Legacy Well Detection Technology

Rick Hammack

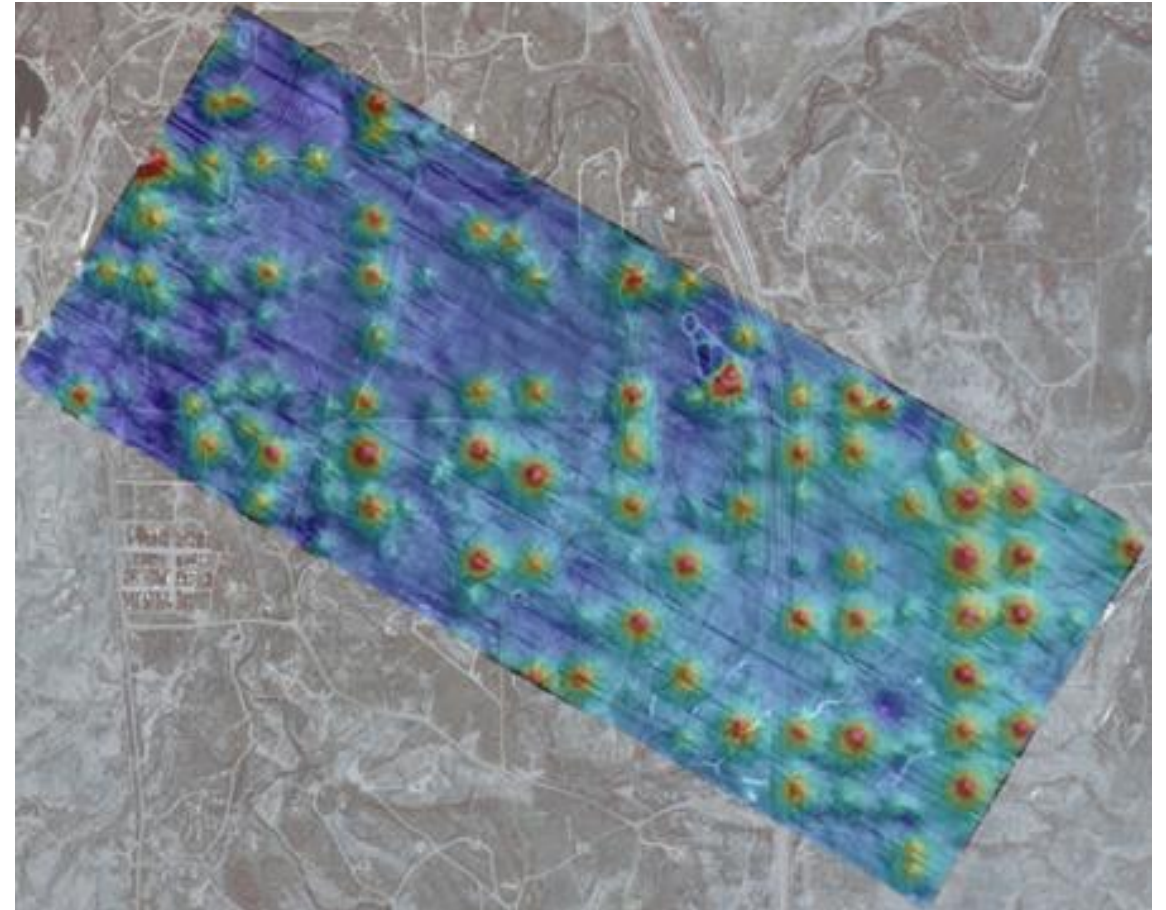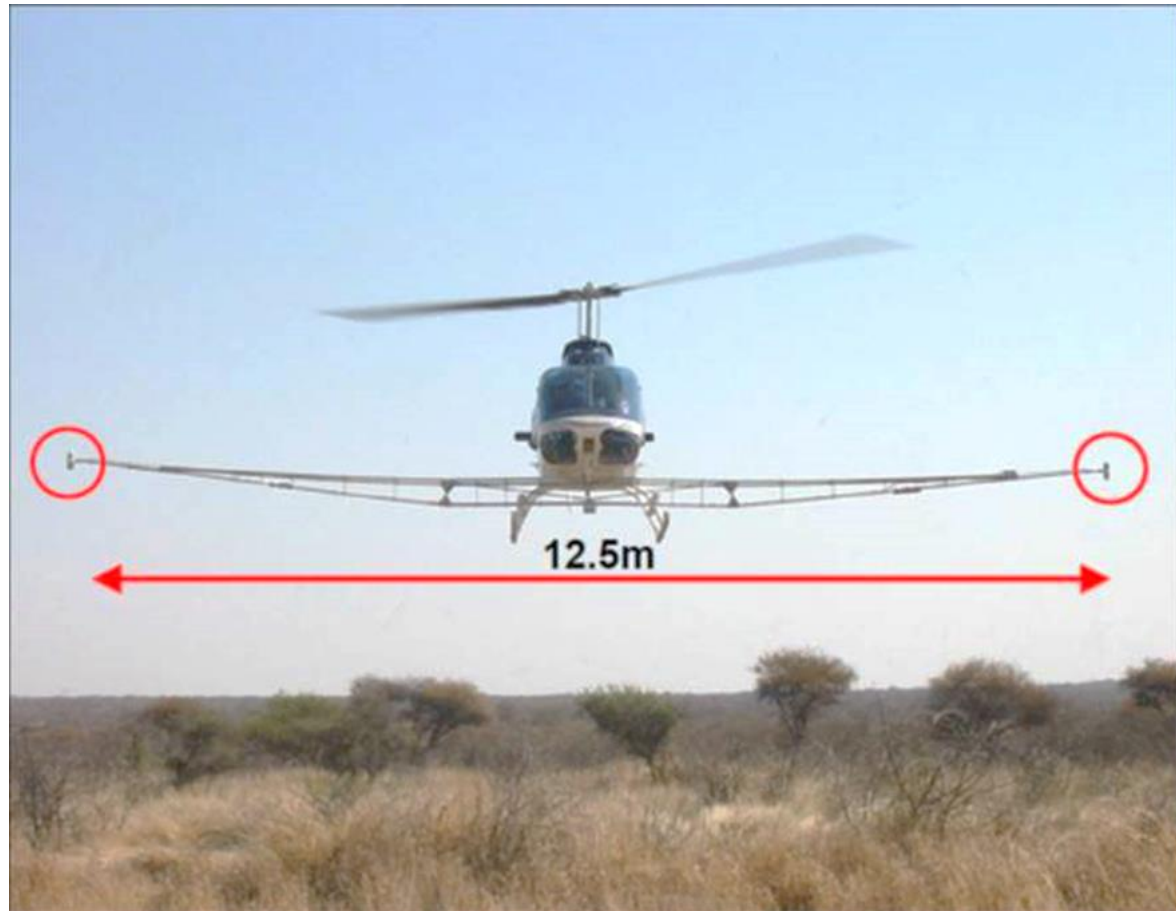June 27, 2019

2002-2003   2005   2007, 2012, 2014   2017-present

NATIONAL ENERGY TECHNOLOGY LABORATORY

U.S. DEPARTMENT OF ENERGY
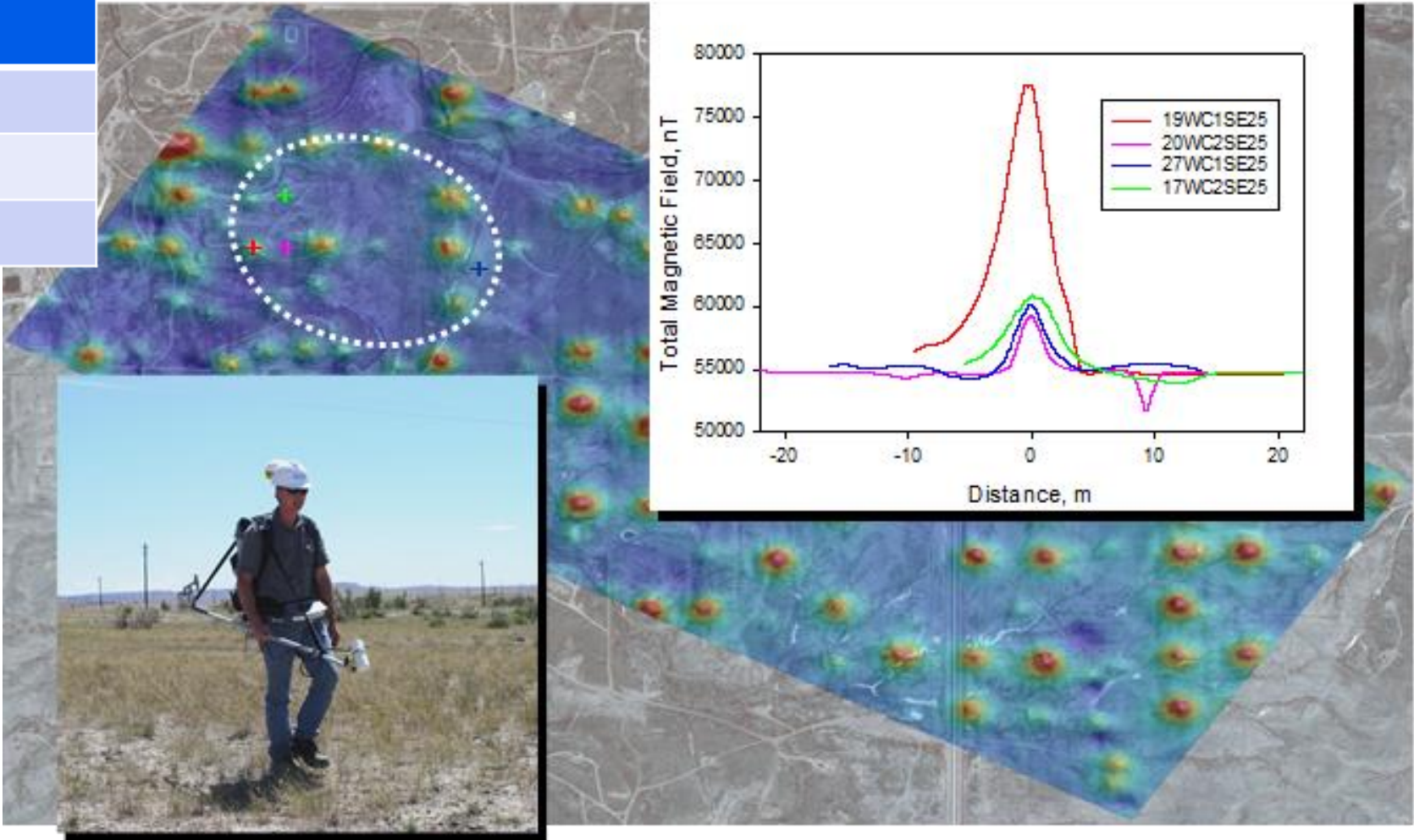
NETL Airborne Well Location Methods

