

Nov 14, 2016

To: Members of the Seismic Monitoring Advisory Committee,  
Southeast Geysers Effluent Pipeline Project (SEGEP)

Fm: Northern California Power Agency

Re: SEGEP Operation and Seismicity Report for April 1 through Sept 30, 2016

### **A. Pipeline Operations**

The Southeast Geysers Effluent Pipeline (“SEGEP”) has been in operation for 19 years and has delivered over 52 billion gallons of water at an average rate of 5,226 gpm to the South East Geysers steam field for injection. **Figure 1** illustrates the daily delivery rates since the beginning of the project.

During the recent six month period of April 1, 2016 through Sept 30, 2016, the SEGEP Pipeline was in operation 98.6% of the time (**Figure 2**). Pipeline delivery rates have averaged 7.2 million gallons per day (MGD) or 5,008 gpm. There were 2 brief pipeline outages related to the Clayton fire, and 1 for routine maintenance.

### **B. Observed Seismicity**

#### Seismic Activity in The Geysers (KGRA)

Within the Known Geothermal Resource Area (KGRA) of The Geysers geothermal field, there have been 331 events of magnitude 1.5 and greater recorded by the USGS for the past six months. There were 7 events of magnitude 3.0 and greater. The largest event was magnitude 3.83, occurring May 12th, 2016. The event was located in the North East Geysers approximately 7 miles from the Anderson Springs Strong Motion instrument (Figure 4). 801 seismic events greater than magnitude 1.5 are projected for 2016. (Figure 6) This is an increase from 758 events recorded in 2015.

#### Seismic Activity in the Southeast Geysers

The USGS recorded a total of 46 seismic events of magnitude 1.5 and greater within the SE Geysers area from April 1, 2016 through Sept 30, 2016. Their locations are shown in **Figure 5**. During this period, there was 1 seismic event in the area equal to or greater than magnitude 3.0.

This was an event of magnitude 3.37 near the southern edge of the NCPA lease. This event occurred July 30, 2016.

During this period, seismic activity between magnitudes 1.5 and 3.0 in the Southeast Geysers averaged 7.6 events per month. This level of activity is down from an average of 13.2 events per month for the period of Oct 1, 2015 through March 31, 2016. 117 seismic events greater than magnitude 1.5 are projected for 2016. This is down slightly from the 121 events in year 2015 (Figure 7).

