TSX/PAZ Satellite Update
InSAR Subsidence
April 10, 2025

Lonquist comment:

The PAZ satellite from the TSX/PAZ constellation (4 & 7-day revisit) passed by Sulphur on Thursday April 10. We received the dataset Saturday and verified that none of the point groups within the review area are showing deviation from their respective trends. The attached report has been prepared for reference.

TSX/PAZ Satellite Update

Continuous InSAR Monitoring of
Ground Displacement At Westlake
Caverns and Western Dome Flank

Sulphur Mines Salt Dome

Prepared for:
Westlake Chemical

Prepared by:
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Dataset
Satellite Source
TerraSAR-X - PAZ Constellation
Most Recent Image Date
Thursday, April 10, 2025

Analysis Report Date:

April 15, 2025

Dataset Information

Satellite Source	TerraSAR-X - PAZ Constellation
Revisit Frequency	4 and 7 days
Most Recent Image Date	Thursday, April 10, 2025
Dataset Image Count	142
Dataset Time Range	January 24, 2023 - April 10, 2025
Dataset Length	2.21 Years
Satellite Line-of-Sight (LOS)	37° East of Vertical (Viewing site from the East)

Analysis Methodology

Time Series Charts

Trend lines were calculated for the averaged displacement values within each AOI. Both a nonlinear (quadratic) and linear regression were applied to each AOI point group to identify rates of change in LOS displacement. These trends are displayed in the Time Series section of this report.

Contour Maps

A nonlinear (quadratic) and linear trend was also calculated for each individual measurement point across the analysis region. Nonlinear trend values for each point were used to generate Velocity and Acceleration contour maps to convey the spatial distribution of the calculated movement. The linear trend values for each point (which lack an acceleration component) were used to generate an additional Velocity contour map. Maps depicting the individual data points colored by these trend values are also included in the last section of the report.

Negative velocity values indicate subsidence or westward movement and positive velocity indicates uplift or eastward movement. Negative acceleration values indicate increasing rates of subsidence, increasing westward movement, or slowing eastward movement and positive acceleration values indicate slowing rates of subsidence, slowing westward movement, or increasing eastward movement.

Observations

To-date there have been <u>no acute deviations</u> from established subsidence trends in the areas investigated.

The time series charts show broadly consistent near-linear trends among the analysis AOIs. Acceleration values for the quadratic (non-linear) trend fit are positive in all AOIs (slowing negative displacement) but minor overall. A slight seasonal fluctuation is evident in some of the charts.

The contour maps show the greatest negative displacement centered aroud the eastern central portion of the dome where the combination of subsidence and western horizontal movement (toward the dome center) are expected to produce the greatest rate of movement away from the satellite's line of sight from the east.

Date Signed: April 15, 2025
Austin, Texas

Nathaniel L. Byars, P.E.
Principal Engineer
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InSAR Data Sources

InSAR Data

Interferometric Synthetic Aperture Radar (InSAR) is the most well established method to continually evaluate small, normally undetectable, ground movement over a large area. Radar imagery collected via satellites over successive orbital passes is used to identify and define measurement points on the ground. Objects or ground features providing a stable reflection of radar energy such as buildings, roads, and infrastructure produce the highest quality measurement points. InSAR analysis identifies the change in distance between the satellite and each measurement point over time relative to a stable reference point within the imaged area.

Satellite Sources

Two InSAR datasets are being used to evaluate subsidence over the Sulphur Mines Salt Dome. These datasets provide Line-of-Sight (LOS) displacement measurements from both ascending and descending orbits. An ascending orbit denotes the satellite's longitudinal course from south to north as it passes over the site, while a desceding orbit denotes the satellite is moving from north to south.

The first dataset comes from a low-resolution Sentinel-1 (SNT) satellite on an ascending orbit that captures data from the west of the site on a 12-day frequency. The second comes from a pair of high resolution satellites that share the same descending orbit and capture data from east of the site. These are a TSX satellite and the PAZ satellite (TSX/PAZ constellation), both with an 11-day revisit frequency. Their orbits are offset with the PAZ satellite passing over the site 4 days after the TSX satellite. Prior to May 2023, data was captured from a different high-resolution TerraSAR-X (TSX) satellite on a descending orbit that captured data from the east of the site on an 11-day frequency. The transition was made for the increased data frequency that resulted from a 4 and 7-day revisit period. The image below depicts the orbital paths of the satellites in relation to the Sulphur Mines Salt Dome.

Satellite Orbital Diagram

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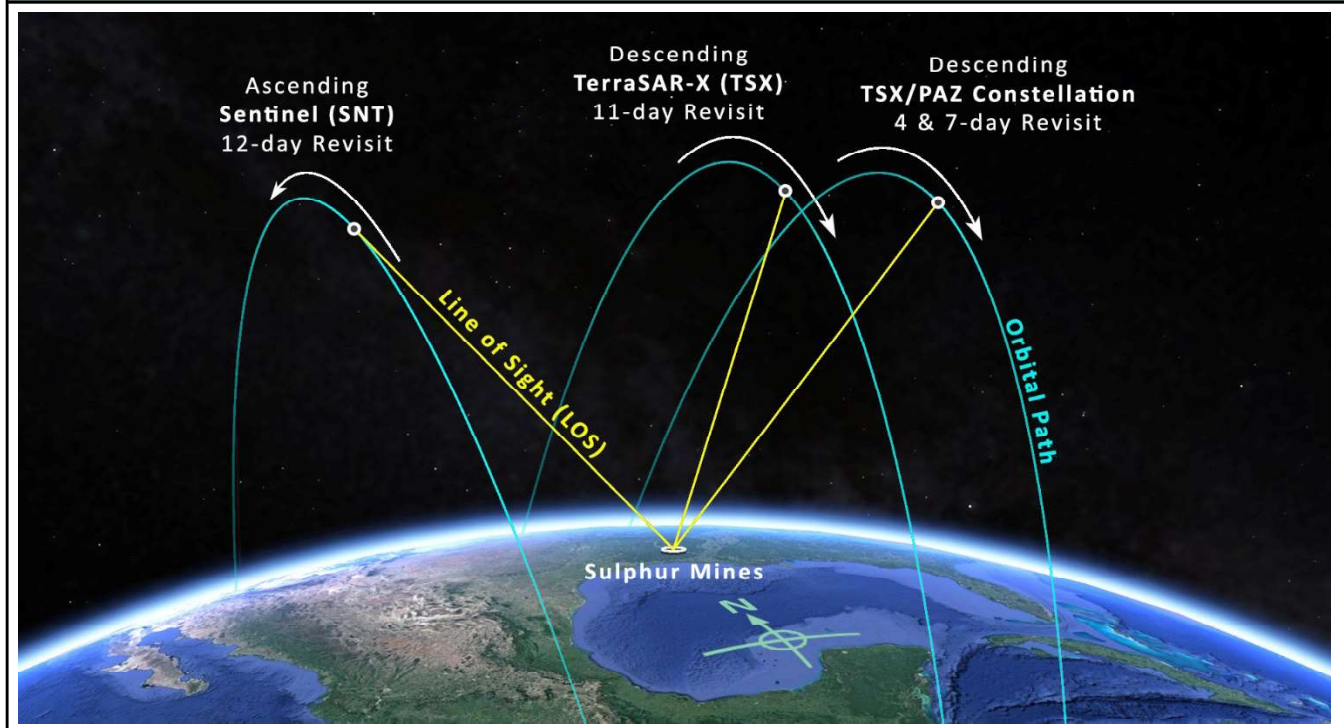
InSAR Line-of-Site (LOS) Data