Salt Creek Oilfield Study with Anadarko Petroleum (2005)
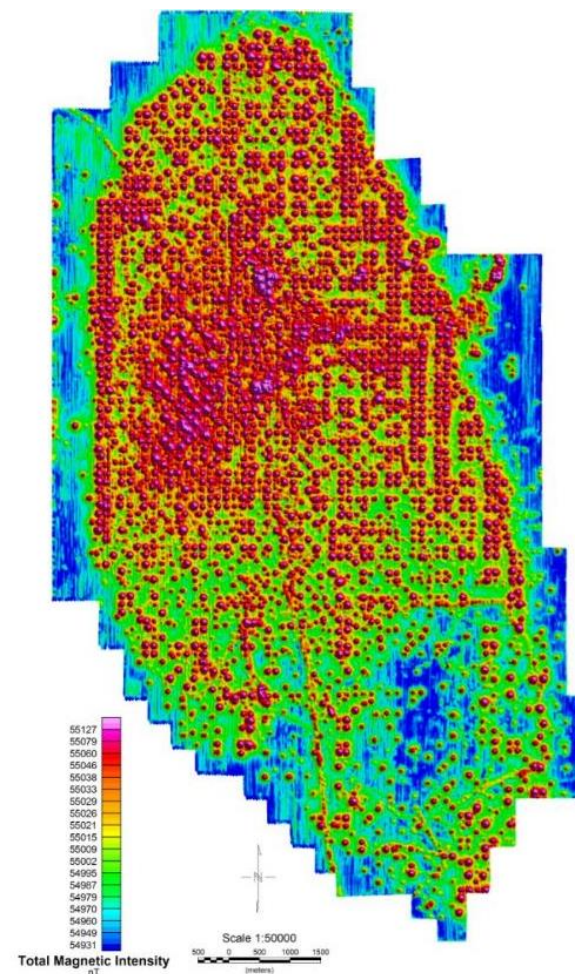
NETL Airborne Well Location Methods

Salt Creek Oilfield Study with Anadarko Petroleum (2005)

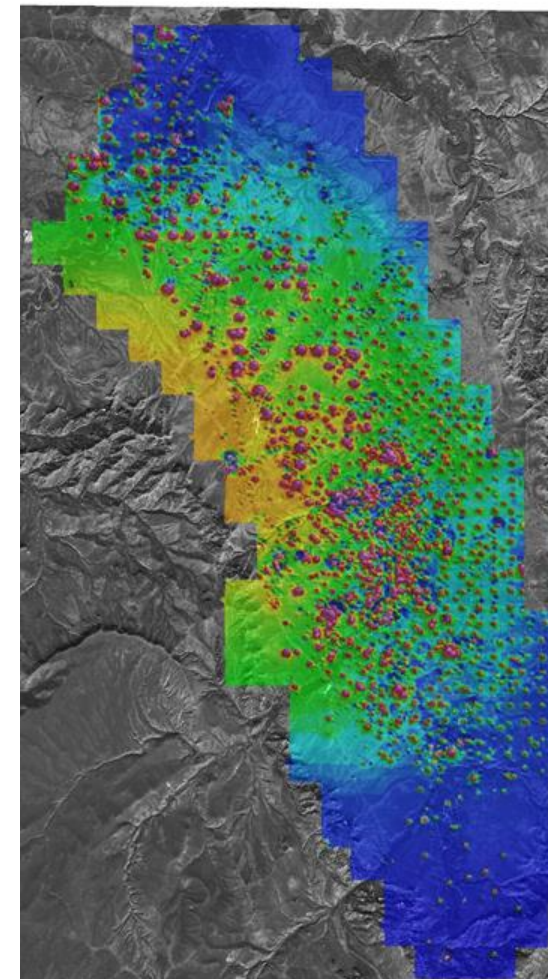| Completion Date	Wells Found
1912-1926	100%
1965-1990	82%
Overall	93%

Helicopter Well Location in Wyoming Oilfields (2005-2007)

Helicopter Magnetic Surveys of Salt Creek Oilfield and Naval Petroleum Reserve No. 3
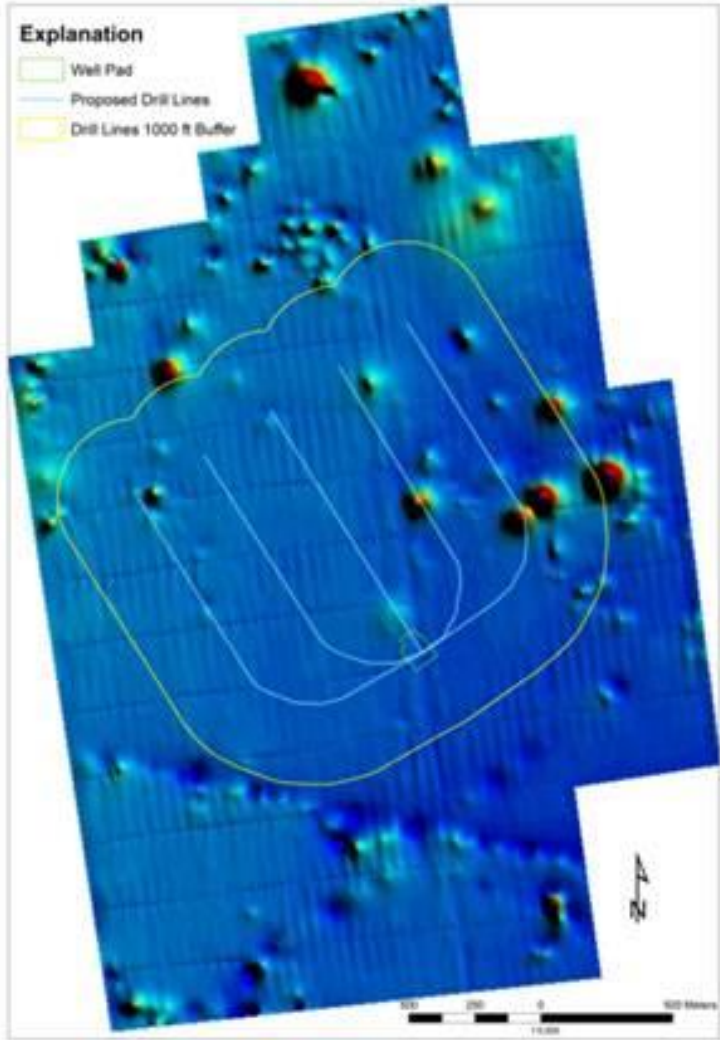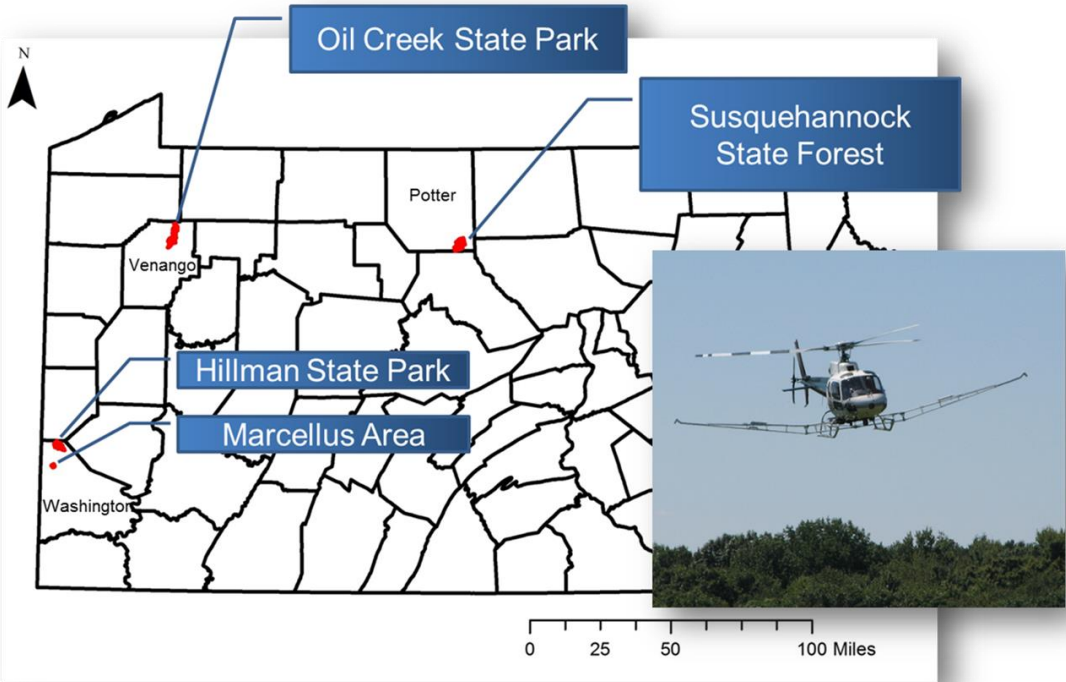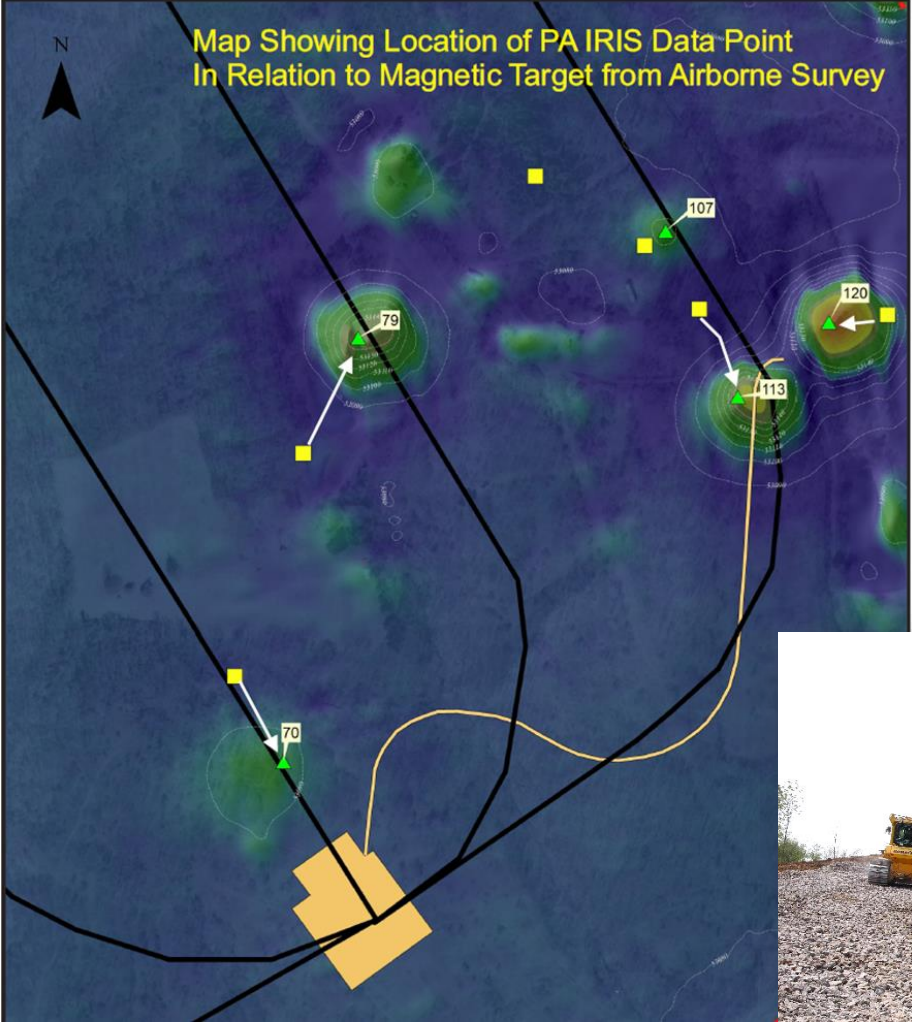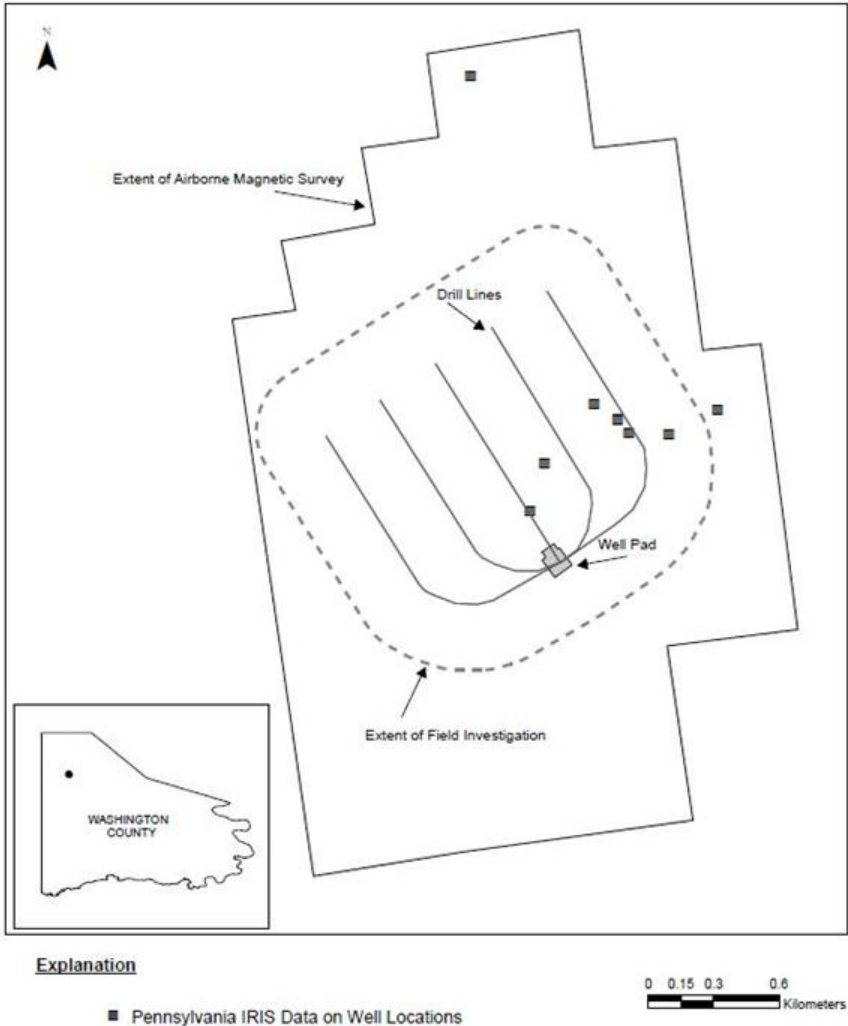

