



Evaluating Vadose Zone Mmunition Explosive Constituents (MEC) Compound Migration with Lysimeters

AMEC Earth and Environmental

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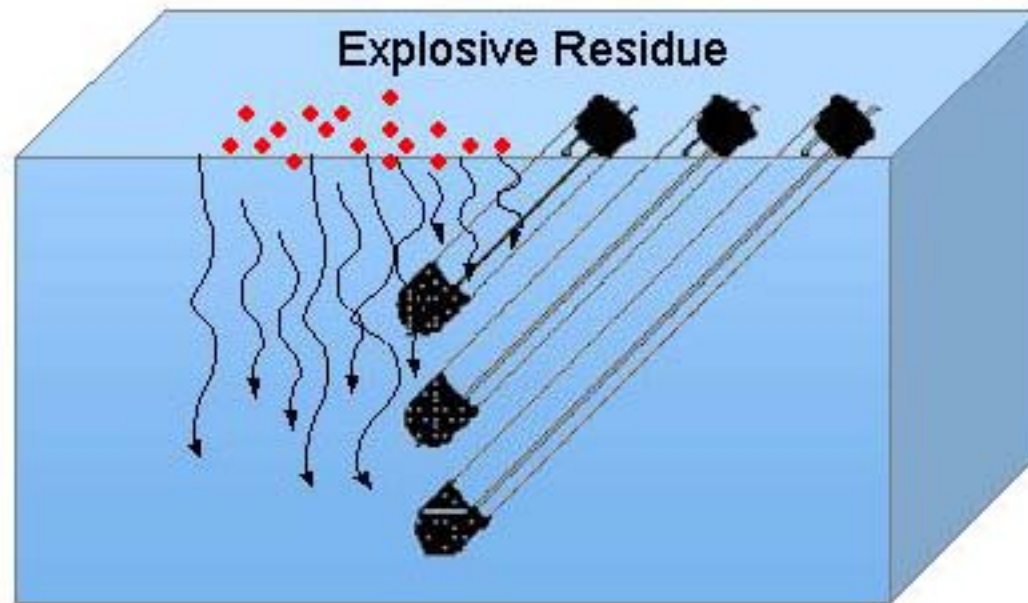
Purpose

- Assess effectiveness of lysimeters to evaluate migration of munition explosive constituents (MEC) compounds from surface soil through the shallow vadose zone.
- Evaluate source strength, spatial and temporal distribution of source material, and provide baseline data prior to remedial efforts.

