

# Upper He Creek hydraulic and hydrogeologic control solutions in east central Tennessee

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# engineering for success<sup>SM</sup>

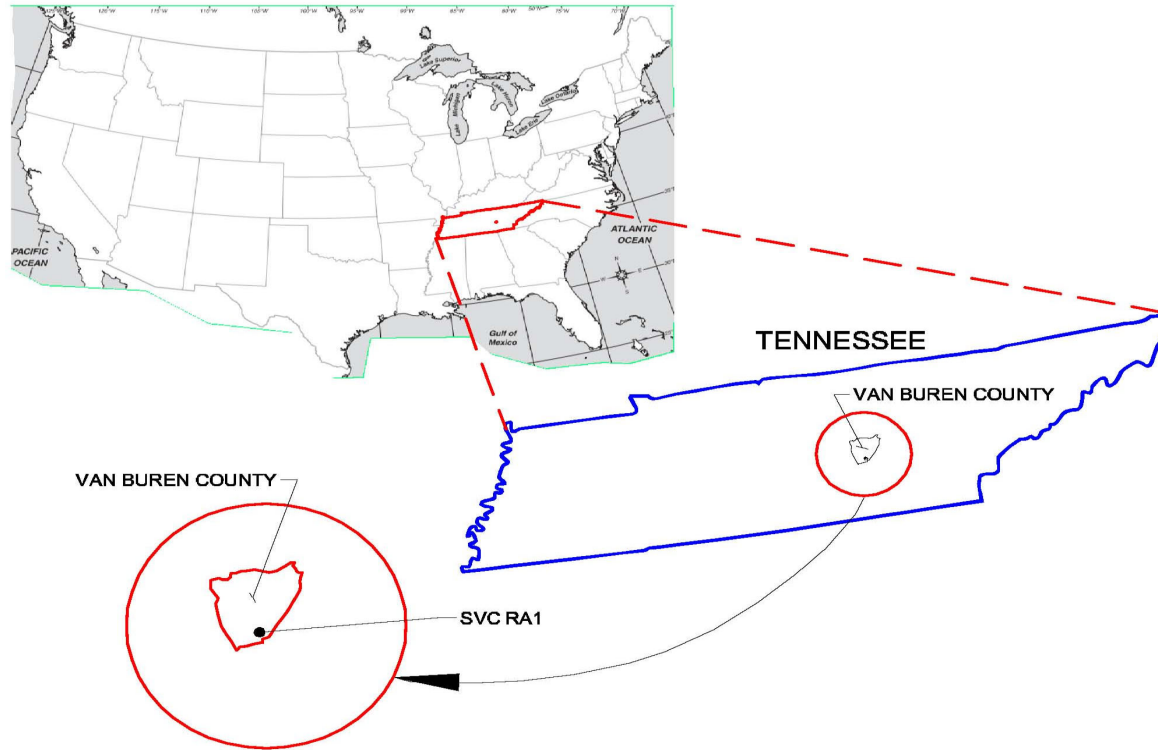
Philadelphia Region  
Appalachian Region



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# Project Location



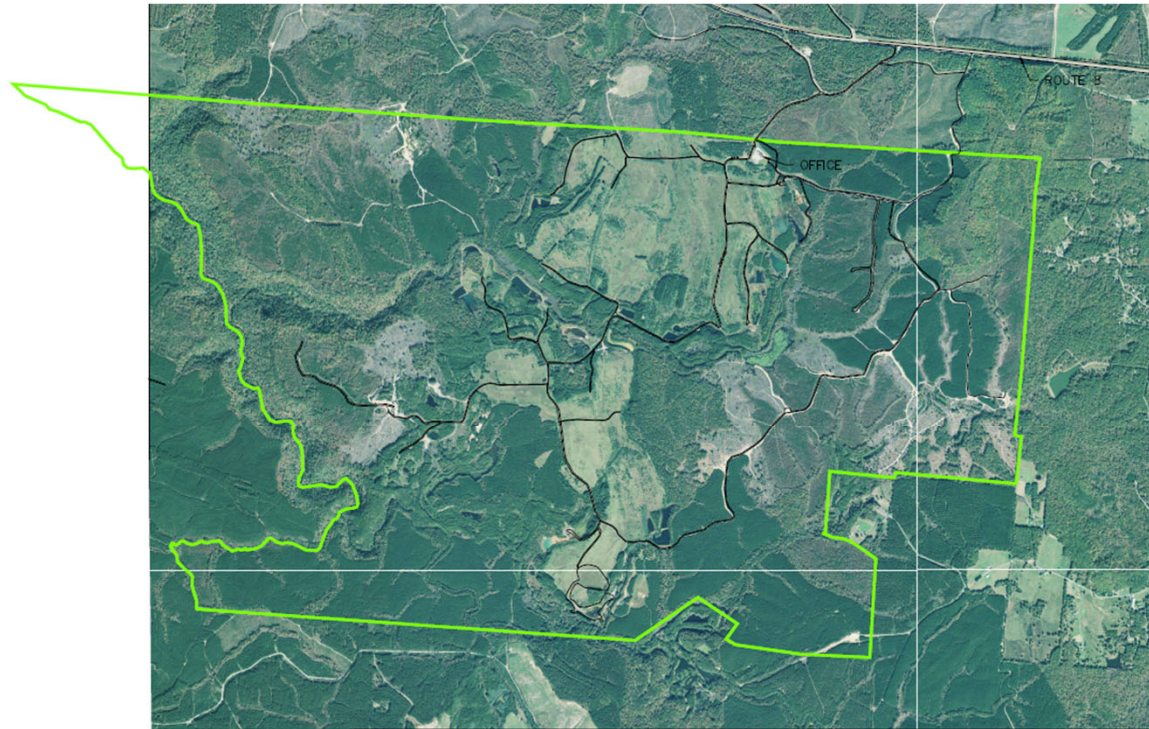
## Background

- **Sequatchie Valley Coal Corporation (SVC) Main Area**
- **1,000+ acre area dragline mine**
- **Owned by Navajo Transitional Energy Company (NTEC)**
- **Surface coal mine reclamation site since 1992**
- **Primarily pumping to control GW with active treatment**
- **Discharges to Upper He Creek**





# Navajo Transitional Energy Company Sequatchie Valley Coal Corporation (SVC)



**LEGEND**

- PROPERTY BOUNDARY
- ACCESS ROADS

SHEET NO.

1



HEADQUARTERS  
PHILADELPHIA REGION  
P.O. Box 488  
19320 Center Road  
Philadelphia, PA 19107

APPALACHIAN  
REGIONAL OFFICE  
P.O. Box 784  
4020 Courline Farm Drive  
Hugoton, WV 26025

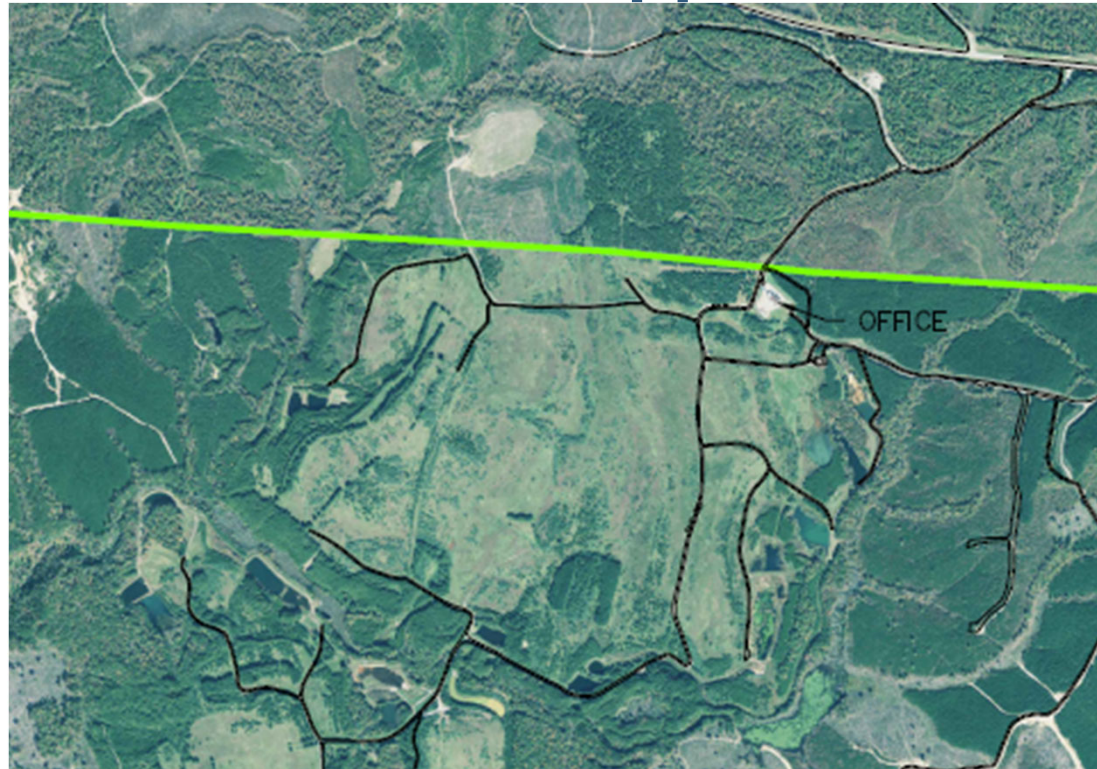
DRAWN BY: H.S.  
DATE: 4/15/2022  
DRAWING SCALE: 1"=2500'

