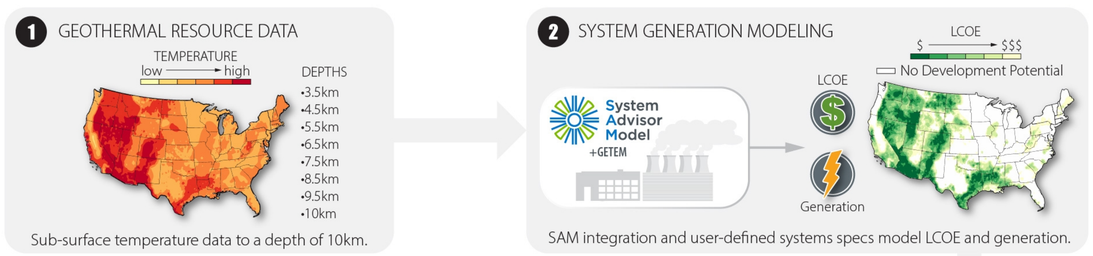
Proceedings World Geothermal Congress 2026, Calgary, Canada, June 8—11, 2026

Capturing Water Availability and Permitting Considerations & Enhanced Geothermal Systems Technical Potential: LLM-derived layers for reV

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EGS TECHNICAL CAPACITY & EXCLUSIONS

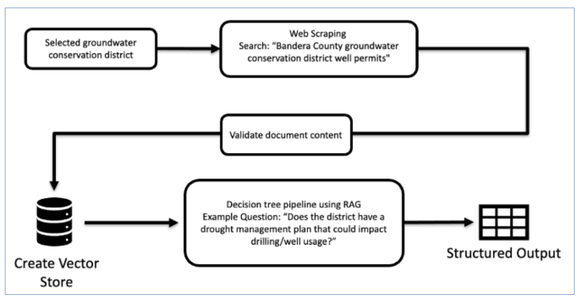
reV allows for EGS resource techno economic calculations combined with transmission calculations and technical exclusions (ecological, land use, etc. considerations).

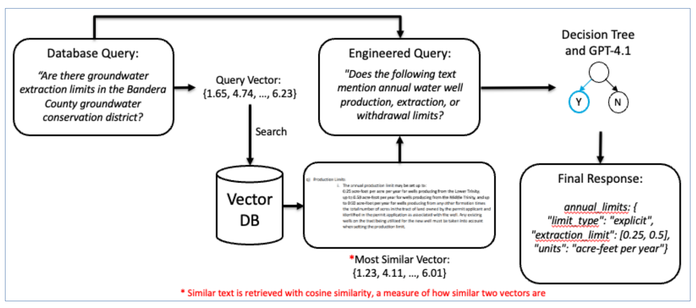


WEB SCRAPING & LARGE LANGUAGE MODELS

EGS will require water for stimulation activities and water policy may influence where EGS can be developed. We approach this by retrieving groundwater permitting & extracting guidelines with an advanced language model

- **Objective:** retrieve information detailing groundwater well permitting in Texas using a Large Language Model (LLM) to extract unstructured data from text documents
- **Approach:** Retrieval Augmented Generation (RAG) allows for consideration of multiple sources of information simultaneously; ability to answer more general questions; most up to date information is considered; accuracy considerations



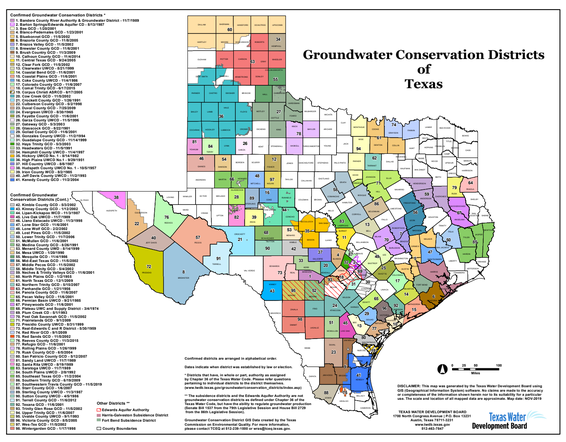


RESULTS

Texas has 98 groundwater conservation districts exist, each with their own guidelines. Since there is no central location for information and each district is highly variable it is a good target for LLM. We defined decision trees to capture:

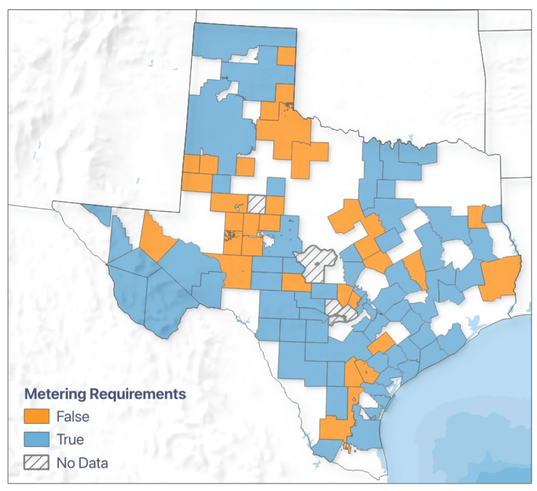
- Well spacing requirements
- Metering requirements
- Drought management plan
- Maximum extraction limits
- Well permit required
- Plugging requirements
- Drilling window/time limits

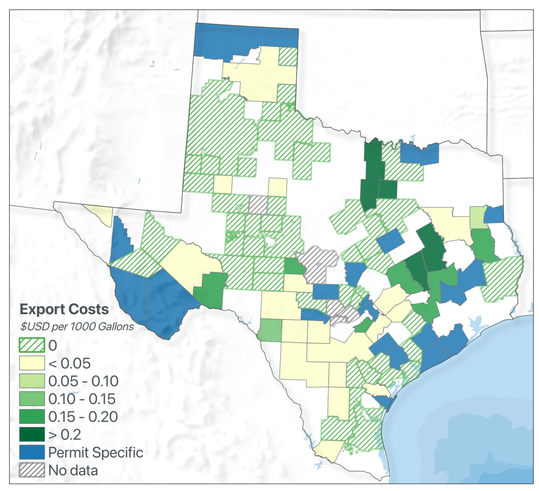
No color == No Water Conservation District

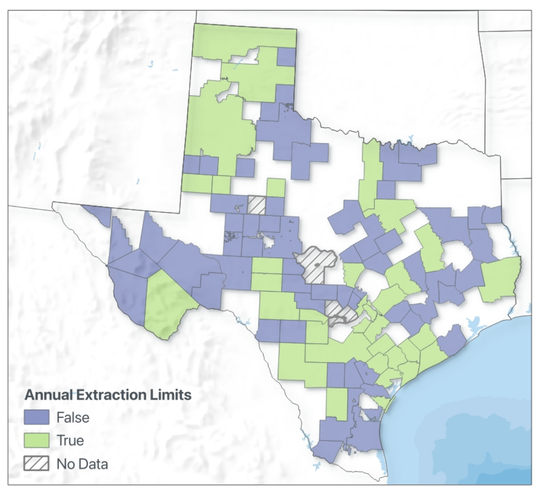


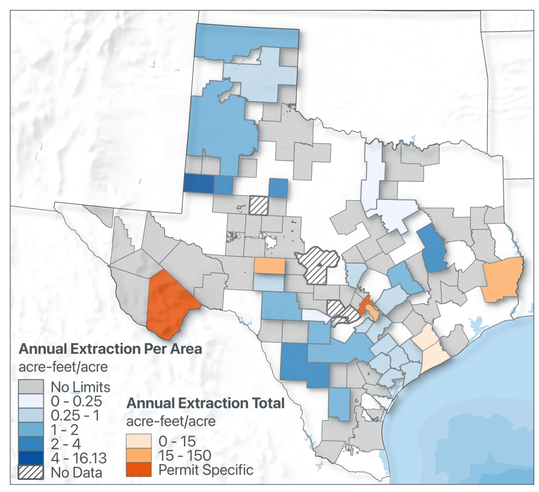
Extraction Step	Average Completion Time per District**
Document Processing*	4 minutes 36 seconds
Value Extraction	1 minute 48 seconds
Total	6 minutes 24 seconds

*Document Processing involves web scraping, document validation, and embedding





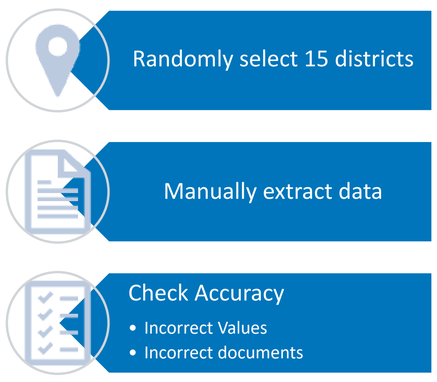




VALIDATION

This method provides a fast retrieval of information, but requires careful quality control to ensure the prompts are precise.

