



Finding, Assessing and Abandoning or Repurposing Orphan and Idle Wells

Jason Simmerman, Rob Lowe, and Tessa Sorensen
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Technologies for Locating Orphan Wells

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Orphan Well Program History



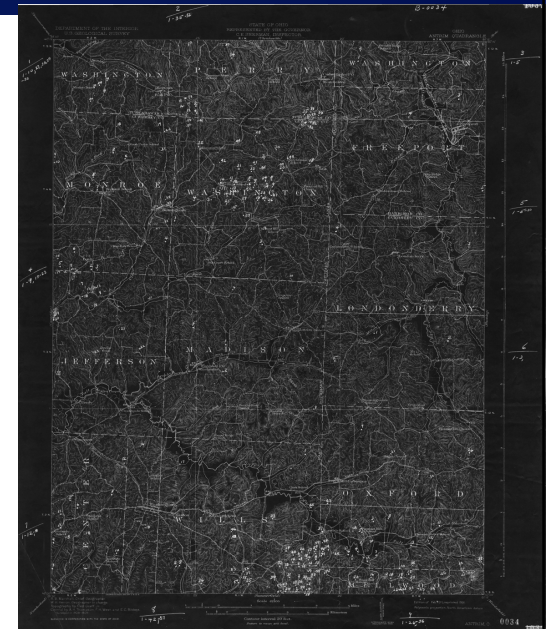
- Oil and gas drilling begins 1859
- Oil and gas regulatory programs created in mid 1900s
- Orphan Well Programs (OWP) created in 1970s-80s



Oil and Gas Records



- Many states had 100 years of drilling prior to regulation
- Historical records intermittent
- Location data accuracy based on area and records retained
- Human disturbance/develop affect applicability of records
- These factors generate great need to locate a mass number of wells and problematic wells



Ohio's Magnetometer Program History



- ODNR initiated aeromagnetic program in 2019 by first contracting test flights.
- ODNR followed test flights with purchase of Geometrics Magarrow®, G857® ground mag and signed an MOU with the Ohio UAS Center for the drone flight aspect.
- IJA funding prompted OWP to contract for well locating that include aeromagnetic detection of orphan wells with consultants.
- Recently purchased Sensys Magwalk®, MagDrone® R3 and 35 handheld metal detectors for Division use.