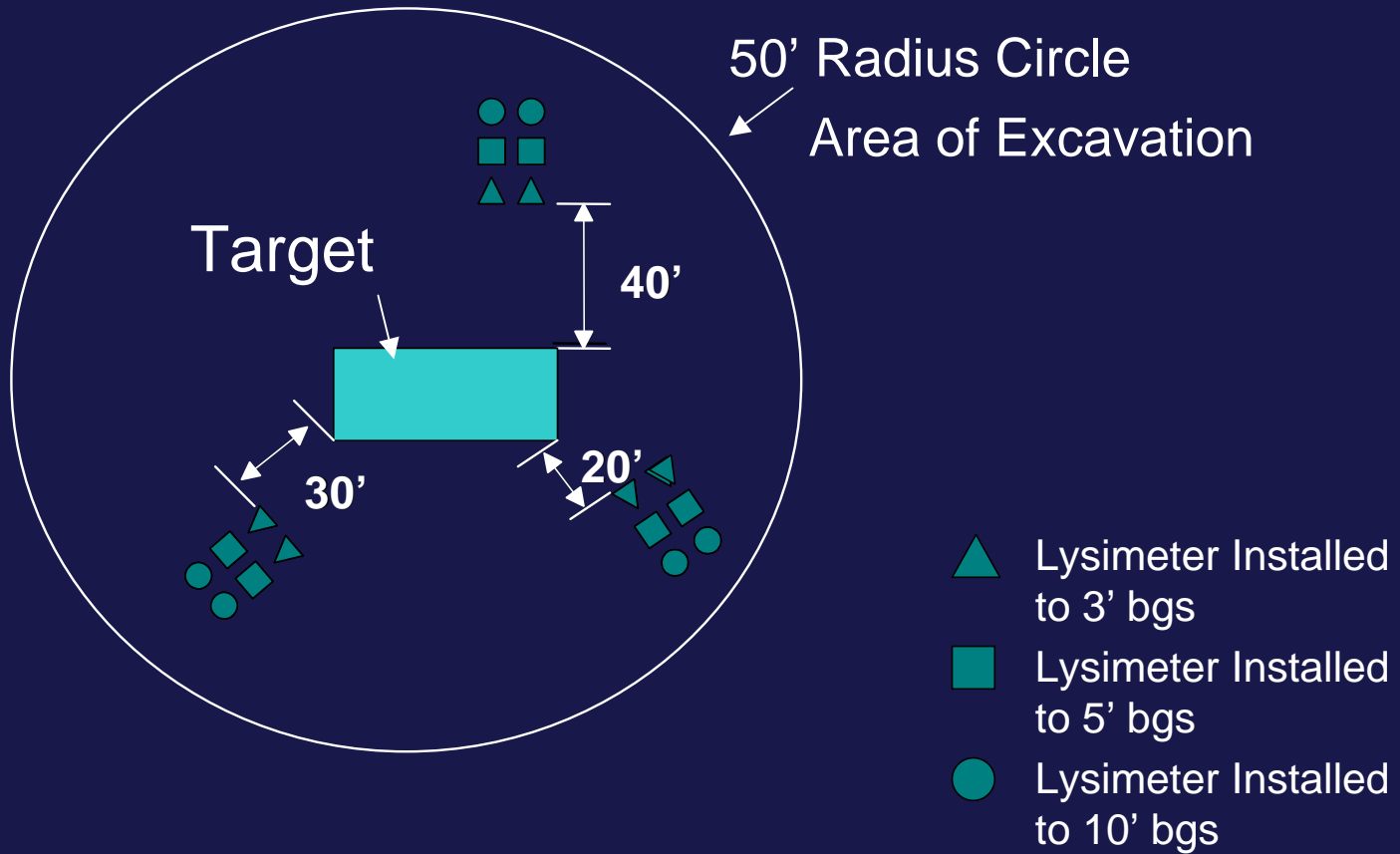
MEC Compounds Evaluated:

- Perchlorate
- Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)
- Octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazocine (HMX)
- 2,4,6-trinitrotoluene (TNT)
- 2,4-dinitrotoluene (2,4-DNT)
- 2,6-dinitrotoluene (2,6-DNT)
- Nitroglycerine (NG)
- Secondary degradation products of TNT
 - 2-amino-4,6-dinitrotoluene (2a-DNT)
 - 4-amino-2,6-dinitrotoluene (4a-DNT)
 - 2,4-diamino-6-nitrotoluene (2,4-DANT)