LOS displacement measurements refer to a change in distance between the satellite sensor and the ground target. Measurement positions on the west side of the Sulphur Dome are are known to be experiencing some eastward movement toward the dome center due to the geometry of the subsidence basin. The InSAR satellites view the site from eastward and westward positions so LOS measurements are understood to convey a movement distance that is not purely vertical. The diagram to the right illustrates the geometric relationship between the theoretical Real movement of a ground target and LOS displacement measurements from two different satellite viewing directions.

Side View
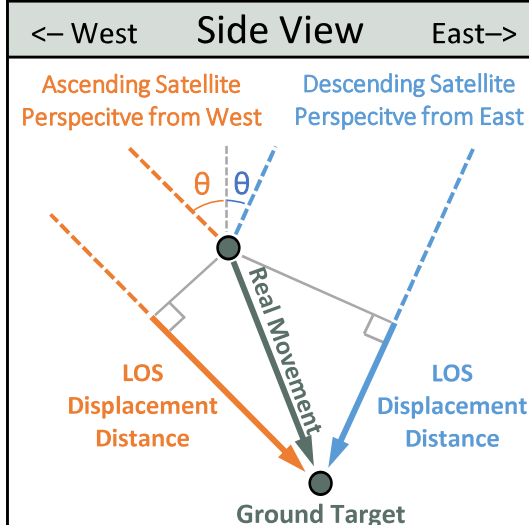
Satellite Properties & Image Frequency

Satellite and Data Properties	SNT	TSX	TSX/PAZ Constellation
Band (Wavelength)	C-band (2.20 in)	X-band (1.22 in)	X-band (1.22 in)
Track	T136	T29	T67 & T120
Pixel resolution	65 x 16 ft	3 x 3 ft	3 x 3 ft
Revisit frequency	12 days	11 days	4 & 7 days
Orbit (LOS Angle, θ)	Ascending (43°)	Descending (17°)	Descending (37°)
Data Start Date	10/4/2016	6/16/2022	1/24/2023
Measurement error range	± 0.20 in	± 0.03 in	± 0.03 in

Dataset Measurement History
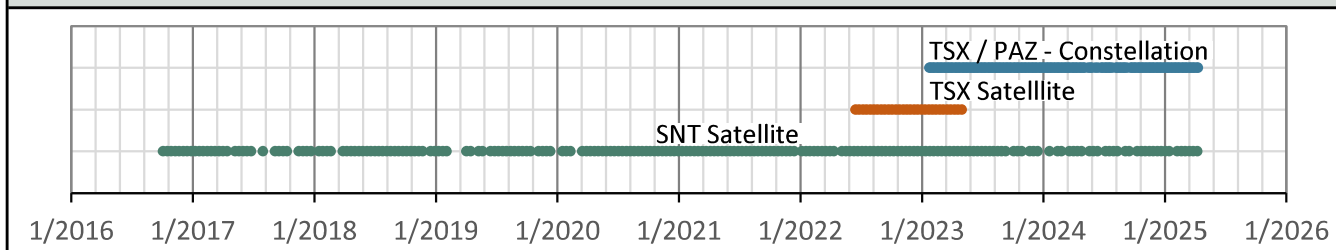
Dataset Update Frequency

