Geothermal Resource Assessment, City of Truth or Consequences, NM

Overview

**Project Dates:** October, 2012 to October, 2013  
**Project Cost:** $50,000  
**Matching Funds:** NM Bureau of Geology Aquifer Mapping Program for Geochemical Analyses

**Goals of Study:**

1. Determine if there are significant changes to thermal and hydrologic conditions within the Truth or Consequences Geothermal Resource Area between 1940s and 2013.
2. Determine the lateral extent of the recharge area of the geothermal district and sustainable pumping rates using mathematical modeling.
3. Prepare report based on 1-year study.

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Water level measurements  | Collecting temperature profiles  | Surveying  | Setting equipment
Project Web Site

TRUTH OR CONSEQUENCES STUDY

Geothermal Resource Assessment for the City of Truth or Consequences

The City of Truth or Consequences has contracted with Earth Science and
Environmental Services of Albuquerque to undertake a 5-year field and hydrologic modeling study focused on the
sustainability of geothermal resources. The New Mexico Bureau of Geology and the
aquifer mapping program will provide additional funding and support for this
study.

This study will focus on the discharge area within the downtown as well as determine the
lateral extent of the flow system to the east and west. The goals include:

- Data collection:
  - Collect field measurements to determine ground-water and thermal
    properties of the system.
  - Collect geophysical data to define the extent of the flow system.
  - Collect and analyze ground-water samples for isotopic and chemical
    analysis.

- Conceptual Model of Geothermal System

- Hot unconfined aquifer (many wells produce from this aquifer)
- Leaky Confining unit (role of abandoned/leaky wells?)
- Confined Aquifer-Geothermal Reservoir (few wells produce from deep reservoir)
- Many abandoned or unaccounted for wells from the 1930 era

(figure sources: 2008)
Project Activities:
1. Water Level Collection & Surveying
2. Geochemical Sampling
3. Temperature Logging
4. Geologic Mapping & Synthesis

Measurements to Date:
- Water level measurements in 45 wells
- Completed elevation survey of 9 wells
- 17 temperature-depth logs
- 10 water samples collected for geochemical analysis

Geochemical Sampling: Major Ions, Trace elements, $^2$H, $^{18}$O, $^{14}$C
Stable Isotope Sample Locations & Precipitation Data

Collect Precipitation and Groundwater Isotope samples

The isotopic composition of H2O isotopes can be influenced by elevation. Can help identify source of recharge.

Geothermal Exploration 101
Figuring out Flow Patterns from Temperature Profiles
Temperature Conversion
°F  °C
112  44.4
110  43.3
114  45.6
116  46.7

2012-2013 Temperature Logging

Western and eastern temperature profiles are quite different. Compartamentalized flow system?
We will attempt to interpret this data using hydrothermal modeling.
Simple Hydrologic Model of TorC Water Table Aquifer

Transmissivity = 4 x 10^4 ft²/day
Δx = Δy = 180 feet

Steady-State Groundwater Flow Eq.
\[ \frac{\partial}{\partial x} \left[ I \frac{\partial h}{\partial x} \right] + \frac{\partial}{\partial y} \left[ I \frac{\partial h}{\partial y} \right] = -Q(x, y) \]

How Would Pumping Influence Water-Table Patterns?

Increased pumping creates a cone of depression
Increase pumping should reduce water levels in unconfined aquifer
Many wells will create complex interference patterns with a lot of drawdown

Q = 0 ft²/day  One Well  Q = 10 ft²/day  One Well  Q = 50 ft²/day  Four Wells  Q = 10 ft²/day

This model assumes no vertical leakage from deep aquifer!
Preliminary 1939-2013 Water Table Comparison

Preliminary Interpretation:
No discernible cone of depression in surveyed wells.
Little evidence of water level changes in shallow aquifer.

1939-2013 Artesian Heads

While we have only sampled 2 deep wells tapping the confined reservoir, there is little evidence of artesian conditions today. Available discharge records suggest declining flow and hydrologic connection to river.

Theis et al. (1942) reported 20 to 4 feet of Artesian Heads In Confined Aquifer.
Daily Temperature & Water Level Measurements

Preliminary Findings & Recommendations

- The water table aquifer is the source of water for most current wells. Evidence to date indicates little change in either temperature or water-table elevation in since 1939.

- Based on a limited number of deep wells (2) which penetrate the deep, confined aquifer, fluid pressures appear to have declined since the study of Theis et al. (1942).

- No clear evidence of temperature declines to date in the deep confined aquifer.

- More data is needed from wells that are screened in the confined aquifer.

- A long-term monitoring program would be a good idea (temperatures, water levels, salinity). To some extent, this could be done using existing wells.

- Sealing old, abandoned wells is a good idea to minimize loss of artesian pressure