

# The Lee Ranch Mine's Use Attainability Analysis for the San Isidro Arroyo and Its Tributaries

Peabody Natural Resource Company's Petition for Regulatory Changes

Jeffrey Olyphant  
Peabody Energy Company

Water Quality Control Commission Hearing  
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# Qualifications: Education & Experience

- Education
  - B.S. from Indiana University, Environmental Science, Minors in Geological Sciences
  - M.S. from Indiana University, Geological Science - Hydrogeology
- Work History:
  - April 2017-Present: Manager, Hydrology (Peabody Investment Corporation)
  - March 2012-July 2017: Hydrologist (Peabody Investment Corporation)
  - September 2010-February 2012: Geologist (ENVIRON International Corp.)
  - November 2009-August 2010: Field Hydrologist (Indiana Geologic Survey)

# Introduction:

## Regional Hydrology of the Lee Ranch Mine Area

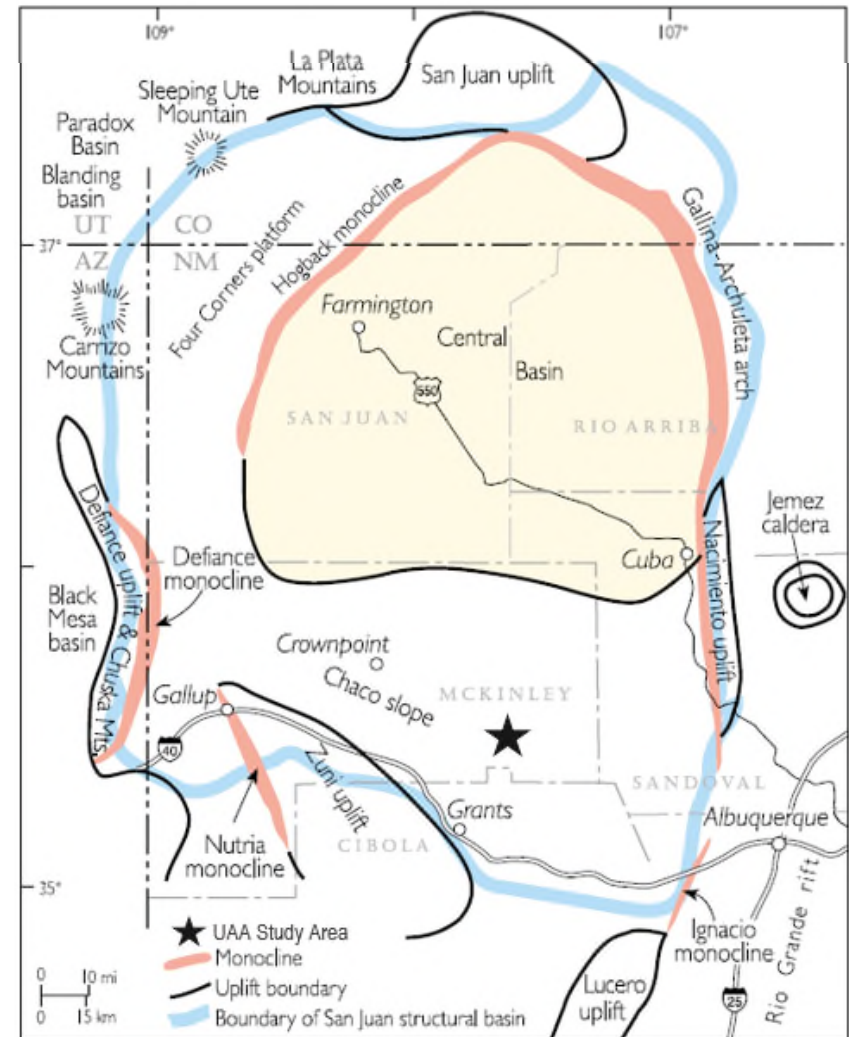
- San Juan Structural Basin
  - ~19,400 mi<sup>2</sup> in northwestern New Mexico, southern Colorado, northeast Arizona, southeast Utah
  - Climate – Semi-arid to arid
    - Annual Precipitation – ~8 - 30 inches
    - Annual Evaporation – 46 – 67.37 inches
  - Primary Surface Water Drainages
    - San Juan River (north) and Puerco River (south)
    - Rio Puerco (southeast)
  - Groundwater
    - Major Aquifers
      - Quaternary Valley Fill
      - Sandstones of the Tertiary and Mesozoic



Peabody Exhibit 14. Location of the San Juan Structural Basin (Craig, 2001)