CHECKED BY: TWS  
PROJECT NO: 4

STOP SITE  
ACCESS ROADS

FACILITY STOP SITES  
SVC  
SEQUATCHIE VALLEY COAL CORPORATION  
SEQUATCHIE COUNTY

# Navajo Transitional Energy Company SVC Main Area – Upper He Creek



# Water Management Evaluation Goals

- Define source and quantity of water exposed to acid bearing minerals
- Determine how water moves through the site
- Provide insight regarding how to
  - reduce water infiltration
  - improve treatment success
  - manage groundwater levels
- Provide a tool to measure costs versus benefits



# Watershed Drainage Areas

- **Big He Creek (1,310 acres)**
  - 640 acres from permit areas + 670 acres from other areas
- **Little He Creek (1,050 acres)**
  - 400 acres from permit areas + 650 acres from other areas
- **He Creek (2,750 acres)**
  - 1085 acres from permit areas (40%) + 1665 acres from other areas
- **Other areas include abandoned mined land and forest**



# Water Balance Parameters

- **Precipitation**
- **Surface Runoff**
- **Evapotranspiration (ET)**
- **Infiltration**
- **Pumping Withdrawals**
- **Change in Groundwater Storage**
- **Groundwater Inflow**



# Monitoring Stations

- **1 Weather Station (Precipitation)**
- **7 Surface Water Flow Stations**
  - **3 stream flow stations**
  - **3 pump flow stations**
  - **1 gravity flow discharge station**
- **5 Groundwater Level Stations**
- **1 Evapotranspiration Lysimeter**
- **Monitored 3/15/12 – 10/11/12 (10 min intervals)**





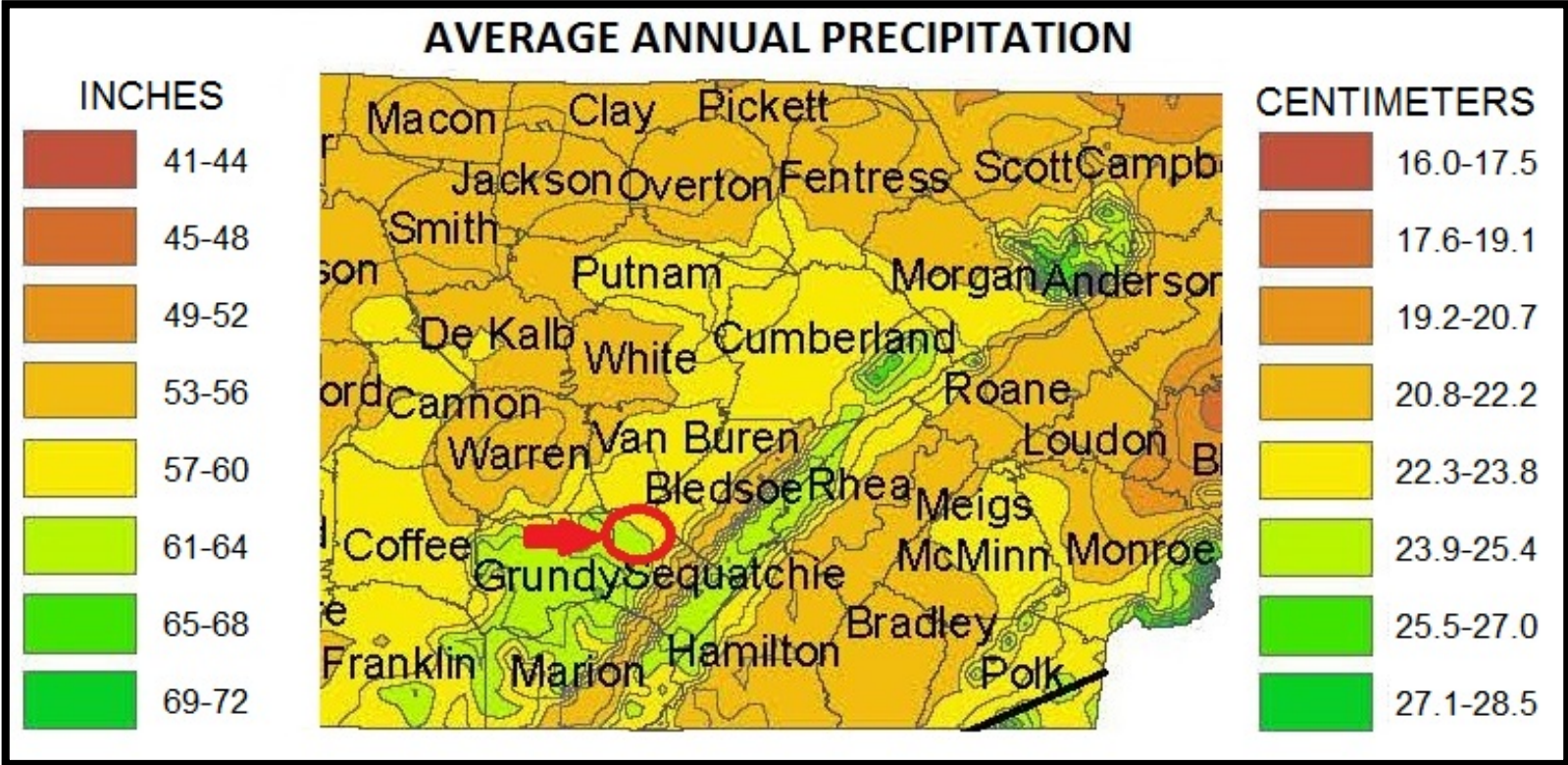
# Weather Station



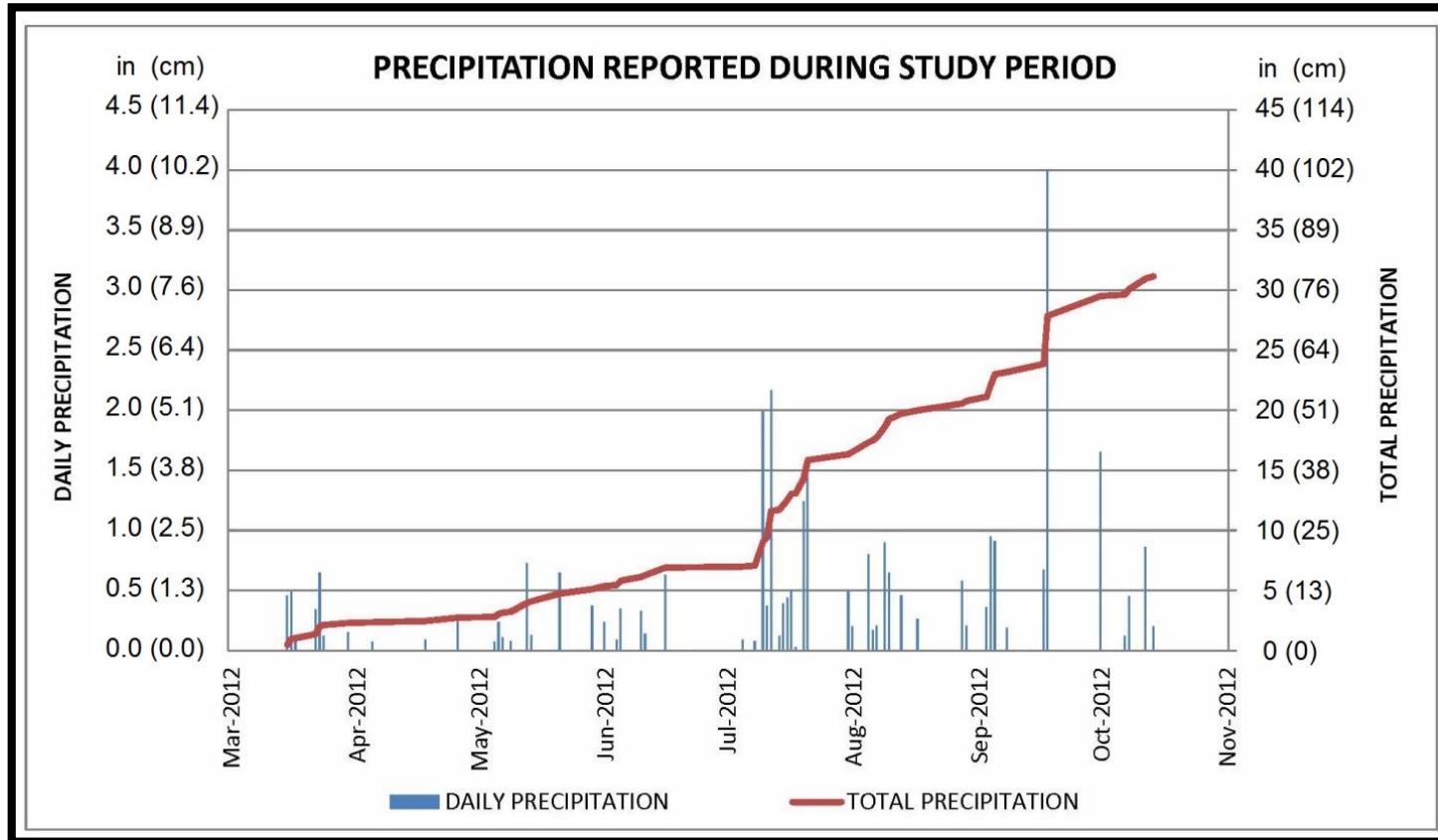


# AVERAGE PRECIPITATION

(Source: University of Tennessee, Institute of Agriculture)