Pore Water Sampling Conceptual Site Model



Proposed Installation Approach

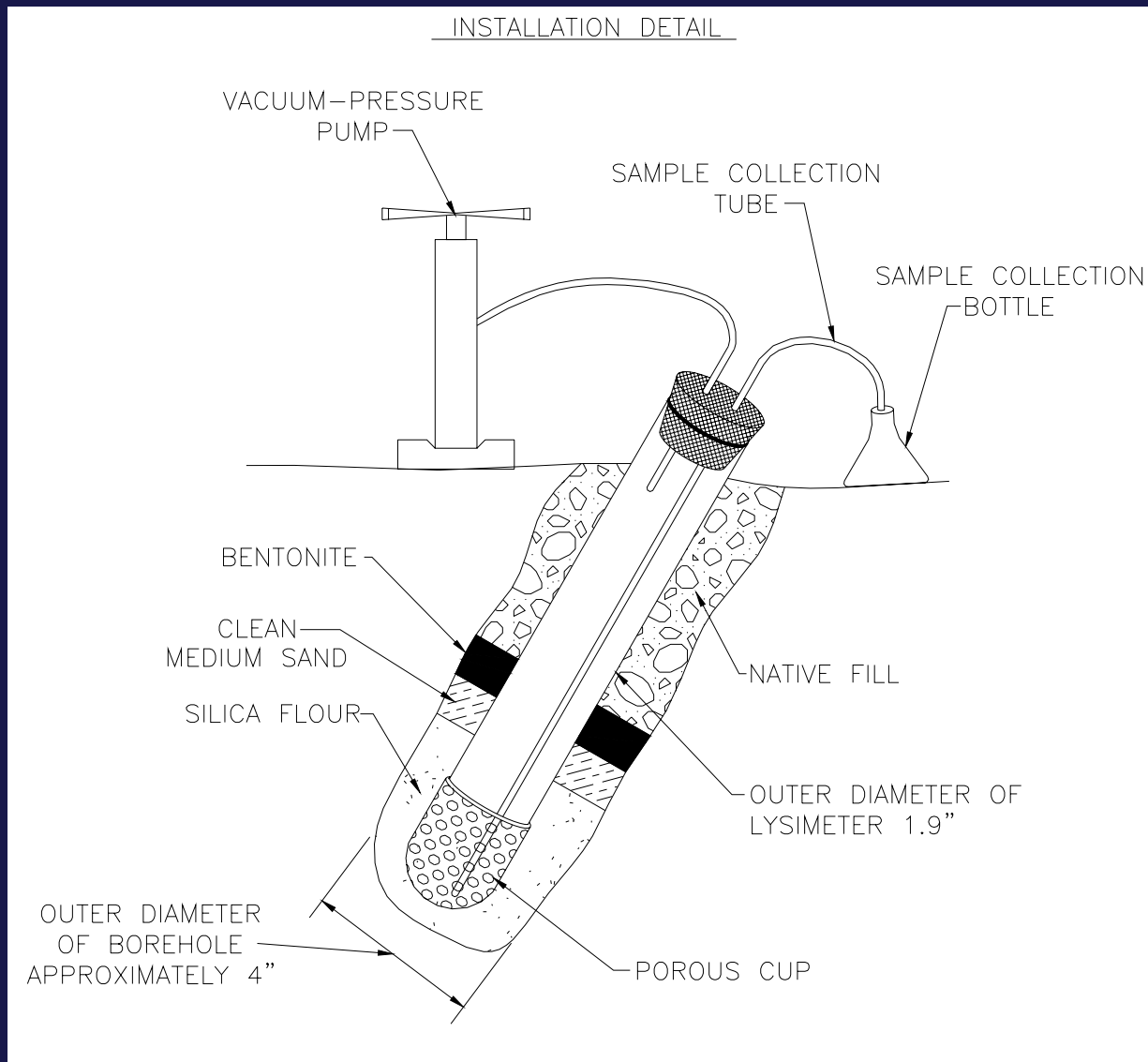


Lysimeter Installation

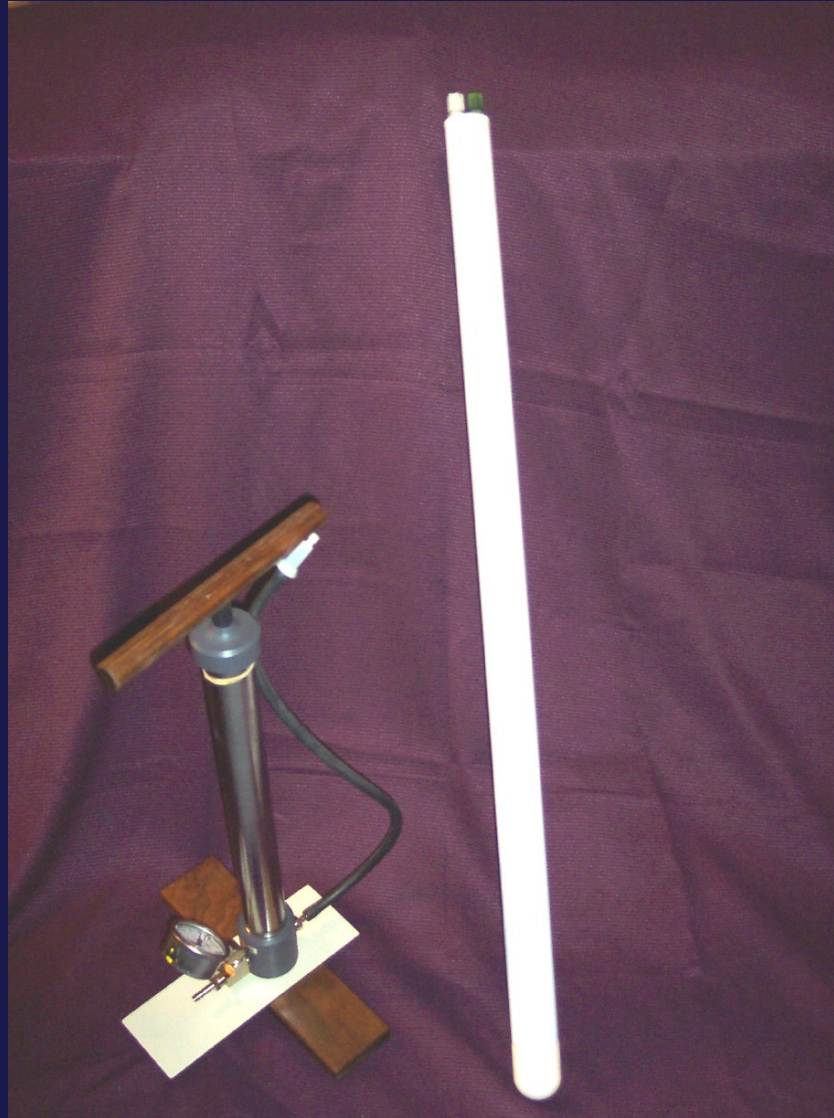
- Lysimeters soaked in deionized water 2 hrs prior to installation
- During soaking process, each lysimeter was pressure and vacuum checked
- Boreholes advanced at a 45° angle using a hand auger
- Intrusive downhole UXO clearance performed during borehole advancement
- Poly vinyl chloride (PVC) pipe used to keep borehole open
- Lysimeters installed at three vertical depths: 3 ft bgs, 5 ft bgs, 10 ft bgs (some shallower due to refusal)
- 18 lysimeters installed around Target 23
- 18 lysimeters installed around Target 42 (6 of these installed under cracked open projectile)



