Update on the UIC National Technical Workgroup Injection Induced Seismicity Project

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Background

- The UIC National Technical Workgroup (NTW)
  - Comprised of staff from each EPA Regional Office, HQ, and six members from state UIC programs
  - Forum to discuss, review and resolve UIC technical issues
  - Assistance in development of UIC technical guidances
  - NTW is not a policy or rule-making body

Background

- **NTW tasked to develop technical recommendations that UIC regulators may consider for managing or minimizing significant seismic events associated or with injection induced seismicity**

Background

- NTW formed a subgroup or working group to work on injection induced seismicity project
- R6 designated as lead
- Proposed project timeframe:
  - June to December 2011
- Limited project to Class II disposal wells
- Selected three case study areas:
  - Central Arkansas
  - North Texas
  - Braxton County, West Virginia

What are the project objectives?

- **Analyze existing technical reports, data and other relevant information on case studies, site characterization and reservoir behavior**
- **Answer the following questions related to injection induced seismicity:**
  1. **What parameters are most relevant for screening?**
  2. **What measurement tools or databases are available and useful for screening existing or proposed disposal well sites?**

Project objectives (continued)

3. What screening or monitoring approaches are considered the most practical and feasible for evaluating significant injection induced seismicity?
4. What lessons have been learned from evaluating the case histories?

What are the anticipated outputs?

- **Report that EPA can share with UIC Directors describing technical recommendations directed towards minimizing or managing injection induced seismicity**

Proposed elements of the report

1. **Compare parameters identified as most applicable to induced seismicity and to the technical parameters collected under current UIC regulations**
2. **Prepare a decision making model or flow chart**
   - **Incorporate answers to questions posed in the project objective**
3. **Summarize any lessons learned from the case studies**
4. **Recommended measurement or monitoring techniques for UIC Director consideration in areas identified as higher risk**
5. **Determine the applicability of the conclusions to other well classes**
6. **Define specific areas of research needed**

What's in the draft report?

- **Literature summary**
  - **Listing of historical and current scientific literature reviewed for the project**
- **Decision model**
- **Review of three case study areas**
  - **Summary of lessons learned**
- **Evaluation of petroleum reservoir engineering approach used on case study areas**
- **Several appendices with supplemental and supporting documentation**

Literature Summary

- **Extensive reference listing of articles compiled and reviewed**
  - **Many detailed case history studies, reservoir studies, and geophysical studies have been published**
- **Gap in the available literature sources**
  - **Practical multidisciplinary approach involving:**
    - **Geophysics**
    - **Geology**
    - **Petroleum engineering**
  - **Provide a holistic assessment**

Decision Model

- **Practical tools for consideration by UIC regulators**
- **Received several comments from the NTW on the decision model included in the draft report**

Case Studies

- **Case studies for the report included:**
  - **Central Arkansas**
  - **North Texas**
    - **Dallas-Fort Worth airport and Cleburne, Texas**
  - **Braxton County, West Virginia**
- **Summary of lessons learned included in the report**
- **Seismicity has not been conclusively linked to the disposal wells in all the case study areas**