# Precipitation Summary From Weather Station

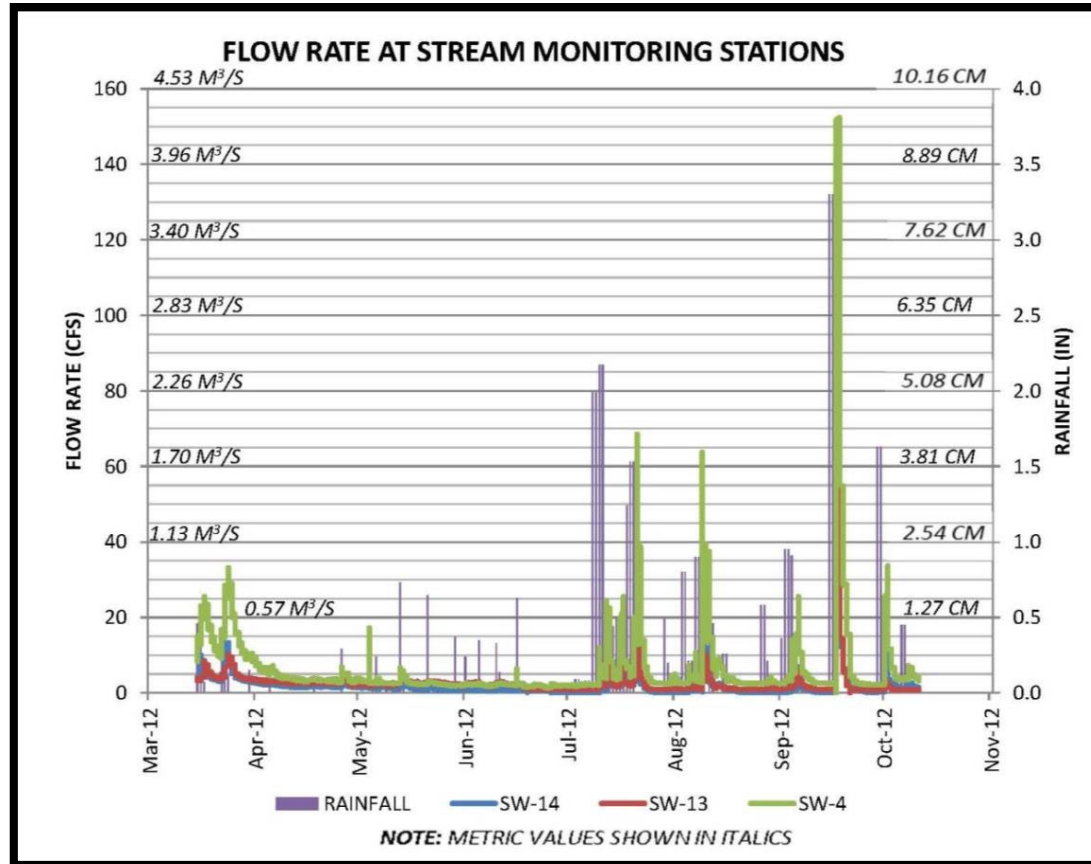


## Example - Big He Creek Monitoring Station





# Stream Flow Gauge Rates Summary

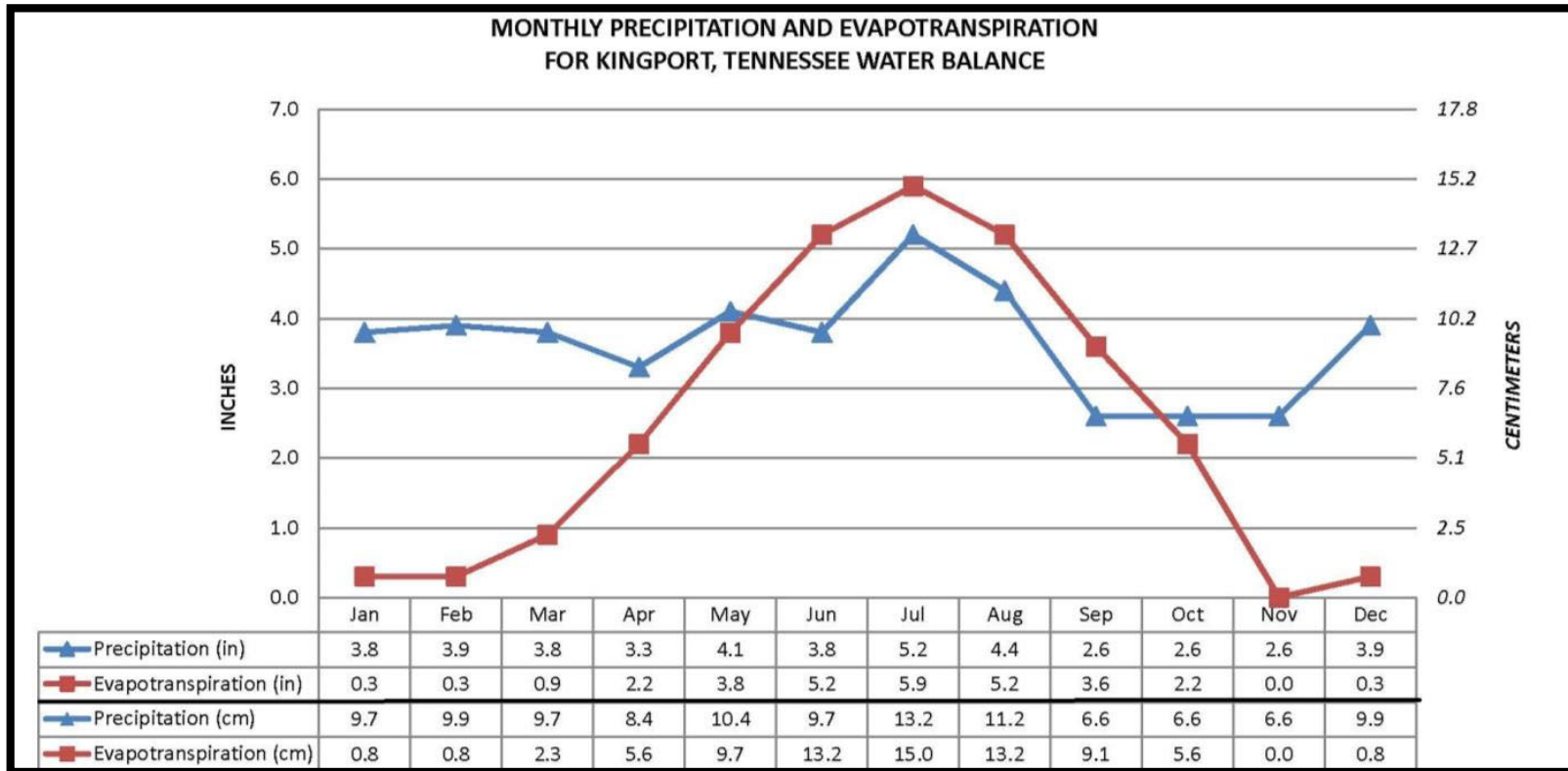


# Stream Runoff %

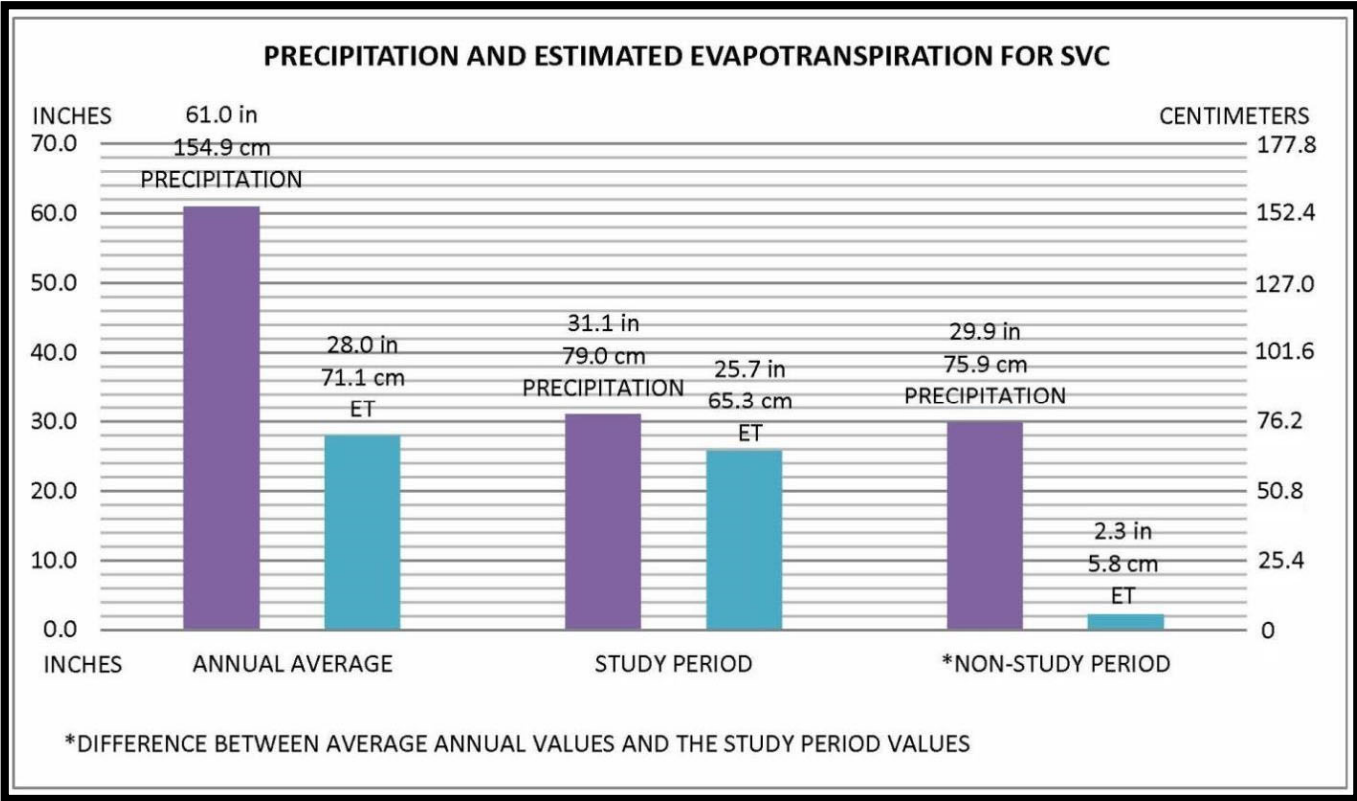
**TABLE 3  
PRECIPITATION AND RUNOFF FROM ALL DRAINAGE SHEDS  
DURING THE STUDY PERIOD IN INCHES**

	STUDY PERIOD (210 DAYS MID-MARCH THROUGH MID-OCTOBER)		
	BIG HE CREEK (SW-13)	LITTLE HE CREEK (SW-14)	HE CREEK (SW-4)
Precipitation [in (cm)]	31.1 (79.0)	31.1 (79.0)	31.1 (79.0)
Runoff [in (cm)]	6.5 (16.5)	8.3 (21.0)	8.5 (21.5)
Recharge + ET [in (cm)]	24.6 (62.6)	22.8 (58.0)	22.7 (57.6)
