Advocating for enhanced groundwater protection by:

- identifying abandoned wells
- identifying risks to water quality based on well condition
- identifying risks to water quality based on well circumstances, i.e. proximity to contaminants…
- utilizing GIS tools for risk analysis and mapping

Mariah Bonham, Environmental Coordinator
Taylor Bruecher, Environmental Analyst – GIS
Roger Andrade, P.G. Groundwater Protection Manager
Outline

Roger:
- Basic water well configuration and specifications
- Abandoned well procedures and methodology – case studies

Mariah:
- Risk Criteria
- Ranking System

Taylor:
- GIS Analysis and Applications
- Mapping
How do we become aware of abandoned wells?

- Calls from Concerned Citizens
- Registration Efforts
- Other Agencies
- Water Pollution Abatement Plans (TCEQ)
- Drillers inquiring about specific wells
- Real Estate agents
- Consultants
- Others
Abandoned and Deteriorated Wells

- Pose threat to well water and public safety
- Serve as conduits or channels for contaminants to reach groundwater.
- Top of the list of potential groundwater contamination sources that can be identified and eliminated.

http://tgpc.state.tx.us/water-wells/#3
Mechanism for How Abandoned Wells can contribute to Groundwater Contamination
Grouting Factor
Grout protects the aquifer from contamination

Grout is a sealant that is used to fill in the spaces around the outside of the well. It protects the well against the intrusion of contaminants. A grout mixture can be made of cement, bentonite, or concrete (each used separately).

http://www.groundwater.org/get-informed/basics/wells.html
Proper cement placement between the well casing and the formation is essential.
Grout Deterioration Over Time

- Cement deteriorates over time
-Leaks occur when cement shrinks, develops cracks or channels
Steel is thermodynamically unstable under normal atmospheric conditions and will release energy and revert back to its natural state—iron oxide, or rust. This process is called corrosion.

Casing Deterioration Over Time

Casing Subject to:
• Oxidation (rust)
• Corrosion process
• Structural Collapse
  • Rupture
  • Stress
• Inflow of low quality water
Deteriorated Casing:
Split casing and holes in casing
Abandoned wells are subject to increased scrutiny due to well age

Old Wells

- Turbine Pumps are likely to leak lubricating oils over time.
- Casings are likely to have undergone corrosion process.
- Environmental forces have been stressing well casing and cement grout.
- Even 30-40 year old modern casings are subject to corrosion and perforation.

http://extension.missouri.edu/p/EQM103F
Turbine pump column with pump bowls removed from a recently plugged water well

Lubricating oil leaked from turbine pump
Deteriorated Wells: Water Quality Issue

Suspected oil source
Geophysical Log Facts:

- The gamma tool measures the natural-gamma radiation (photons) emitted by all rocks and soils.
- Clays and Shales are high emitters compared to sandstone, limestone, and dolomite.
- Gamma tools can be run in cased or uncased wellbores, in or out of water.
- Caliper tool measures diameter of well as it ascends through the borehole and casing.
- Current
- Resistivity
Geophysical Log Uses:

- Standardized methodology to categorize well lithology
- Supplements well driller’s notes
- Fills in missing data
- Gamma signal highly distinct through confining units above Edwards
Destroyed Well Case Study
Research and Uncover in Leon Valley

- Concerned citizen reports well
- Phase I Environmental Site Assessment – no well mentioned
- Neighbors provided signed affidavit of their knowledge of a well at site

- Well reported June 2010
- Geophysics May 2011
- Excavated June 2011
- Plugged 2015
Leon Valley Well Site GPR and Magnetometer Survey Results
Case Study
Ackermann Rd Well Site: Landis Wilson Water Supply System
• Reported seepage at site
• TWDB indicates two wells
• Owner excavating in search of well
• Magnetometer and GPR Survey
Ackermann Rd Well Site: Landis
Wilson Water Supply System
Ackermann Rd Well Site: Landis Wilson Water Supply System
MEMORANDUM FOR THE RECORD

6 March 1974

I met with Mr. Charles McGee, City Public Service Board, and Mr. Hugh Whorton, Halliburton Company, to discuss means of determining which of the four wells at 202 Mission Road could be leaking and causing their seepage problem.