Lysimeter Schematic



Pressure-Vacuum Pump and 36-inch Lysimeter



0.5-bar, high-flow pressure-vacuum porous cup located at the tip of lysimeter



Lysimeter Sampling Methodology

- Purge lysimeters and collect pore water chemistry readings, including pH and conductivity
- After purging, apply vacuum of 45 centibar (cbar), and allow lysimeter to collect additional soil pore water
- Return following day to collect samples for lab analysis
- Laboratory analysis of EPA Method 8330 for explosives and EPA Method 314.0 (and/ or 8231) for perchlorate
- If insufficient sample volume on the first day, re-sample until enough volume collected





Vegetation Around Target 42



Target 23



| 125F | | C(2-3ft)N |
|---|--------------|-----------|
| ANALYTE | Date Sampled | UG/KG |
| HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE | 03/09/2004 | 430* |

| 125TA | | C(0-0.25ft)N |
|--|--------------|--------------|
| ANALYTE | Date Sampled | UG/KG |
| HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE | 12/29/2003 | 150J |
| OCTAHYDRO-1,3,5,7-TETRANITRO-1,3,5,7-TET | 12/29/2003 | 160 |

| 125TB | | C(0-0.25ft)N |
|--|--------------|--------------|
| ANALYTE | Date Sampled | UG/KG |
| 2-AMINO-4,6-DINITROTOLUENE | 12/29/2003 | 660 |
| 4-AMINO-2,6-DINITROTOLUENE | 12/29/2003 | 410 |
| OCTAHYDRO-1,3,5,7-TETRANITRO-1,3,5,7-TET | 12/29/2003 | 850 |
| HEXAHYDRO-1,3,5-TRINITRO-1,3,5-TRIAZINE | 12/29/2003 | 15,000 |

