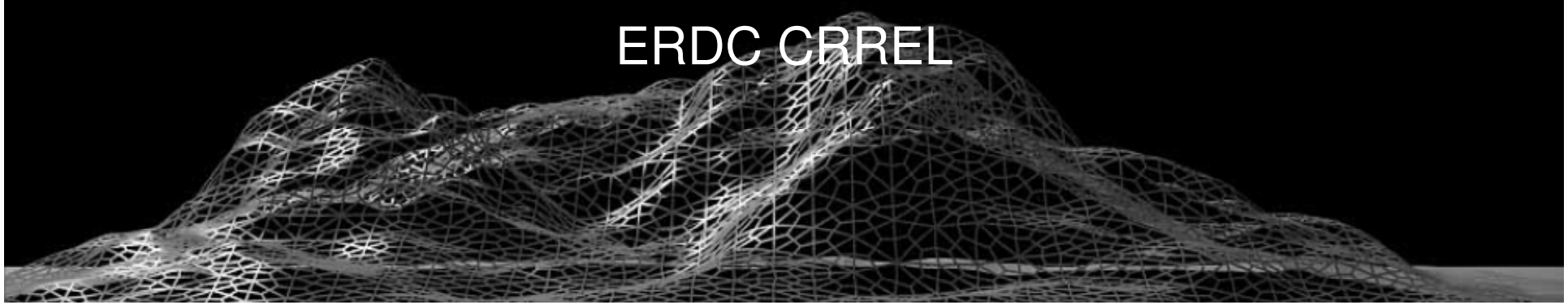
Field Scale Evaluation of Energetic Material in Training Range Soil and Soil Pore Water

AMEC Earth and Environmental

ERDC CRREL



Site Background

- 21,000 acre facility
  - 14,000 acres of Training Ranges
  - 2,200 acre Impact Area
  - 330 acre Central Impact Area

- Central Impact Area received ordnance from artillery, mortar and rockets
- Training activity began in 1908

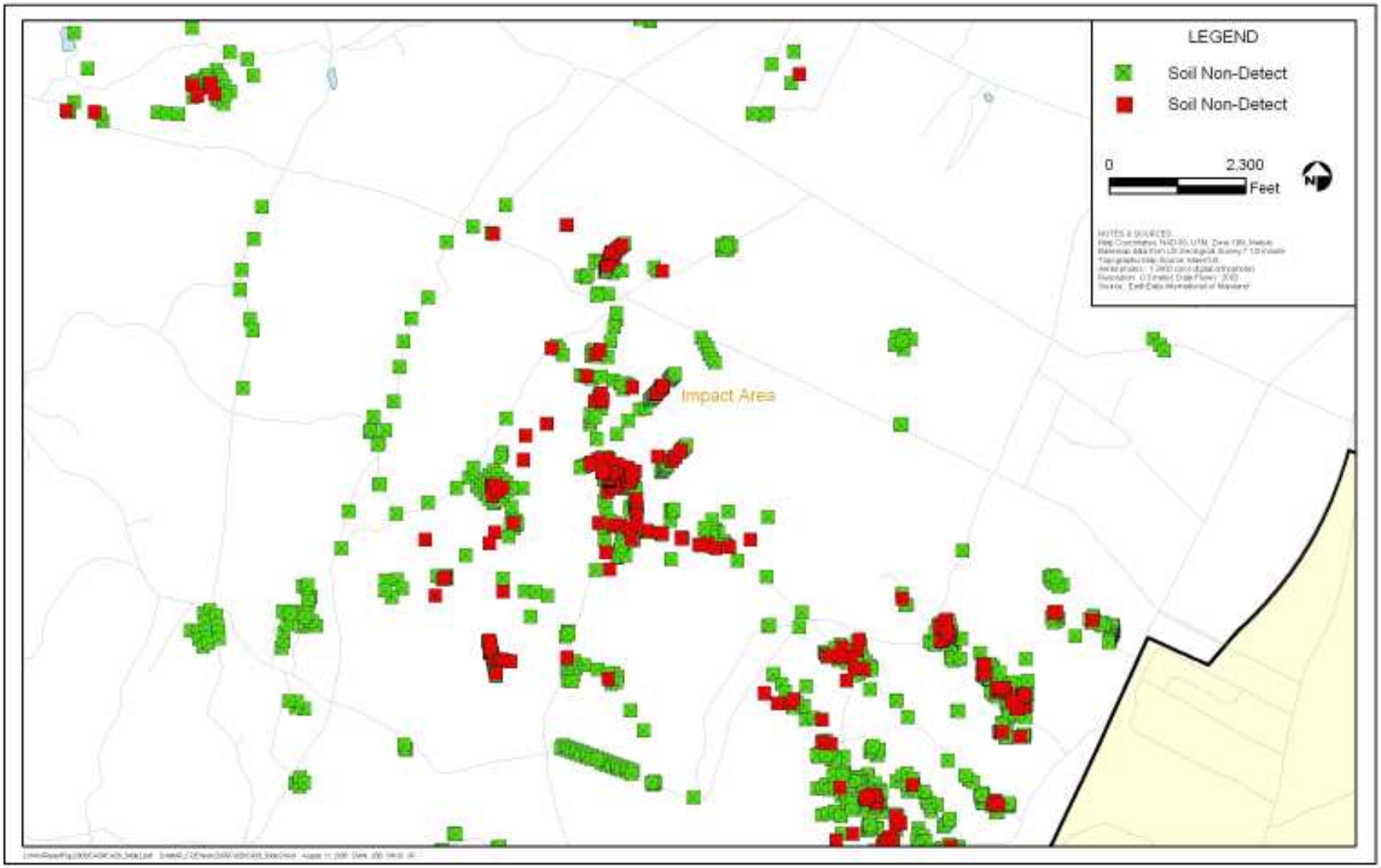
Potential Source Terms

- Low-Order Detonation
- Secondary Detonation
- High Order Detonation
- Blow-in-Place Activities
  - High Order Detonation
  - Low Order Detonation
- Corrosion of UXO and Filler Release to Environment