Salt Creek Oilfield

NPR No. 3

NETL's Helicopter Magnetic Surveys in Pennsylvania

Marcellus Site, Washington County, PA

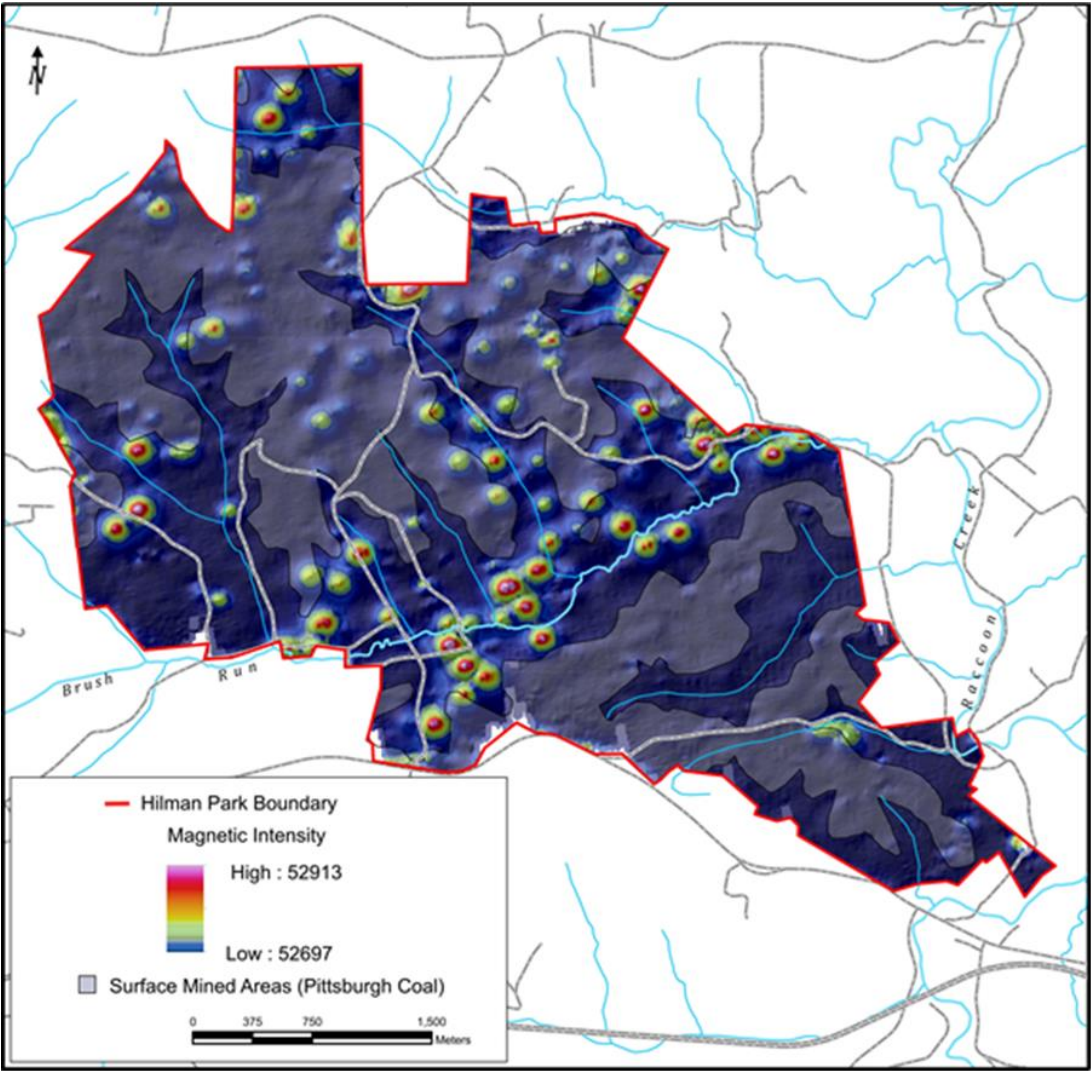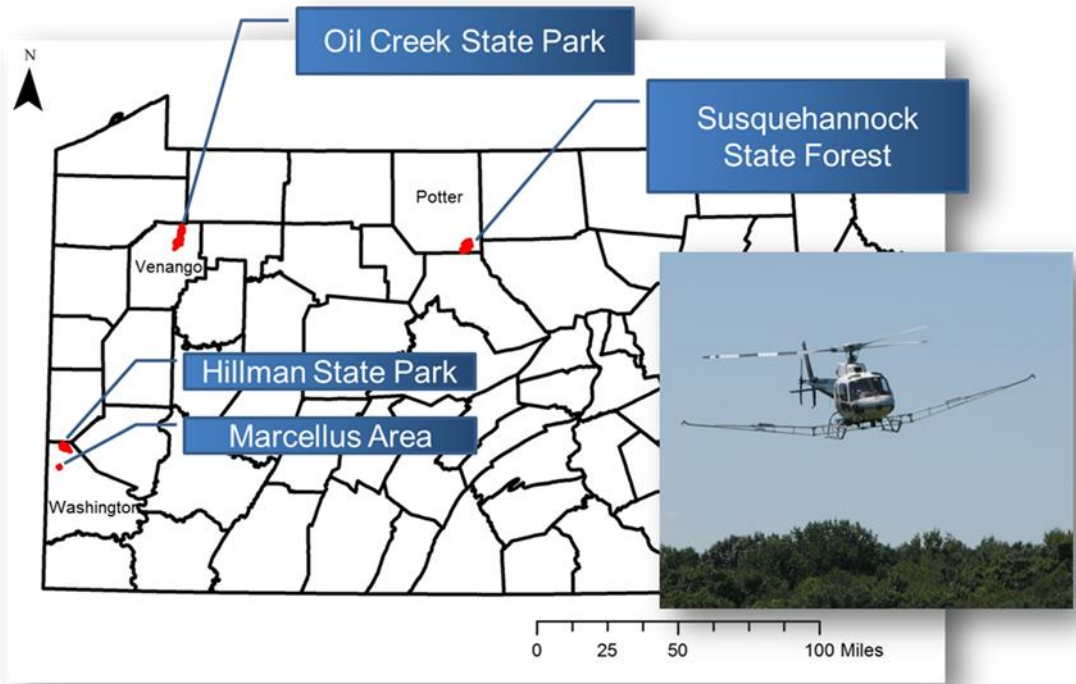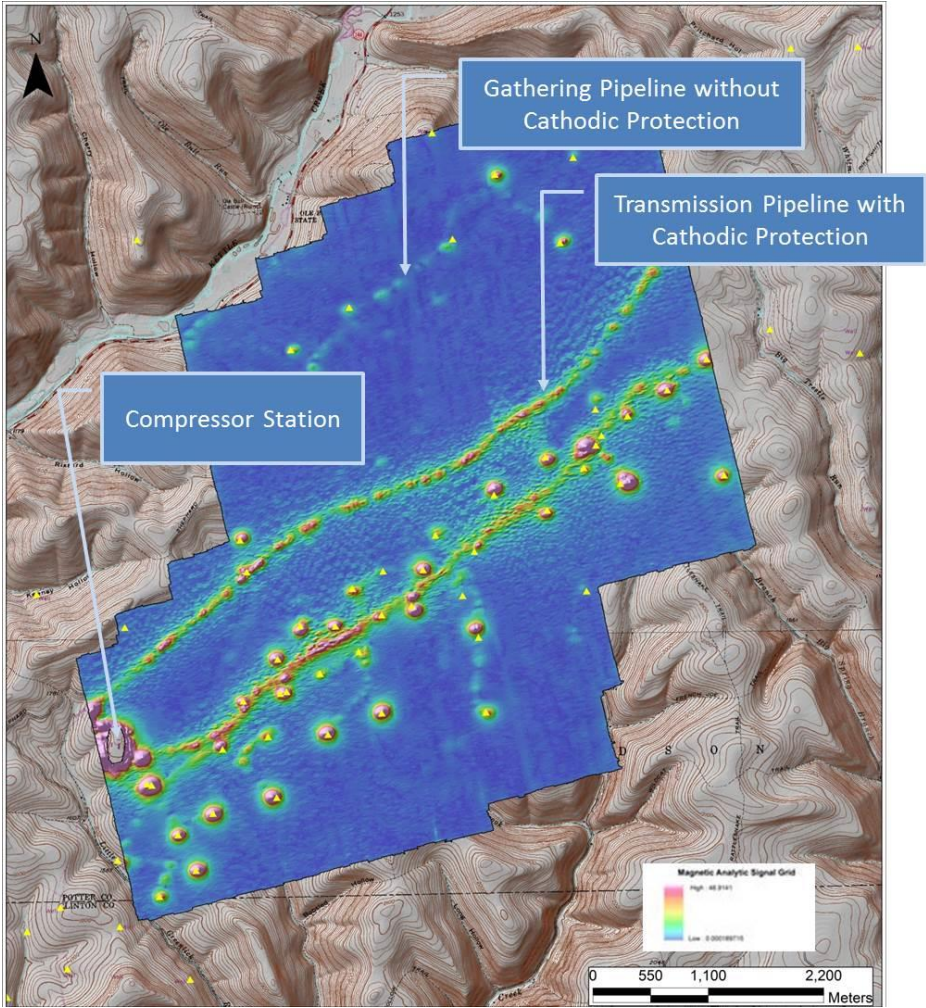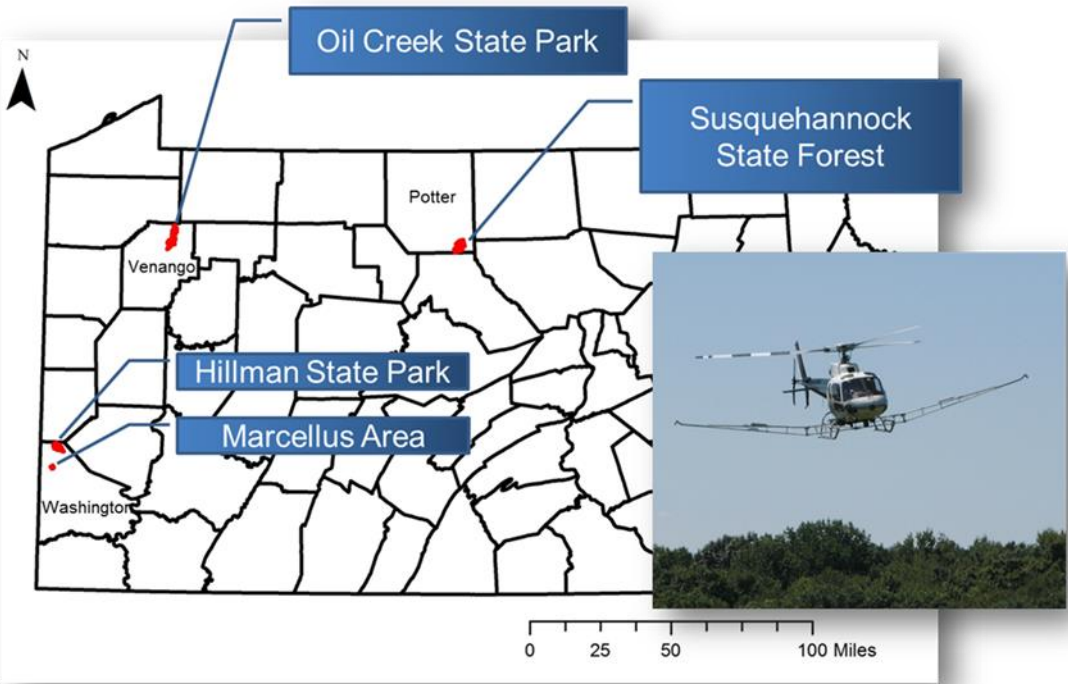# How Accurate are Locations in State Well Databases?