50' Excavation Radius

Target 42

Transect for UXO Survey and Soil Grid Sampling

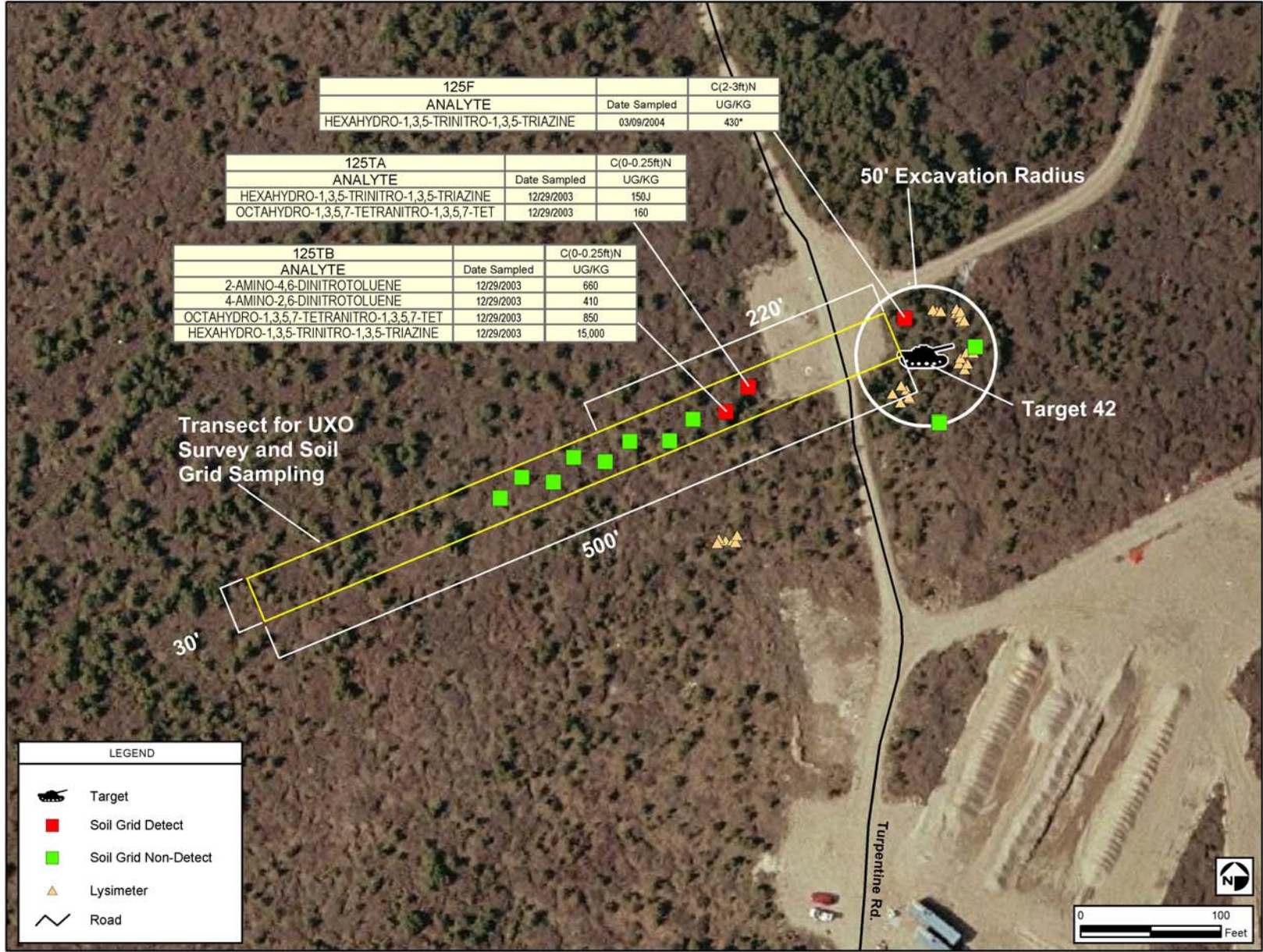
220'