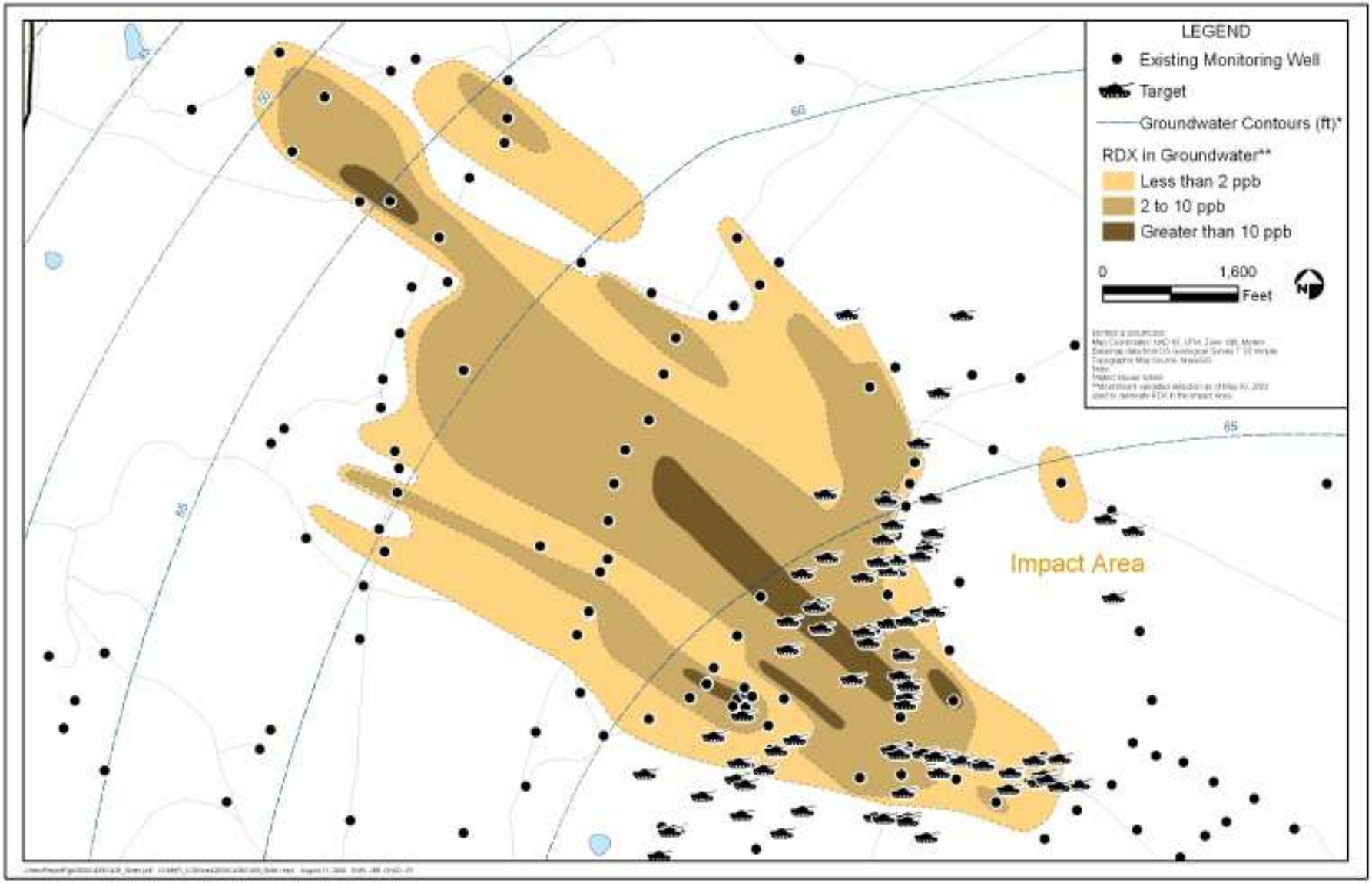
Fate and Transport Conceptual Model

- Explosives and other munitions constituents released
- Heterogeneous distribution of particles on ground surface
- Redistribution of particles
- Dissolution of particulates
- RDX, HMX, Perchlorate
  - Key process is rate of dissolution from solid
  - Once dissolved, readily move through aquifer matrix, don't adsorb significantly to matrix
- DNTs, aDNTS, Nitroglycerine, TNT
  - Undergo rapid transformation and sorption
  - Low to moderate mobility