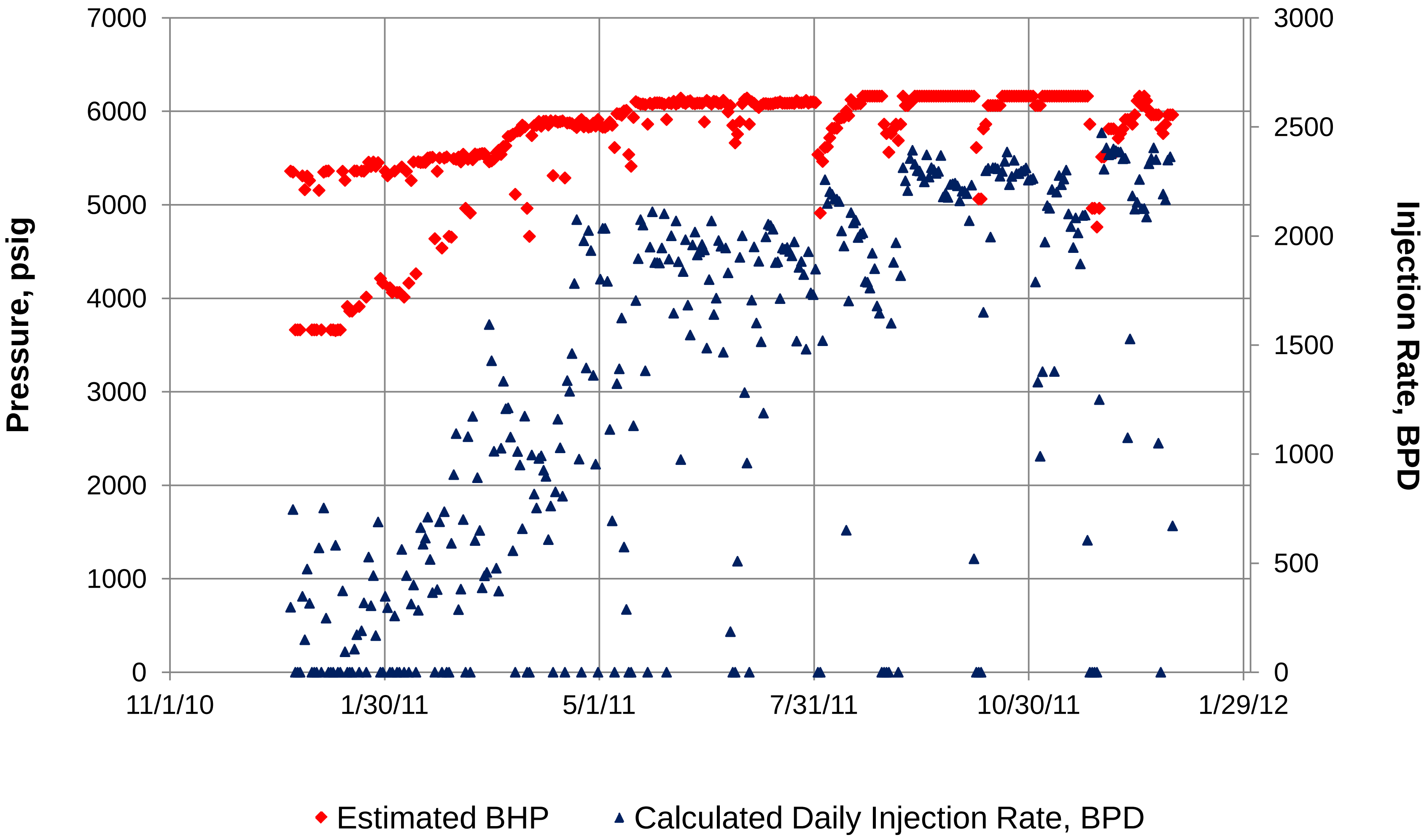
Reservoir Engineering Approaches

- **Apply industry & regulatory experience**
- **Review operational data submitted for permit compliance**
  - **Injection pressure**
  - **Injection volumes**
- **Analysis of operational injection data using reservoir engineering methods**
- **Pressure transient test analysis on available data**