Methods discussed which could be used to determine the source of the water were:

1. Run complete chemical analysis from all wells and from seepage.
2. Pump fluorescent dye, as recommended by USGS, into one well at a time and check seepage for trace of dye.
3. Use an air compressor to pump down water to determine possible hole in casing. This should be done with great caution.

Some mention was made that the CPSB plans to plug Well No. 1 which produces very little water and Well No. 2 which produces a strong sulphur odor. I informed both Mr. McGee and Mr. Whorton that a permit was required for any repair or plugging with a waiver on the fees. They were requested to notify us any time work is done.

Oliver Grobe, Jr.
Water Quality Inspector
Only well visible at ground surface.

MRP Site south of downtown S.A. on east side of San Antonio River
MRP Site
Case Study: Bexar County Abandoned Flowing Artesian Well

Significant ecosystem has developed over many years from an abandoned flowing artesian well. Suggestion to plug well met significant resistance from community entities.
Flowing Artesian Well

Costly to plug:
• Build platform around well
• Deep Well
• Stop artesian flow
Recent high aquifer levels to start flowing above standpipe height, requiring additional PVC section.
Downtown San Antonio Well Site
Abandoned Wells
Repair process involved installing 2-foot stainless steel, 10 gauge patch overlaid with a 4-foot stainless steel, 10 gauge patch over the casing separation located approximately 70 feet below land surface.

Swage tool that applies 1,500 PSI to both patches to seal the separation.
Plugging an abandoned well:

- Long and challenging process
- A well may need to be cleaned out
- Access to the well has to be established
- Can be costly
- Each abandoned well has unique circumstances
Risk Based Assessment:
Categorizing and Prioritizing Abandoned Wells and Identifying Areas of Concern

• Identify Abandoned Well Risk Criteria
  1) *Threat to the Aquifer*
     Abandoned Well Condition
     Proximity of Well to Contaminants
  2) Feasibility of Plugging Wells
     Cost
     Time-Sensitivity

• Introduce GIS tool
  1) Cumulation of risk criteria
  2) Rank abandoned wells
Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Deteriorated Casing
Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Casing Location
Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Casing Seal
Risk Criteria—Threat to the Aquifer
Abandoned Well Condition: Communication with poor quality waters or Petroleum-Bearing Formations
Risk Criteria—Threat to the Aquifer
Abandoned Well Proximity to Contaminants and Potential Contaminants
Risk Criteria—Threat to the Aquifer
Land Use & Population Density at Abandoned Well Sites
Criteria: Plugging Abandoned Wells – Flowing Artesian Wells
Criteria: Plugging Abandoned Wells – Large Diameter, Deep Wells
Criteria: Plugging Abandoned Wells – Clearing out wells
Criteria: Time-Sensitivity – Security of Abandoned Well Site
Criteria: Time-Sensitivity – Planned or Active Development
CREATING A GIS TOOL FROM RISK CRITERIA

Collaborative Effort
Feedback
Dynamic Process
272 Abandoned Edwards Aquifer Wells

Question 1: Which wells pose the greatest threat to the Aquifer?
Criteria:
• Abandoned Well Conditions
• Abandoned Well Proximity to Contaminants

Question 2: Which wells can then most effectively be plugged?
Criteria:
• Cost
• Time-Sensitivity

Prioritized list of Abandoned Wells for Plugging
GIS TOOL

http://arcg.is/2ffDODk
Areas of Concern

Abandoned Wells

- High
- Moderate - High
- Moderate
- Moderate - Low
- Low
Other qualitative considerations

To fulfill our mission to Manage, Enhance, & Protect the Edwards Aquifer many wells should be additionally prioritized for plugging to:

- Prevent instances of waste or neglect
- Prevent potential litigation
- Demonstrate “Proactive” rather than “Reactive” environmental stewardship
References and Acknowledgments:

- http://tgpc.state.tx.us/water-wells/#3 Texas Groundwater Protection Committee Publications
- Texas Commission on Environmental Quality
- Environmental Geophysics Associates (Mustafa Saribudak, Alf Hawkins.
- https://pa.water.usgs.gov/reports/fs218-95.pdf USGS
- Corrosion of Water Wells, Chapter 5, Robert G. McLaughlan
- https://www.thebalance.com/types-of-corrosion-2340005