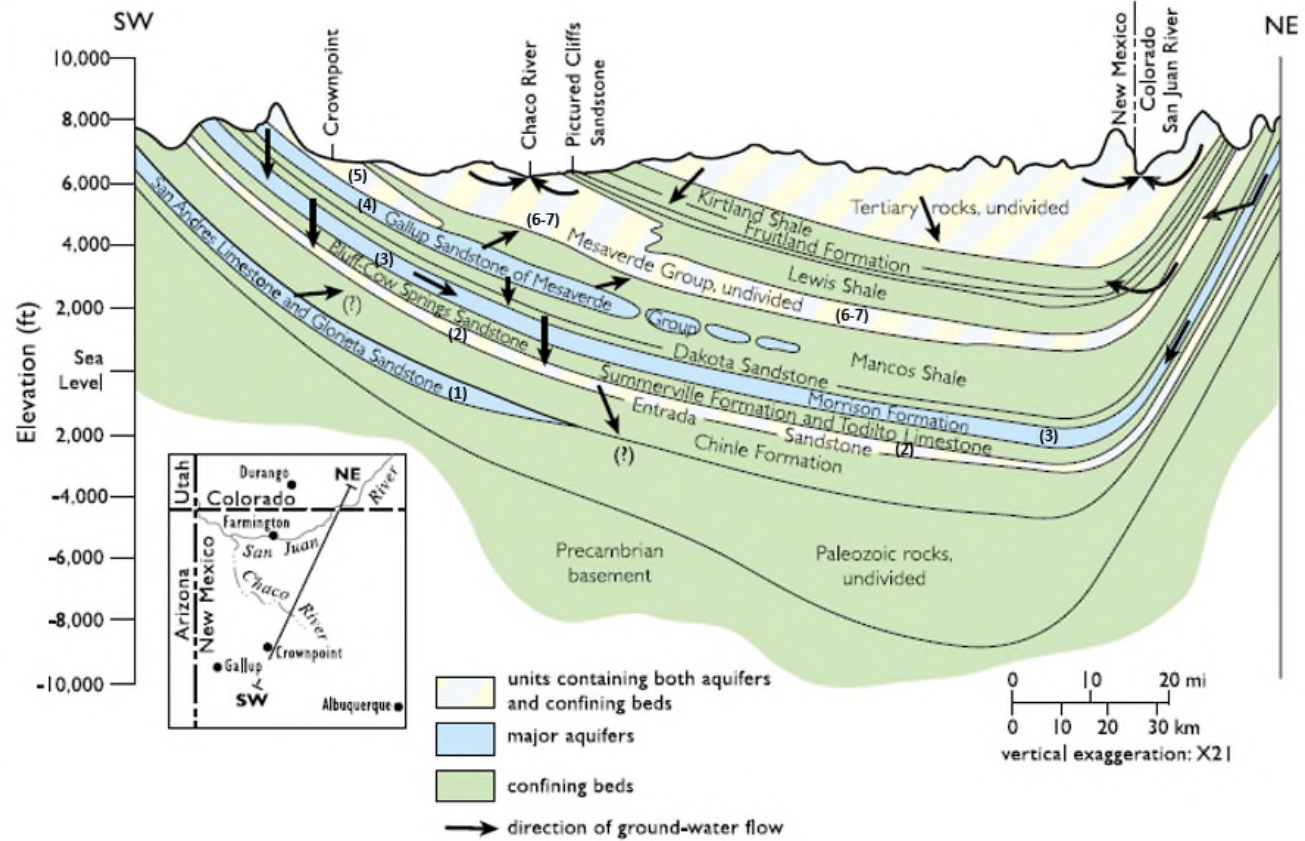
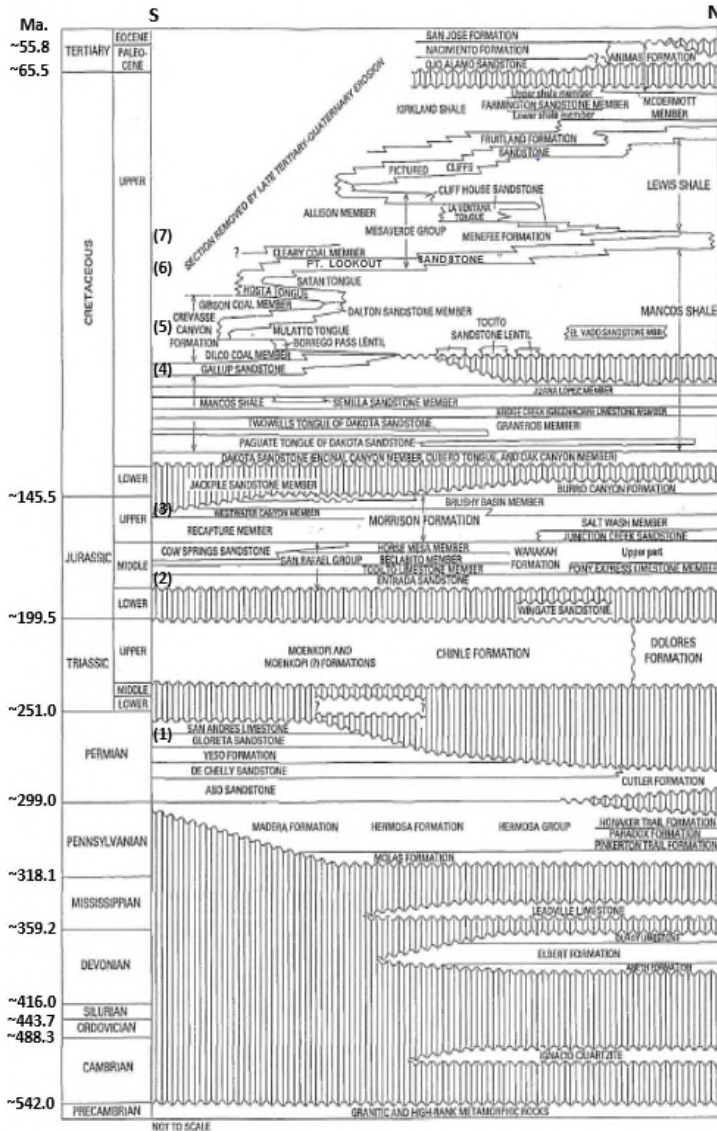
# Hydrogeology of San Juan Basin