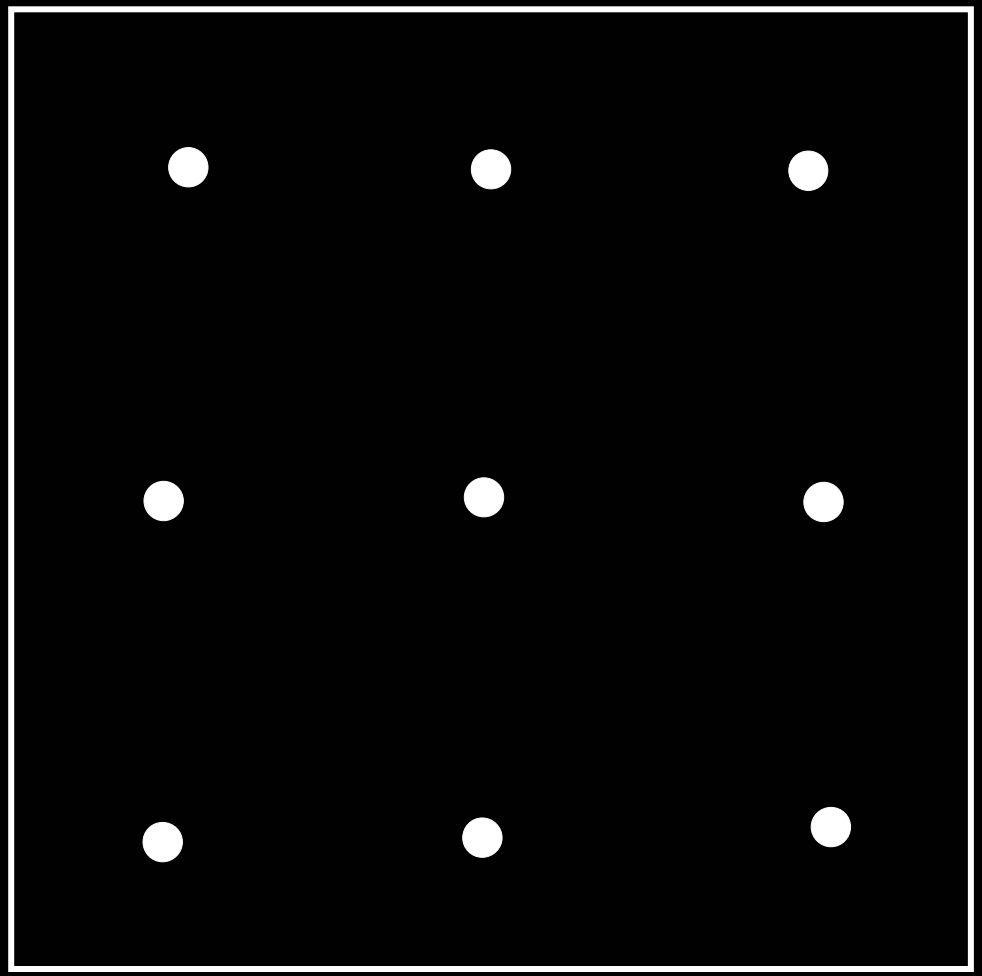
Explosives in Soil



RDX in Groundwater

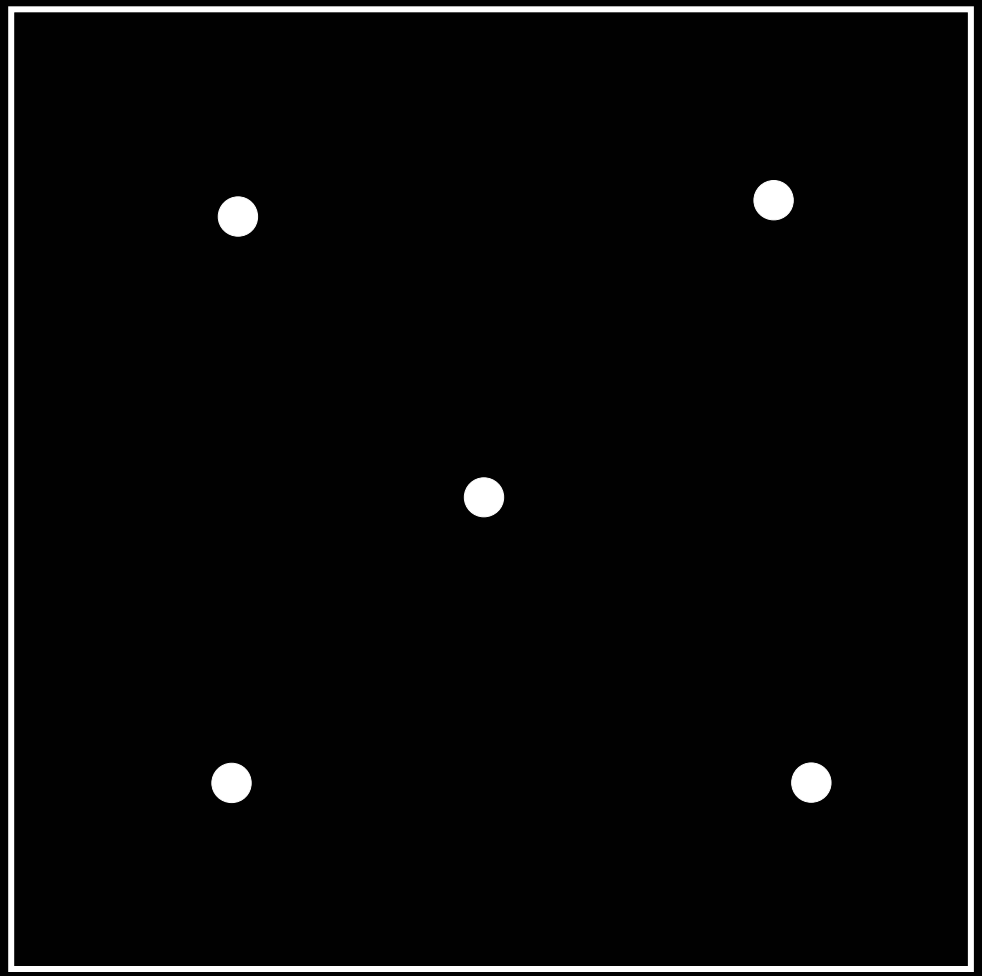


Soil Sampling - Phase 1 Soil Grid



Nine Subsamples
0-6 inches
18-24 inches

Soil Sampling - Phase 2 Soil Grid

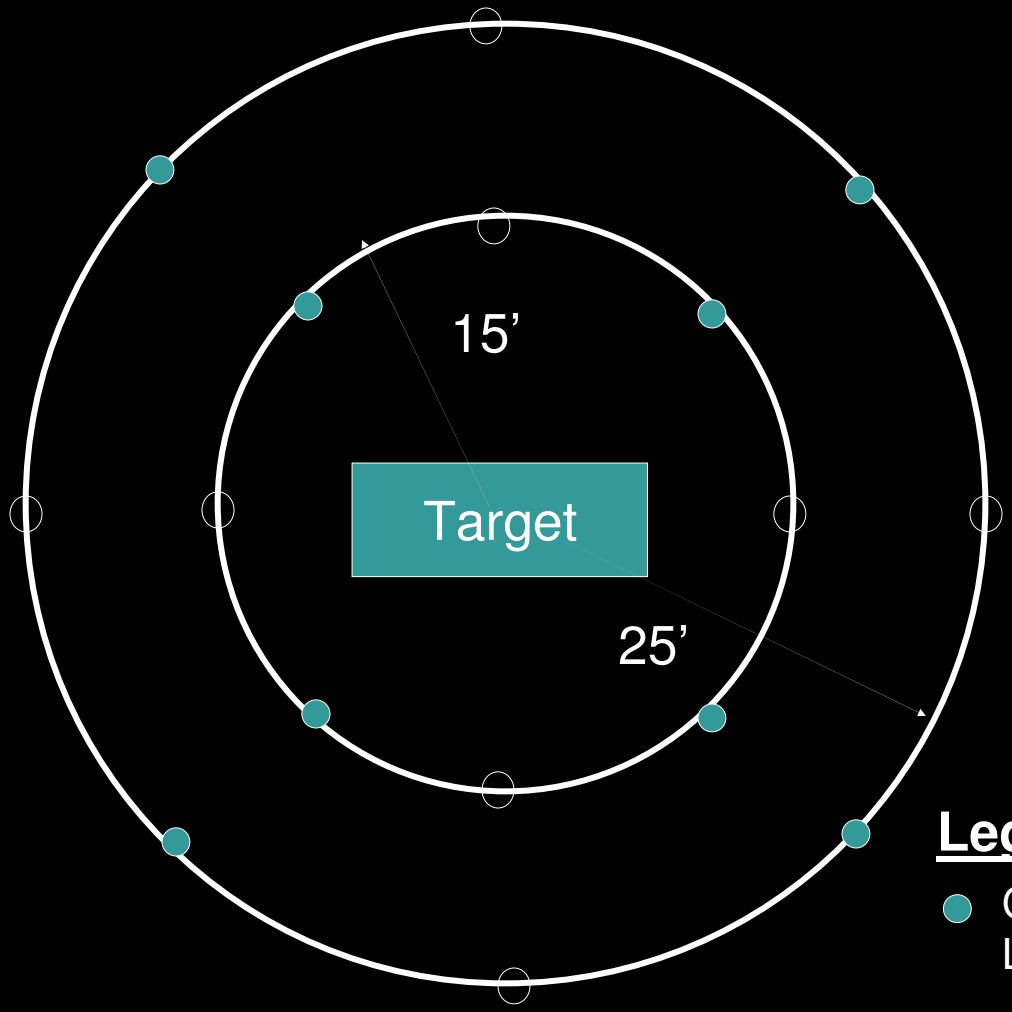


