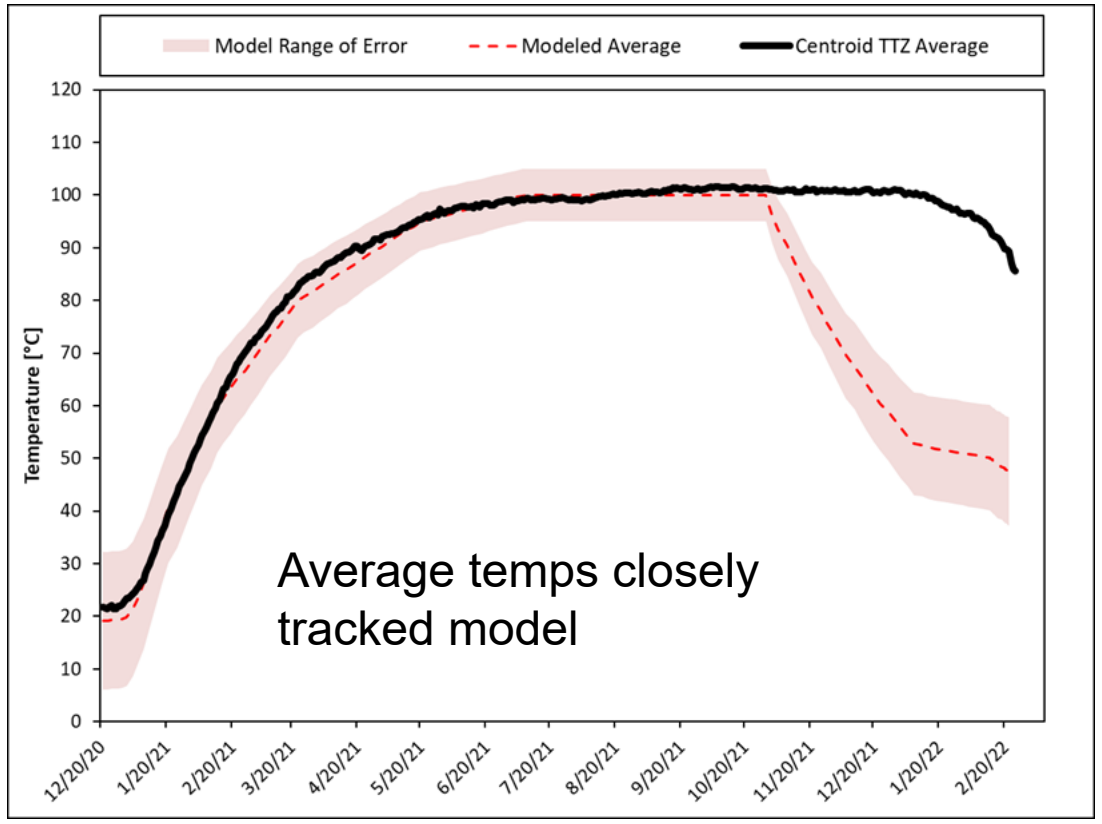
Ph 1: Lagging temps in shallow areas

- Added 4 deep heaters
- Added13 shallow heaters
- Surface insulation in spots