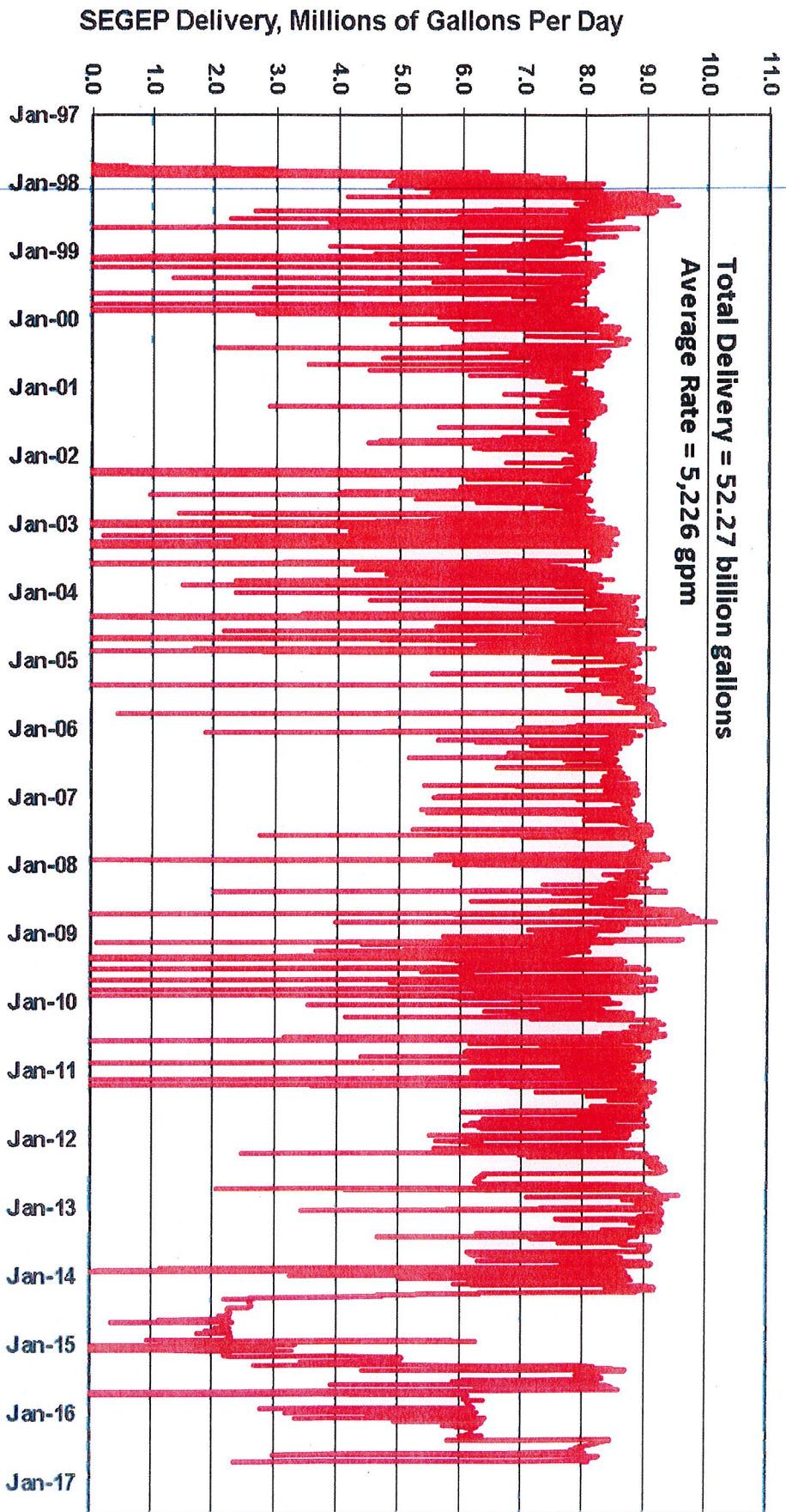
### **C. Injection and Steam Production**

Steam production for the Southeast Geysers area was up significantly to 18.30 billion pounds mass for the past six months. This previous six month production of 14.06 billion pounds was a result of the extensive Calpine plant fire damage. Water injection was 12.76 billion pounds. This compares with the 13.89 billion pounds of water injected from Oct 1, 2015 through March 31, 2016. **Figure 3** shows the cumulative steam production and water injection in six month periods within the Southeast Geysers area. Steam production was 30% higher, water injection was approximately 8.5% lower, and seismic activity was approximately 41% lower compared to values from the previous six month period.