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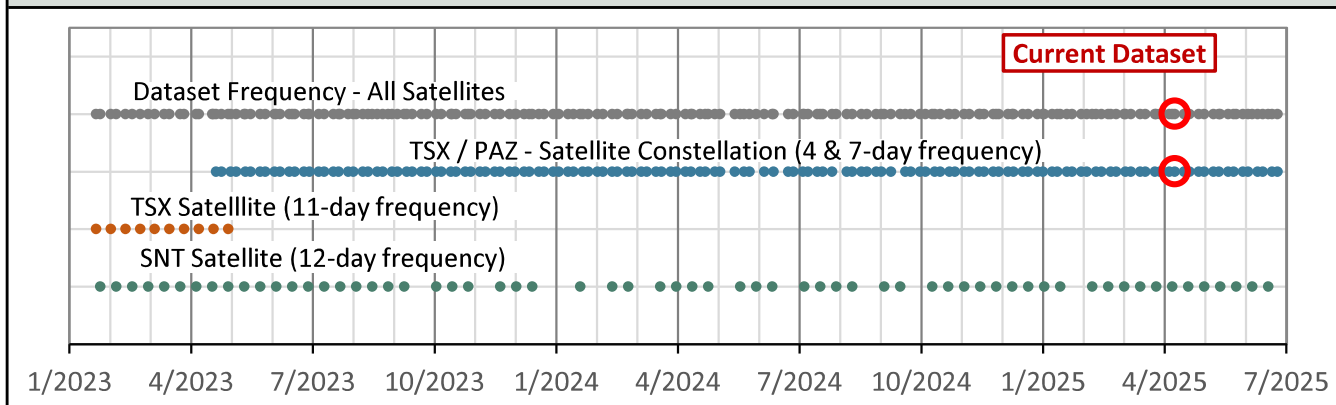
AOI Boundaries & InSAR Measurement Points
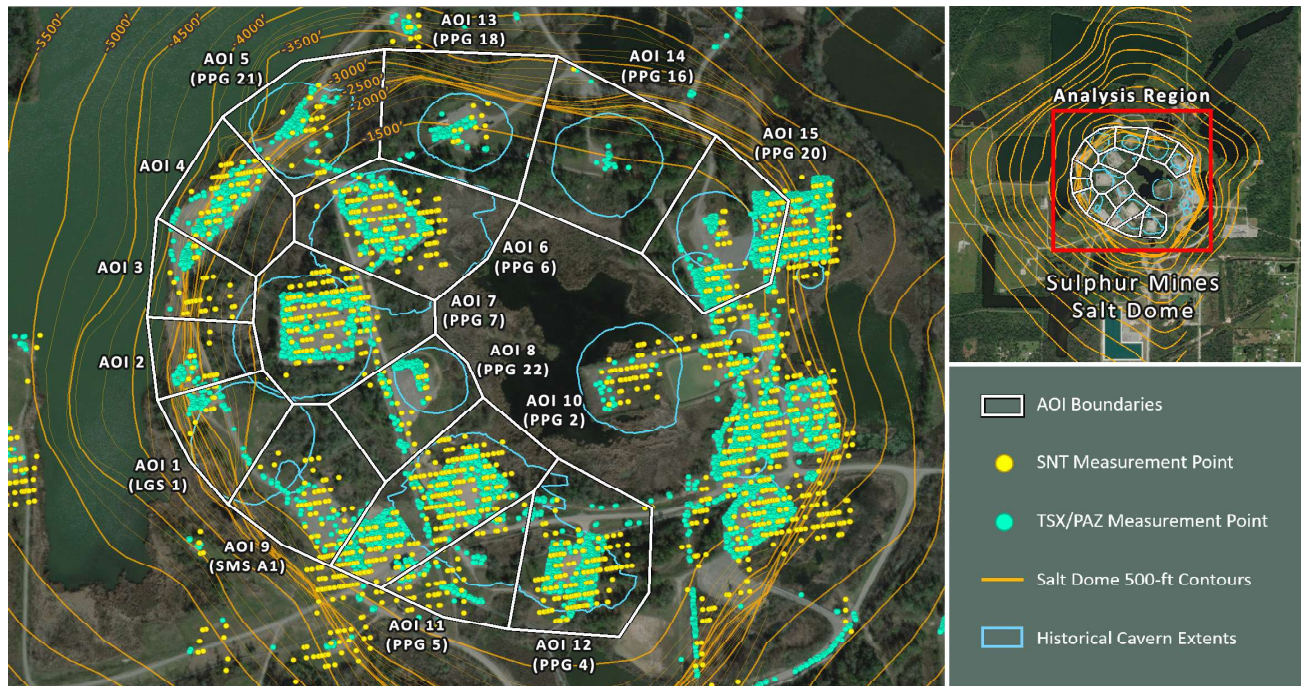
Subsidence Monitoring Areas of Interest (AOIs)

To visually convey and evaluate trend consistency for the displacement time series of each ground target, measurment points were grouped and their displacement values were averaged. The point groups are referred to as Areas of Interest (AOIs) in this analysis and their boundaries are depicted on the above map. The below table lists the trend values calculated in each AOI for the dataset evaluated in this report.

AOI Name	TSX/PAZ (4/10/2025)	LOS Velocity (in/yr)		LOS Acceleration (in/yr²)	
	Point Count	Nonlinear	Linear	Nonlinear	Linear
AOI 1 *(LGS 1)*	77	+0.03	-0.12	+0.14	0.00
AOI 2	44	-0.01	-0.18	+0.15	0.00
AOI 3	71	-0.19	-0.29	+0.09	0.00
AOI 4	224	-0.02	-0.12	+0.09	0.00
AOI 5 *(PPG 21)*	138	-0.09	-0.19	+0.10	0.00
AOI 6 *(PPG 6)*	356	-0.37	-0.46	+0.08	0.00
AOI 7 *(PPG 7)*	396	-0.25	-0.35	+0.09	0.00
AOI 8 *(PPG 22)*	127	-0.48	-0.66	+0.16	0.00
AOI 9 *(SMS A1)*	69	+0.00	-0.25	+0.23	0.00
AOI 10 *(PPG 2)*	809	-0.42	-0.54	+0.11	0.00
AOI 11 *(PPG 5)*	127	-0.34	-0.51	+0.15	0.00
AOI 12 *(PPG 4)*	553	-0.69	-0.79	+0.09	0.00
AOI 13 *(PPG 18)*	108	-0.20	-0.39	+0.18	0.00
AOI 14 *(PPG 16)*	22	-0.44	-0.79	+0.32	0.00
AOI 15 *(PPG 20)*	742	-0.82	-0.92	+0.09	0.00