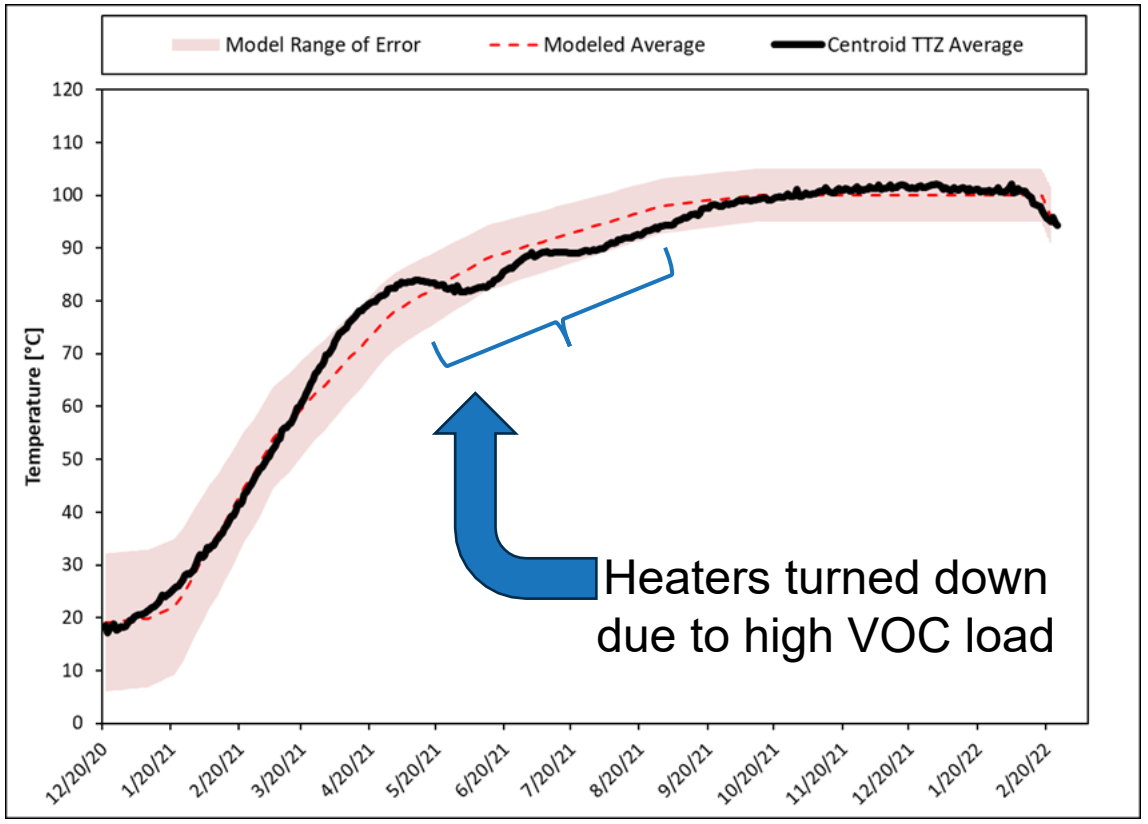
Ph 2: Design Changes

- Top of TTZ <9’ bgs
  - Insulating vapor cover
- Top of TTZ <5’ bgs
  - Insulating vapor cover
  - Tighten heater spacing to 15’