<i>Runoff (%)</i>	<i>20.8%</i>	<i>26.6%</i>	<i>27.2%</i>
<i>Recharge + ET (%)</i>	<i>79.2%</i>	<i>73.4%</i>	<i>72.8%</i>

# Evapotranspiration



# PRECIPITATION AND ET



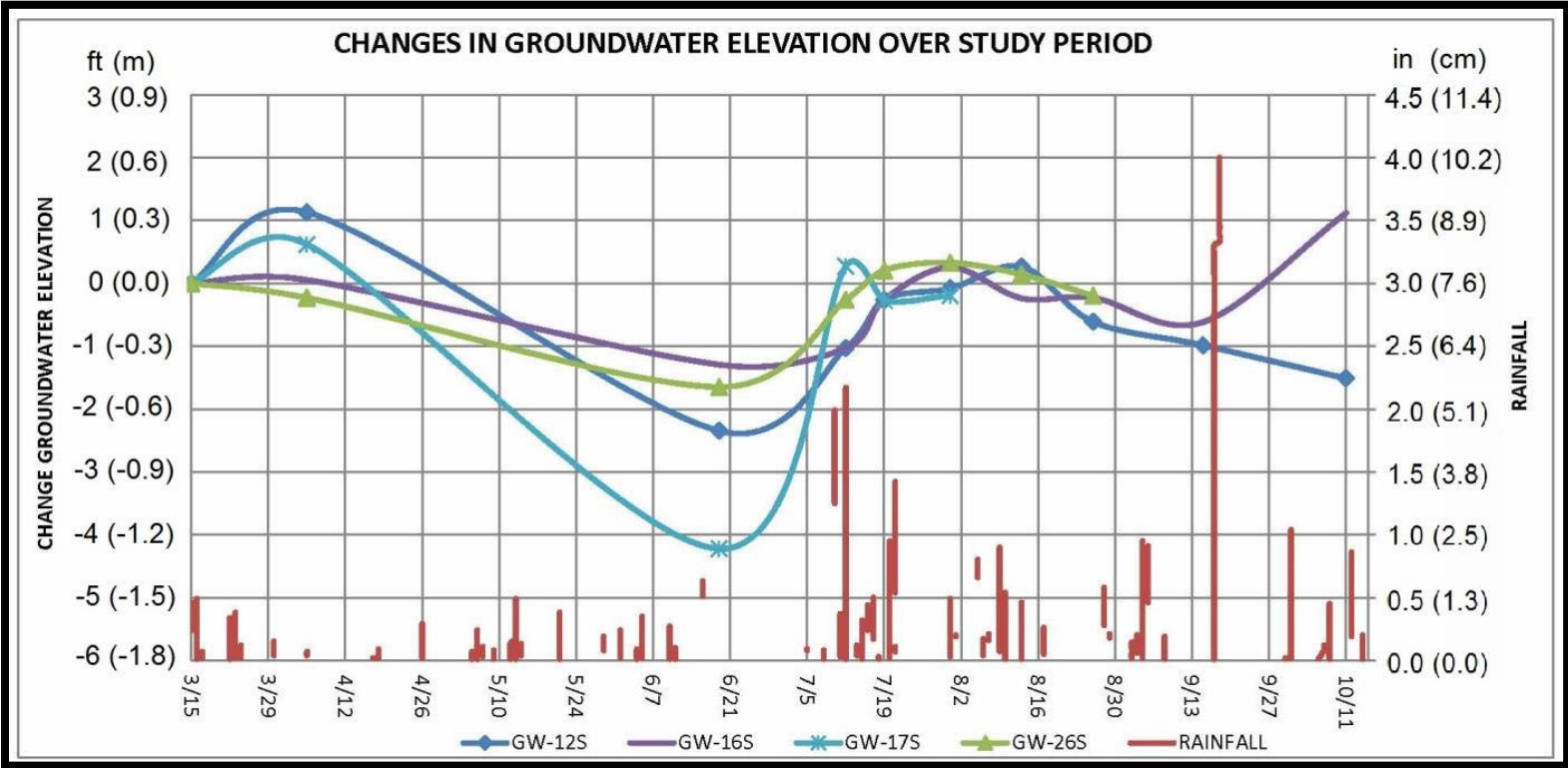


# INFILTRATION

**TABLE 6**  
**AVERAGE ANNUAL ESTIMATED INFILTRATION**  
**(Recharge + ET) – ET = Infiltration Recharge**

	<b>BIG HE CREEK (SW-13)</b>	<b>LITTLE HE CREEK (SW-14)</b>	<b>HE CREEK (SW-4)</b>
Recharge + ET [in (cm)]	48.3 (122.7)	44.8 (113.7)	44.4 (112.8)
ET [in (cm)]	28.0 (71.1)	28.0 (71.1)	28.0 (71.1)
<b>Infiltration Recharge [in (cm)]</b>	<b>20.3 (51.5)</b>	<b>16.8 (42.6)</b>	<b>16.4 (41.7)</b>