7 m

7 m

Five Subsamples
0-6 inches
18-24 inches

Soil Sampling - Ring Grid Methodology



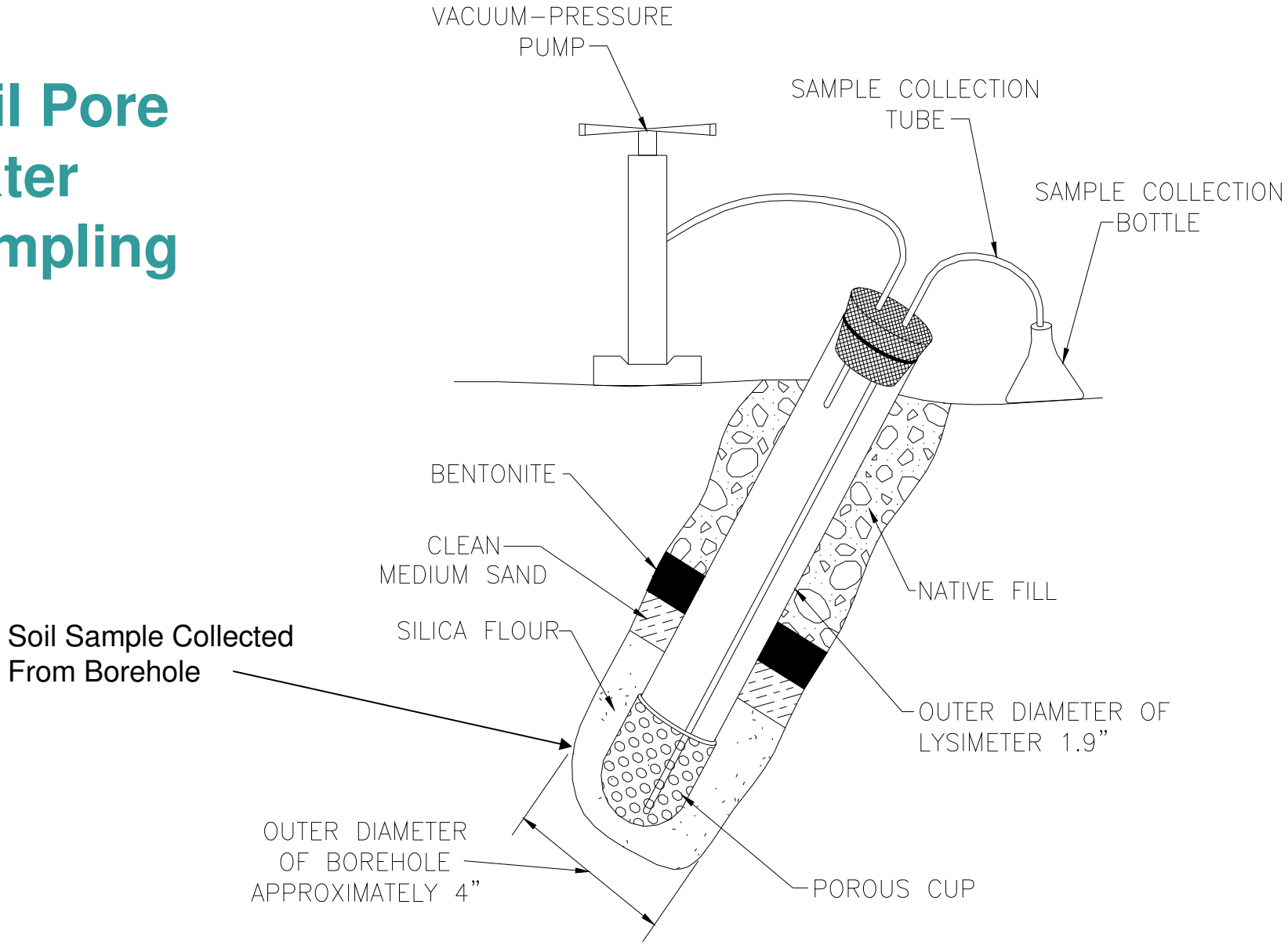
Legend

- Composite Subsample Location
- Discrete and Composite Subsample Location

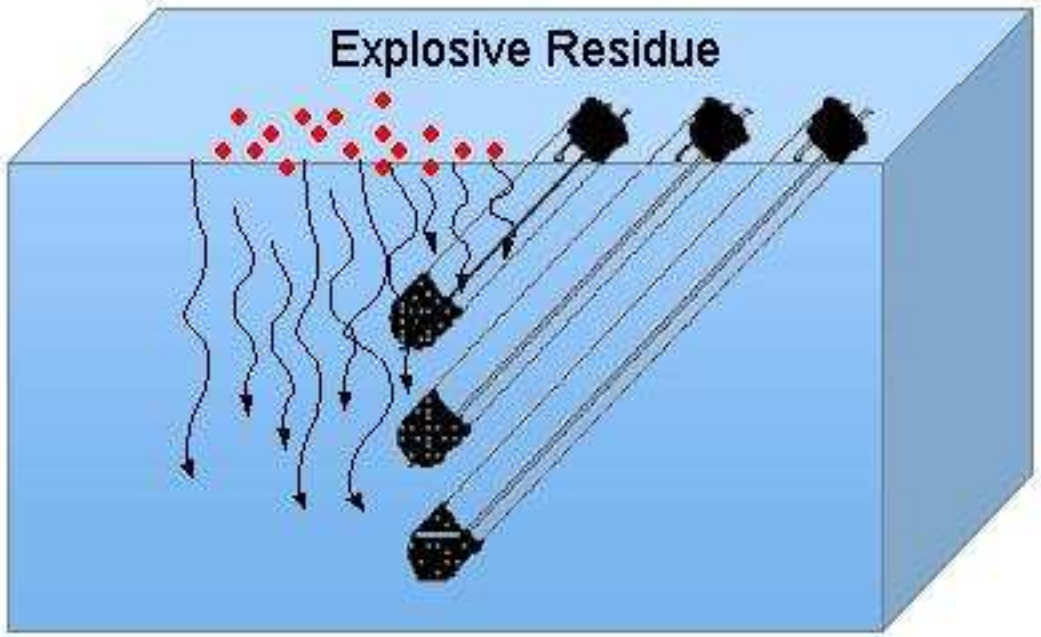
25 and 100 Point Composite Soil Sampling