Les Drake  
Geologist  
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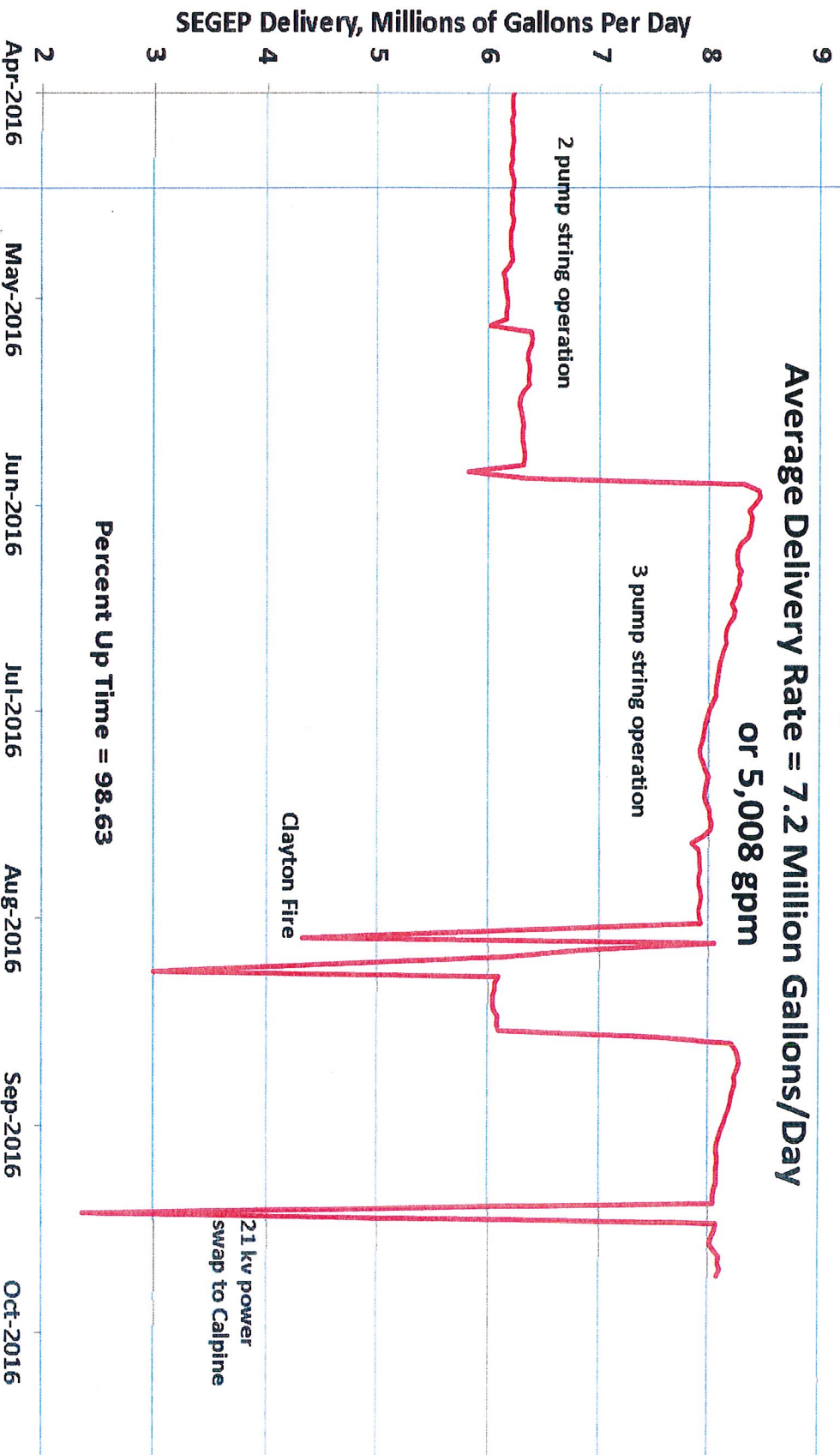