# Groundwater Monitoring

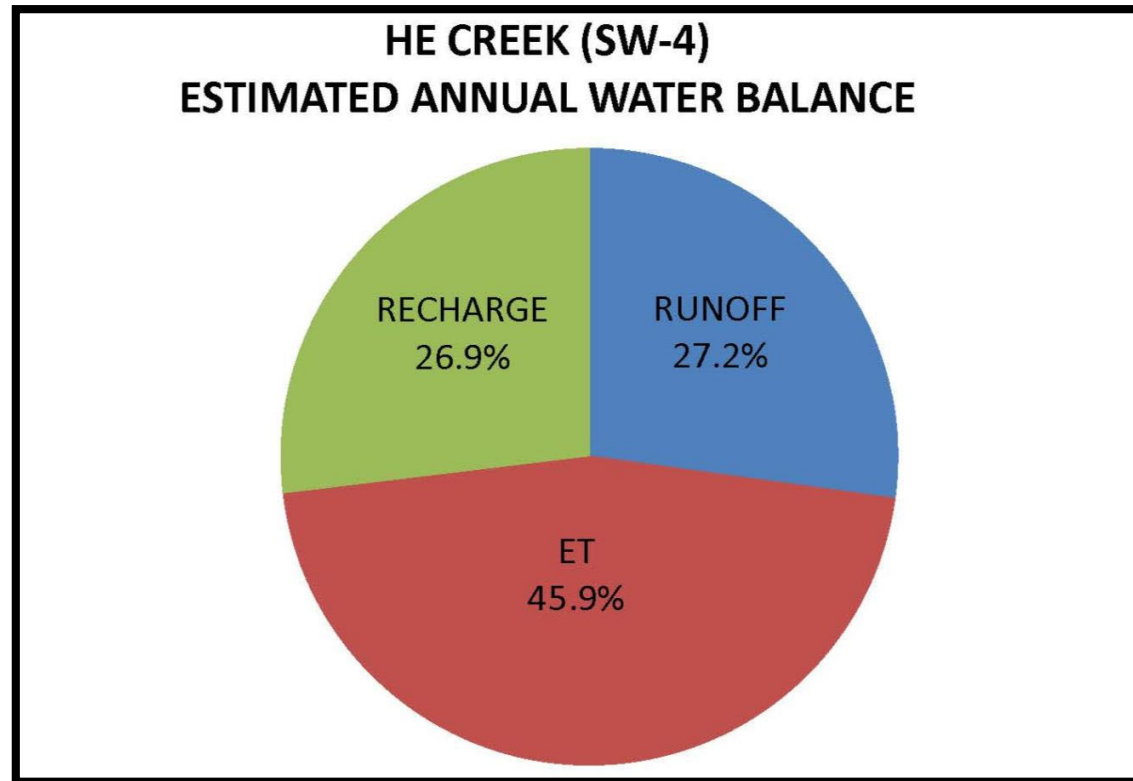


# WATER BALANCE

TABLE 8  
ANNUAL WATER BALANCE RESULTS

	PRECIPITATION	RUNOFF	ET	INFILTRATION
	GPM (M <sup>3</sup> /min)	GPM (M <sup>3</sup> /min)	GPM (M <sup>3</sup> /min)	GPM (M <sup>3</sup> /min)
BIG HE CREEK	4,128 (15,624)	860 (3.26)	1,895 (7.17)	1,373 (5.20)
LITTLE HE CREEK	3,309 (12,525)	880 (3.33)	1,519 (5.75)	910 (3.45)
HE CREEK	<b>8,667 (32,805)</b>	<b>2,356 (8.92)</b>	<b>3,978 (15.06)</b>	<b>2,332 (8.83)</b>
	IN (CM)	IN (CM)	IN (CM)	IN (CM)
BIG HE CREEK	61.0 (154.9)	12.7 (32.3)	28.0 (71.1)	20.3 (51.5)
LITTLE HE CREEK	61.0 (154.9)	16.2 (41.2)	28.0 (71.1)	16.8 (42.6)
HE CREEK	<b>61.0 (154.9)</b>	<b>16.6 (42.1)</b>	<b>28.0 (71.1)</b>	<b>16.4 (41.7)</b>

# WATER BALANCE



# Convert Infiltration to Runoff – Hydraulic Controls

- **Pumping and treatment system flow path improvements**
- **Remove unlined (leaky) basins**
- **Route runoff directly to streams where possible**



## Pumping and Treatment System Flow

- **Average Pumping Rate 1,000 GPM +/-**
- **Average Discharge Rate 700 GPM +/-**
- **Pump water losses 300 GPM +/-**
- **Average 30% recycle through infiltration (>1/3 loss seasonally)**
- **Hydraulic Improvement 1 – re-route to avoid infiltration points**
- **Hydraulic Improvement 2 – extend discharge pipe/line channel**



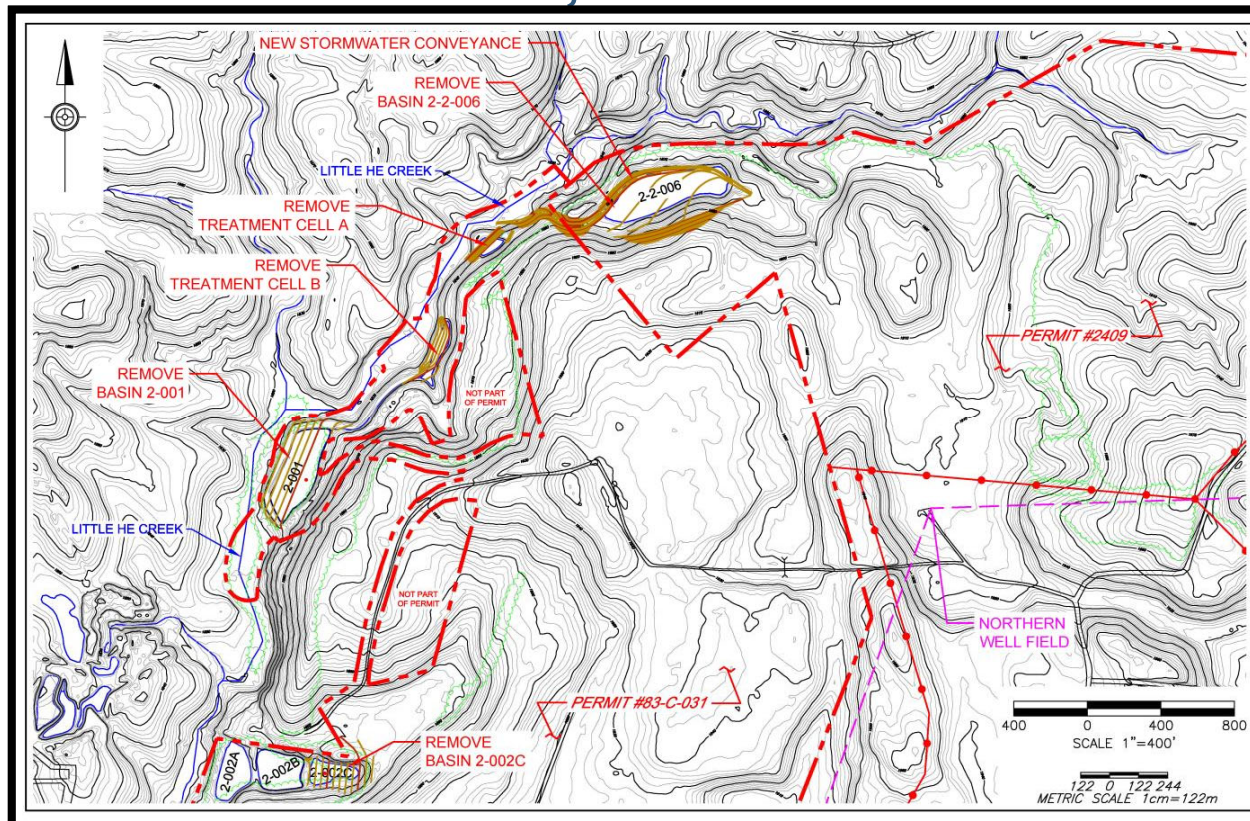
## Remove Unlined (leaky) Basins

- **Basin 2-2-006 (Completed 2013/2014)**
- **Basin 2-001 (Completed 2014)**
- **Basin 2-002C (Completed 2014)**
- **Basin 2-2-001A (Completed 2015)**
- **Basin 2-2-001D and E Reclamation (Future)**





