

# **SENECA RESOURCES COMPANY, LLC**

## **2018 ANNUAL SEISMIC MONITORING SYSTEM ACTIVITIES REPORT FOR THE FEE SENECA RESOURCES WARRANT 3771 #38268 (API NO. 37- 047-23835-00-01) CLASS II DISPOSAL WELL**



**February 2019**

## **Introduction**

ALL Consulting (ALL) has been requested by Seneca Resources Company, LLC (Seneca Resources) to prepare an annual summary of all 2018 activities associated with the Seismic Monitoring and Mitigation Plan (SMMP) that was submitted to the Pennsylvania Department of Environmental Protection (PA DEP) in March of 2017. The SMMP, which was developed for Seneca Resources by ALL, was a permit condition requirement of the Class IID saltwater disposal permit issued for the Fee Seneca Resources Warrant 3771 #38268 injection well (API No. 37-047-23835-00-01). This injection well is located in Highland Township of Elk County, Pennsylvania, near James City. The annual summary of all activities associated with the SMMP includes any maintenance, system upgrades, downtime periods, and triggered event detections and are detailed in the following sections.

## **Maintenance and System Upgrades**

Since installation of the seismic monitoring network (five seismic stations and one accelerometer) in late August of 2017, ALL has maintained the seismic network on a routine basis and has conducted inspections of the seismic stations as needed to ensure the system was active and sending the data to the Incorporated Research Institutions for Seismology (IRIS). Below is a summary of the maintenance and system upgrade activities performed by ALL on the seismic monitoring network since initial installation:

- 09/13/2017 – Seismic station ALL02 was not sending data. The modem was replaced and a new antennae was added to the station.
- 09/15/2017 – Station ALL02 was still down and was not transmitting data. The data logger was swapped out and ALL02 started sending out data.
- 11/17/2017 – Some issues were detected with the accelerometer. Ground cover insulation and infiltration barrier were added over the accelerometer.
- 01/13/2018 – Snow was cleaned from solar panels and insulation was added around the batteries.
- 02/12/2018 – Battery was replaced at ALL02.
- 02/12 to 02/15/2018 – Additional solar panels were added to three stations and accelerometer. ALL04 was inaccessible due to lease road conditions.
- 06/01/2018 – Second solar panel was added to ALL04 and insulation was removed from all station batteries.
- 06/19/2018 – Modem was replaced at ALL05 and firmware was upgraded on ALL00 and ALL03. ALL04 was working after resolution of network provider issues.
- 11/28/2018 – Solar panels were covered with snow. Battery at Station ALL00 was replaced and batteries at other stations were charged. ALL04 station was inaccessible due to lease road conditions.
- 12/03/2018 – Batteries were replaced at seismic stations ALL01, ALL02, ALL03, and ALL05.

## Seismic Station Downtime

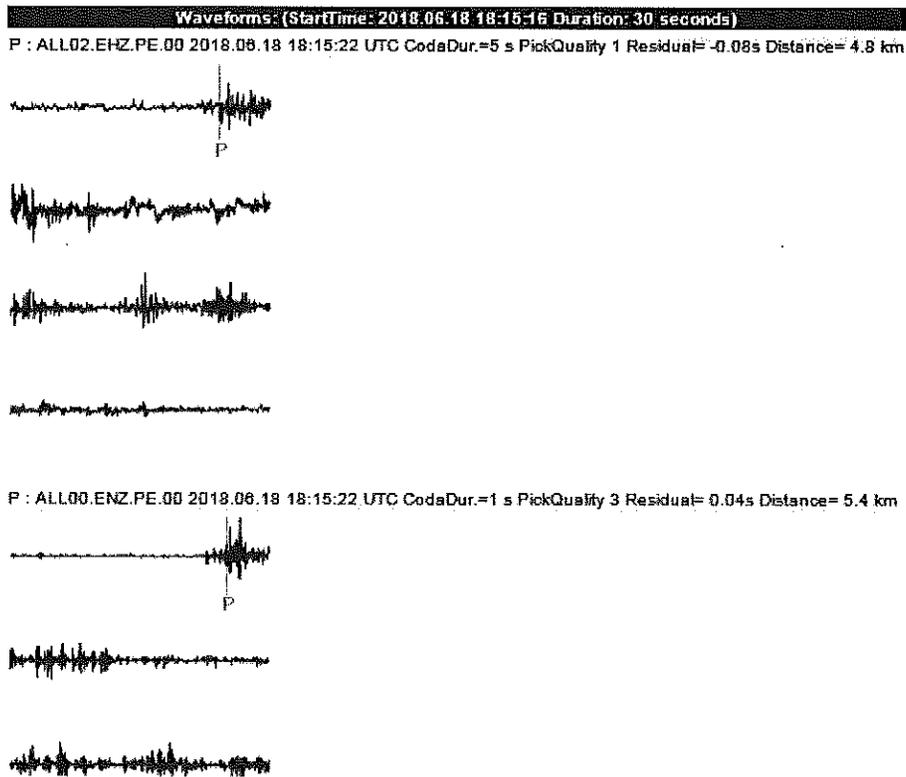
The seismic monitoring network is monitored in real time and did experience some station downtime in 2018, which normally was caused by weather-related conditions, but was also due to random equipment failure. Cold weather and heavy snow had the biggest impact on seismic station downtime due to snow cover on the solar panels or low-voltage readings on the batteries due to cold weather and lack of sunlight. Whether it was weather conditions or random equipment failure, ALL would mobilize staff as quickly as possible to go out to the station sites and restore operating conditions at the seismic stations.