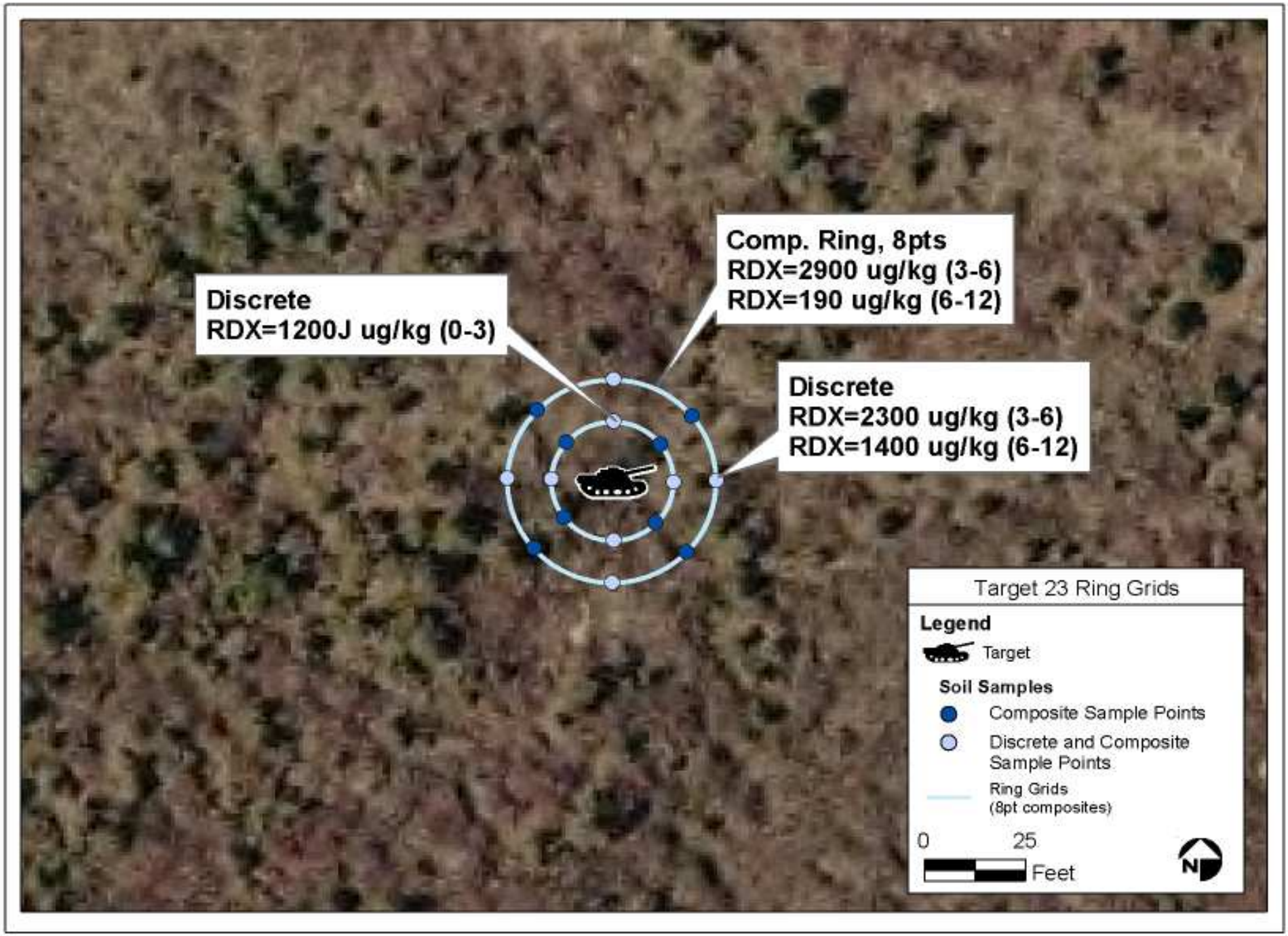
- 25 Point Composite - 5 x 5m square area
- 100 Point Composite - 30 x 30m square area
- Samples collected from 0-2cm interval
- Vegetation retained within sample
- Duplicates collected in same area, slightly different locations