- Geologic Controls on Groundwater
  - Basin Geologic Structure
  - Distribution and characteristics of permeable geologic materials (sandstones)
  - Regional Stratigraphy
  - Example
    - Topography – Implications for Recharge and Discharge areas
      - Structural Processes
      - Geomorphic Processes
- Structure of the San Juan Basin
  - Structural Features
    - Uplifts
    - Monoclines
    - Chaco Slope
    - Central Basin



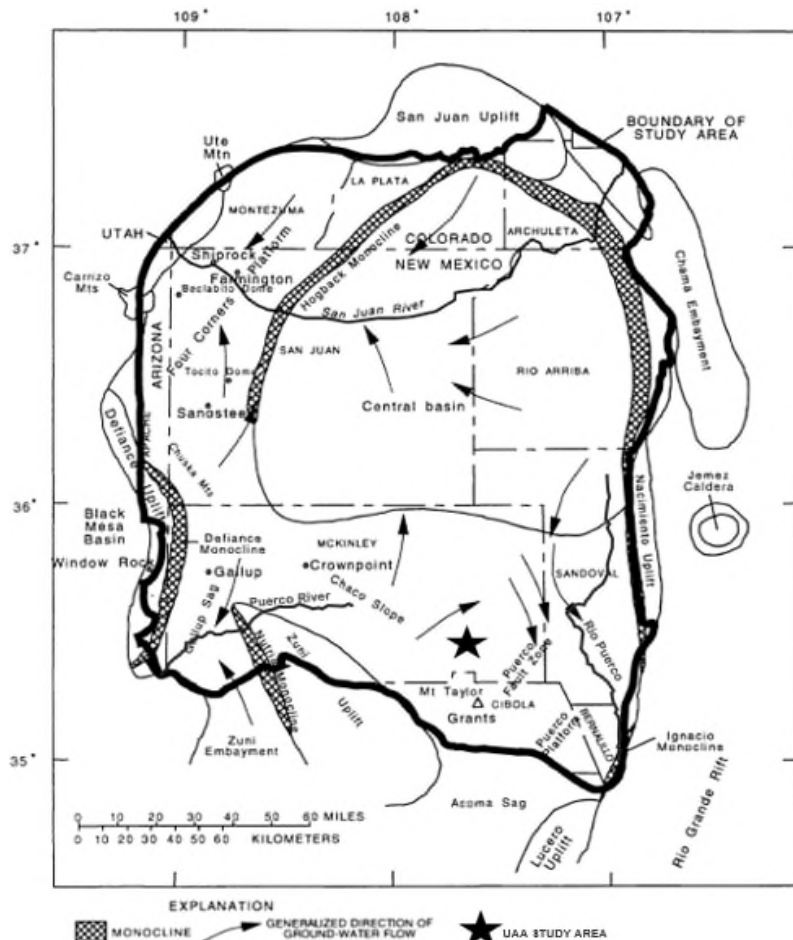
Peabody Exhibit 15. Structural Elements of the San Juan Structural Basin (Modified from Brister and Price 2002)

# Hydrogeology of San Juan Basin



**Peabody Exhibit 20.** Stratigraphic framework of the San Juan Basin from south to north (modified Craigg, 2001) and generalized southeast to northwest cross-section of the San Juan Basin (modified from Brister and Price, 2002).

# Groundwater Flow in the San Juan Basin



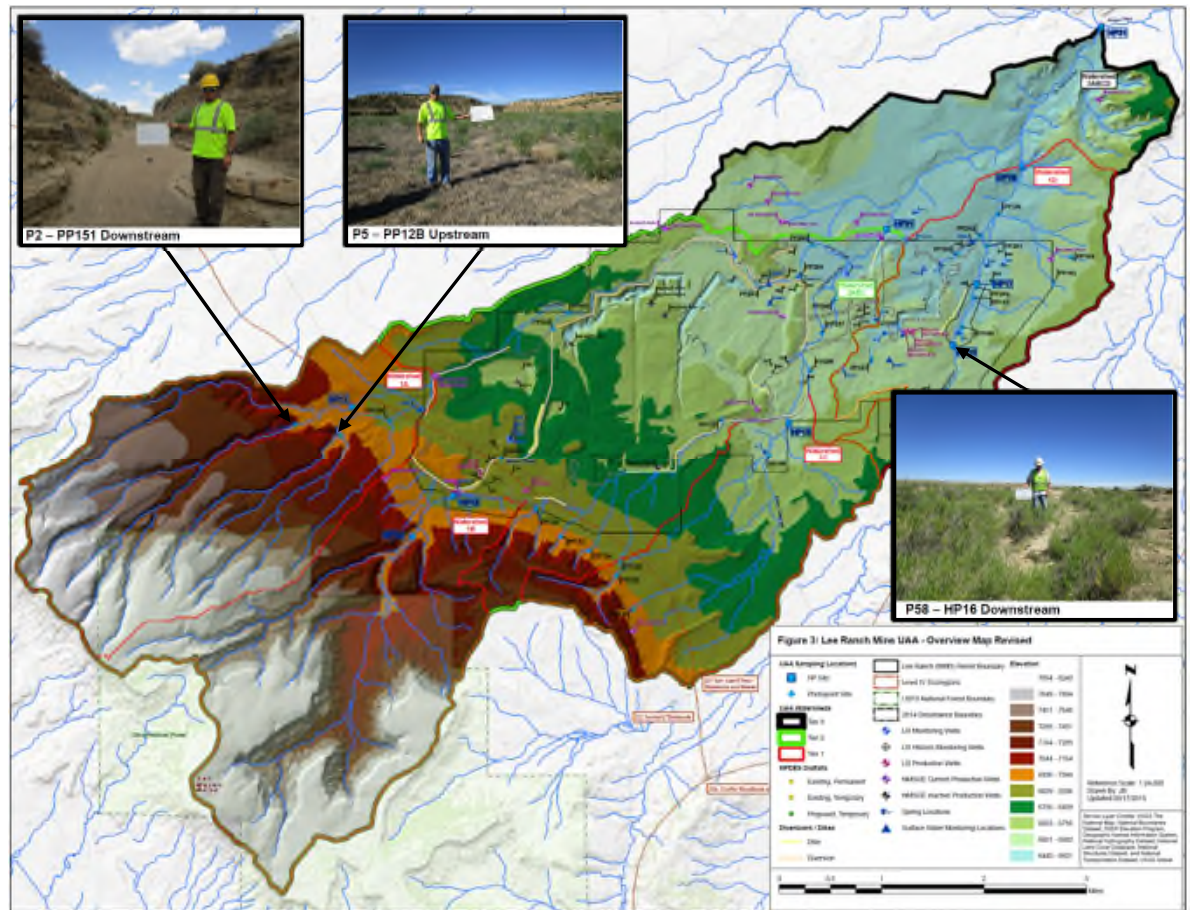
Peabody Exhibit 16. Structural elements of the San Juan Basin and generalized patterns of groundwater flow in Jurassic and Cretaceous age bedrock (modified from Dam, 1995)