# 2-2-006 Removal, (129 acres) 2-2-001 Removal 2-002C Removal, 2-002D Prior Removal



# Basin 2-2-006 Removal Example

## 129-acre drainage area



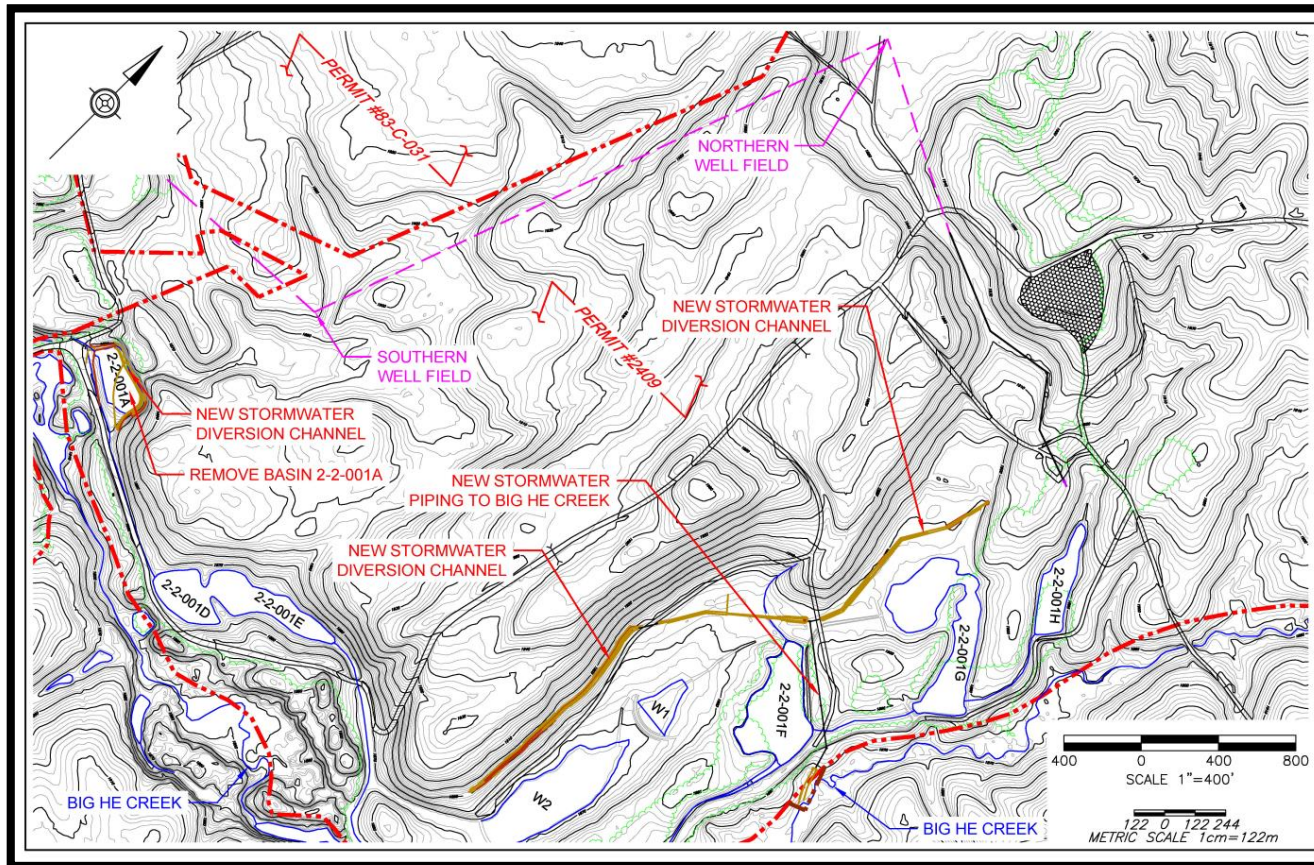


# Basin 2-2-006 Channel Failure & Repairs





# Route Runoff Directly to Streams (>250 acres)



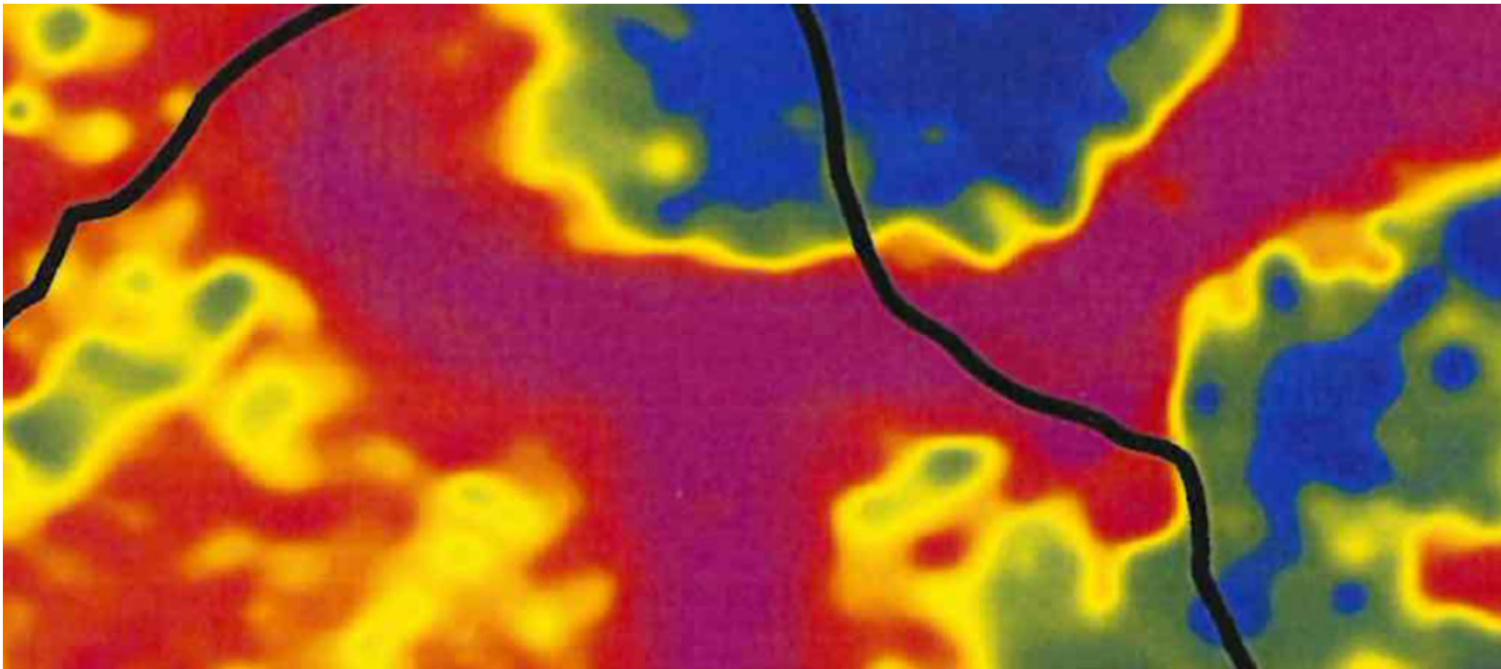
# Hydrogeologic Considerations

## After path corrections/basin removals

- Rainwater Infiltration << Pumping volume (MODFLOW 2015+/-)
- Additional pumped water originates from groundwater source
- Groundwater flow is generally north to south
- Could clean groundwater be intercepted before entering the backfill and becoming contamination?
- Geophysical techniques employed to evaluate