Map Showing Location of PA IRIS Data Point
In Relation to Magnetic Target from Airborne Survey

NETL's Helicopter Magnetic Surveys in Pennsylvania

Hillman State Park – Washington County, PA

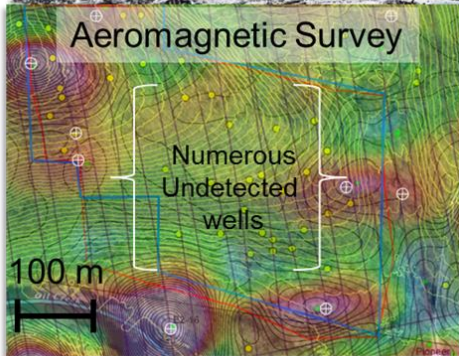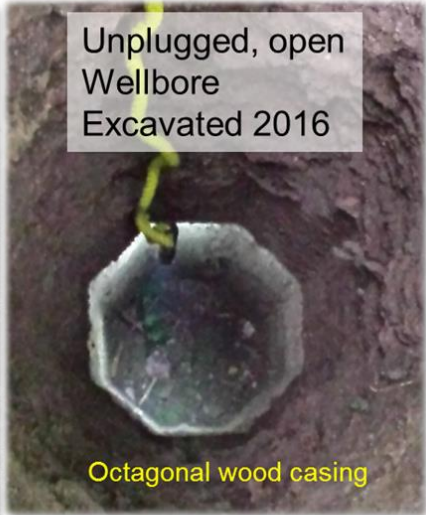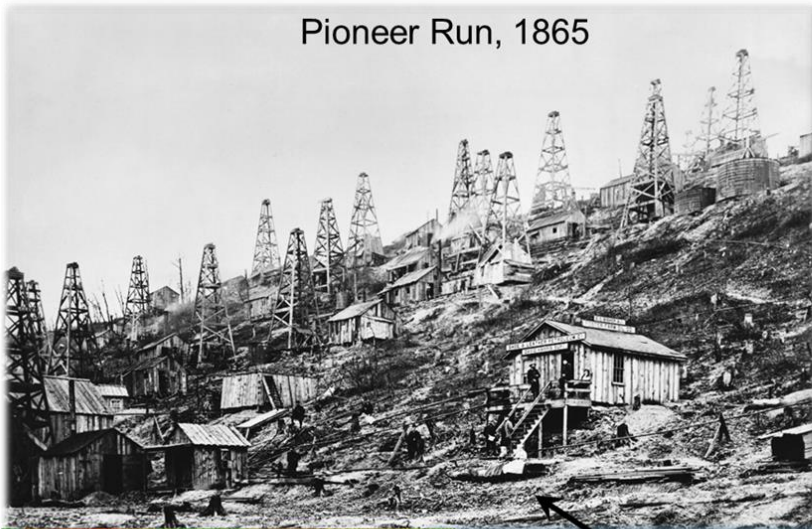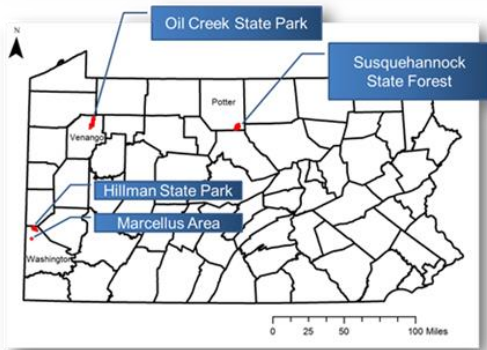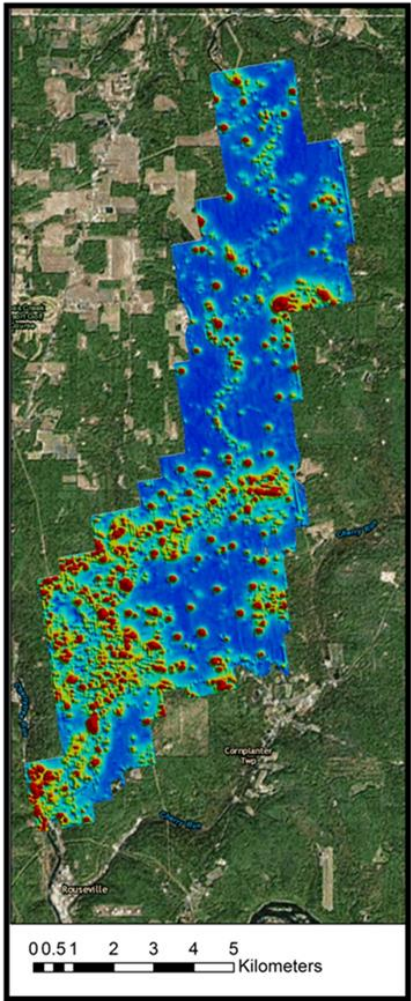# NETL's Helicopter Magnetic Surveys in Pennsylvania

Susquehannock State Forest, Potter County, PA

Helicopter Magnetic Surveys in Pennsylvania

Oil Creek State Park, Venango County, PA

Pioneer Run, 1865

Unplugged, open Wellbore Excavated 2016

Octagonal wood casing

Aeromagnetic Survey

Numerous Undetected wells

100 m

LiDAR wellpad evidence

Pioneer Run, July, 2016

Pioneer Run

Oil Creek State Park

Susquehannock State Forest

Potter

Venango

Hillman State Park

Marcellus Area

Washington

0   25   50   100 Miles

0 0.5 1   2   3   4   5 Kilometers
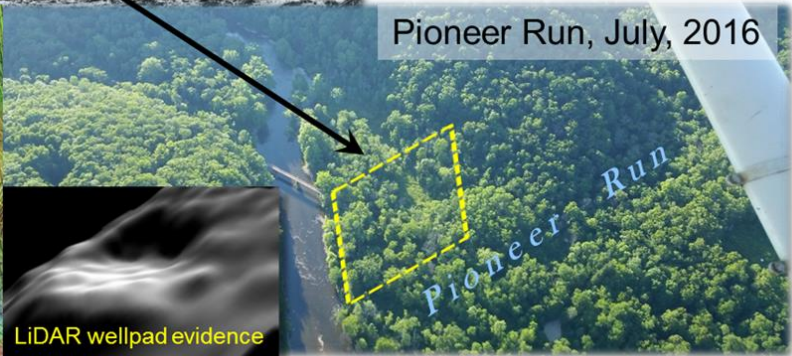
What about Wells without Steel Casing?

Magnetic map showing well location
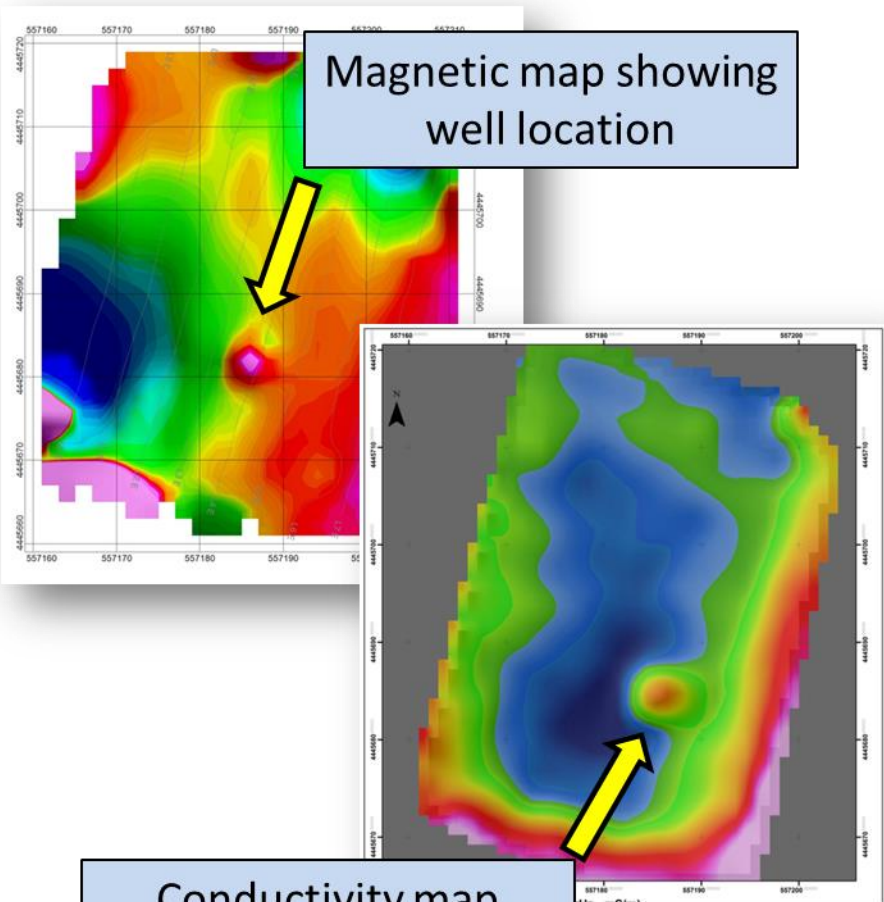
Conductivity map showing well location

What if Casing is Missing?

- This well with no casing still exhibits magnetic and conductive signatures at ground level.