- Groundwater flow is from recharge areas located at elevated Basin margins towards discharge areas along the lower reaches of the San Juan River (northwest), Puerco River drainage (southwest), and parts of the Rio Puerco (southeast).
- Springs and seeps in low parts of outcrops
- Artesian discharge from movement across confining units along fault planes and fractures
- Subsurface, inter-formational movement across low permeable units
- Wells – free flowing and pumped

# Introduction:

## Local Hydrology of the San Isidro Arroyo Watershed

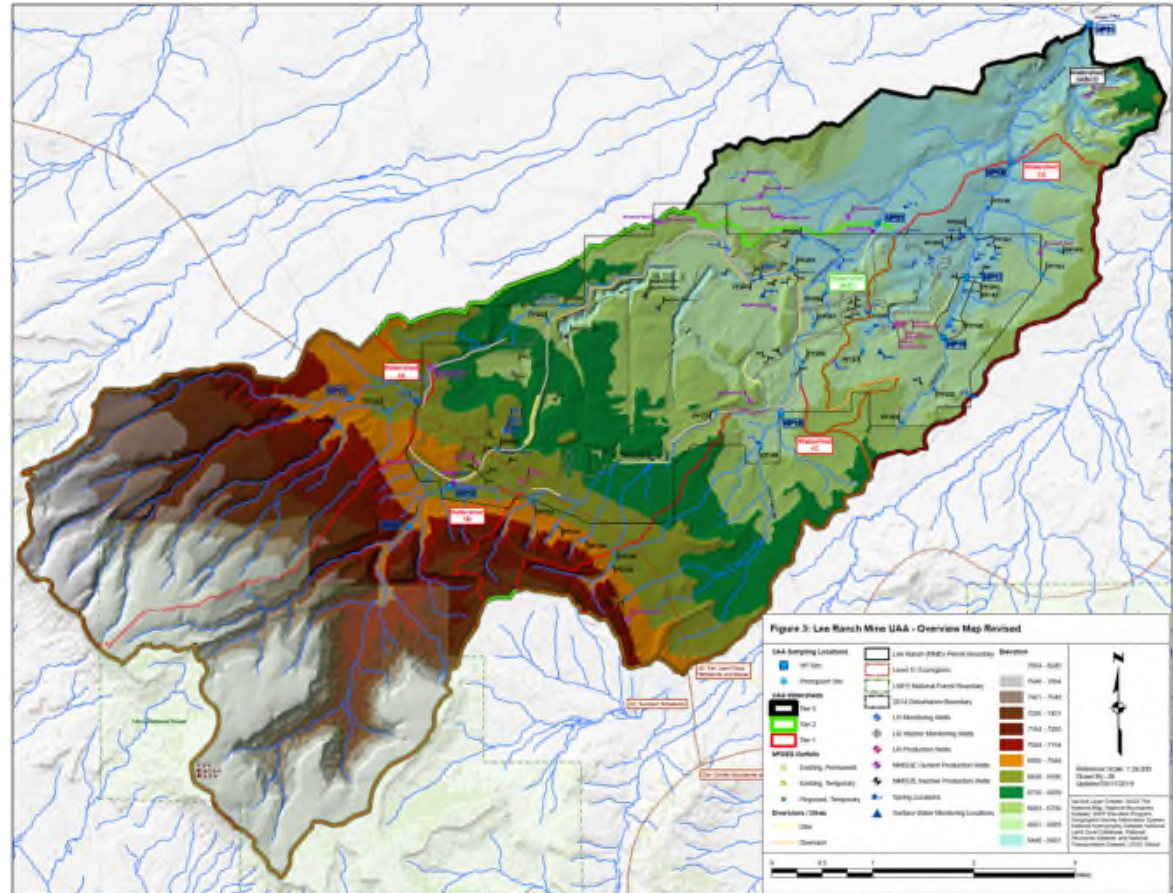
- Southern end of San Juan Basin, north of Mt. Taylor
- Bound by San Mateo Mesa (south)
- Drains northeast towards Arroyo Chico
- Elevation - 6,440 ft to 8,200 ft
- Headwaters originate in steep, deeply incised canyons which rapidly drop in elevation to rolling hills and broad, flat channels



Peabody Exhibit 7. Figure 3, UAA overview.