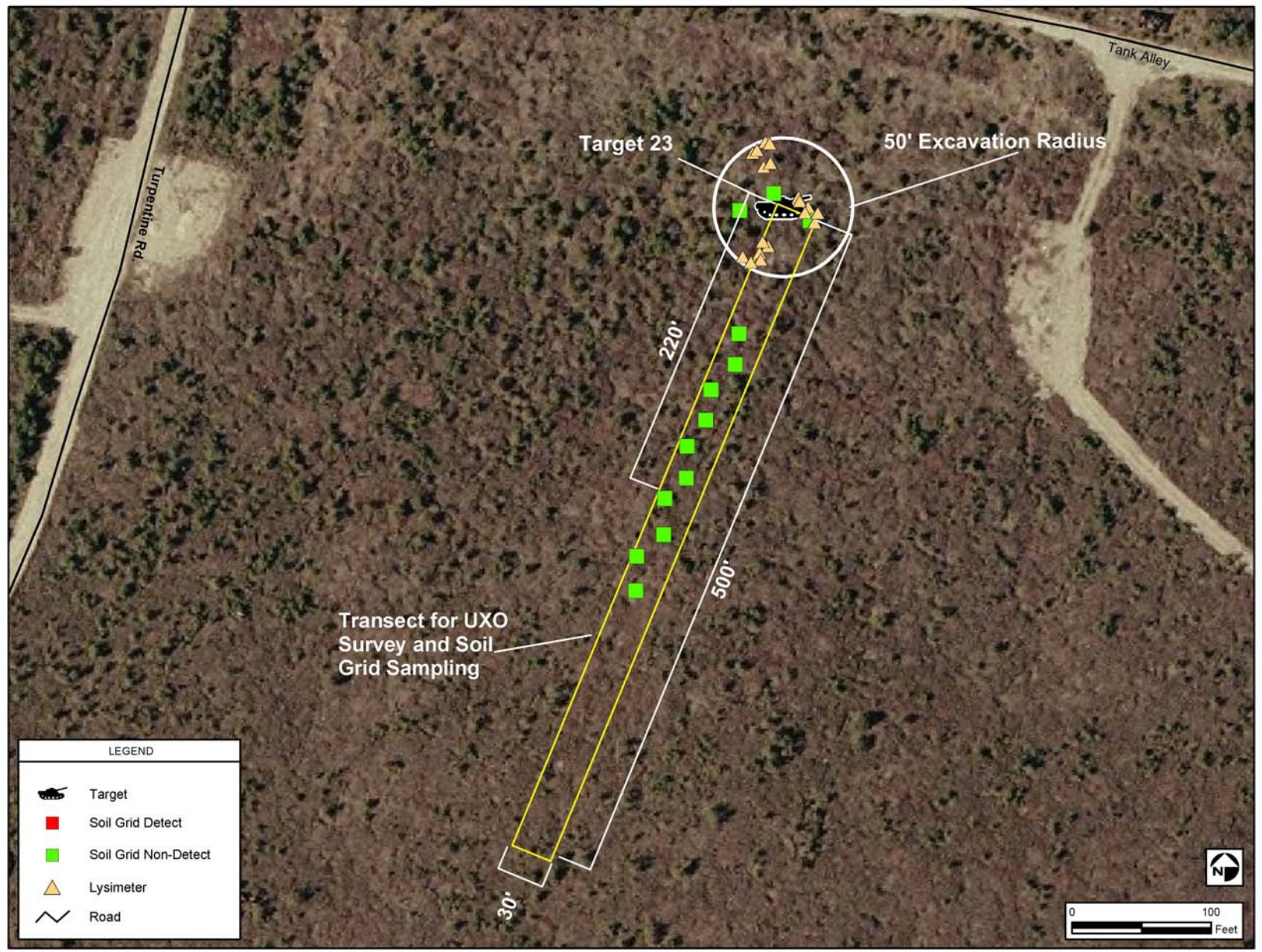
500'

30'

Turpentine Rd.

| LEGEND | |
|---|----------------------|
|  | Target |
|  | Soil Grid Detect |
|  | Soil Grid Non-Detect |
|  | Lysimeter |
|  | Road |





| LEGEND | |
|--------|----------------------|
| | Target |
| | Soil Grid Detect |
| | Soil Grid Non-Detect |
| | Lysimeter |
| | Road |



LEGEND

- Target
- Lysimeter Detections
 - Non-detect
 - 0.1 ppb to less than 10 ppb
 - 10 ppb to less than 100 ppb
 - Greater than 100 ppb
- Existing Monitoring Wells
- Road