Oil Creek State Park

2006-2008 DCNR PAMAP LIDAR 3.2ft

2017 NETL DRONE LIDAR 0.2ft

Engine House.   Belt House from Engine.   Derrick.
                 House to Derrick.
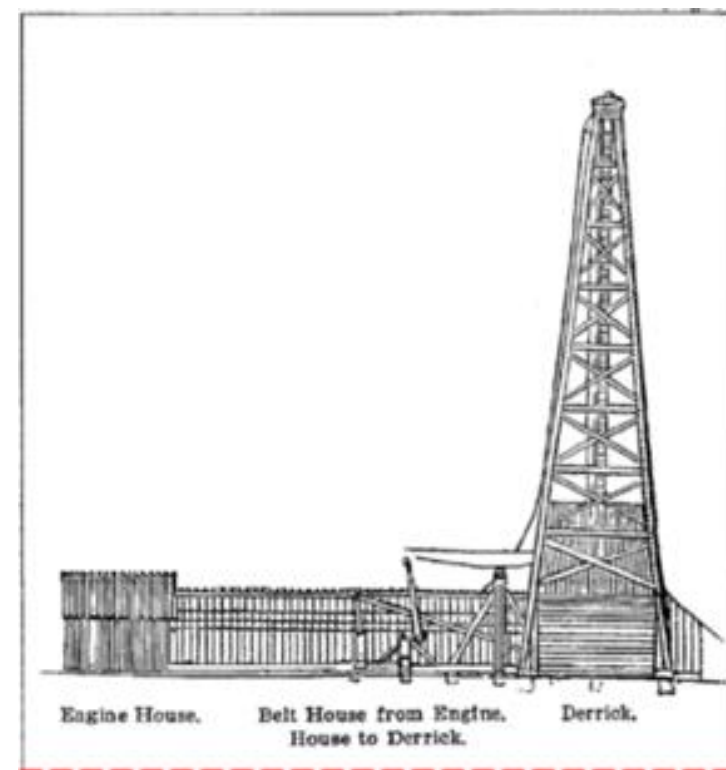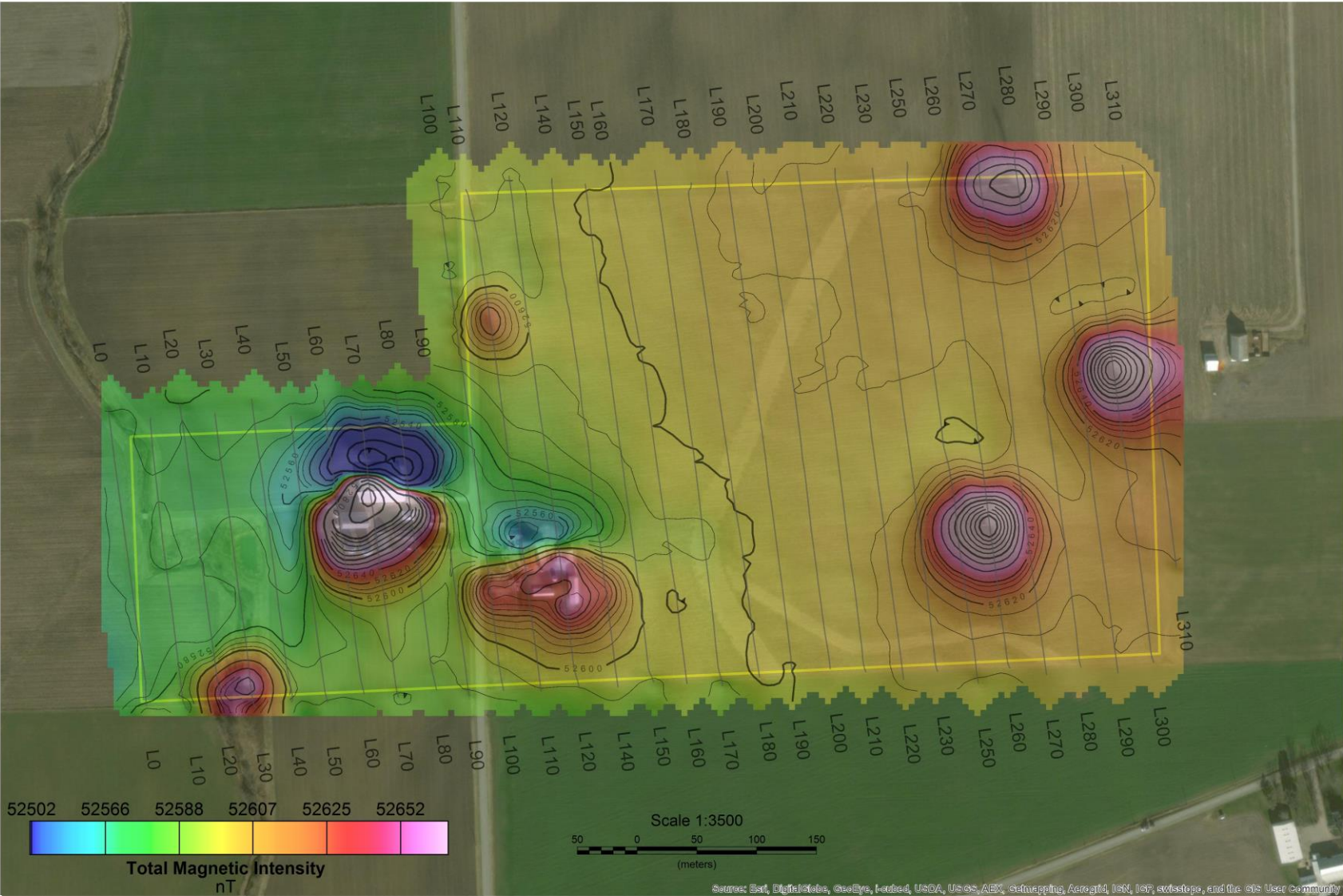
Wells Missed by Magnetic Surveys
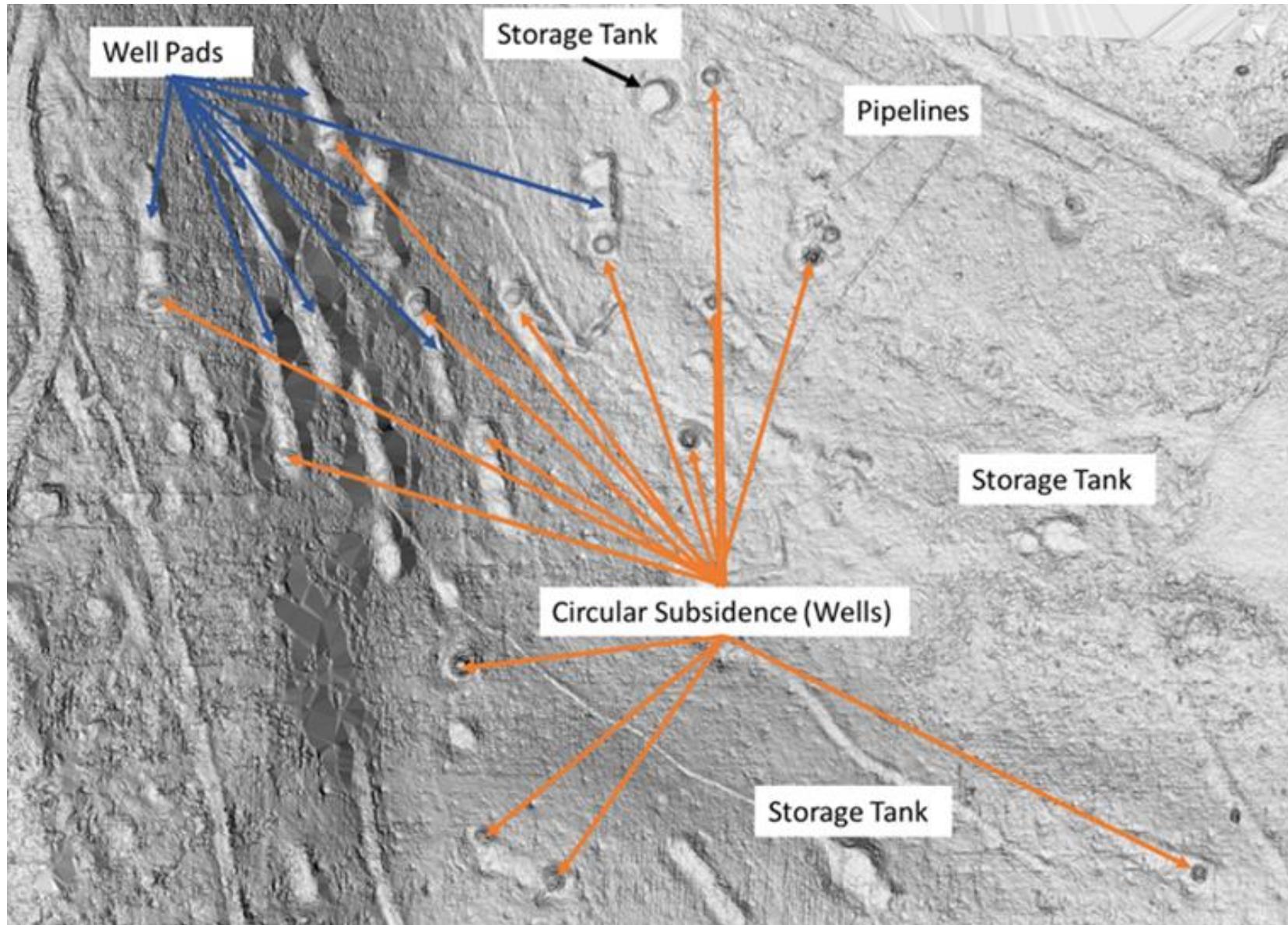
Micro Fabricated Atomic Magnetometer (MFAM)

Demonstration Survey for Ohio DNR

Scale 1:3500

50   0   50   100   150
(meters)

Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
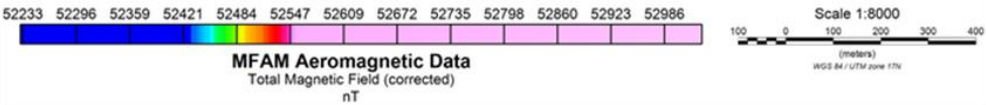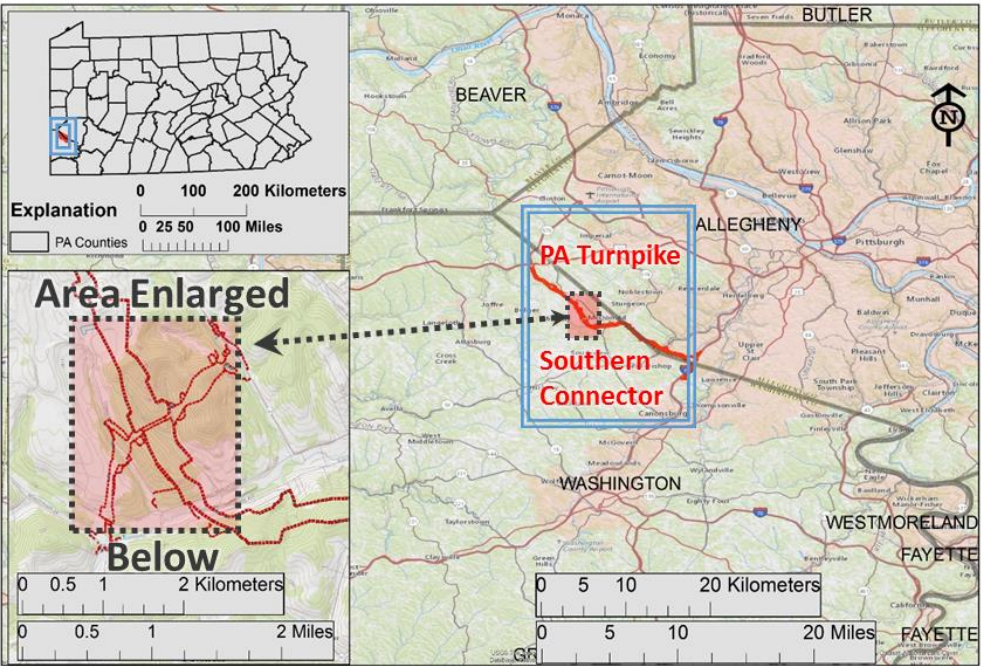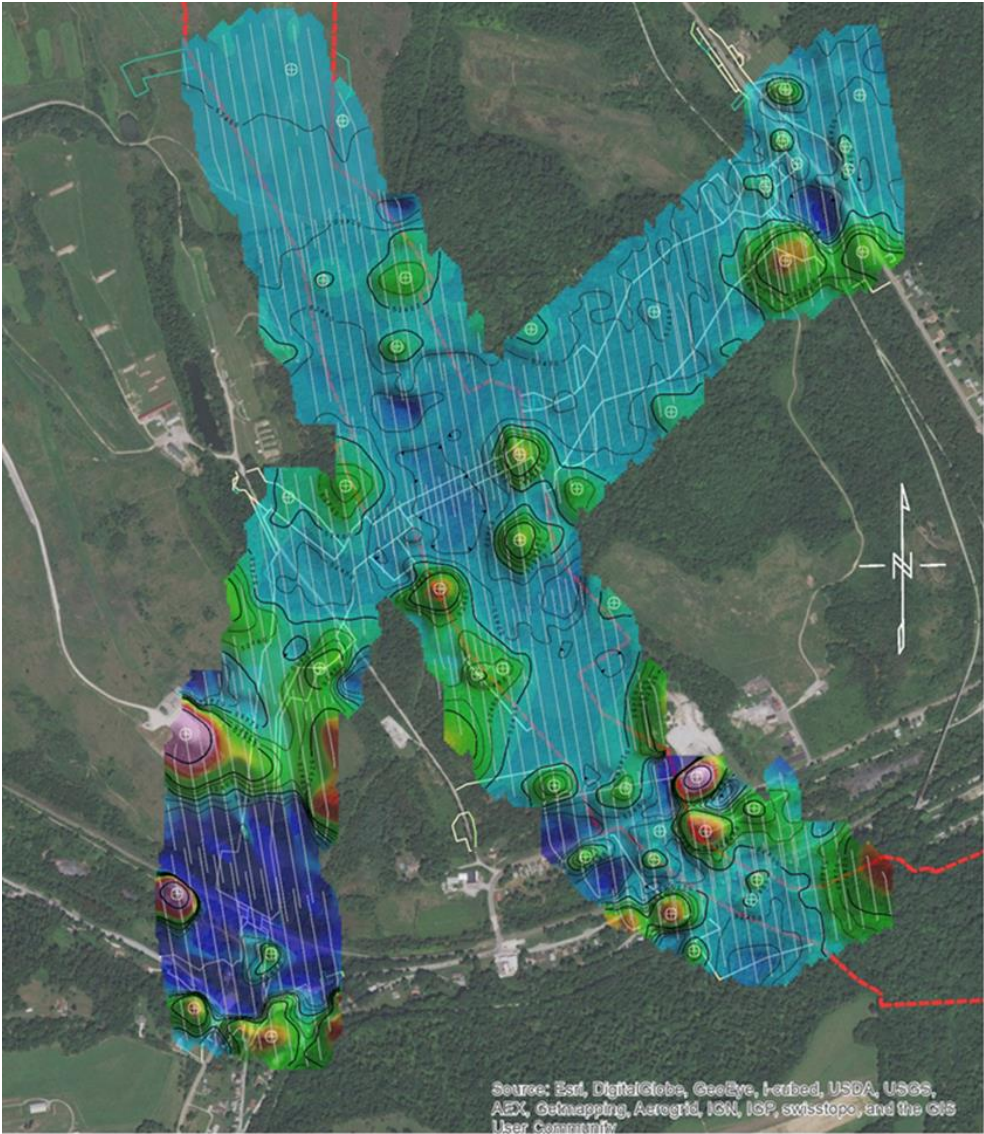
Demonstration Survey for Ohio DNR

Demonstration Survey for Ohio DNR
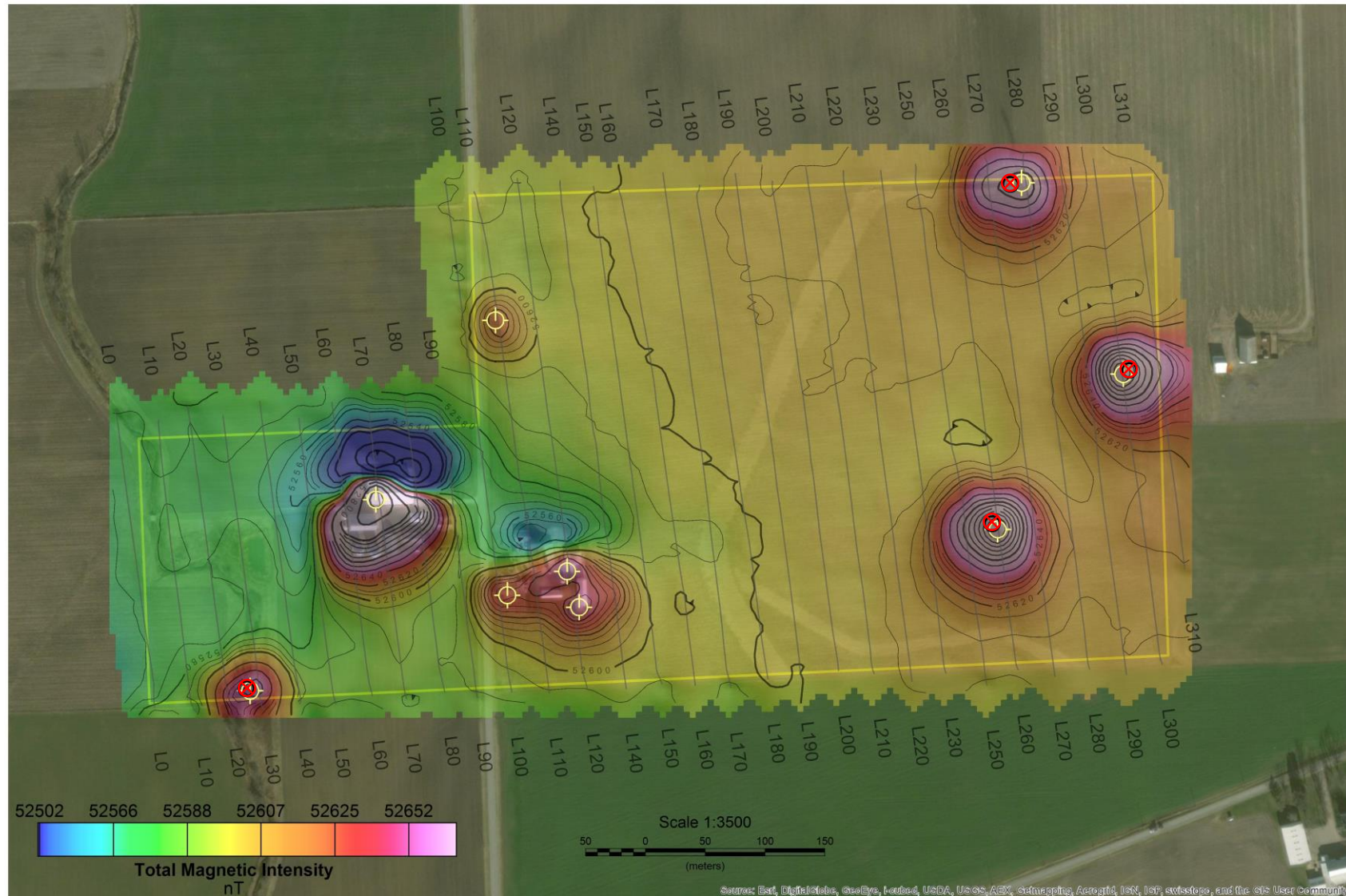
Collaboration with Pennsylvania Turnpike Commission
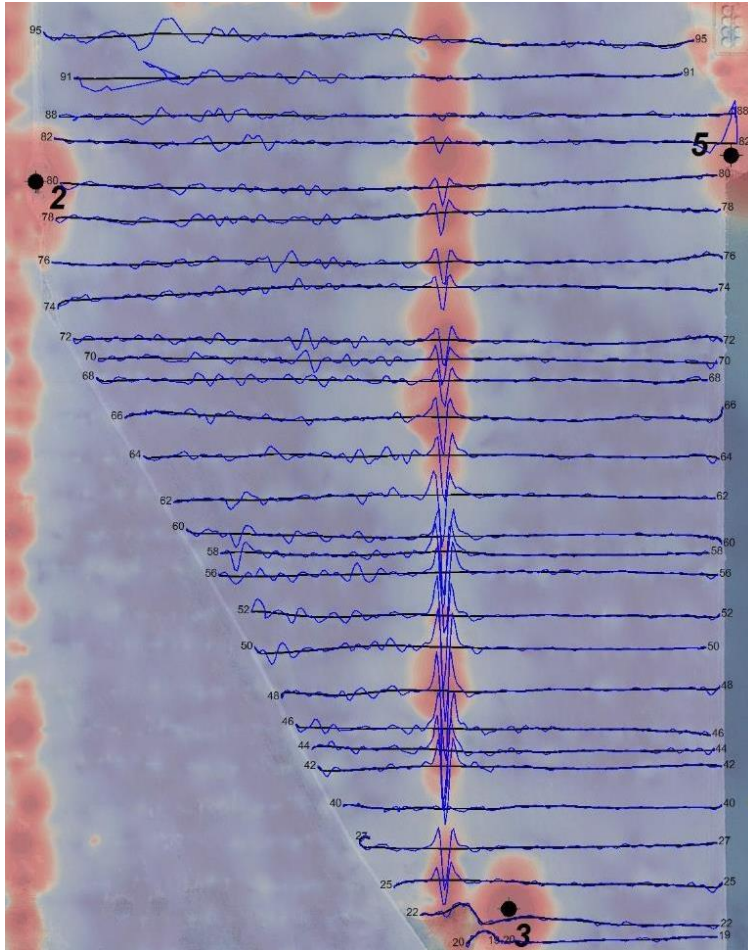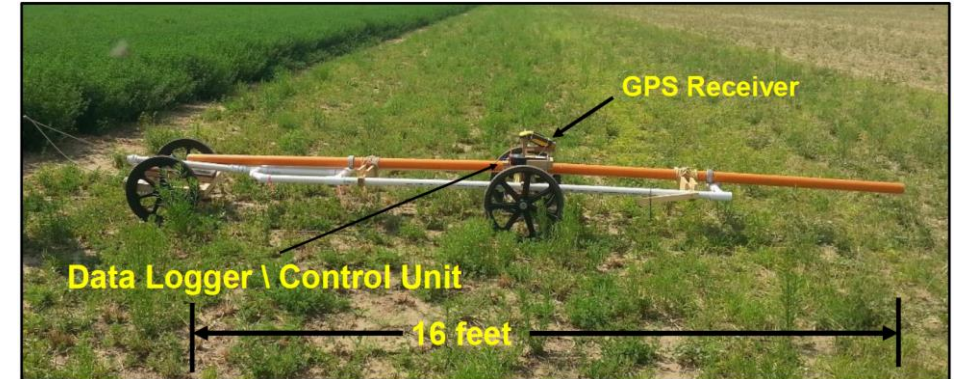
Motivation
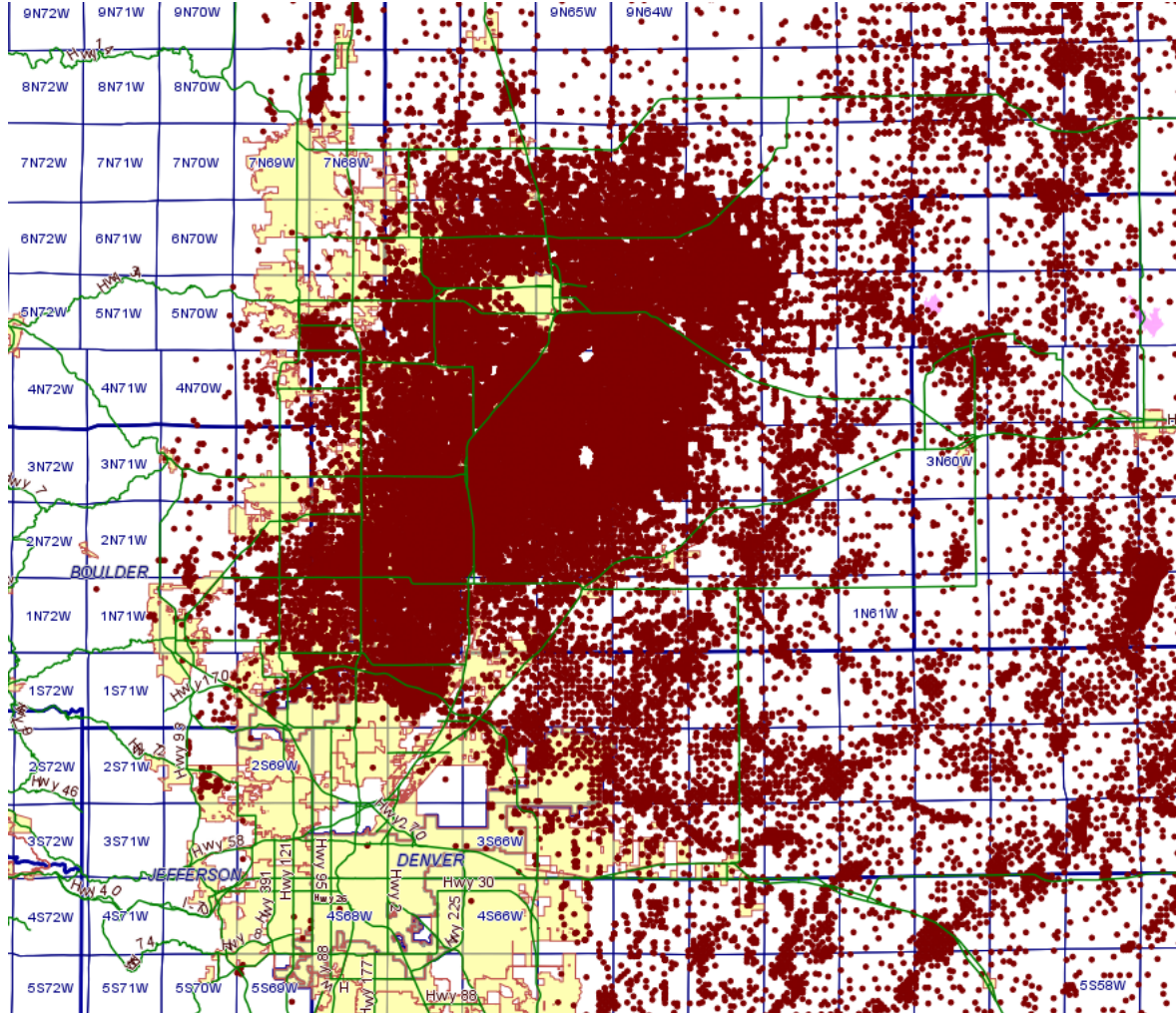
Firestone, Colorado 2017