AOI 1 *(LGS 1)* - Location Map
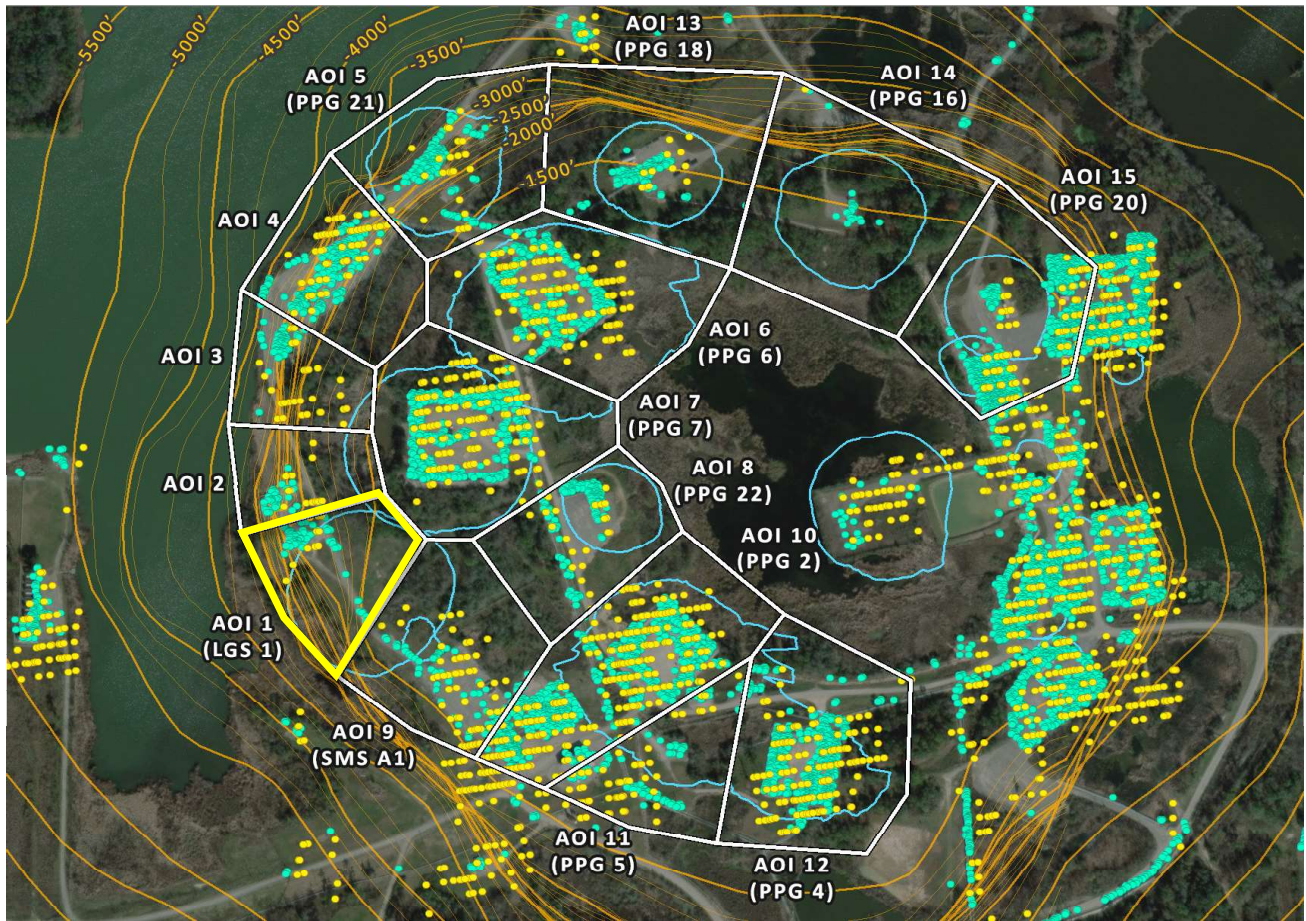
AOI 1 *(LGS 1)* - Displacement Time Series

TSX/PAZ (4/10/2025) Point Count: **77**
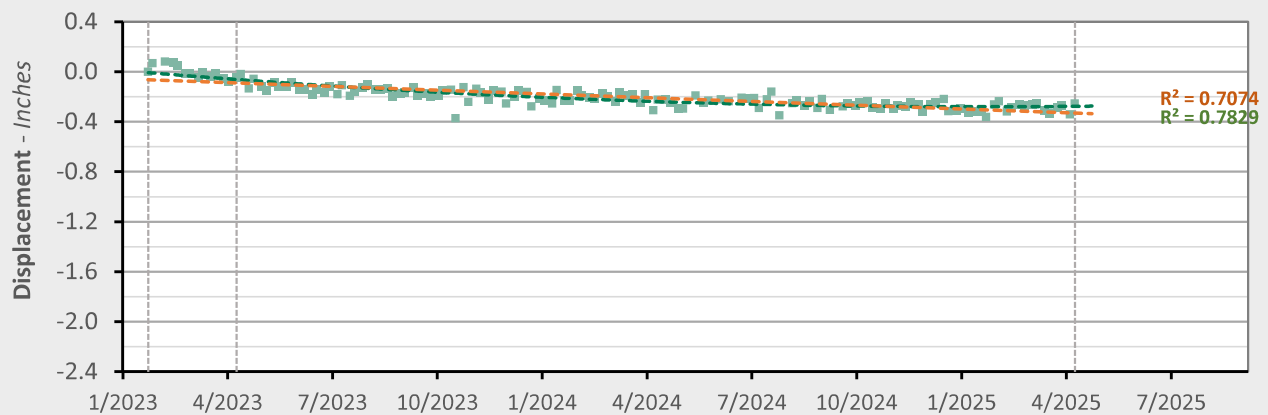
	Nonlinear Trend	Linear Trend
Velocity:	+0.03 in/yr	-0.12 in/yr
Acceleration:	+0.14 in/yr^2	0.00 in/yr^2