# Surface Water San Isidro Arroyo

- Climate
  - Average annual precipitation is ~10.5 inches
  - High evapotranspiration - moisture deficit is > 21 inches
  - Most rainfall occurs July - October
- Flow Events
  - Rapid peak, short duration (typically < 30 min)
  - LRM monitors flow in Arroyo Tinaja, Mulatto Canyon, and Doctor Arroyo for MMD Permit 19-2P
    - Single Stage Non-Automated Sediment samplers
    - Point locations checked monthly or following sizable rain events
    - Flow events that produce sufficient volumes of water for sample collection varies from 1-10 times per year (mean: 4 times per year)



Peabody Exhibit 7. Figure 3, UAA overview.



# USGS Gaging Station 08340500

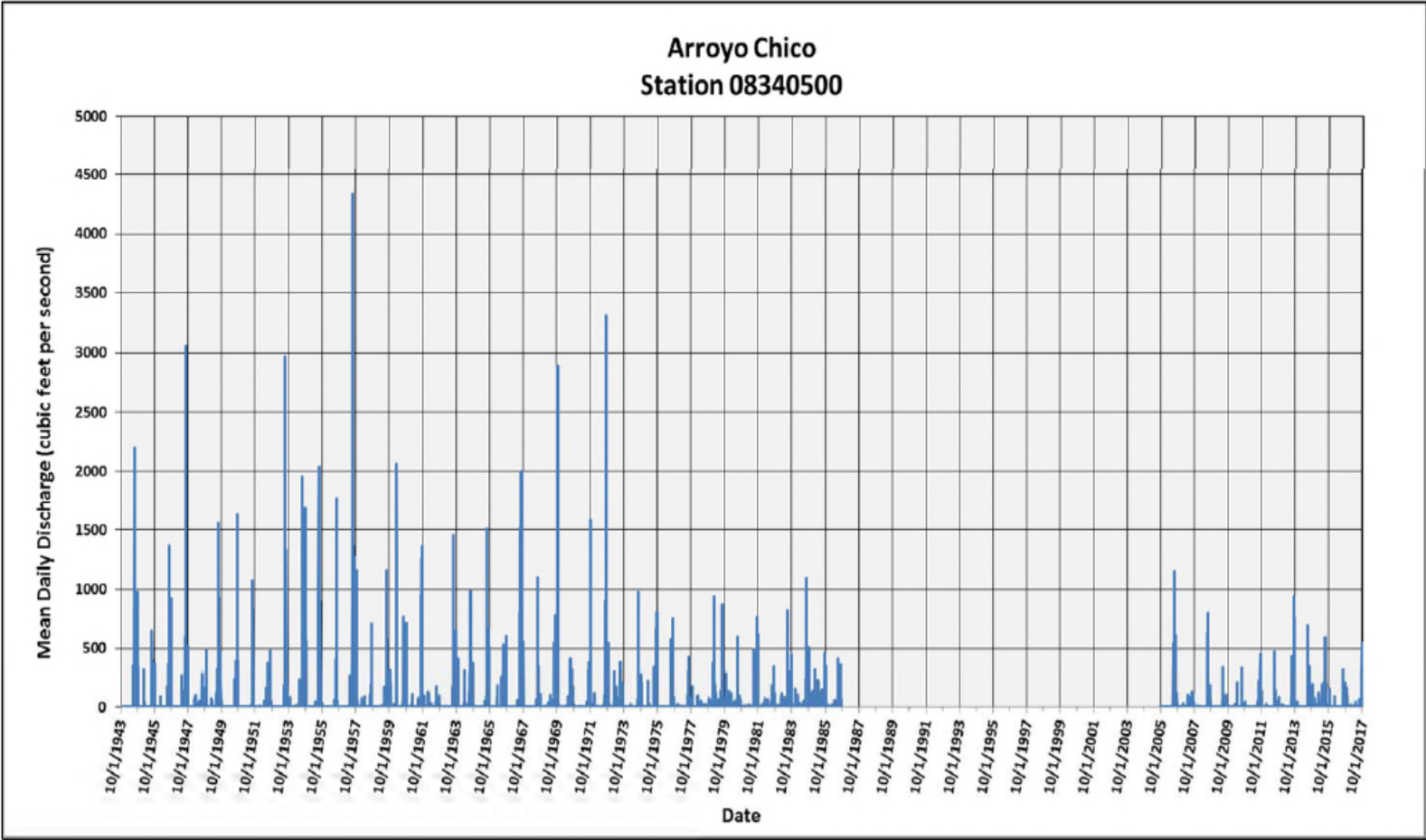
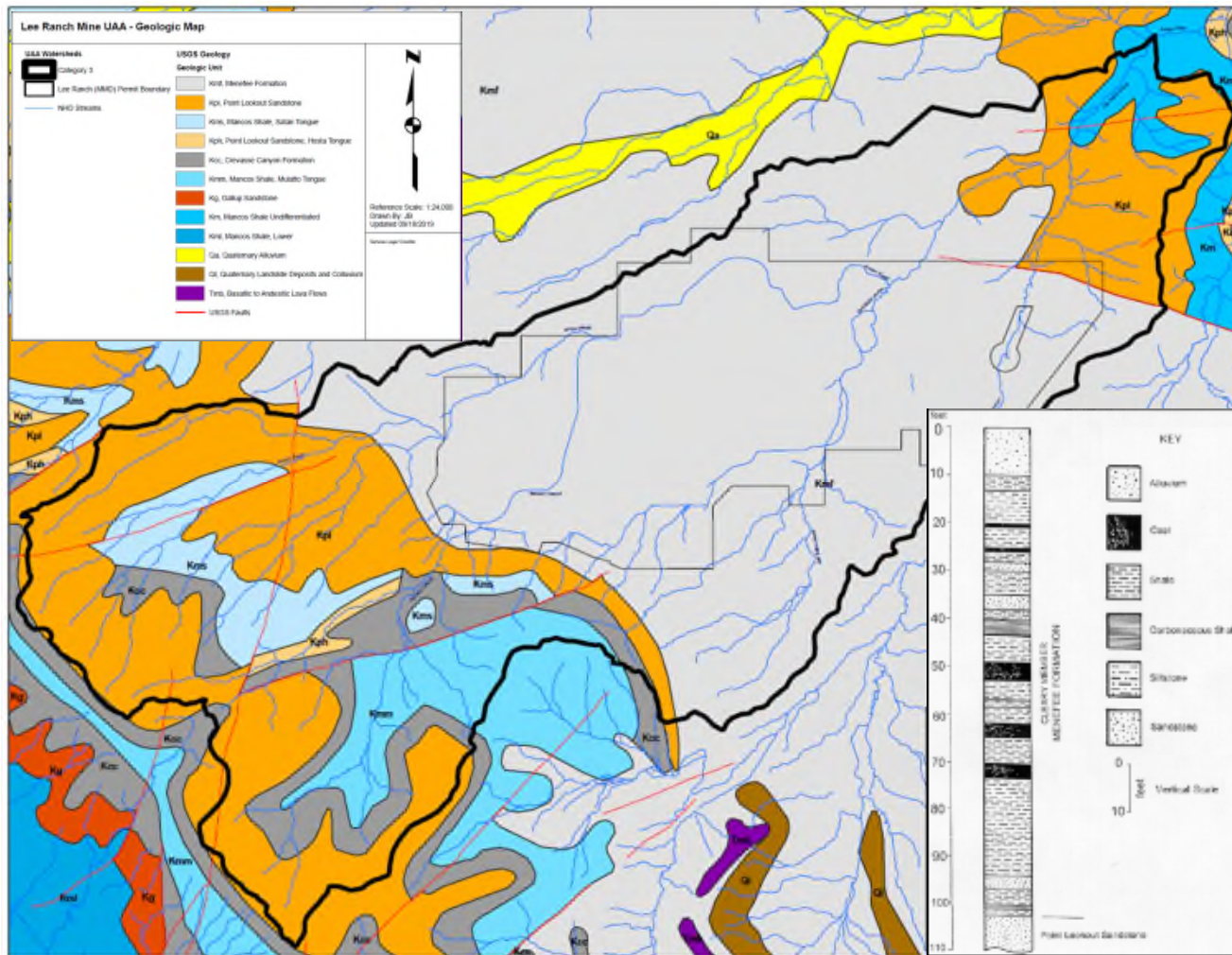