MW-93

Turpentine Rd

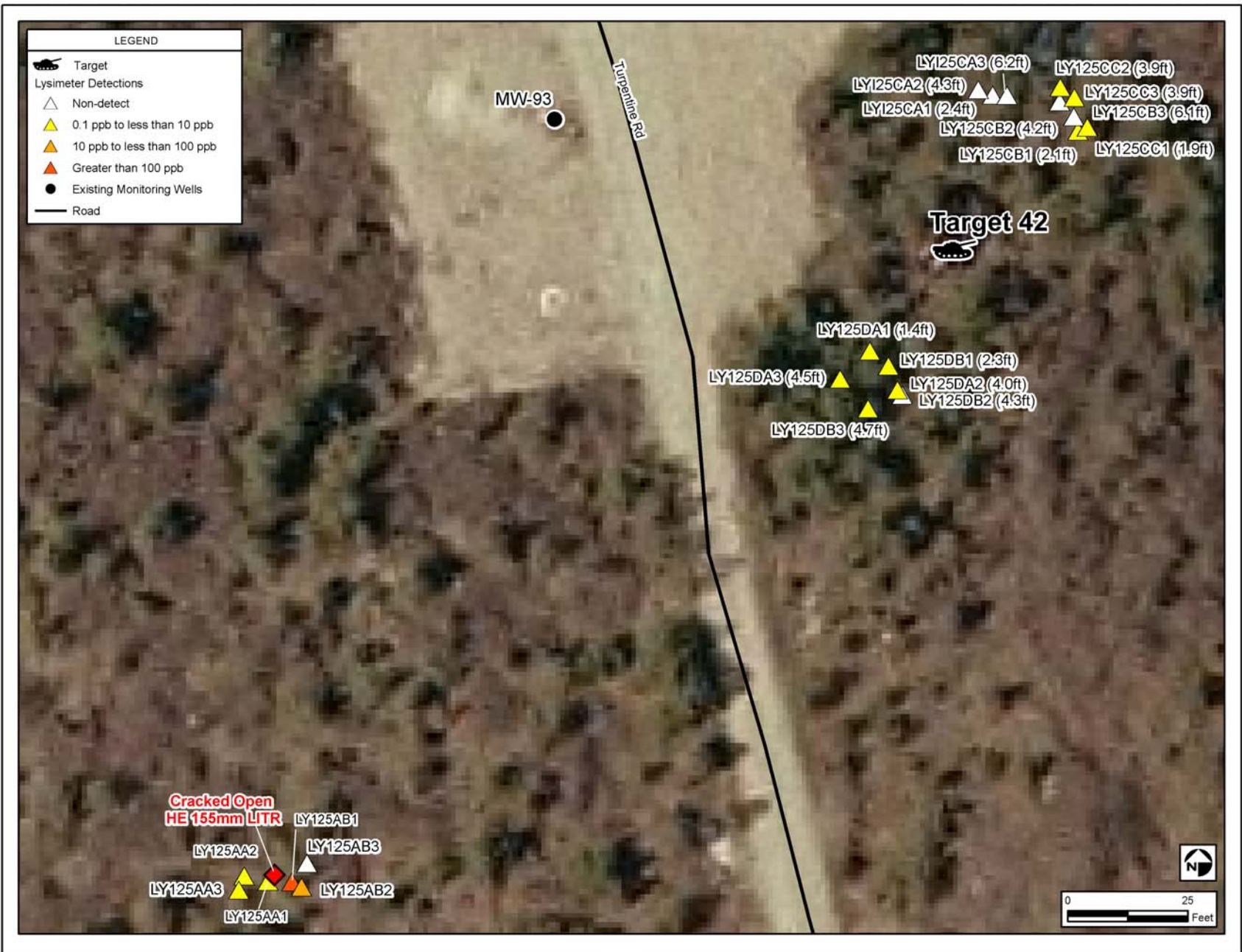
LY125CA3 (6.2ft)
LY125CA2 (4.3ft)
LY125CA1 (2.4ft)
LY125CB2 (4.2ft)
LY125CB1 (2.1ft)
LY125CC2 (3.9ft)
LY125CC3 (3.9ft)
LY125CB3 (6.1ft)
LY125CC1 (1.9ft)