■ LOS Displacement Measurement − − − Nonlinear Trend Line (Quadratic Regression) − − − Linear Trend Line (Linear Regression)
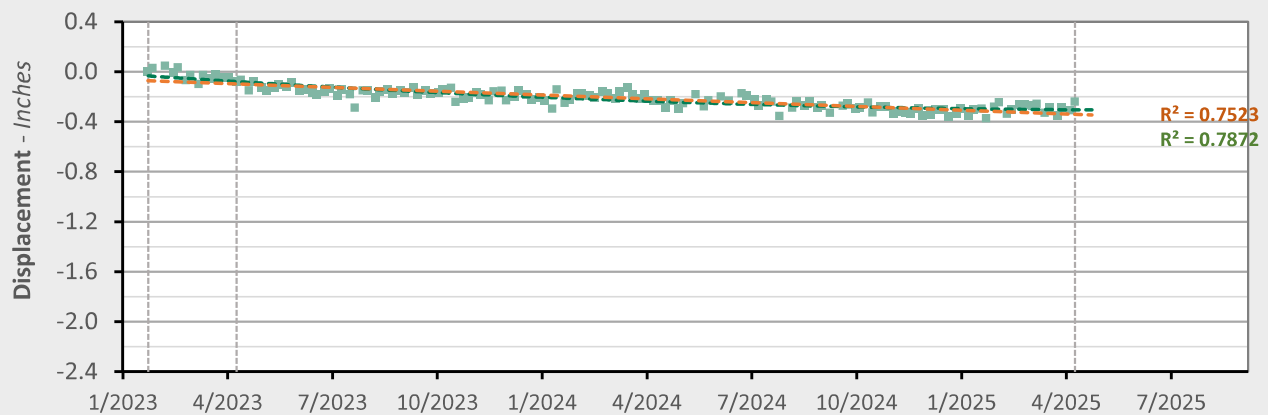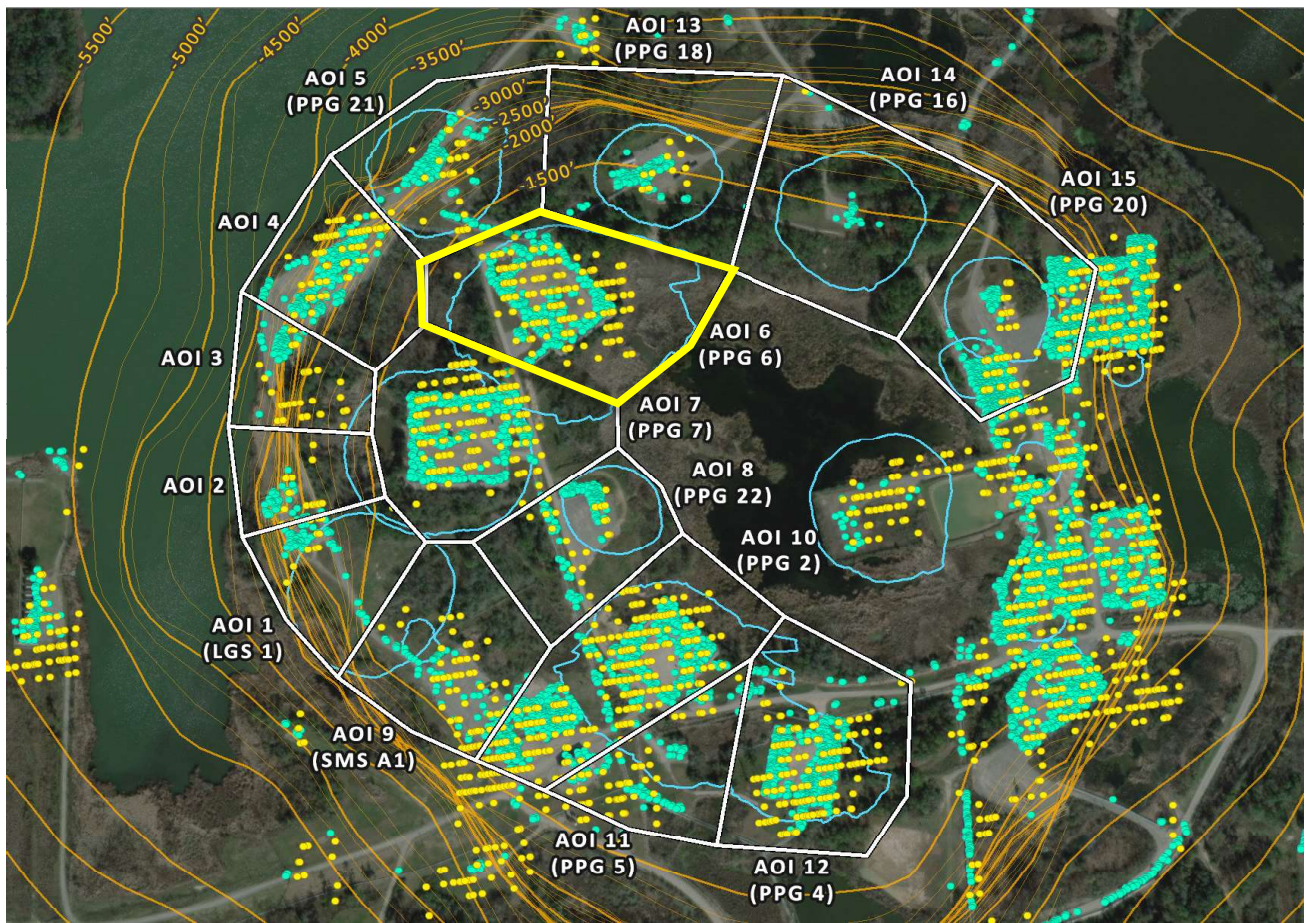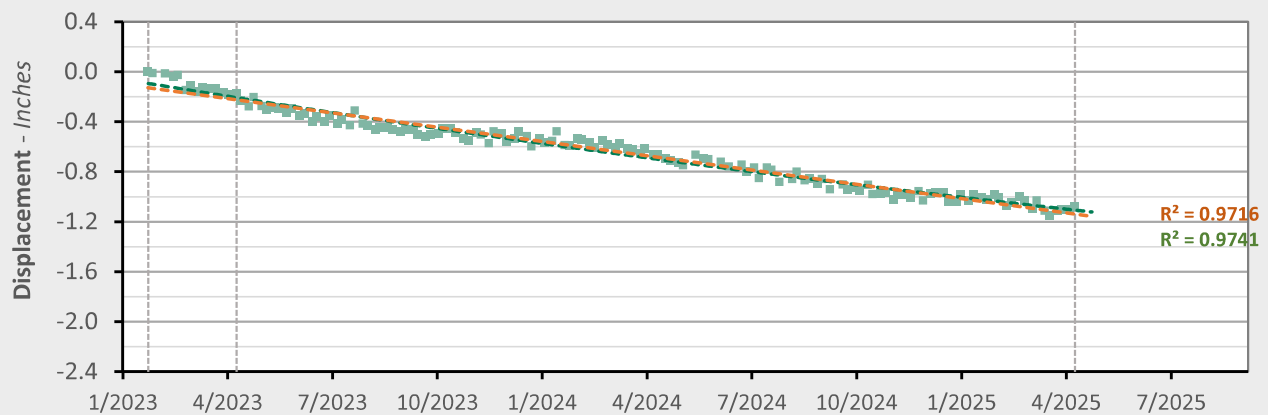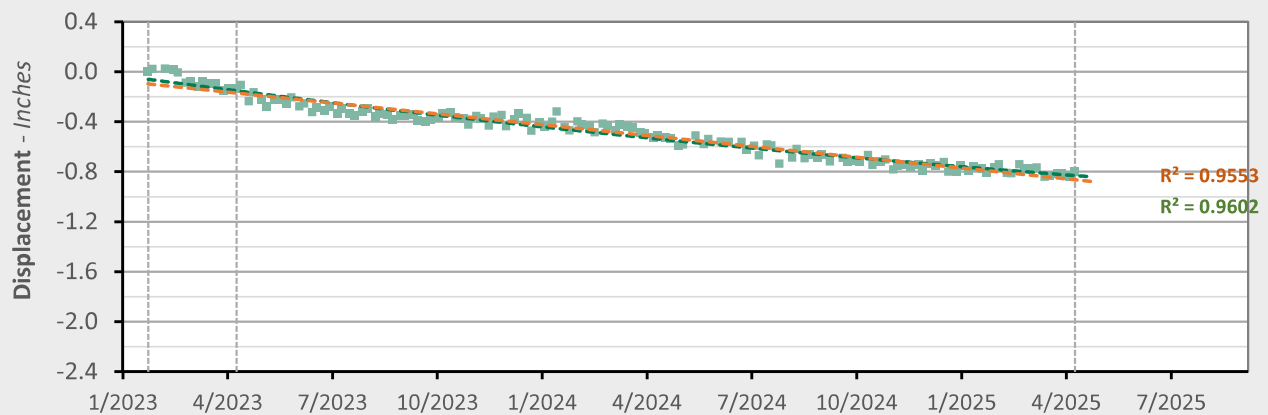