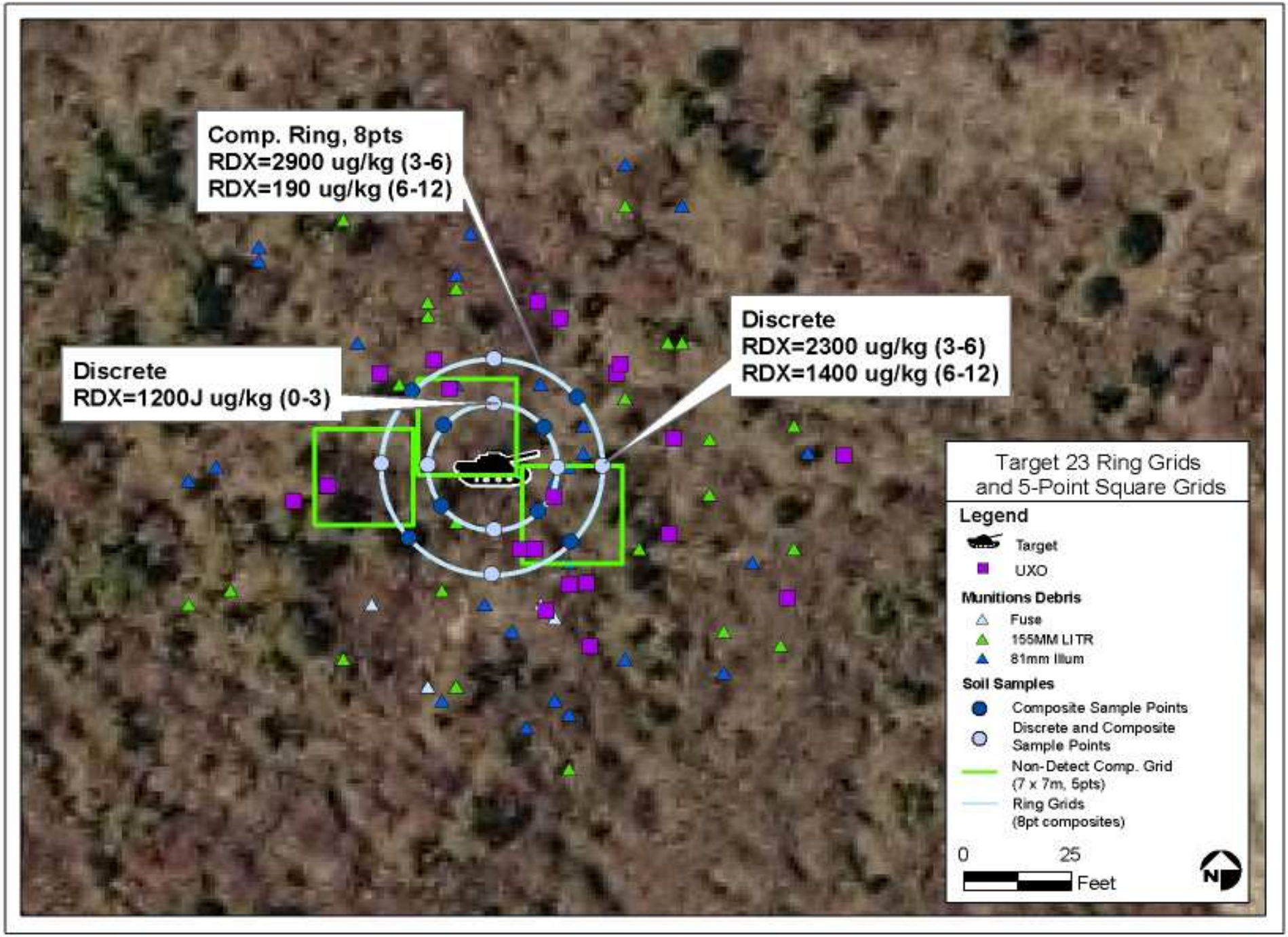
Soil Pore Water Sampling



Pore Water Sampling Conceptual Site Model




Comp. Ring, 8pts
RDX=2900 ug/kg (3-6)
RDX=190 ug/kg (6-12)
Discrete
RDX=1200J ug/kg (0-3)
Discrete
RDX=2300 ug/kg (3-6)
RDX=1400 ug/kg (6-12)
Target 23 Ring Grids
Legend
Target
Soil Samples
Composite Sample Points
Discrete and Composite Sample Points
Ring Grids (8pt composites)
0
25
Feet
N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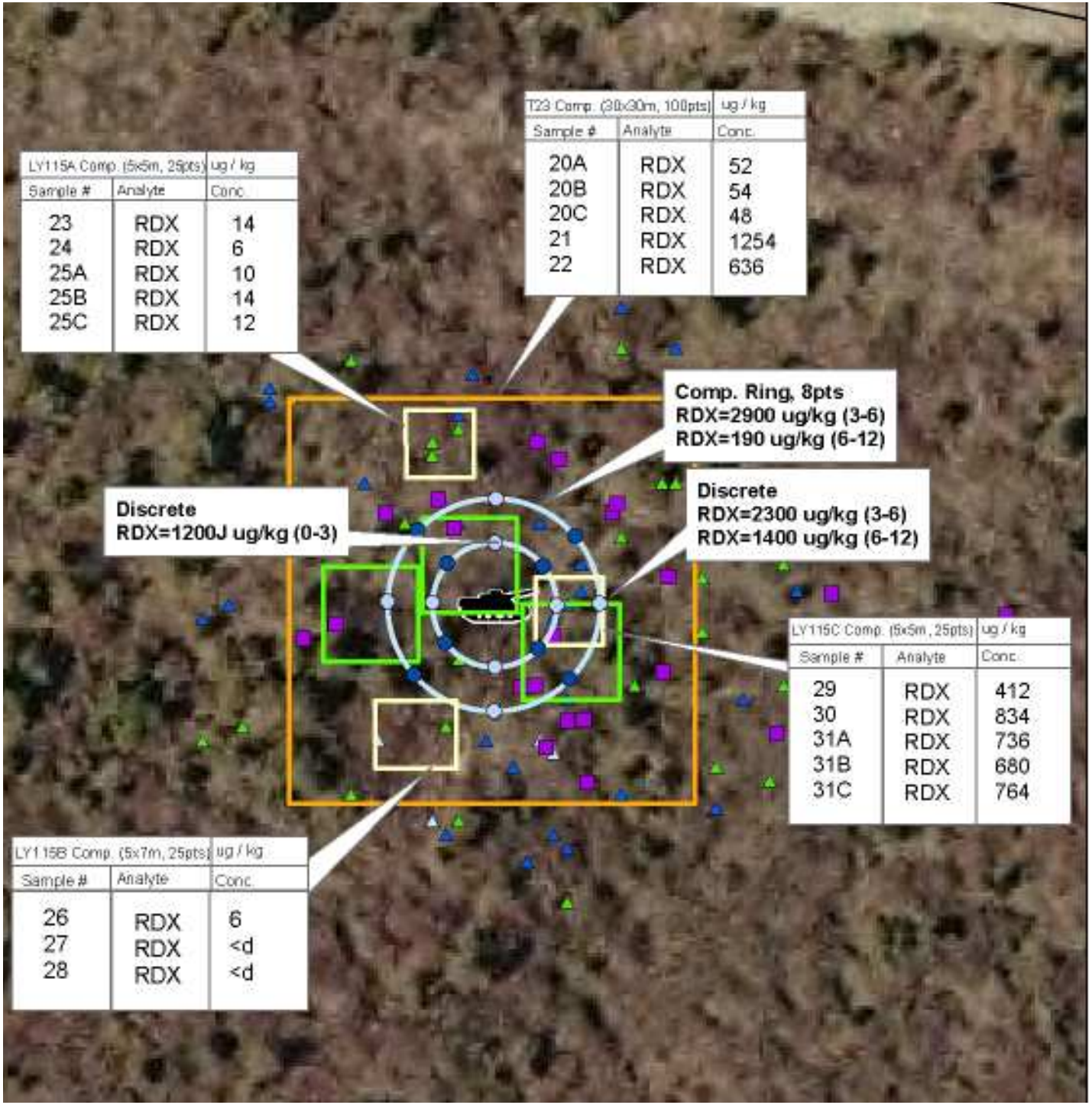
Discrete
RDX=1200J ug/kg (0-3)
Discrete
RDX=2300 ug/kg (3-6)
RDX=1400 ug/kg (6-12)
Target 23 Ring Grids
and 5-Point Square Grids
Legend
Target
UXO
Munitions Debris
Fuse
155MM LITR
81mm Illum
Soil Samples
Composite Sample Points
Discrete and Composite
Sample Points
Non-Detect Comp. Grid
(7 x 7m, 5pts)
Ring Grids
(8pt composites)
0
25
Feet
N



LEGEND

Target

UXO

Munitions Debris

Fuse

155MM LITR

81mm Illum

Soil Samples

Comp. Grid (30 x 30m, 100pts)

Comp. Grid (3 to 5 x 5m, 25pts)

A, B, & C lab replicates

Non-Detect Comp. Grid (7 x 7m, 5pts)

Ring Grids (8pt composites)

Composite Sample Points

Discrete and Composite Sample Points

TITLE

Target 23 Ring Grids, 5-Point, 25-Point and 100-Point Square Grids

0 25 Feet

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Westford, Massachusetts

LEGEND

- Target
- UXO

Munitions Debris

- Fuse
- 155MM LITR
- 81mm Illum

Soil Samples

- Comp. Grid (30 x 30m, 100pts)
- Comp. Grid (3 to 5 x 5m, 25pts)
- A, B, & C lab replicates
- Non-Detect Comp. Grid (7 x 7m, 5pts)
- Ring Grids (8pt composites)
- Composite Sample Points
- Discrete and Composite Sample Points

Average RDX Detections in Lysimeter

- Less than 0.5 ppb
- 0.5 ppb to less than 2 ppb
- 2 ppb to less than 100 ppb
- Greater than 100 ppb

TITLE

Target 23 Ring Grids, 5-Point, 25-Point and 100-Point Square Grids and Lysimeter Result