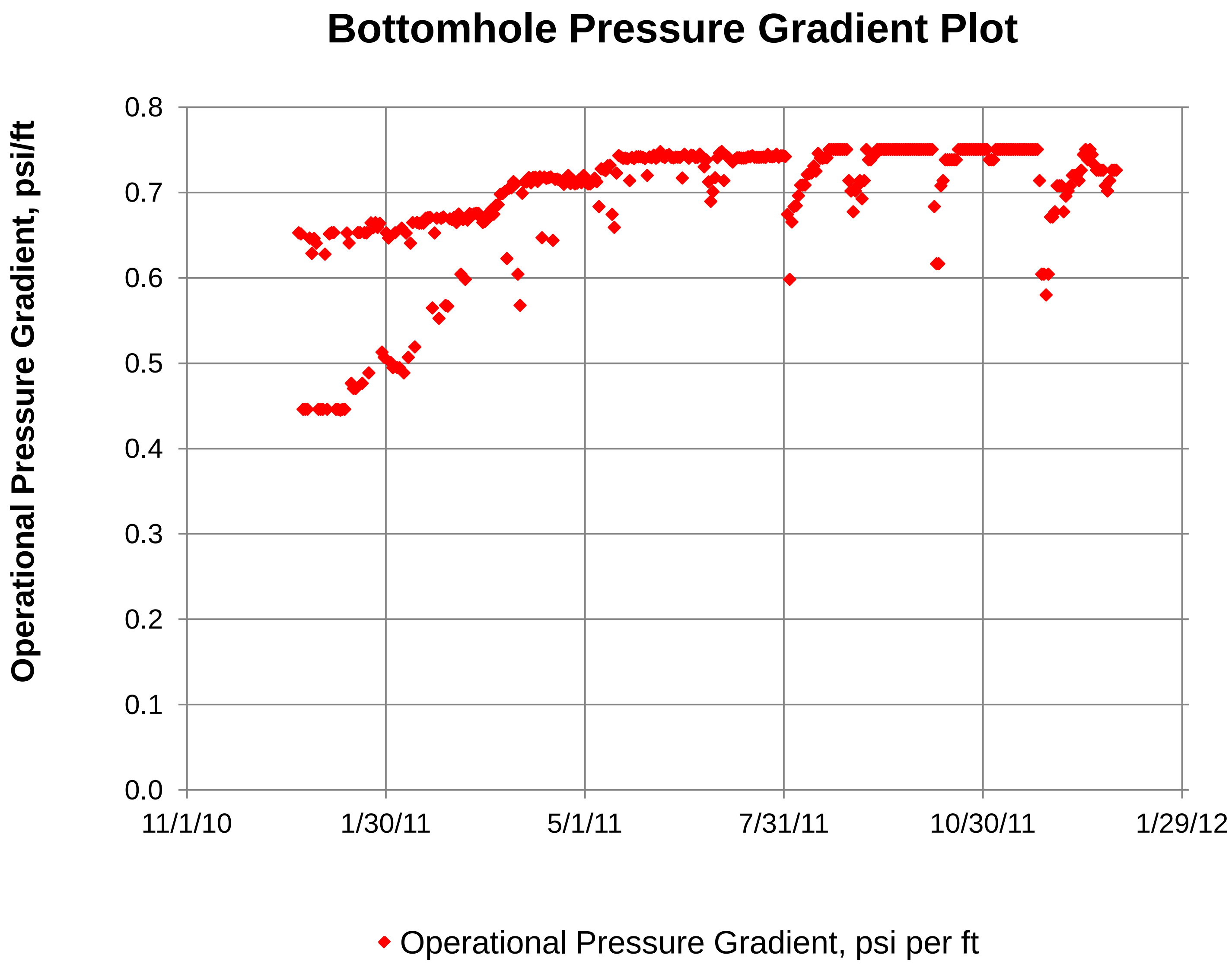
Reservoir Engineering Approaches

- Analysis of available operational data
  - Overview plot
  - Operational pressure gradient
  - Hall integral plot with derivative
  - Silin slope plot
  - Tandem plot that combined the Hall integral plot and area seismicity on the same plot
- Pressure transient analysis
  - Step rate tests
    - Injectivity test of each rate step
  - Pressure falloff tests