AOI 2 - Location Map
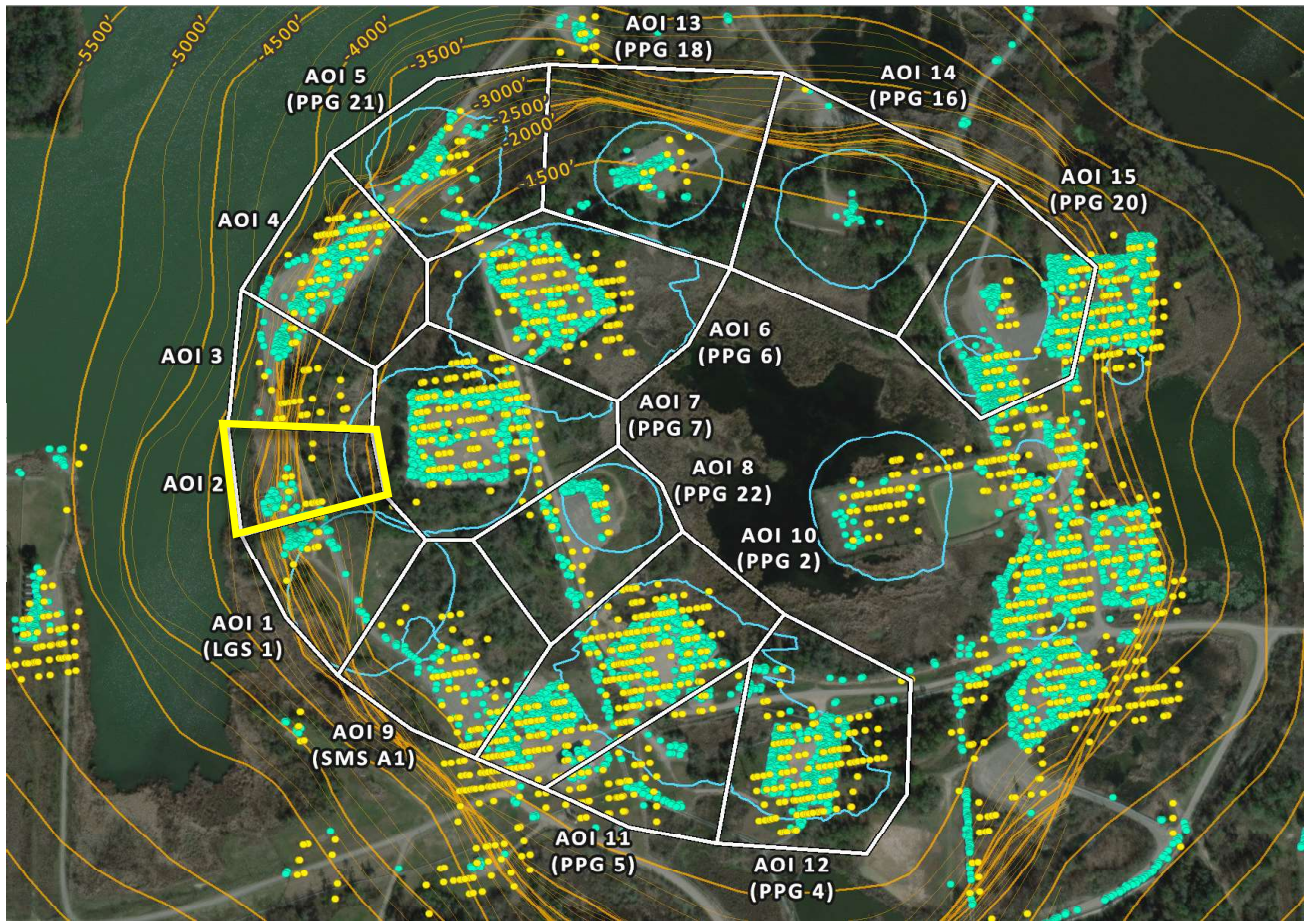
AOI 2 - Displacement Time Series
TSX/PAZ (4/10/2025) Point Count: **44**
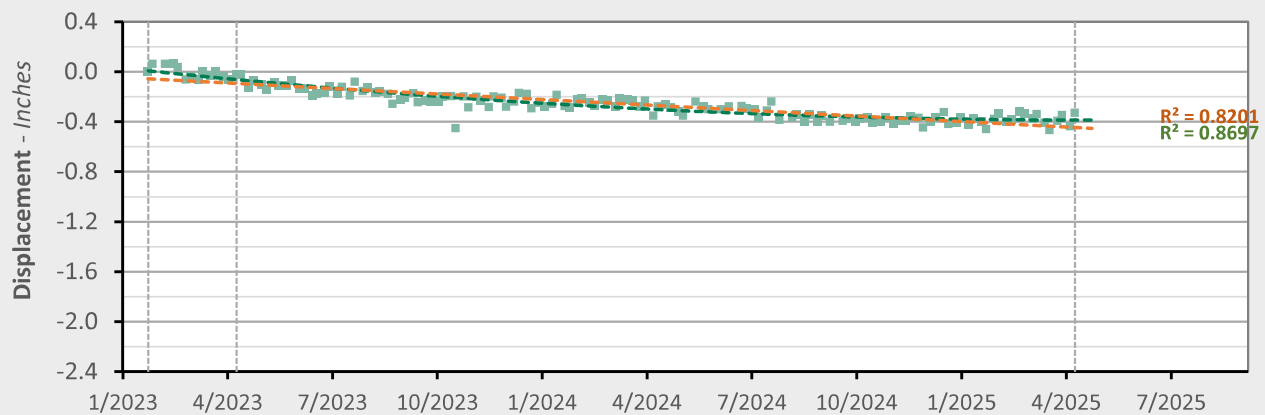
	Nonlinear Trend	Linear Trend
Velocity:	-0.01 in/yr	-0.18 in/yr
Acceleration:	+0.15 in/yr^2	0.00 in/yr^2