Temperatures – Phase 2

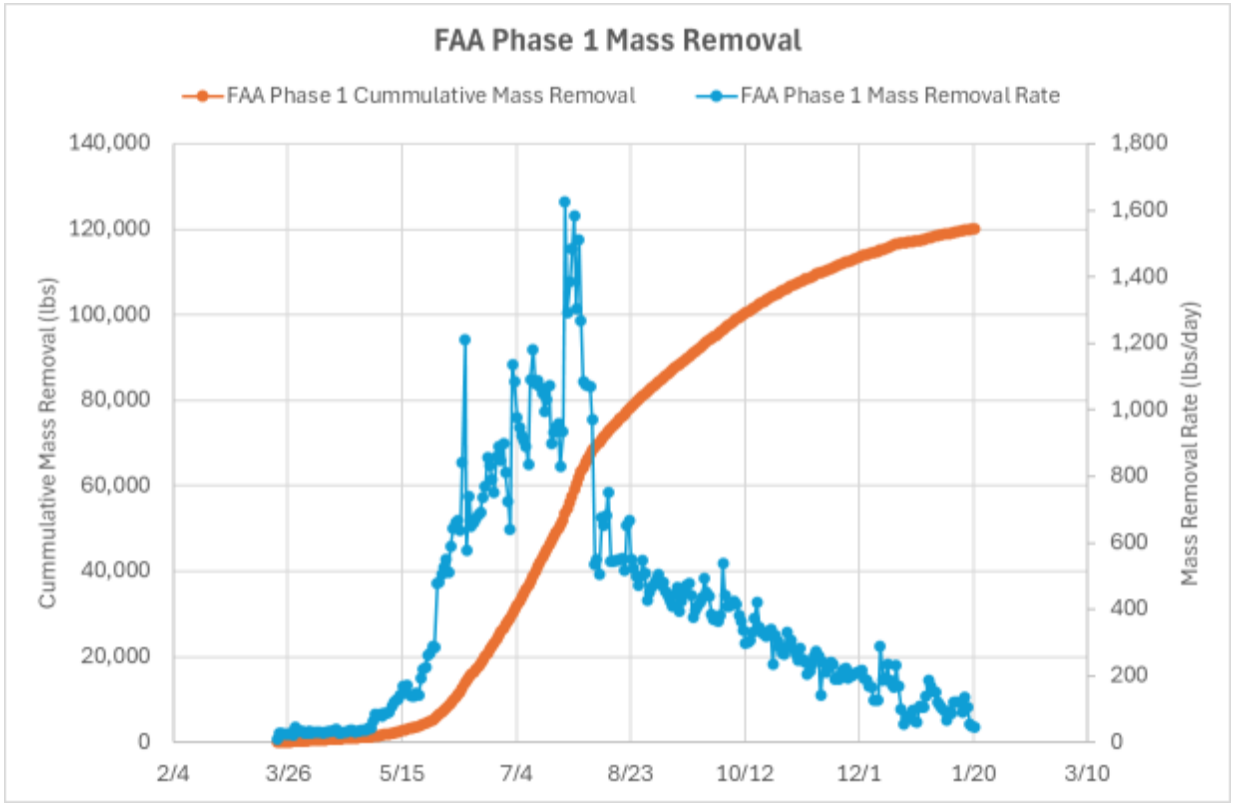


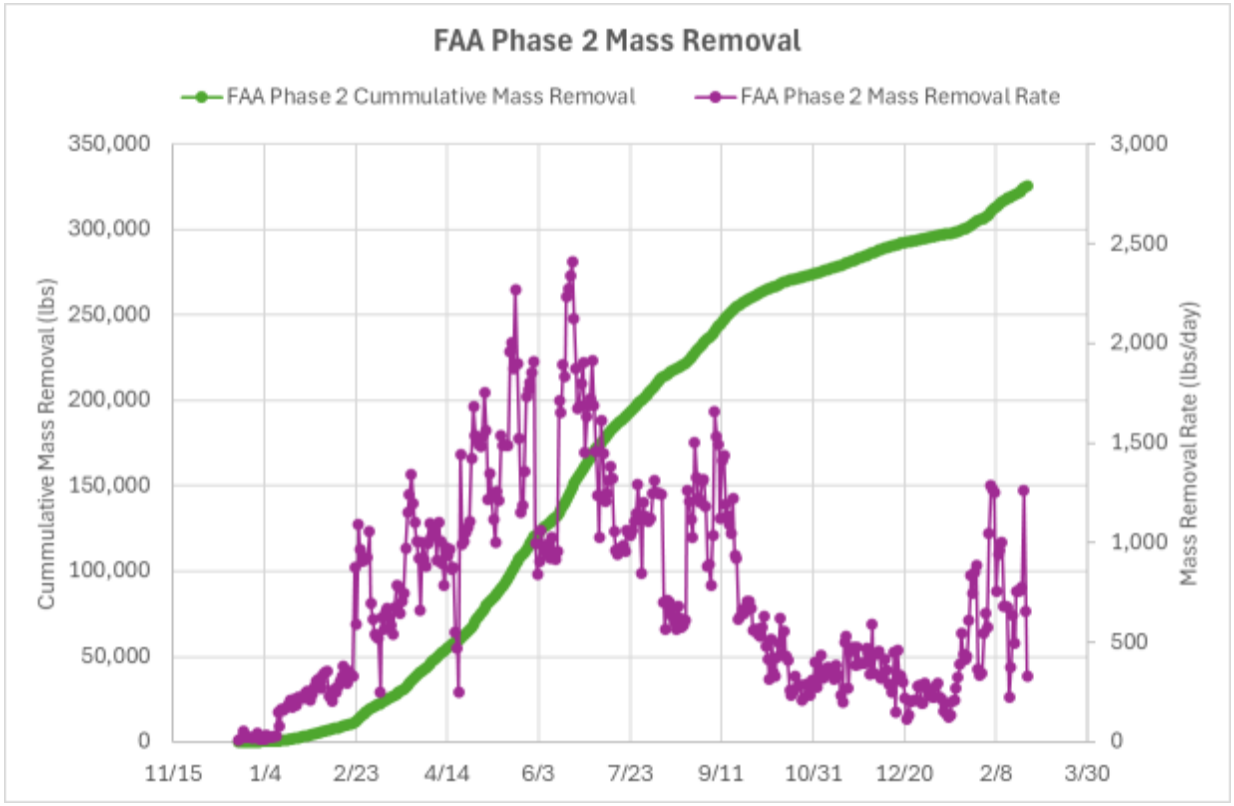
Phase 2A



Phase 2B

JP-4 Mass Removal with TCH



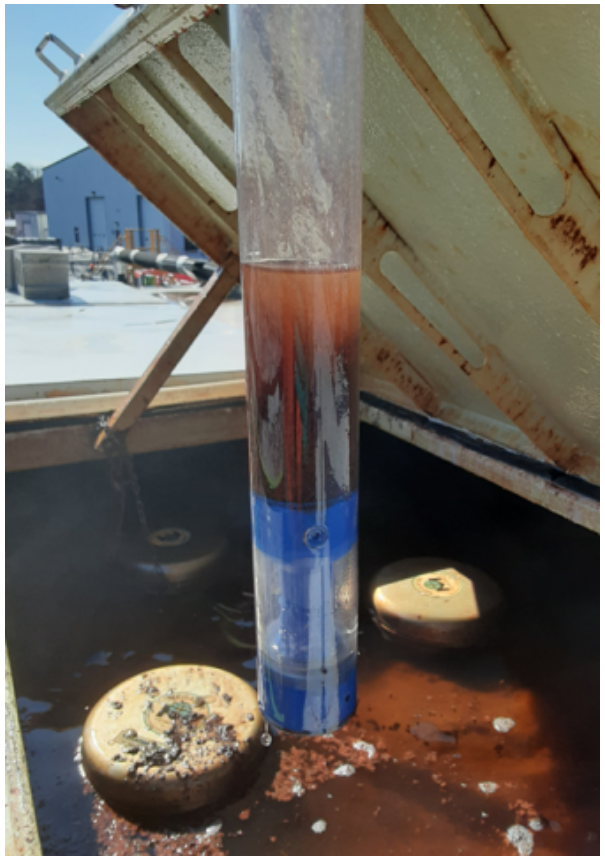


Results

Results

Over 445,000 lbs (202,000 kg) of JP-4 contamination removed during TCH operations

Contaminant Mass Removal (in lbs)		
	Phase 1	**Phase 2**
Vapor	95,275 [79%]	246,152 [75%]
Liquid	*87 [<1%]*	*400 [<1%]*
NAPL	24,715 [21%]	78,906 [25%]
Total	120,077	325,458
Combined	**445,535**	



Results

“The successful completion of this project resulted in a cost avoidance of $218M by reducing the environmental remediation timeline by 140 years.”

Amentum, 2022

Questions?

Jim Galligan
TerraTherm, Inc.
+1 978-730-1214
jgalligan@terratherm.com

One Partner. Many Solutions.

CASCADE

www.cascade-env.com

ADT

TERRATHERM
a Cascade Company

www.terratherm.com