Exhibit \_\_\_\_. Mean daily discharge (cubic feet per second) at the USGS Arroyo Chico Gaging Station (08340500) located downstream of the San Isidro drainage basin.

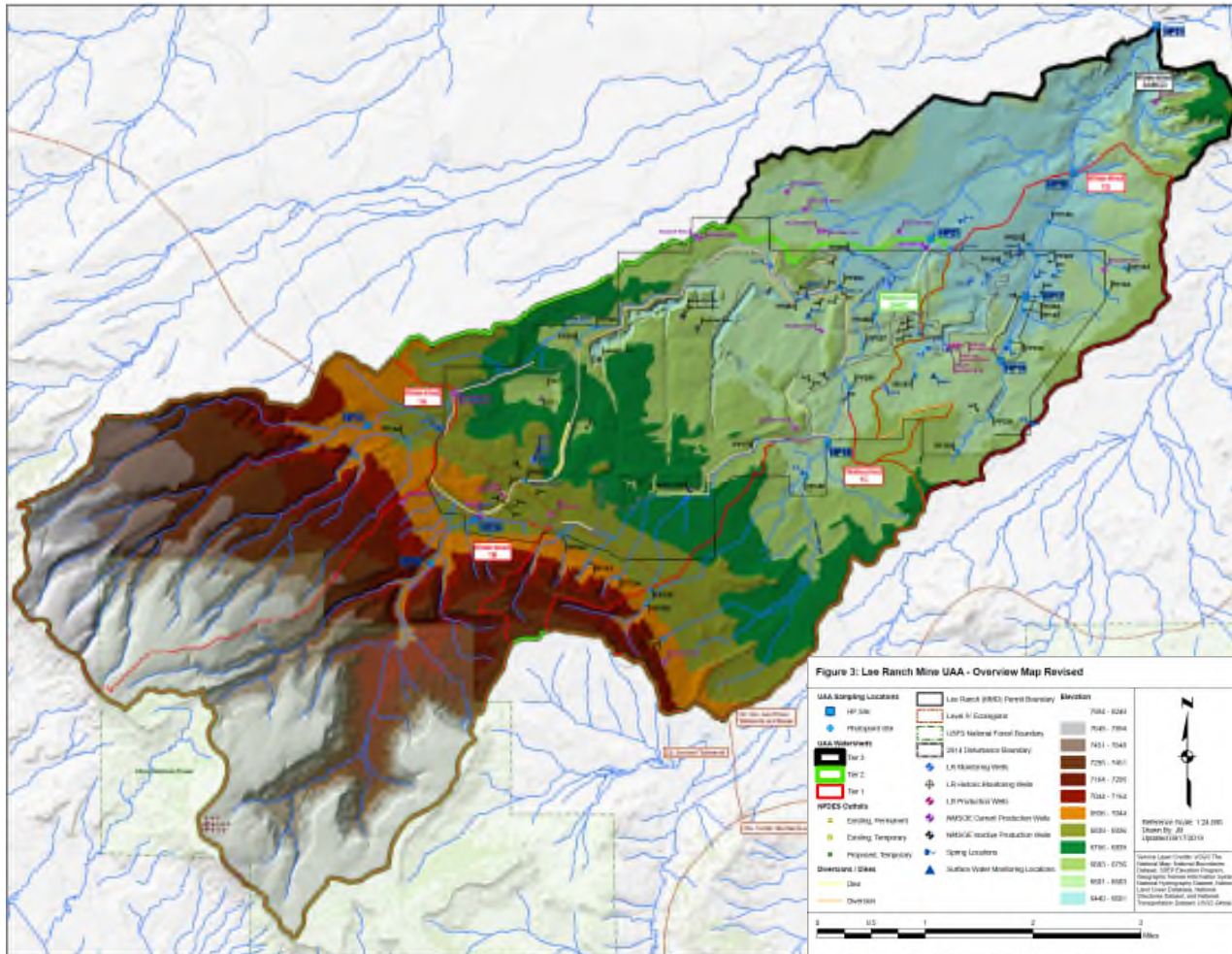
# Local Hydrogeology



Peabody Exhibit 18. Geologic Map of San Isidro Arroyo Study Area and Typical Geologic Column from LRM Permit Area

- Hydrogeologic Units of Importance
  - Clearly Coal Member of the Menefee Formation
  - Point Lookout Sandstone
  - Gallup Sandstone
- Structural Features
  - San Mateo Dome
  - San Miguel Creek Dome
  - Faults

# Local Hydrogeology



- Recharge Area
- Flow Direction
- Confined Hydrologic Conditions
- Discharge Areas
  - Springs
  - Diversion Wells
  - Mine void

Peabody Exhibit 7. Figure 3, UAA overview.