Magnetic Well Locating Equipment



Magarrow®



Sensys Magdrone R3®



G857® ground mag

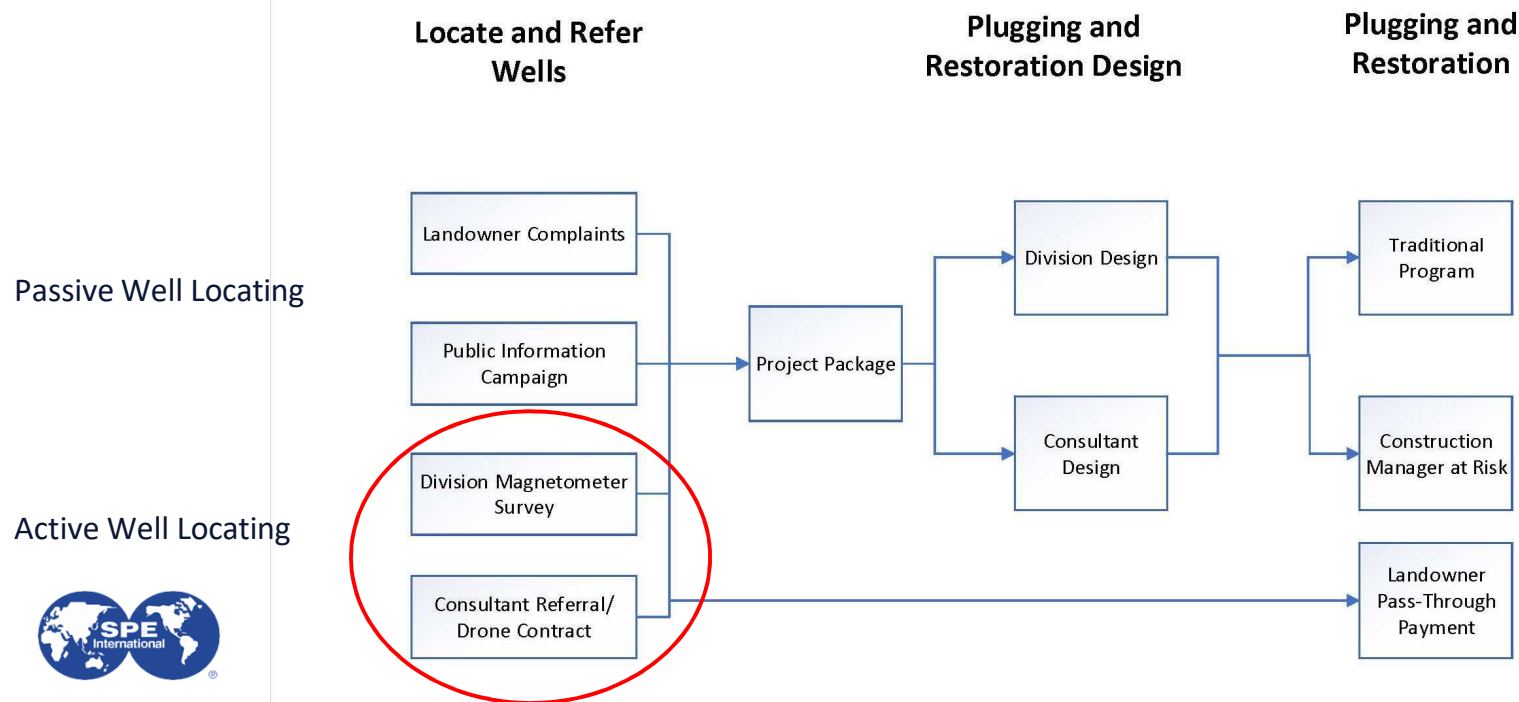


Schonstedt GA52cx®



Sensys Magwalk®

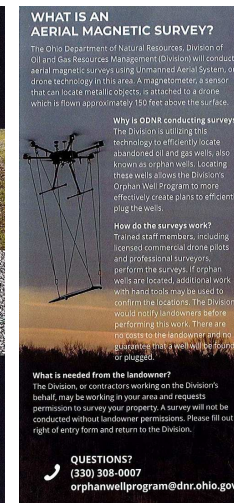
Orphan Well Program Flowchart



Well Locating Challenges



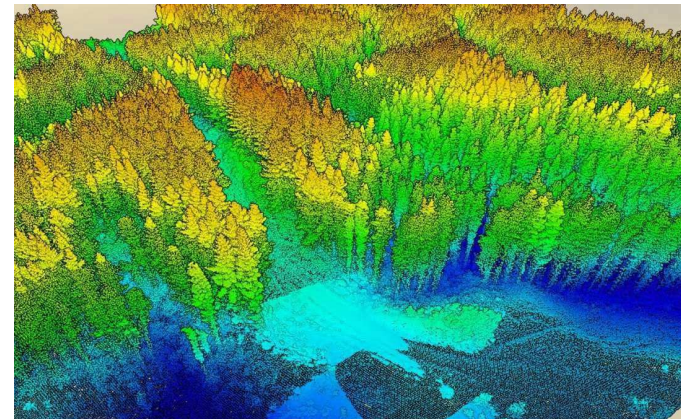
- Right-of-Entry
 - ROE Requirements
 - Personal vs commercial airspace
 - Non-participants
 - Landowner education
 - Pamphlets/door hangers
 - Letters
 - Door to door
 - Division webpage/YouTube



Flying Challenges



- Complex 3D mission planning
- Flying high enough to miss obstacles but low enough to find casings.
- FAA certification
- BVLOS
- Hybrid UAS
- Future UAS tech – fixed wing integration



Flying Parameters



- Plan for 30 m line spacing and 30 m height but adjust height for obstacles.
- 8 m/s forward line speed with rotary UAS
- No flights during high winds to minimize sensor swinging
- Special end of line turn style programming to minimize swing