- Straightforward fields performed well
  - Ex: Metering device requirements
  - Easy to identify, few exceptions
  - **100%** accuracy in sample set
- Complex policy can be challenging
  - Ex: Production cost
  - Numerous exemptions are applicable
  - **63%** accuracy in sample set
- Content validation
  - **2** districts in validation set were likely processed with insufficient information

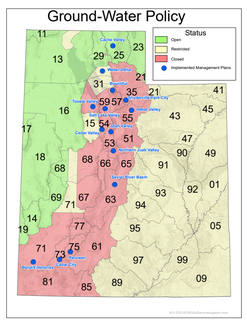


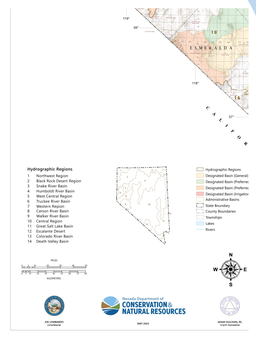
- The objective is to use both the quantitative and qualitative information gathered to define 3 exclusion scenarios: open, reference and limited for EGS development (Mai et al., 2025). Determining how to use this varied water policy is an outstanding challenge and will require many disciplines to come to consensus.

CURRENT WORK

Continued Water Guidelines & Availability

Water guidelines and policy vary from state to state. We are planning on taking the same prompts developed on Texas to Nevada, Utah, New Mexico, California and Pennsylvania.

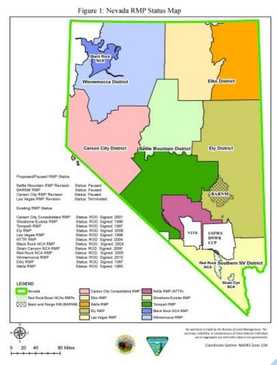




Resource Management Plans (RMPs)

Federal Agency like Bureau of Land Management (BLM) develops Resource Management Plans (RMPs) to "*balance resource values on public lands for present and future generations, ...*" (BLM, accessed October 2025).

Ultimately this data will be prepared for ingestion into models like reV. The impact will allow for efficient updates to the geothermal potential given the updated regulatory landscape, the modelled NLR estimated geothermal future capacity, and how the private industry perceives risks.



Acknowledgements

This work was authored by the National Laboratory of the Rockies for the U.S. Department of Energy (DOE), operated under Contract No. DE-AC36-08GO28308. This work was funded by U.S. Department of Energy - Geothermal Technologies Office. The views expressed in the article do not necessarily represent the views of the DOE or the U.S. Government. The U.S. Government retains and the publisher, by accepting the article for publication, acknowledges that the U.S. Government retains a nonexclusive, paid-up, irrevocable, worldwide license to publish or reproduce the published form of this work, or allow others to do so, for U.S. Government purposes.

REFERENCES

BLM Resource & Land Use Plans: https://www.blm.gov/programs/planning-and-nepa/plans-in-development/nevada. Accessed October 2025.

Buster, G., Pinchuk, P., Barrons, J., McKeever, R., Levine, A., Lopez, A., 2024. Supporting Energy Policy Research with Large Language Models. Energy and AI, 18.

Mai, T., Lopez, A., Marquis, M., Gleason, M., Hamilton, A., Trainor-Guitton, W., Ho, J.& Sharma, S.. 2025. Land of Opportunity: Potential for Renewable Energy on Federal Lands. Golden, CO: NREL. NREL/TP-6A40-91848. https://www.nrel.gov/docs/fy25osti/91848.pdf.

Pinchuk, P., Thomsen, S.-M., Trainor-Guitton, W., Buster, G., Maclaurin, G., 2023. Development of a geothermal module in reV: quantifying the geothermal potential while accounting for the geospatial intersection of the grid infrastructure and land use characteristics. Geothermal Resources Council Transactions. Presented at the Geothermal Rising 2023. Geothermal Rising, Reno, NV, pp. 2564–2586.

Texas Groundwater Districts. https://www.twdb.texas.gov/groundwater/conservation_districts/. Accessed July 2025