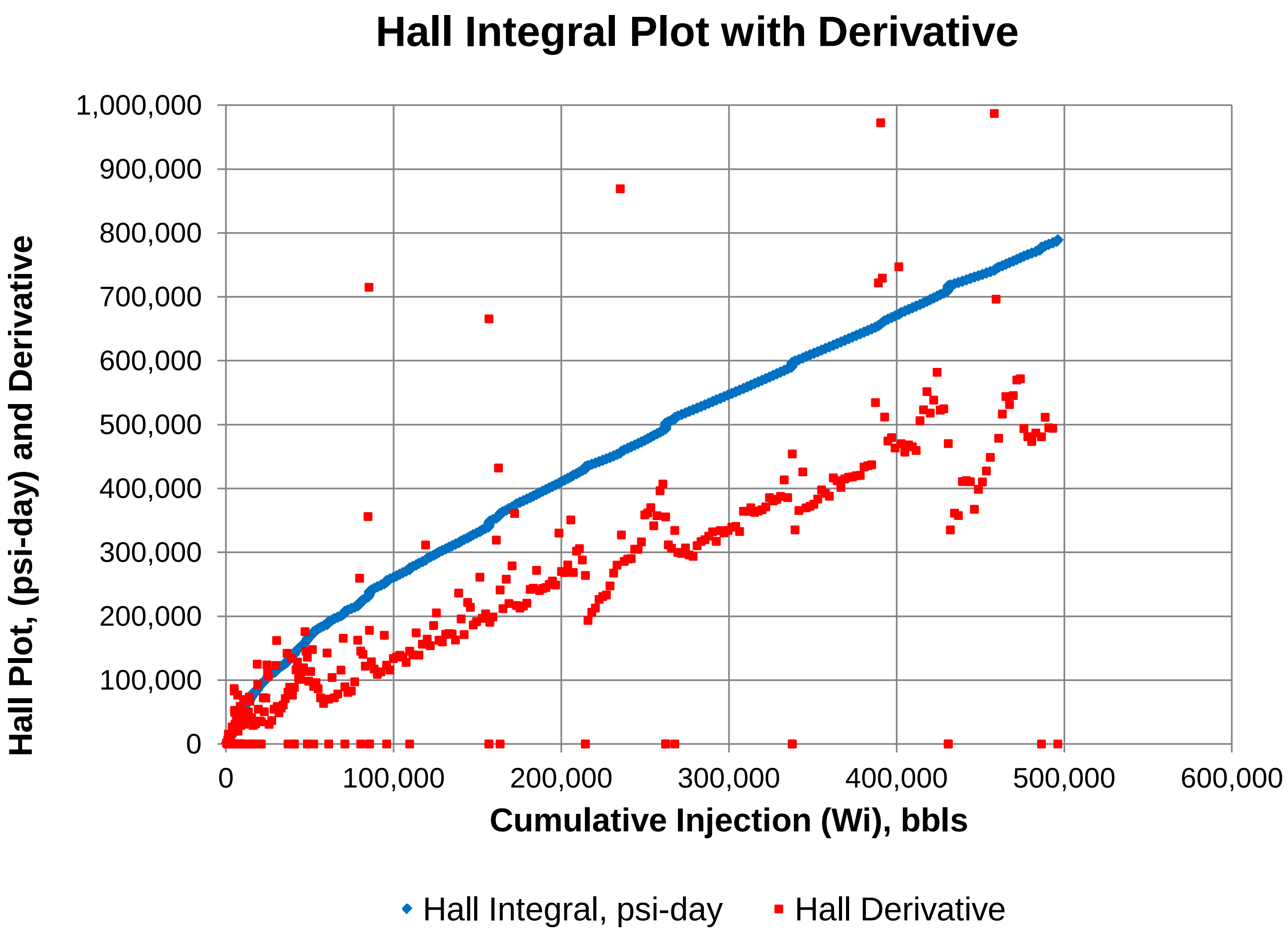
Example Operational Data Plot



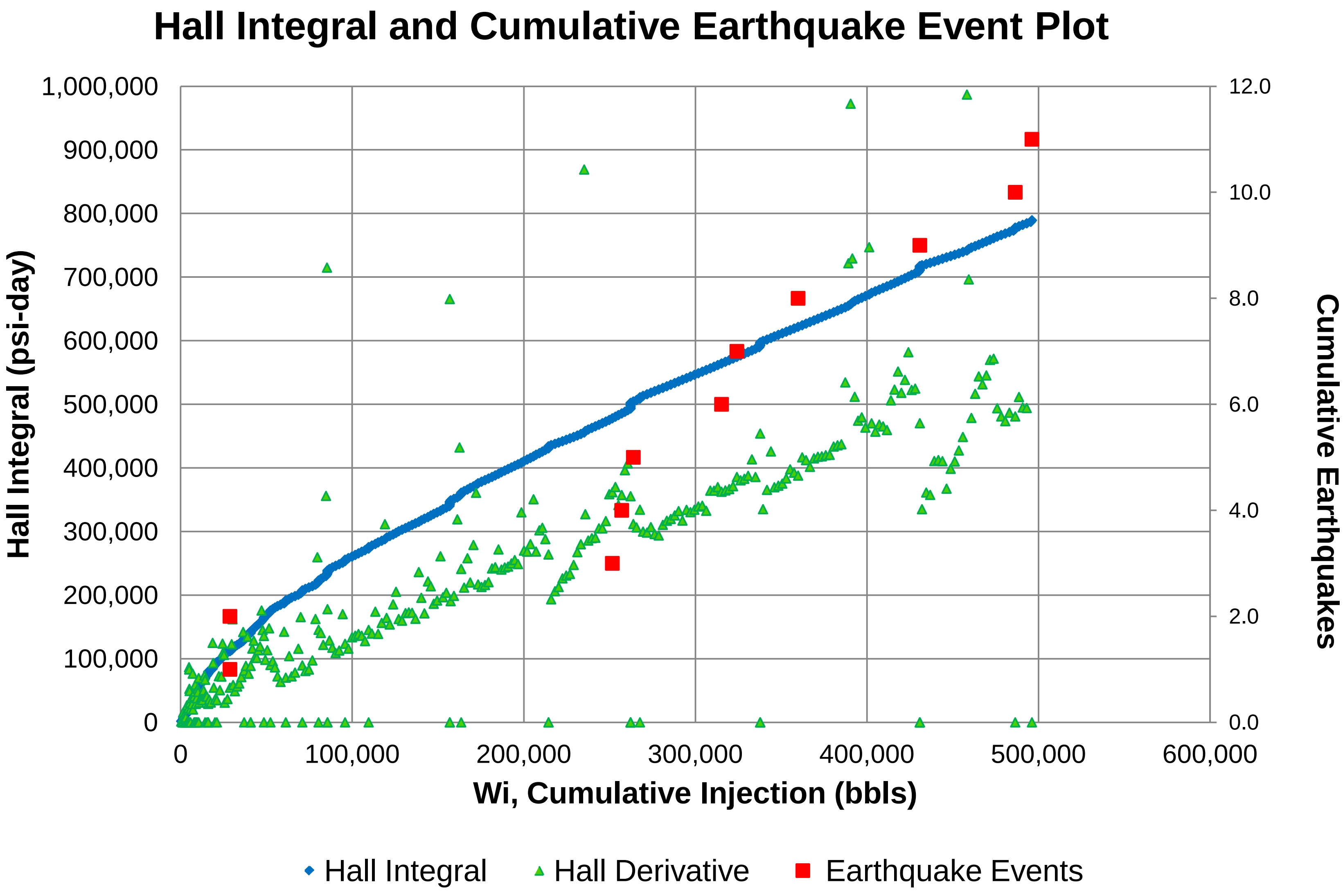
Example Pressure Gradient Plot



Example Hall Plot



Example Tandem Plot



Possible considerations

- **Review of region's historical seismicity**
  - May suggest the propensity for seismic activity
  - Results are typically dependent on the number of monitoring stations in the area
- **Review of the regional geology may help identify the potential for basement faults**
- **Compare the depth of the disposal zone to the basement rock**
  - Identify adjacent formations
- **Well completion**
  - Confirm if multiple formations are commingled

Possible considerations

- Identify the reservoir characteristics of the disposal zone
- Confirm the initial static bottomhole reservoir pressure
  - Suggest if the zone was initially underpressured or normally pressured prior to disposal
- Review of operational data using reservoir engineering approaches
  - Evaluate the reservoir pressure response observed at the well over time

Possible considerations

- **Consider pressure transient testing**
  - Step rate test can measured the formation fracture pressure or fracture extension pressure at the well
  - Falloff tests can indentify reservoir characteristics of the disposal zone and completion condition of the disposal well
- **Prompt response to any low level events**
  - May help minimize higher magnitude events
- **Increased monitoring**
- **Additional permit conditions**