**Historical SE Geysers Effluent Pipeline Deliveries to The Geysers**  
**Figure 1**





**Southeast Geysers Effluent Pipeline Delivery**  
**April 1, 2016 through Sept 30, 2016**  
**Figure 2**



**SE Geysers Production and Injection**  
**Figure 3**

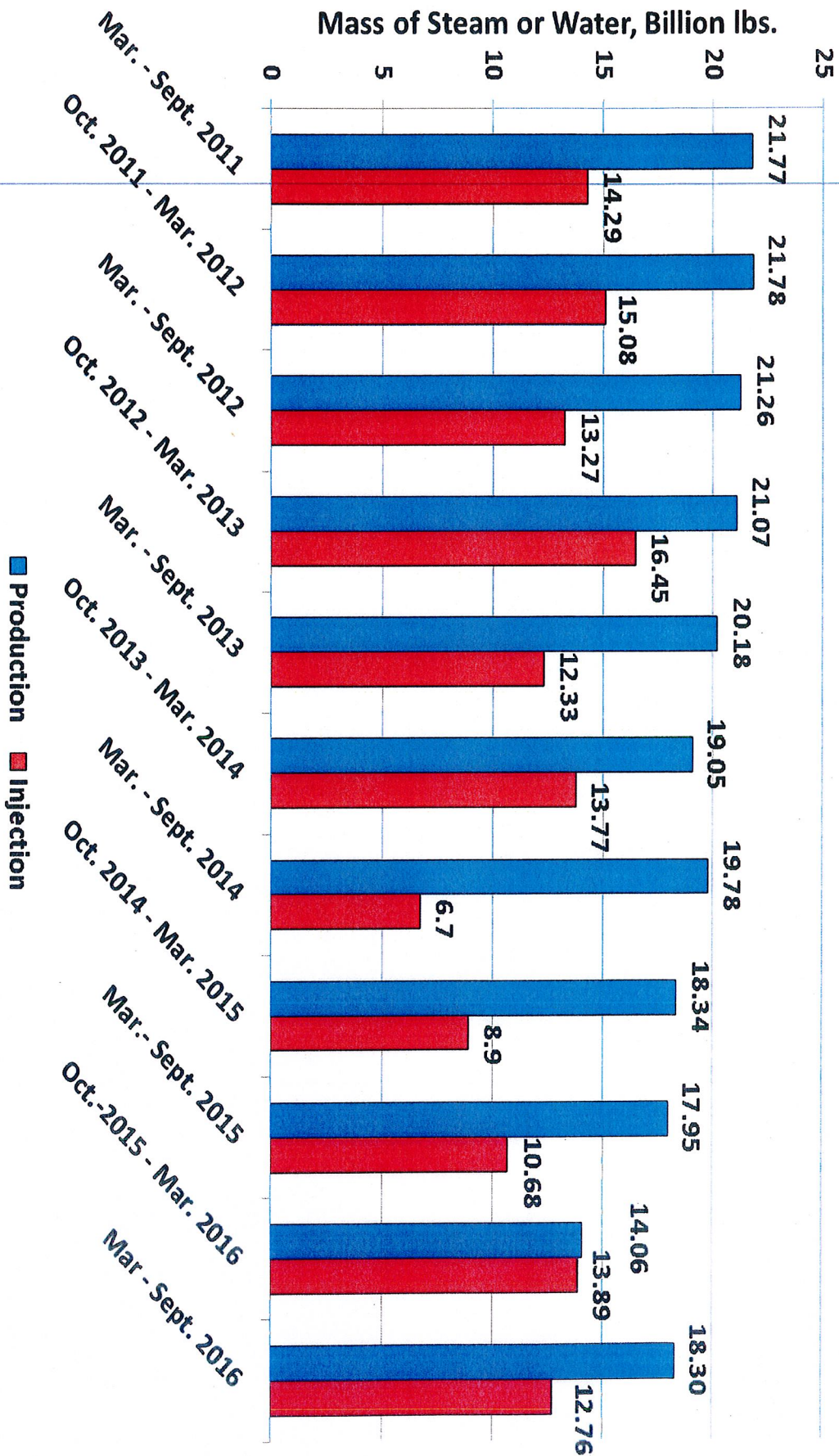
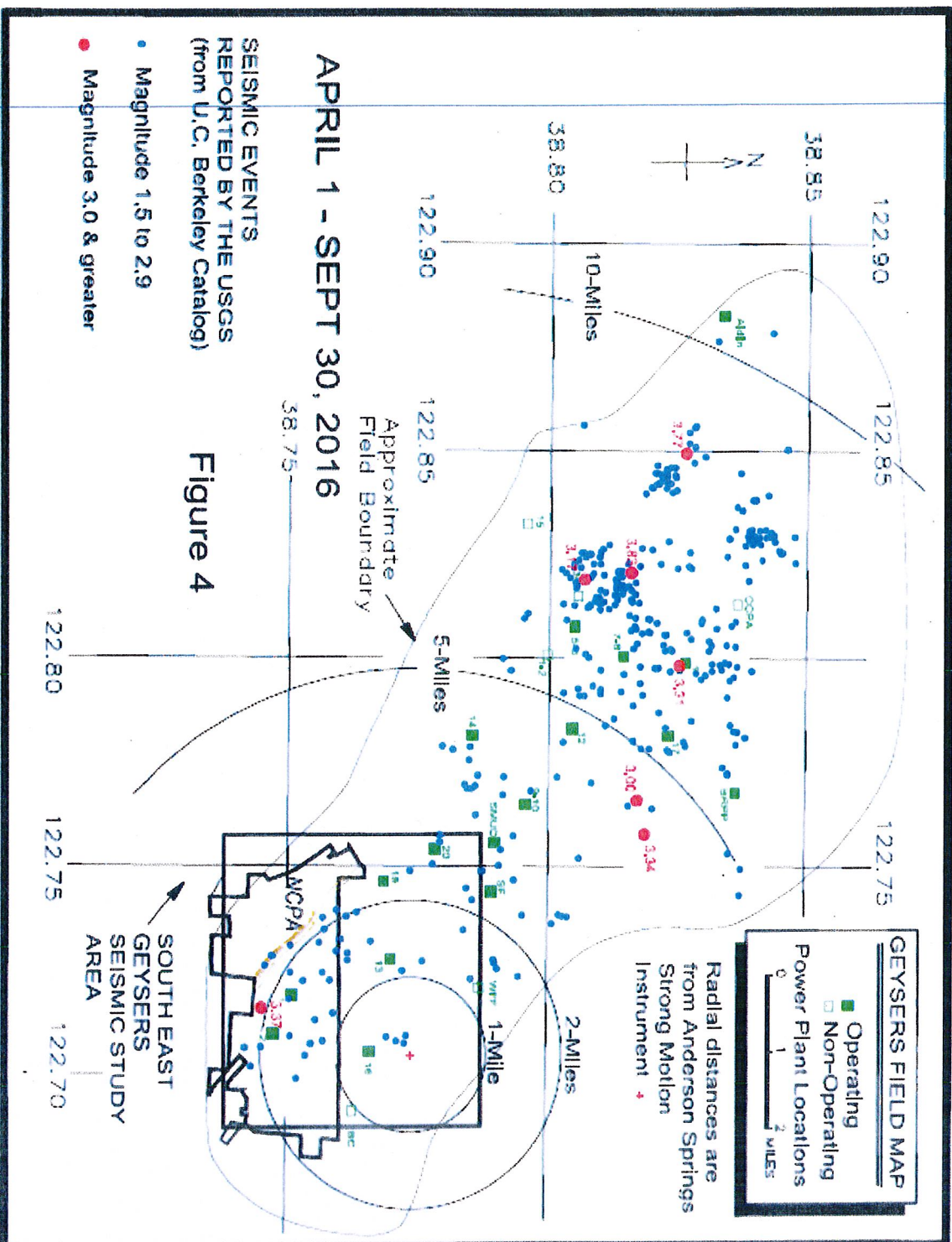