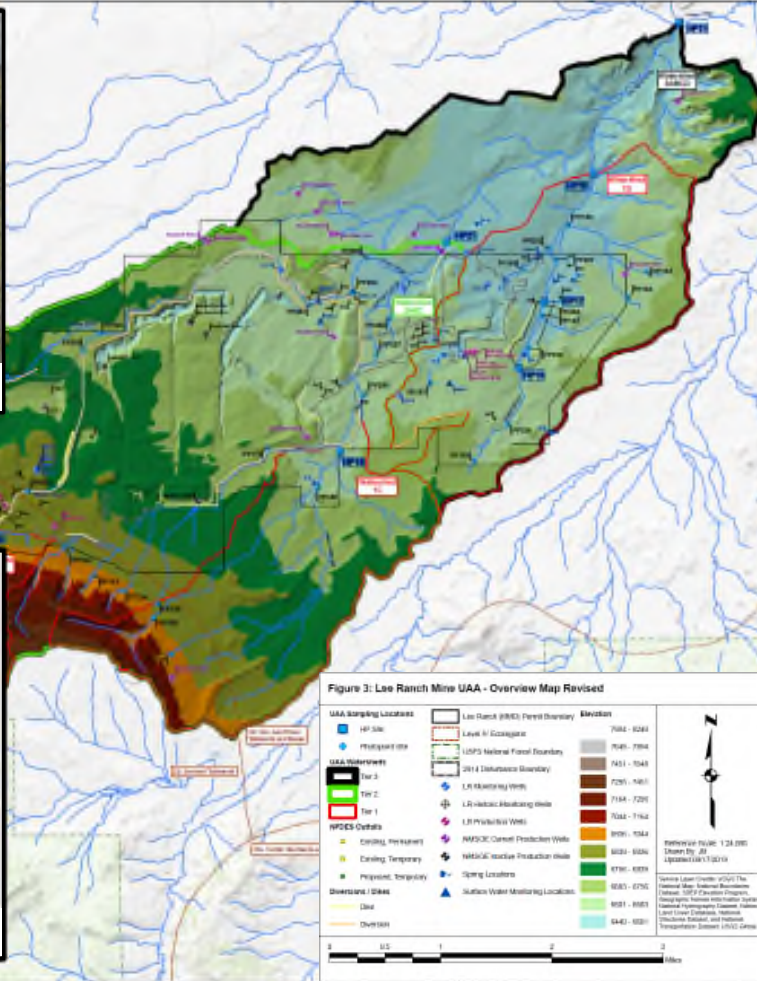
# Local Hydrogeology



S-3 Doctor Springs



PP160 – Doctor Arroyo downstream of S-3

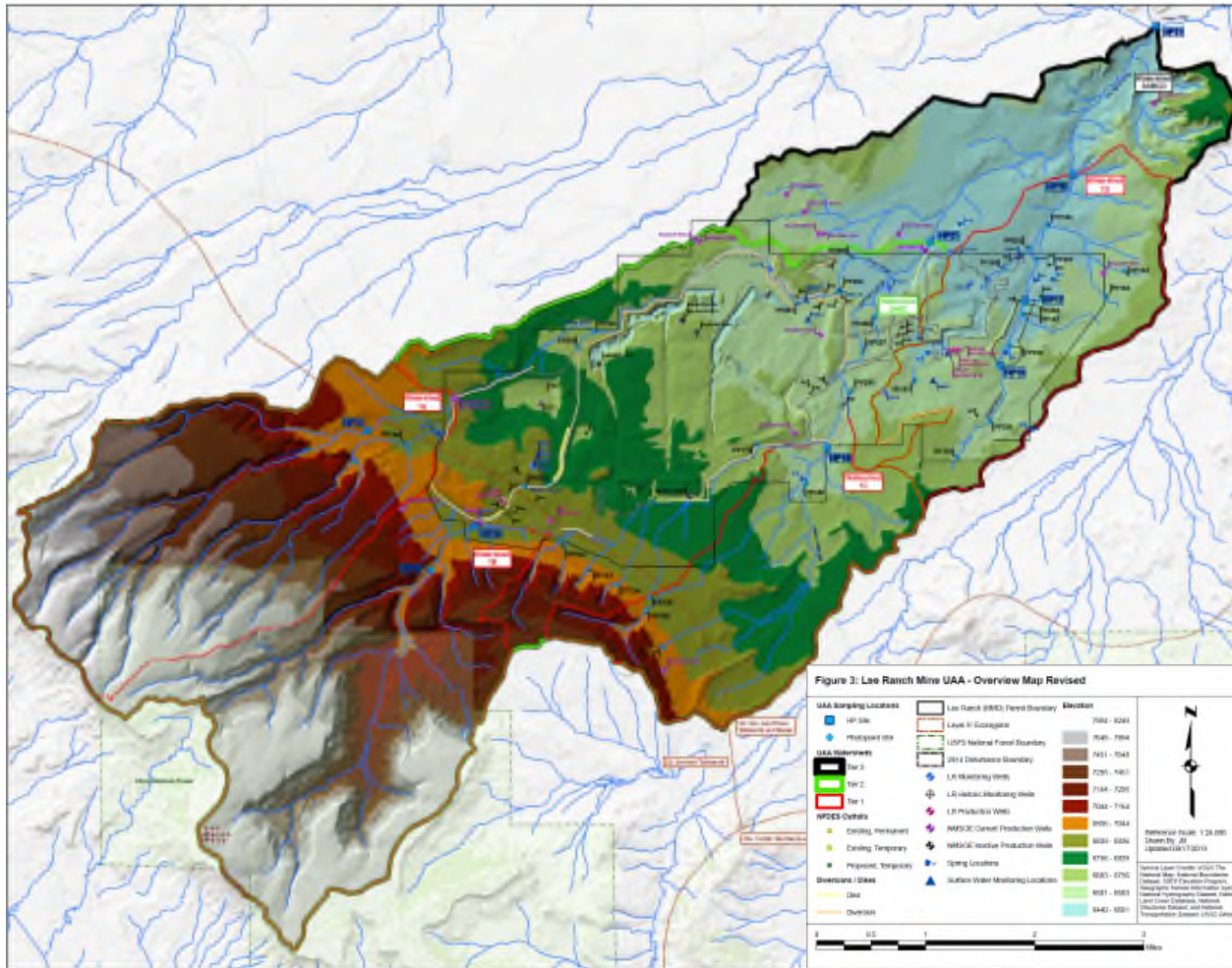


Peabody Exhibit 7. Figure 3, UAA overview.

## Discharge Areas

- Springs
  - General Flow Characterization
  - Doctor Spring (S-3)
  - Within LRM permit boundary (7)

# Local Hydrogeology



Peabody Exhibit 7. Figure 3, UAA overview.

## Discharge Areas

- Diversion Wells
  - 20 diversion wells
  - LRM Wells (5)
    - 3 – Menefee
    - 2 – Gallup Aquifer
  - Adjacent Landowner Wells (15)
    - 15 – Livestock Menefee or Point Lookout Sandstone
- Mine Void

# Local Hydrogeology

- Unconsolidated Quaternary Deposits
  - Alluvium, Colluvium, and Eolian Deposits
  - MMD Permit 19-2P Characterization
    - Thickness – 0 - 80 ft
    - No detectable water identified during LRM exploratory drilling
    - MW-4
      - Drilled in 1982 Prior to Mining
      - Total Depth: 52 ft
      - Did Not Produce Water
  - No unconsolidated diversion wells within study area

Thank you!