- 01/10/2018 – Cold weather and snow conditions caused stations ALL01, ALL02, and ALL03 to go down and stop sending data. These stations came back online the next day with sunny weather. On 01/13/2018, ALL was onsite to clean off solar panels and wrap insulation around the batteries.
- 02/09/2018 – All stations were down due to cold weather and snow. On 02/12/2018, ALL was onsite to charge batteries, replace as needed, and add more solar panels to stations.
- 05/31/2018 – Accelerometer went down and was not sending data. Accelerometer came back on later in the day.
- 06/07/2018 – ALL04 was down due to issues with Verizon network. ALL got station back up and working on 06/19/2018.
- 11/23/2018 – Stations ALL02 and ALL03 were down due to cold weather and snow.
- 11/28/2018 – ALL00 was down due to cold weather and snow. ALL was onsite that day and replaced one battery and charged the other batteries.
- 12/03/2018 – ALL01, ALL02, ALL03, and ALL05 were down due to the weather. Batteries were replaced by ALL at four of the seismic stations.

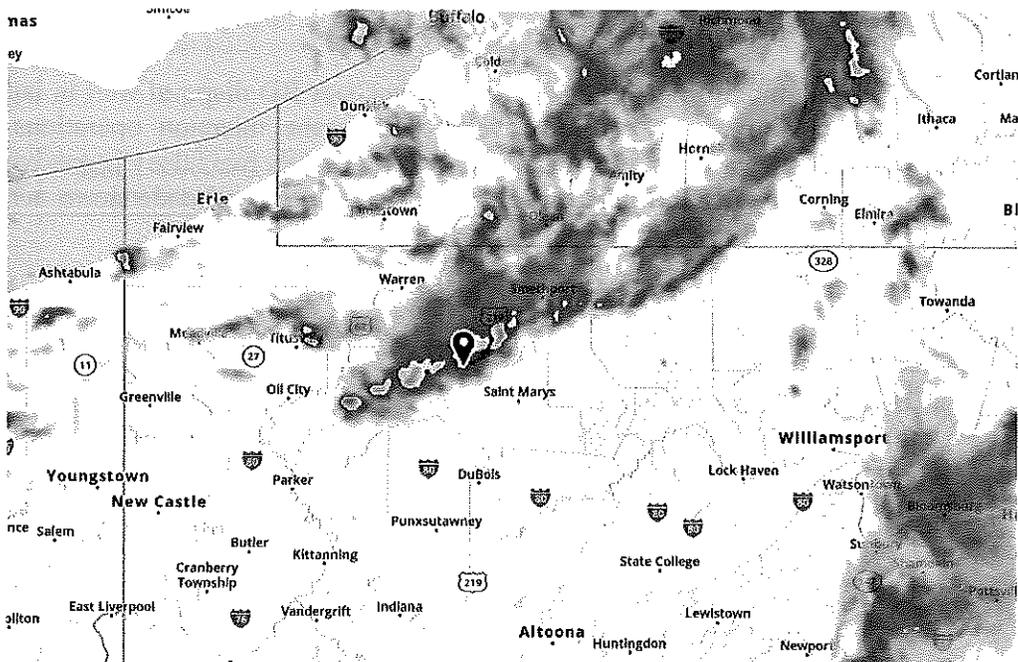
## Event Triggers and Detection

Since initiation of seismic monitoring at Seneca Resources Class IID disposal well in late 2017, there has been no detection of any seismic events due to the injection operations. Since commencement of monitoring operations at this seismic network, only two false triggers have been detected and recorded by the network and these have been caused by thunderstorm activity in 2018. Below are the dates of the triggered activity.

- 06/18/2018 – The seismic network was initially triggered with false detection due to a thunderstorm. **Figure 1** is seismic waveforms of the event detected on ALL02 seismic station and the accelerometer.
- 09/03/2018 – Thunderstorm triggered event and false detection. **Figure 2** is a weather map shown a thunderstorm that triggered a false detection on the seismic network.



**Figure 1. Thunderstorm-induced Trigger Event Detected on the ALL Seismic Monitoring Network in Pennsylvania**



**Figure 2. Weather Map Showing Location of Seneca Resources Disposal Well and Thunderstorm that Triggered a False Detection on the ALL Monitoring Network**

## **Conclusions**

As discussed in the previous sections, the annual 2018 evaluation and assessment of Seneca Resources seismic monitoring network clearly demonstrates that there was no injection-induced seismic activity due to the operations at the Class IID disposal well. The two false detections that triggered the ALL seismic monitoring network were caused by weather-related thunderstorm events.

Routine maintenance and replacement of equipment due to random failure occurred during the entire 2018 year. Most of the issues were caused by cold weather and snow, which were addressed by ALL by adding insulation to the batteries, replacing some batteries, and adding additional solar panels to improve sunlight capture to maintain battery life.

ALL will continue performing routine maintenance and inspection per equipment manufacturers' recommendations in 2019. Additionally, ALL will be upgrading the modems due to forthcoming changes to the Verizon cellular network.