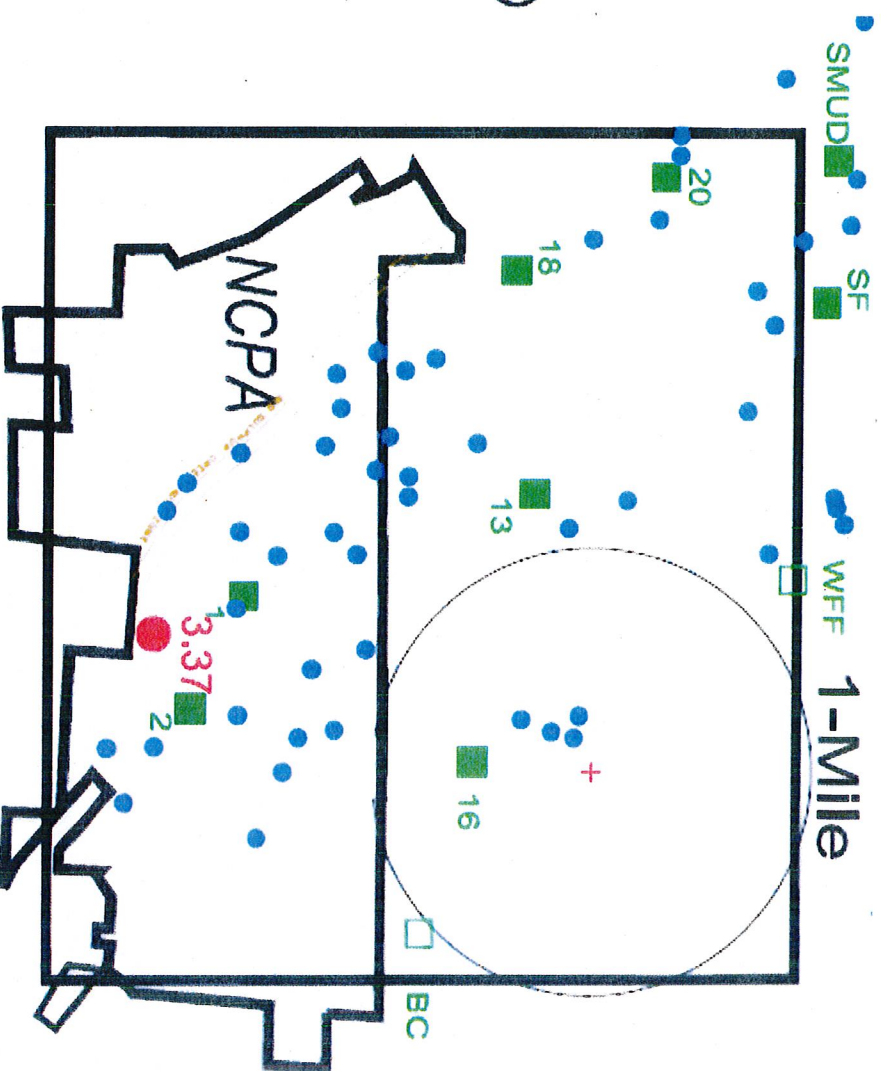
Figure 4



## Figure 5 South East Geysers Seismic Study Area

SEISMIC EVENTS  
REPORTED BY THE USGS  
(from U.C. Berkeley Catalog)