Metal Pipeline Location Methods

Methods for Locating Upstream Pipelines

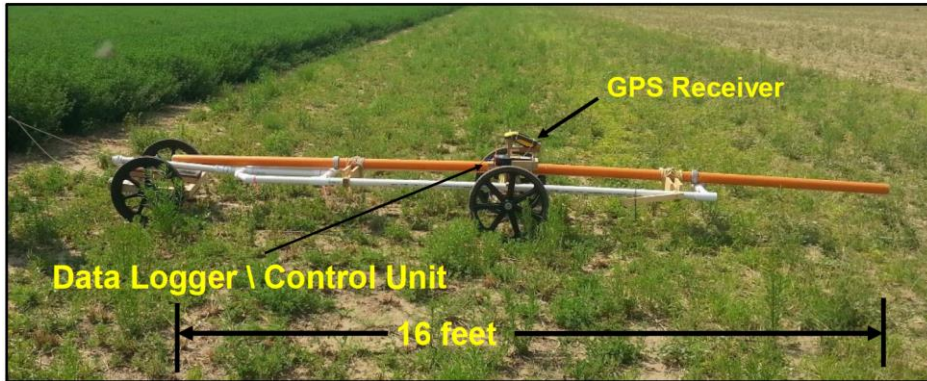Drone Magnetics and Ground-Based EM *from Ron Bell*

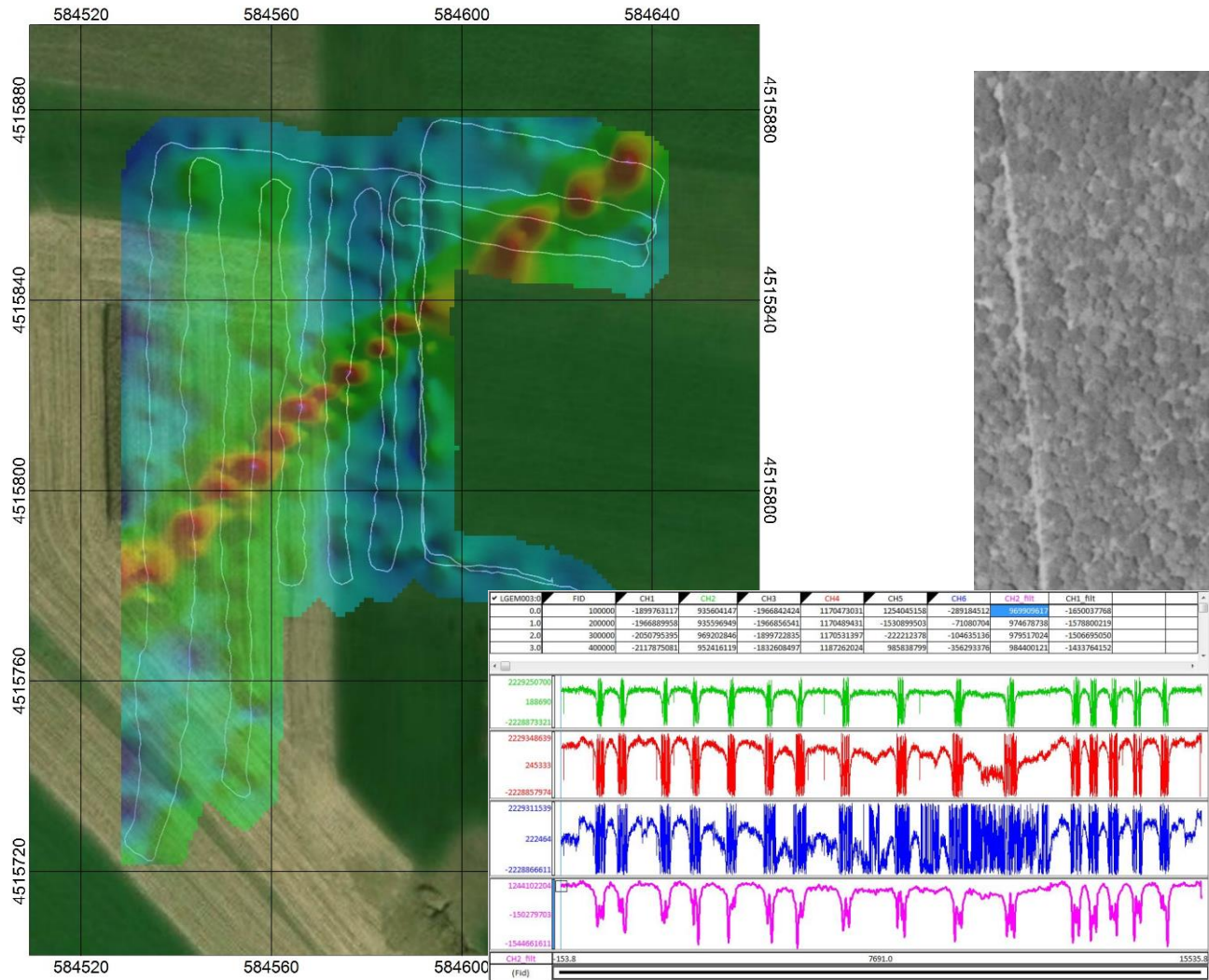Total Magnetic Field – Heat Map
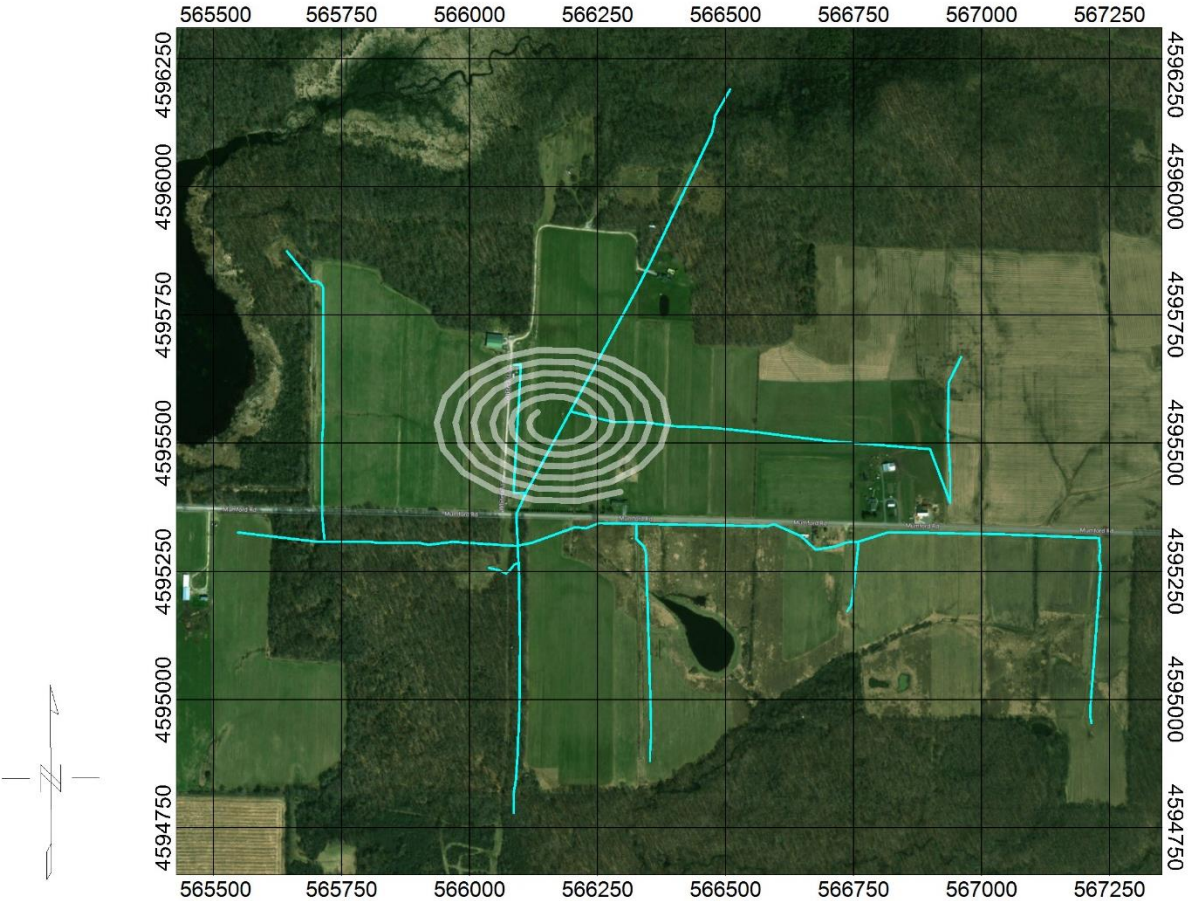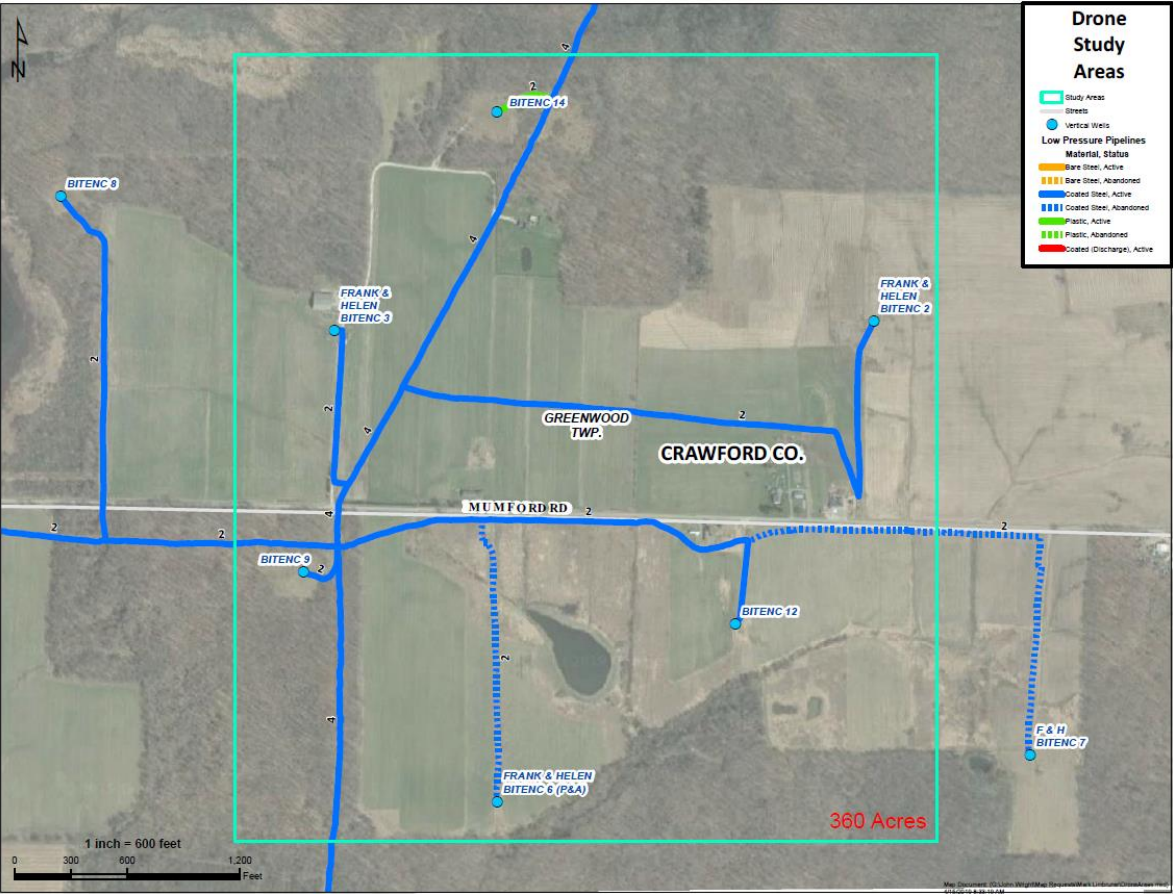ElectroMagnetics - Profiles