0 25 Feet

N

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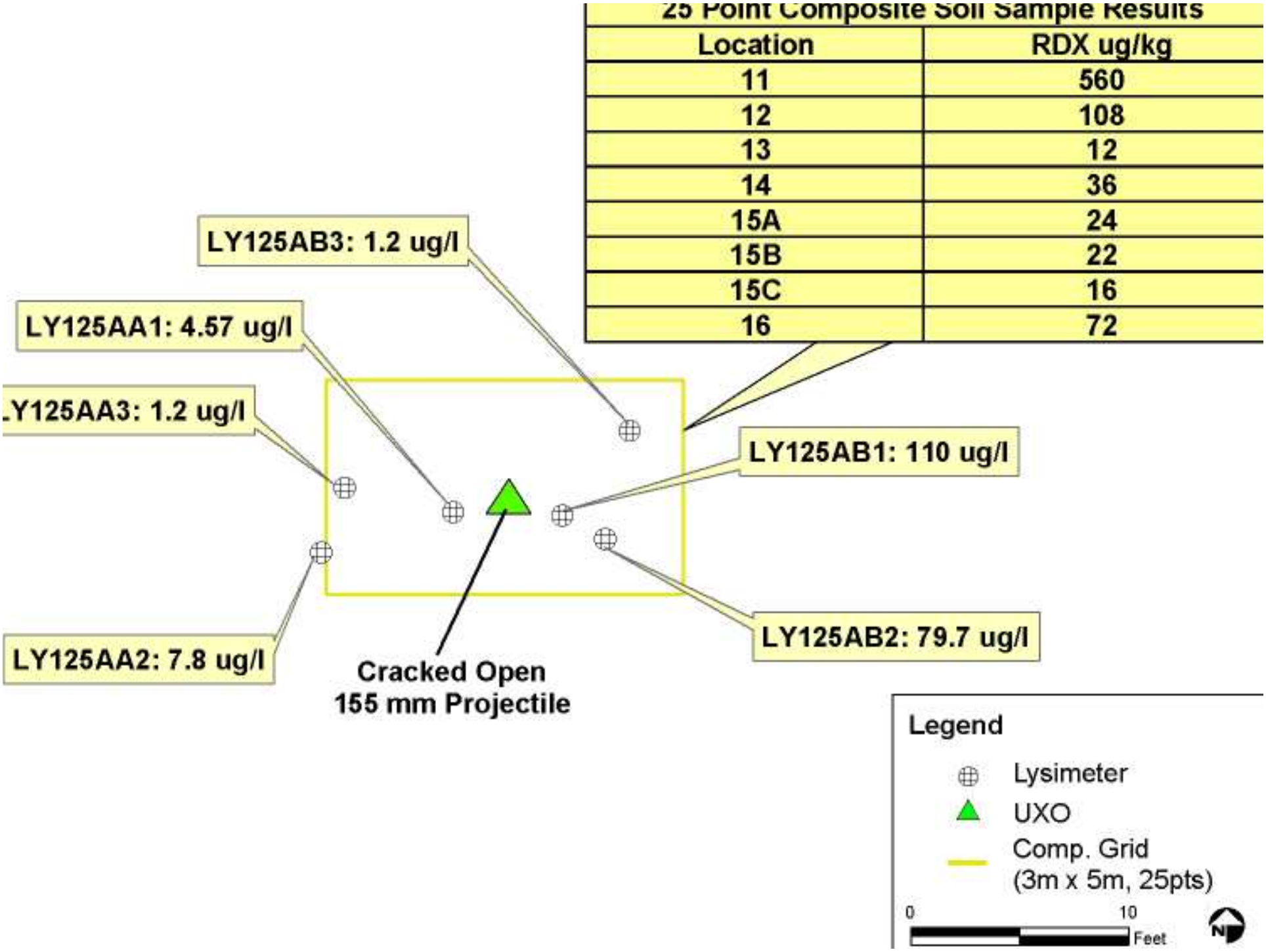
Summary of Co-located Soil and Soil Pore Water Results

Location	Soil Pore Water Results	25-Pt. Composite Soil Sample Results (n=3)
Lysimeter Cluster A (n=6)	Avg: < 0.5 ug/L Min: < 0.5 ug/L Max: < 0.5 ug/L	Avg: 11 ug/kg Min: 6 ug/kg Max: 14 ug/kg
Lysimeter Cluster B (n=6)	Avg: < 0.5 ug/L Min: < 0.5 ug/L Max: < 0.5 ug/L	Avg: 3 ug/kg Min: < 2 ug/kg Max: 6 ug/kg
Lysimeter Cluster C (n=6)	Avg: 50 ug/L Min: < 0.5 ug/L Max: 150 ug/L	Avg: 685 ug/kg Min: 412 ug/kg Max: 834 ug/kg

Sampling at a Cracked Open 155MM Projectile


25 Point Composite Soil Sample Results
Location
RDX ug/kg
11
560
12
108
13
12
14
36
15A
24
15B
22
15C
16
16
72
LY125AB3: 1.2 ug/l
LY125AA1: 4.57 ug/l
LY125AA3: 1.2 ug/l
LY125AB1: 110 ug/l
LY125AB2: 79.7 ug/l
LY125AA2: 7.8 ug/l
Cracked Open
155 mm Projectile
Legend
Lysimeter
UXO
Comp. Grid
(3m x 5m, 25pts)
0
10
Feet
N

General Conclusions

- There was no correlation between soil pore water and soil concentration for soil samples collected from the bottom of lysimeter boreholes (1-3 m depth)
- There is a general correlation between the 25 point composite surface soil sample and the lysimeter results
- Soil pore water detections > 5 ug/l were associated with visible munitions constituents (cracked fuze, cracked open 155mm projectile)

Conclusions – Soil Sampling

- Composite soil samples allow for characterization of a larger area compared to lysimeter sampling
- A greater number of sub samples per area increases the likelihood of detecting explosives particulates
- Optimal number of sub samples for large grids (i.e. > 30x30m) not yet defined, may be site-specific

Conclusions - Lysimeters

- Individual lysimeter samples representative of relatively small area (~ 1 sq m)
- Lysimeters can be a useful tool to evaluate the mobile fraction of contaminant mass
- Lysimeters can be re-sampled; advantageous for in-situ treatability studies