- Magnitude 1.5 to 2.9
- Magnitude 3.0 & greater

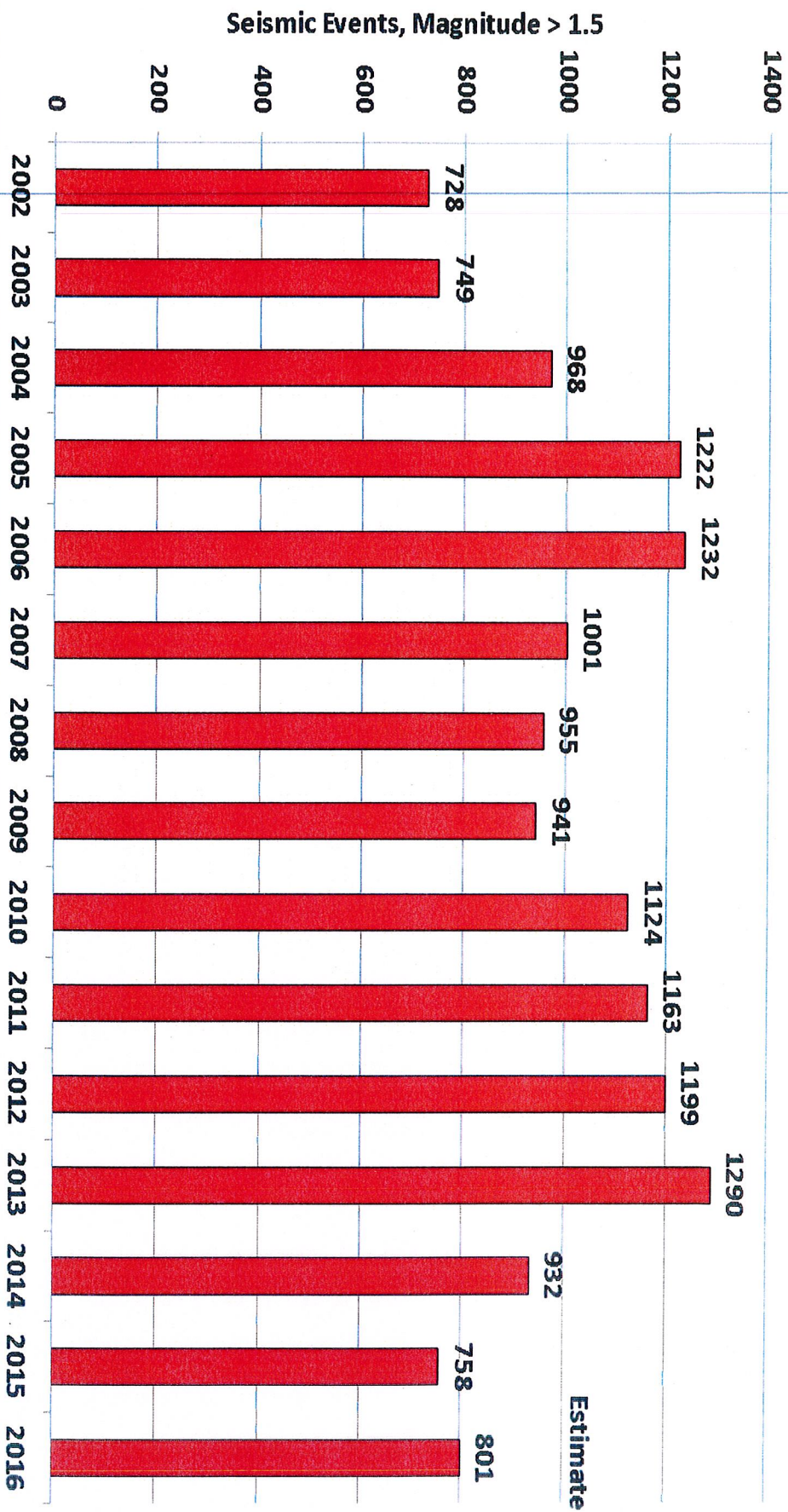




## The Geysers (KGRA) - Historical Seismic Activity

Magnitude > 1.5  
Years 2002 - 2016

Figure 6



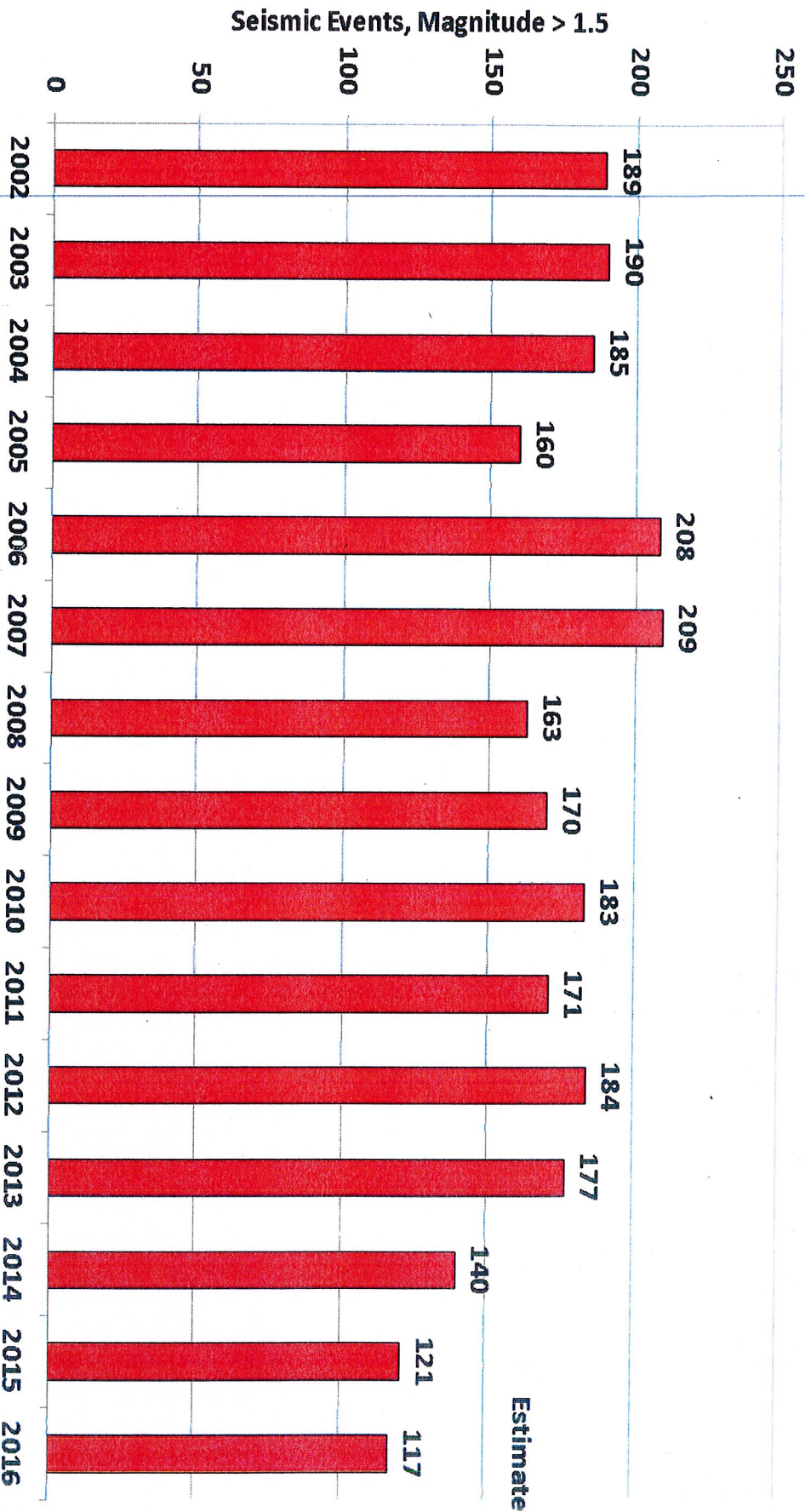


### Southeast Geysers - Historical Seismic Activity

Magnitude > 1.5

Years 2002 - 2016

Figure 7





## Summary

### South East Geysers, April 1, 2016 – Sept 30, 2016

- Average SEGEP injection – 7.2 million GPD
- The pipeline has been in operation 98.6% of this interval.
- There were two brief 2 outages related to the Clayton fire and one maintenance outage.
- SE Geysers water injection totaled 12.76 billion lbs, down 8.5% from the previous interval .
- Seismic activity is down approximately 41% from the previous 6 months in the South East Geysers.
  - 46 seismic events during the last 6 months magnitude 1.5 or greater, compared to 79 events the previous 6 months
  - 1 seismic event with magnitude 3.0 or greater