ElectroMagnetics

Methods for Locating Upstream Pipelines
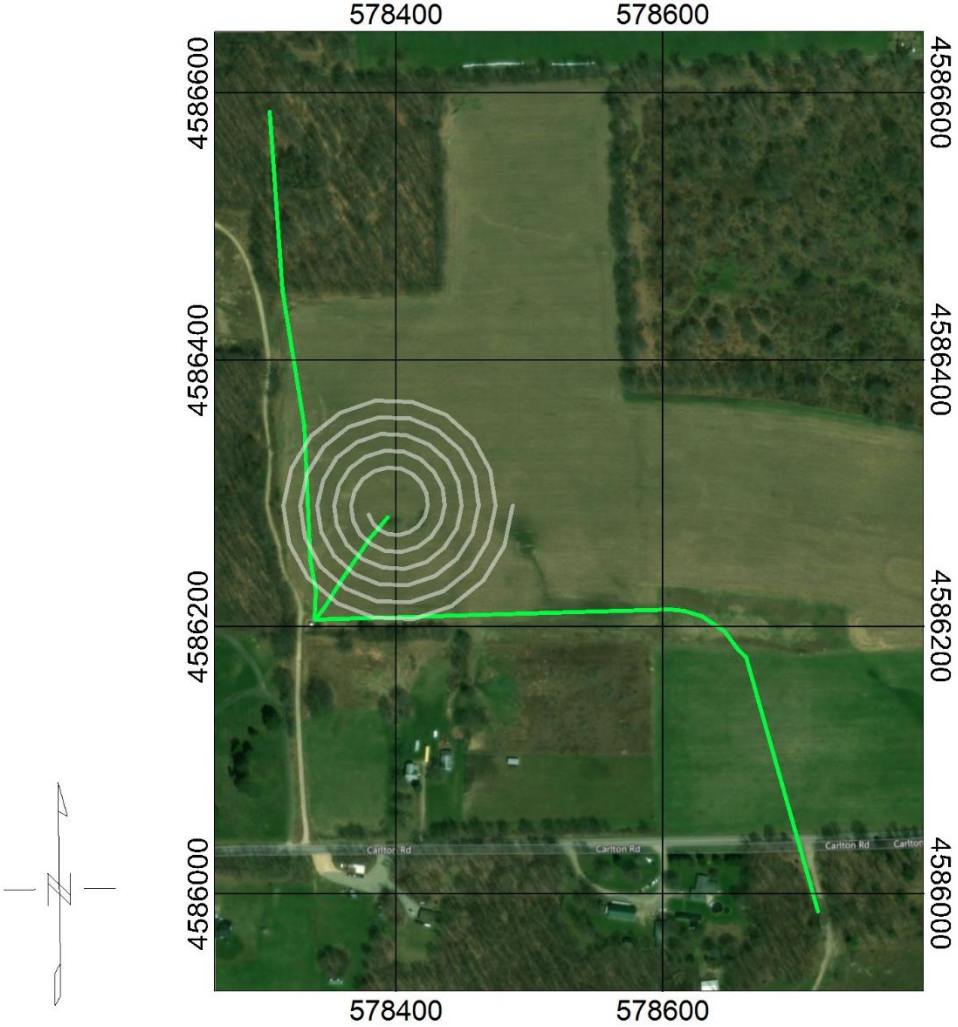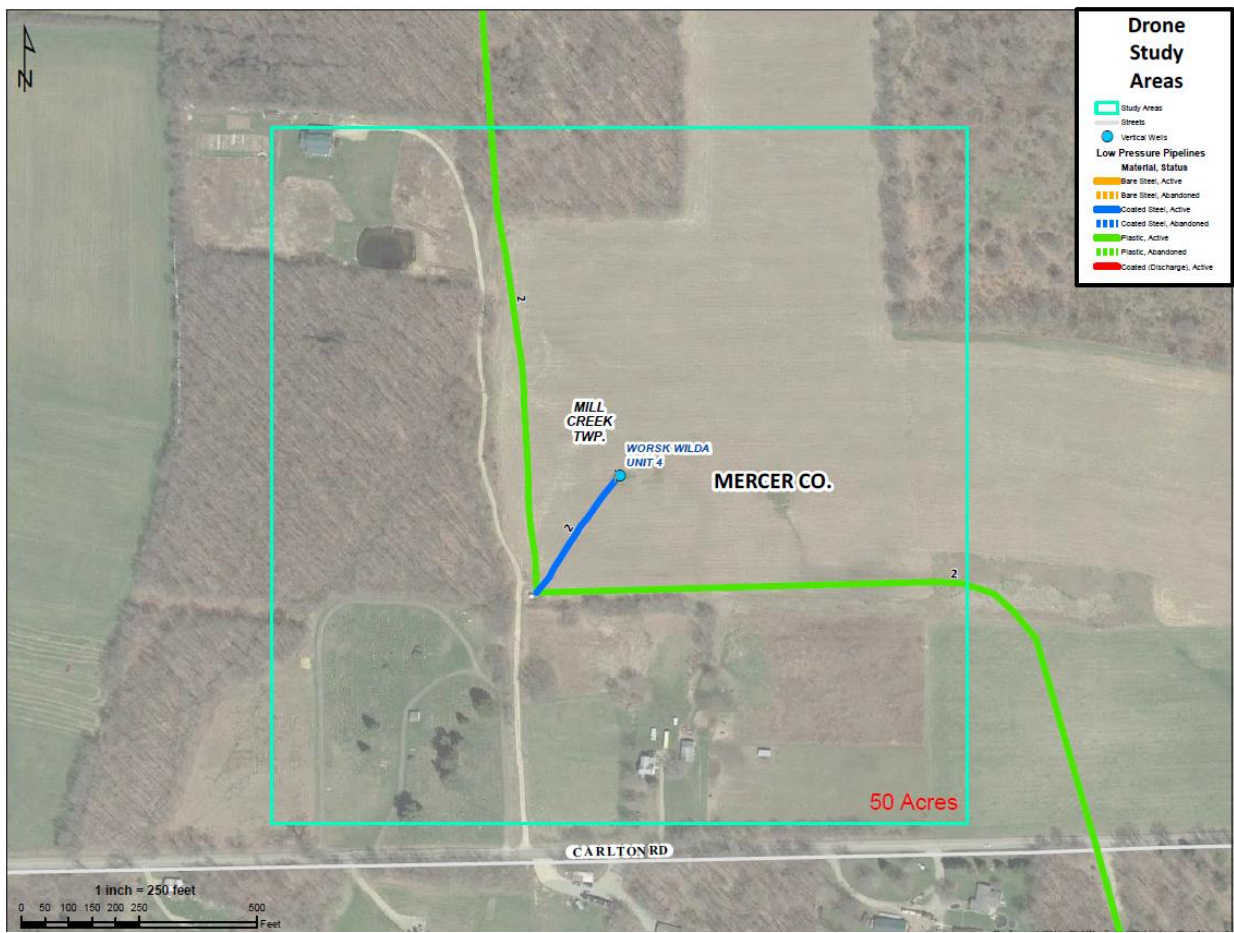
Electromagnetics

Methods for Locating Upstream Pipelines

Drone Magnetics and Electromagnetics

Methods for Locating Upstream Pipelines

Drone Magnetics and Electromagnetics

Methods for Locating Upstream Pipelines

Drone Ground Penetrating Radar – Plastic Pipelines