■ LOS Displacement Measurement | ----- Nonlinear Trend Line (Quadratic Regression) | ----- Linear Trend Line (Linear Regression)

AOI 3 - Location Map
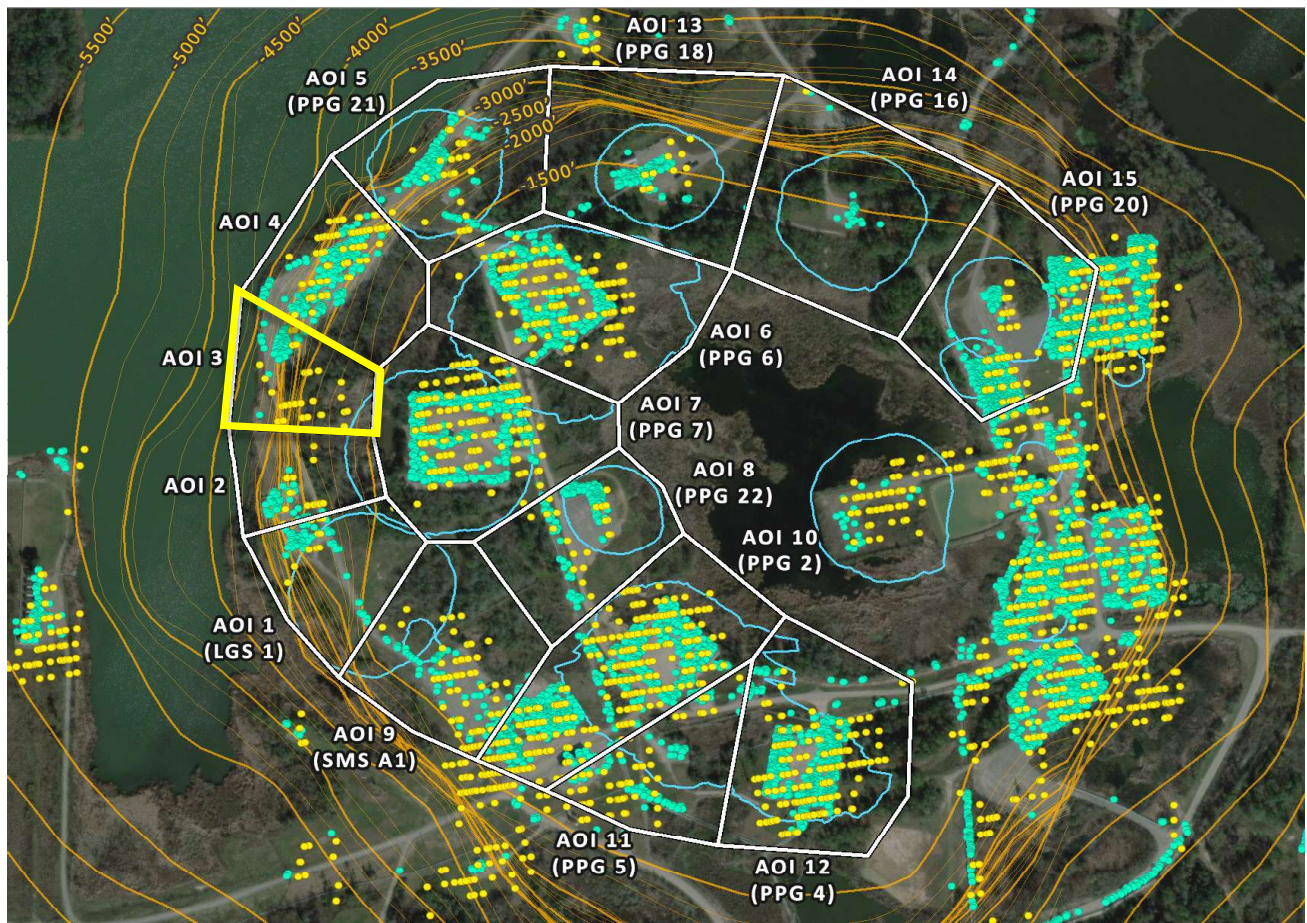
AOI 3 - Displacement Time Series