Post-Flight Processing



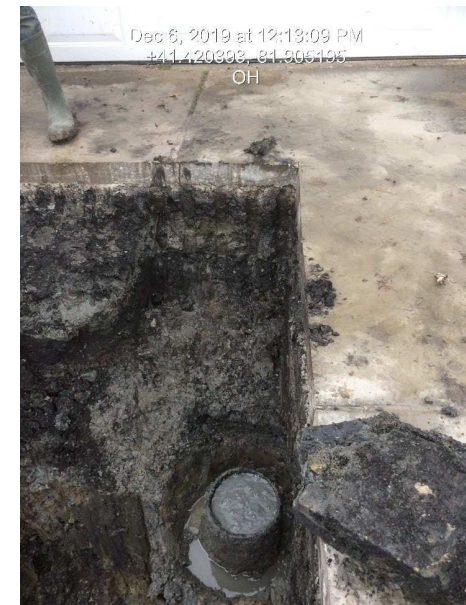
- Who is best suited to do this?
- Can happen in real time or days later
- Basic Gridding to advanced filters
- Target analysis – looking for positive monopoles



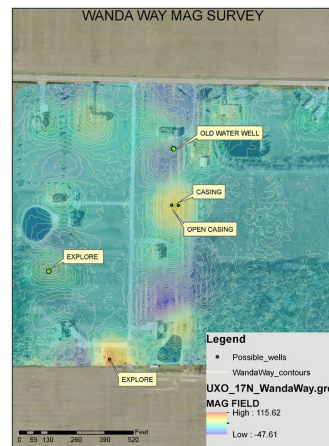
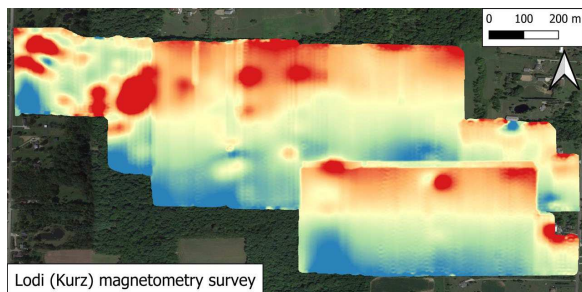
Post- Processing Recon



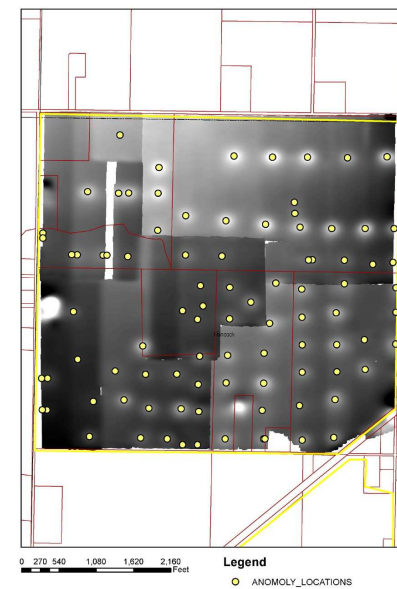
- Mag flight data – ground mag - Schonstedt interpretation
- Contact landowners to schedule field work
- Target return assessment
- Hand tool dig



Aerial Magnetometer Results



HANCOCK COUNTY, EAGLE TWP, SECTION 6 MAG SURVEY



Magnetometer Cost and Timeframes



- Capable UAS (20k-100k)
- Aerial Mag sensor (20k-30k)
- Ground Mag (10k-25k)
- Schonstedt (1k)
- Hybrid around 100 acres/hr
- Traditional less than 50 acres/hr
- Cost varies for inhouse vs consulting



Ground Magnetometer Results





Well Abandonment vs. Re-Use: A Review

Tessa Sorensen, MP PRS

Professor of Practice, Colorado School of Mines

August 16, 2022



Why are wells abandoned?