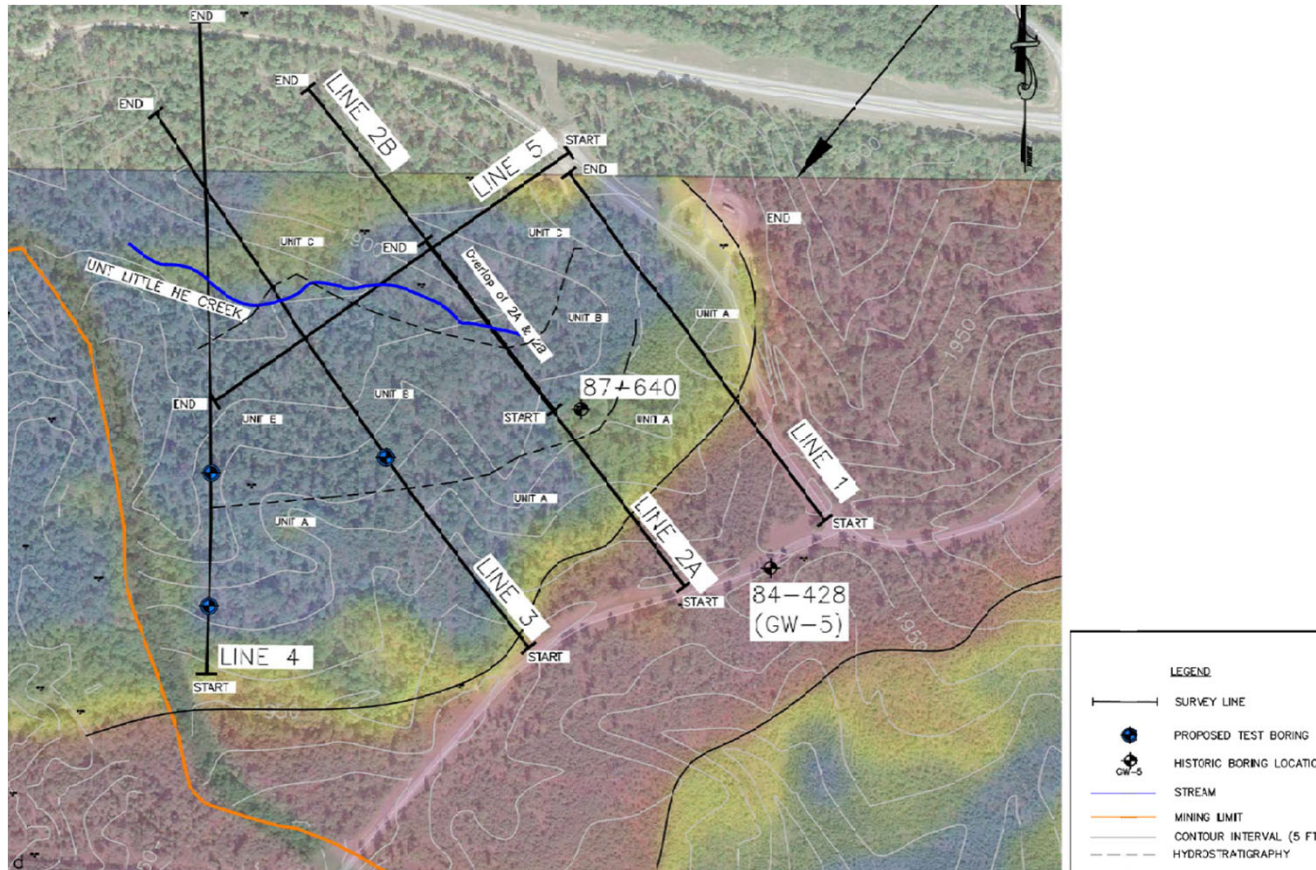


# 2004 Airborne Geophysical Survey - RESOLVE





# ER Geophysical Investigation - 2017





# Geophysical Testing on Adjoining Property in and Adjacent to permit boundary



Figure 2. ERT setup on Line 3 SVC Site, Dunlap, TN



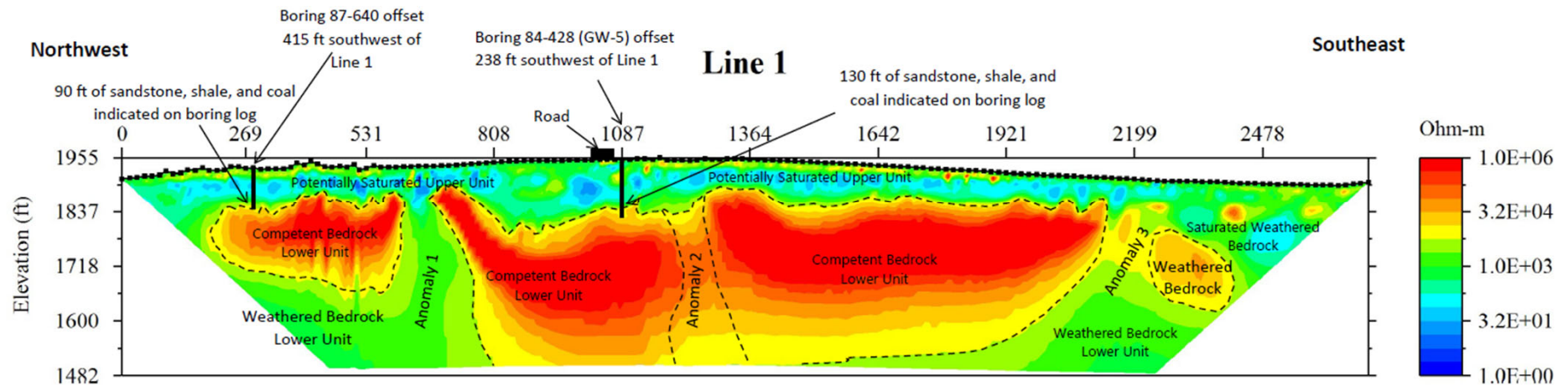
Figure 3. AGI Supersting RES/IP Meter



Figure 4. Complete equipment collecting data on Line 4, SVC Site Dunlap, TN

# Electrical Resistivity Cross-Section

However, test drilling postponed – property control change



## **Hydrogeologic Solution Evaluated - 2018 Class I or Class V Injection Well Permit**

- **Class I likely cost prohibitive and not pursued**
- **Class V potentially feasible option**
- **Class V injection well feasibility study completed**
- **Owner investment went toward pumping system improvements instead of a higher risk injection well permit following a 2018 regulatory meeting**



## **Permittee (Cloud Peak Energy) filed for Chapter 11 Bankruptcy - 2019**

- **Activities slowed as cash flow was low 2018-2019**
- **All activities other environmental compliance were suspended until further notice when bankruptcy filed**
- **On-going basin inspections, pumping, and treatment are part of environmental compliance**
- **Navajo Transitional Energy Company (NTEC) took over late 2019**