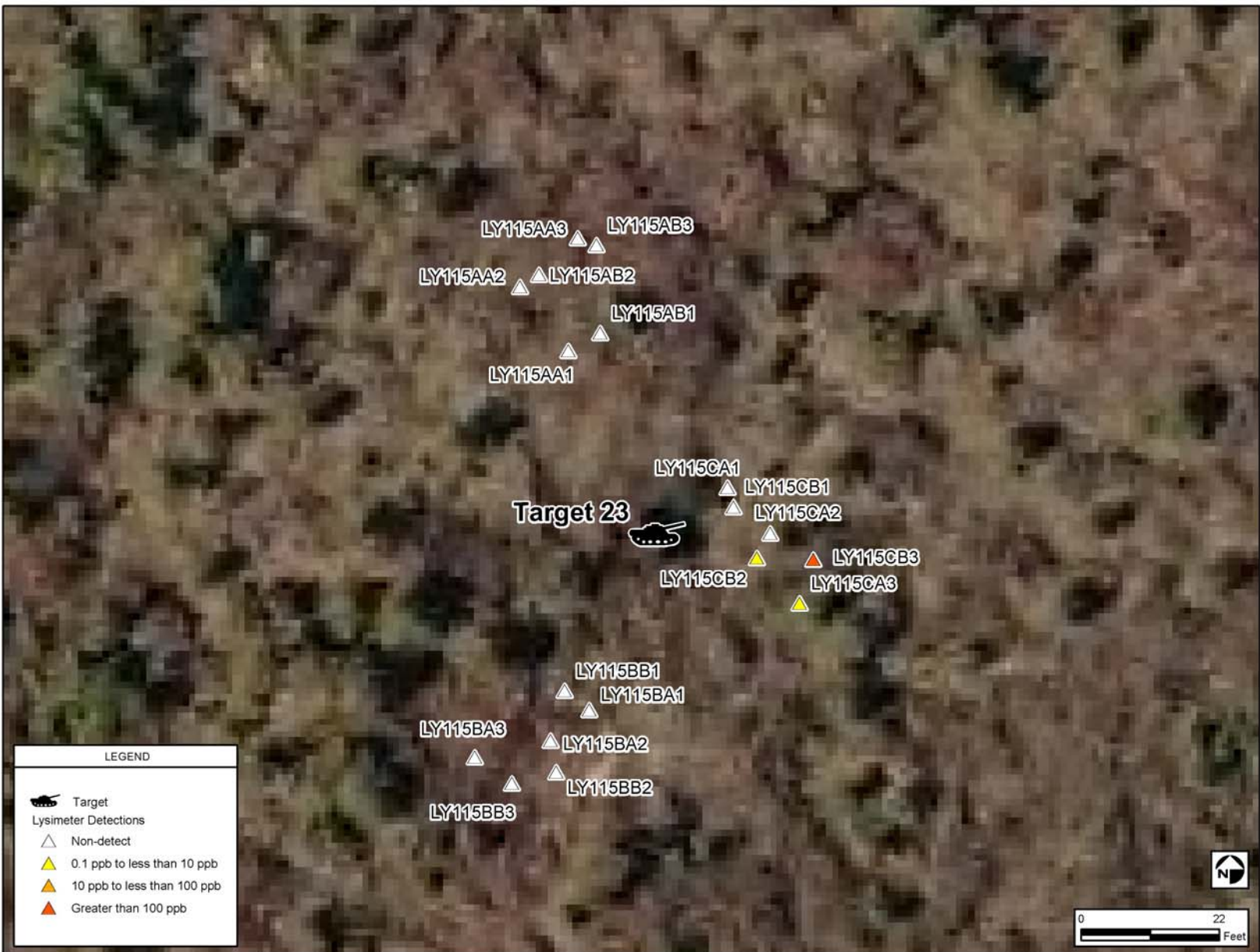
Target 42

LY125DA1 (1.4ft)
LY125DB1 (2.3ft)
LY125DA3 (4.5ft)
LY125DA2 (4.0ft)
LY125DB2 (4.3ft)
LY125DB3 (4.7ft)

Cracked Open
HE 155mm LITR

LY125AA2
LY125AA3
LY125AA1
LY125AB1
LY125AB3
LY125AB2





Lessons Learned

- Silica flour pack in coarse-grained material helps draw water into lysimeter
- Test silica flour for site specific contaminants of interest and general water quality parameters such as pH and conductivity
 - e.g. ground glass silica flour from an Ohio supplier resulted in pH between 10 - 11 and conductivity 1,000 – 5,000 uS/cm
- Choose porous ceramic cup based on ability to allow maximum flow of pore water from the vadose zone into the lysimeter

Conclusions

(Lysimeters Under Cracked Open/Low Order Items)

- Lysimeters installed under 155 mm HE projectile show cracked-open projectiles with exposed explosive filler can act as point sources
- Concentration of RDX in soil pore water beneath cracked open projectile was up to 20X higher than observed in groundwater beneath projectile
- Large volume of explosive filler (93 lbs) suggests item will act as a long- term point source, if not removed
- Density of low-order items is less than 1/acre, based on magnetometer-assisted surface sweep around two artillery/mortar targets
- This estimate of low order density might be low because the sweep only included items visible on the ground surface

Conclusions

(Lysimeters Not Under Cracked Open/Low Order Items)



- Trace levels (< 1 to 4 ug/L) of perchlorate in soil moisture indicate surface soils are still a source of perchlorate, but it appears source is significantly depleted
- Heterogeneous pattern of explosives detections; primarily RDX and HMX
- Average concentration of RDX (considering detections only) in soil pore water is 3 to 5 times higher than the RDX observed in groundwater
- Maximum detection of RDX (150 ug/L) in soil pore-water was not collected under cracked open round – source suspected to be unidentified particulate or chunk of explosives
- Residual explosives particulates in soil continue to dissolve and migrate through vadose zone