- Uneconomic from the start
- Uneconomic due to decline
- Economic risk aversion
- Active environmental/human risk



Boomerangs

Definition: When a well/field is sold (sometimes multiple times) and the current owner goes out of business...making abandonment a prior owner's responsibility

- Emphasis needed on data retention and transfer
 - What data is actually required to transfer in a sale?
 - How long is the data for sold fields planned to be retained? *Usually <10 years*
- The older the boomerang, the less the data
 - Data degradation over time, especially with each transfer of ownership
- Extremely old boomerang abandonments may have all of the challenges associated with orphan well abandonment

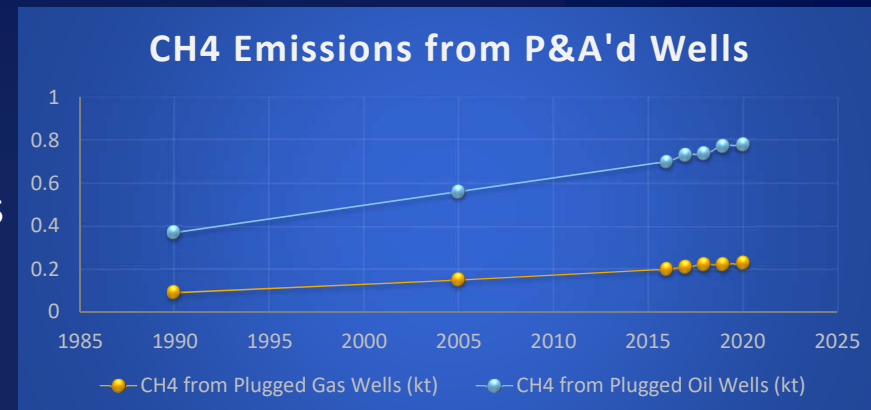


Image Source: https://muppet.fandom.com/wiki/Lew_Zealand

Abandonment



- Will likely NOT be a one-time event...but over what time range?
- Requires proper design
- Requires proper monitoring
 - At wellhead/pad
 - Any possible connected reservoirs



- Similar to mine design...wells need to be designed to fail



Data Source: EPA US GHG Inventory 2022

Orphan Abandonment



- Lack of data
 - Location
 - Configuration
 - Condition
 - History
- Involuntary environmental reclamation
 - ...Trees, Subsidence, and Wildlife
- Environmental damage may(will) be required to reach/prep the site



Image Source:

<https://www.wkyufm.org/environment/2022-02-08/kentucky-to-receive-104-million-to-clean-up-orphan-gas-and-oil-wells>

Possible Well Re-Use Cases



- Behind-pipe reserves recovery
- Disposal/Sequestration
- Injection
- Geothermal
- ...and more



Behind-Pipe Recovery



- Requires verification of reserves and value
- ***Should*** P&A any lower zones
- Adds complexity to design
 - Additional completion
 - Kickoff?
 - Added/Different Casing?
 - Modifications to wellhead/surface?



Disposal/Sequestration



- Regulatory restrictions
- Reservoir compatibility
- Tubular requirements
- Surface facilities
- Disposal material source/transport
- Seasonality and pressure capacity



Injection



- Regulatory restrictions
- Reservoir compatibility
- Reservoir flow design
- Surface facilities
- Injection fluid source
- Seasonality and pressure capacity



Geothermal



- Very specific tubular requirements
 - High corrosion concerns
 - High temperature
 - Cement bonding
- Requires high flowrate
 - ...and therefore a large diameter wellbore
 - Slimhole completions can almost never be re-used as geothermal wells
- Must completely isolate hydrocarbon bearing zones



What can we do?



- Regulatory
 - Additional monitoring requirements for abandoned wells
 - Verifying possible re-use cases
- Operators
 - Large entrepreneurial space for turnkey abandonment
- Academic
 - New abandonment materials
 - New abandonment techniques
 - Cementitious materials



New Technology Examples



- Class L cement
 - Blend of Pozzolan (fly ash) & Portland
 - Class L is not new, but the regulations are
- Bismuth/Thermite
 - Spot-liquified metal plugs
- Perf-Wash-Cement (PWC)
 - Not so new, but not so old either
 - Limited depth applications





QUESTIONS / DISCUSSION