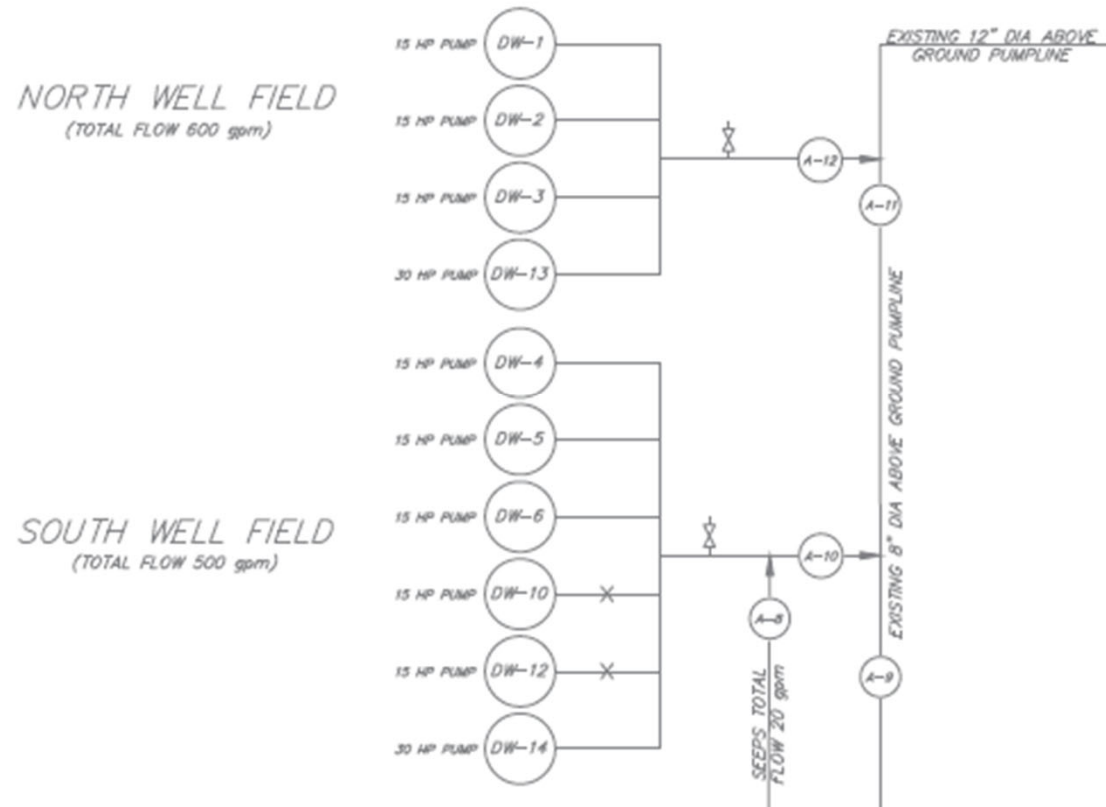


## **Backfill Water Level Observations and Subsequent Plan of Action**

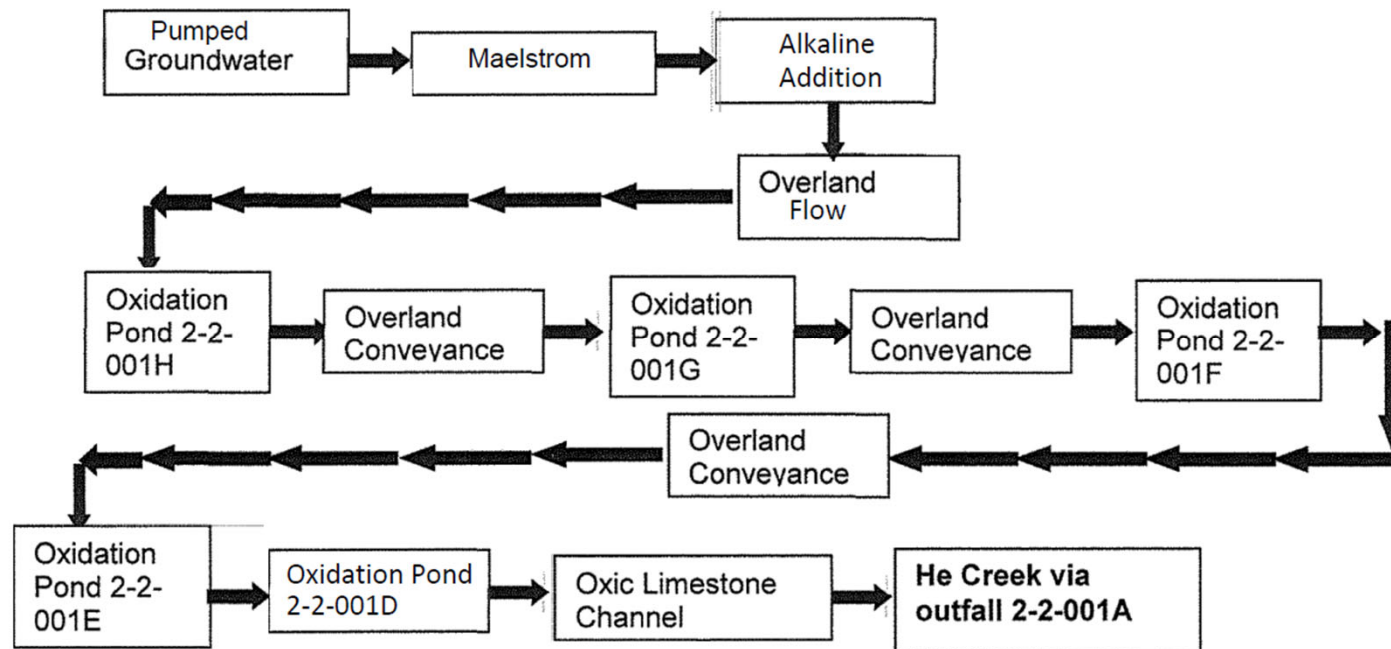
- **Backfill water levels tracked for decades**
- **Seasonal variances could exceed 30 feet (10 meters)**
- **Pumping system rates at both field < peak infiltration**
- **Addition pumping capacity recommended at both fields**
- **NTEC agreed and pursued additional pumping capacity**



# Northern and Southern Pumping Fields



# Pumped Water Treatment Flow Diagram





# Navajo Transitional Energy Company Dewatering Well Capacity Investments

- **2020-2022 Catch up on routine maintenance activities**
- **Basin Cleanouts, Treatment System Modifications, etc.**
- **2022 - drilled new production well at Northern Field**
- **2023 - drilled new production well at Southern Field**
- **Due to supply chain issues, activation of wells delayed until mid-2023 NWF and late 2023 SWF**





## Northern and Southern Production Wells

- **Typical SVC dewatering wells - 15 HP pumps**
- **New wells used 8-inch perforated casing for 80 feet**
- **Gravel filter pack used versus sand filter pack**
- **New - 30 HP pumps for 200 GPM+/- design**
- **Single phase power with 3-phase converter box**

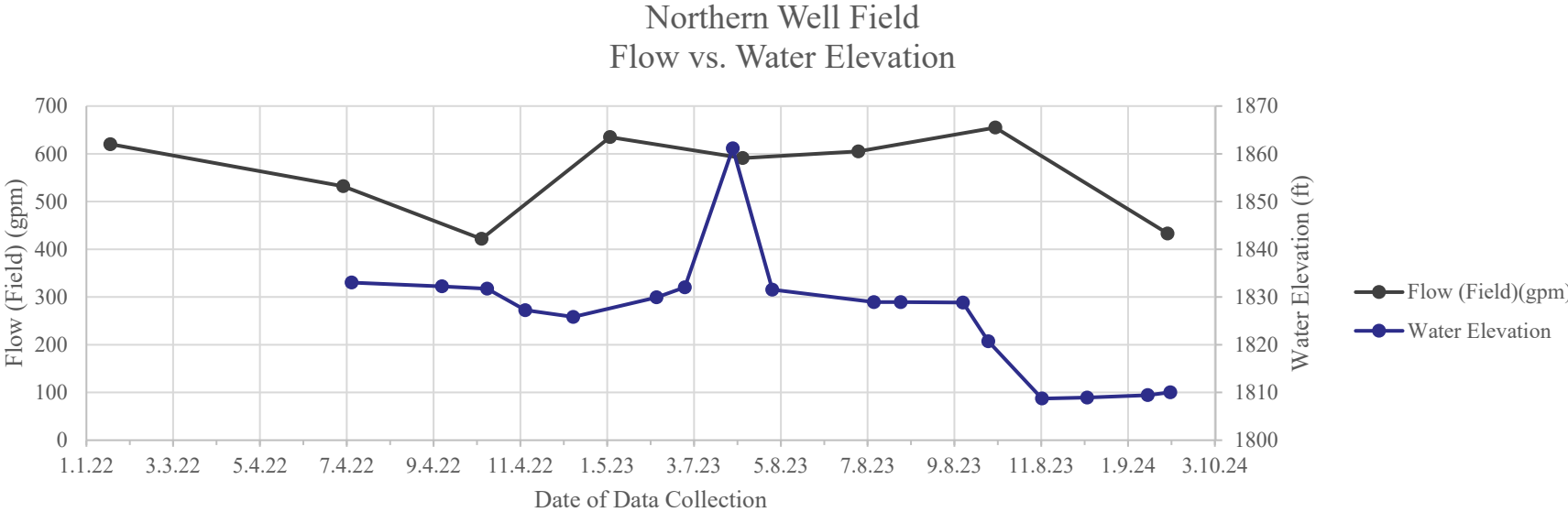


# Northern and Southern Groundwater Elevations

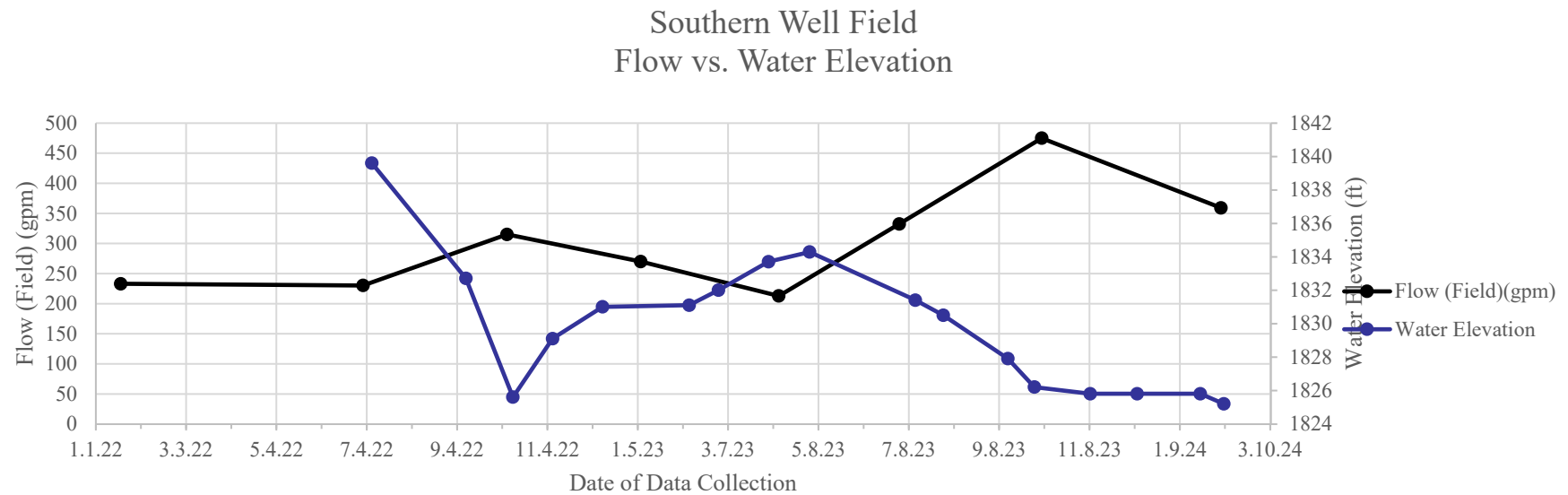
- **Drawdown aided by near draught conditions late 2023 through early 2024**
- **Pumping capacity increased by 200 GPM+/- at each field**
- **Backfill groundwater elevation reached 30-year low**



# Northern Well Field Elevations and Flows



# Southern Well Field Elevations and Flows



# Groundwater Elevations Goals 2024

- **Select optimum groundwater elevations**
- **Allow adequate storage for equipment or power failure**
- **Hold groundwater elevations constant (as possible)**
- **Reduce DO introduction to backfill groundwater**



# Thanks

- **Navajo Transitional Energy Company (NTEC) for willingness to share data**
- **Office of Surface Mining**
- **Tennessee Department of Environment and Conservation**
- **Current/prior owners for opportunity to work at SVC on interesting and challenging projects for over 30 years**





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