TSX/PAZ (4/10/2025) Point Count: **71**

R² = 0.9573
R² = 0.965
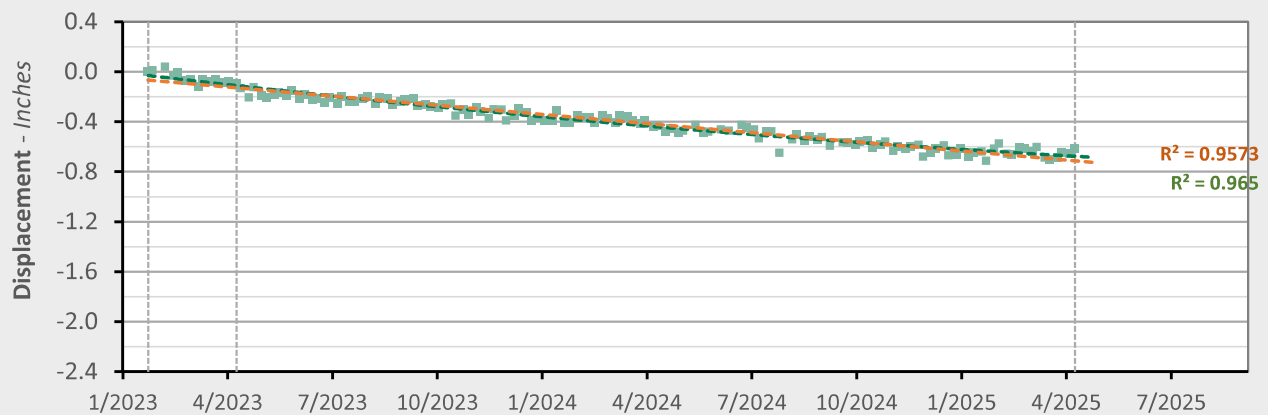
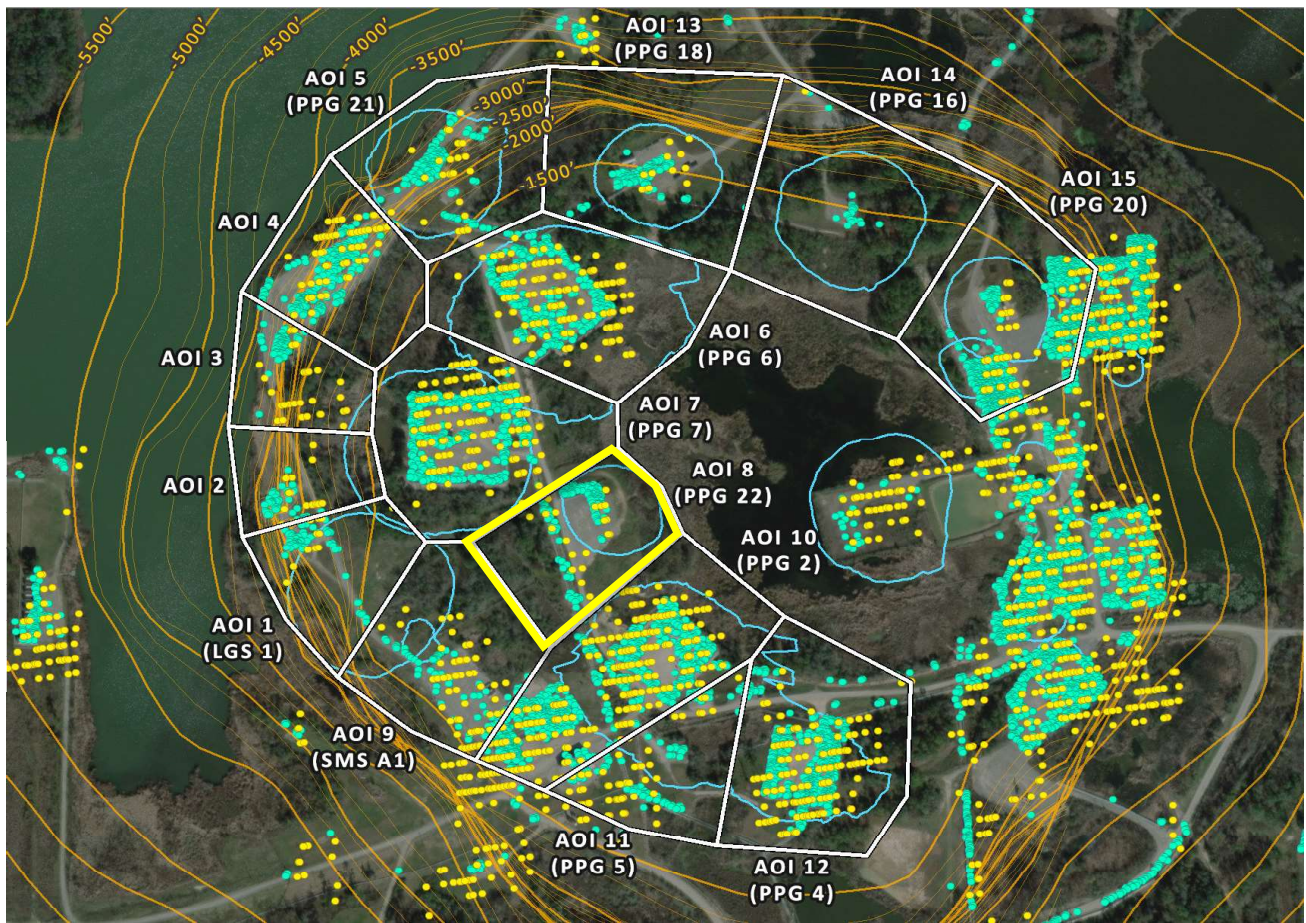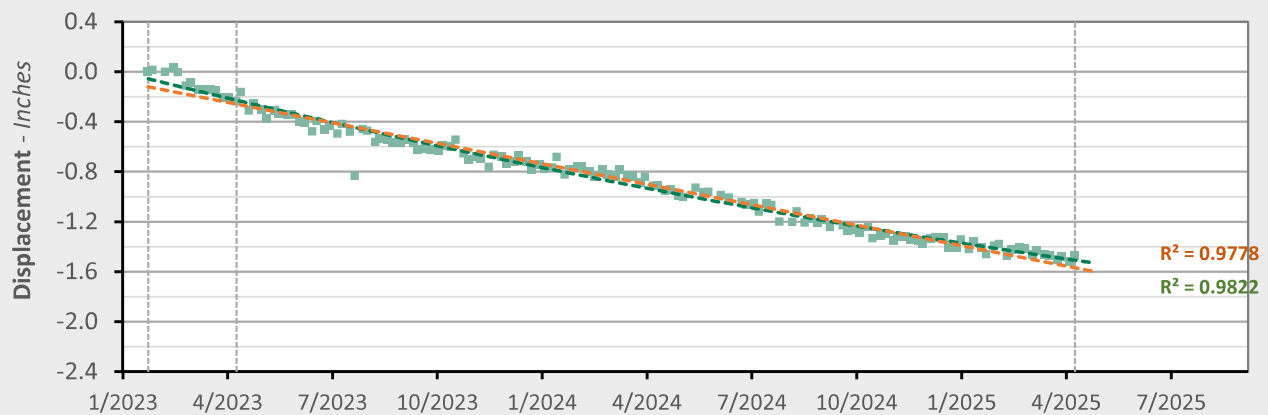|	Nonlinear Trend	Linear Trend
Velocity:	-0.19 in/yr	-0.29 in/yr
Acceleration:	+0.09 in/yr²	0.00 in/yr²

LOS Displacement Measurement · Nonlinear Trend Line (Quadratic Regression) · Linear Trend Line (Linear Regression)

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AOI 4 - Location Map
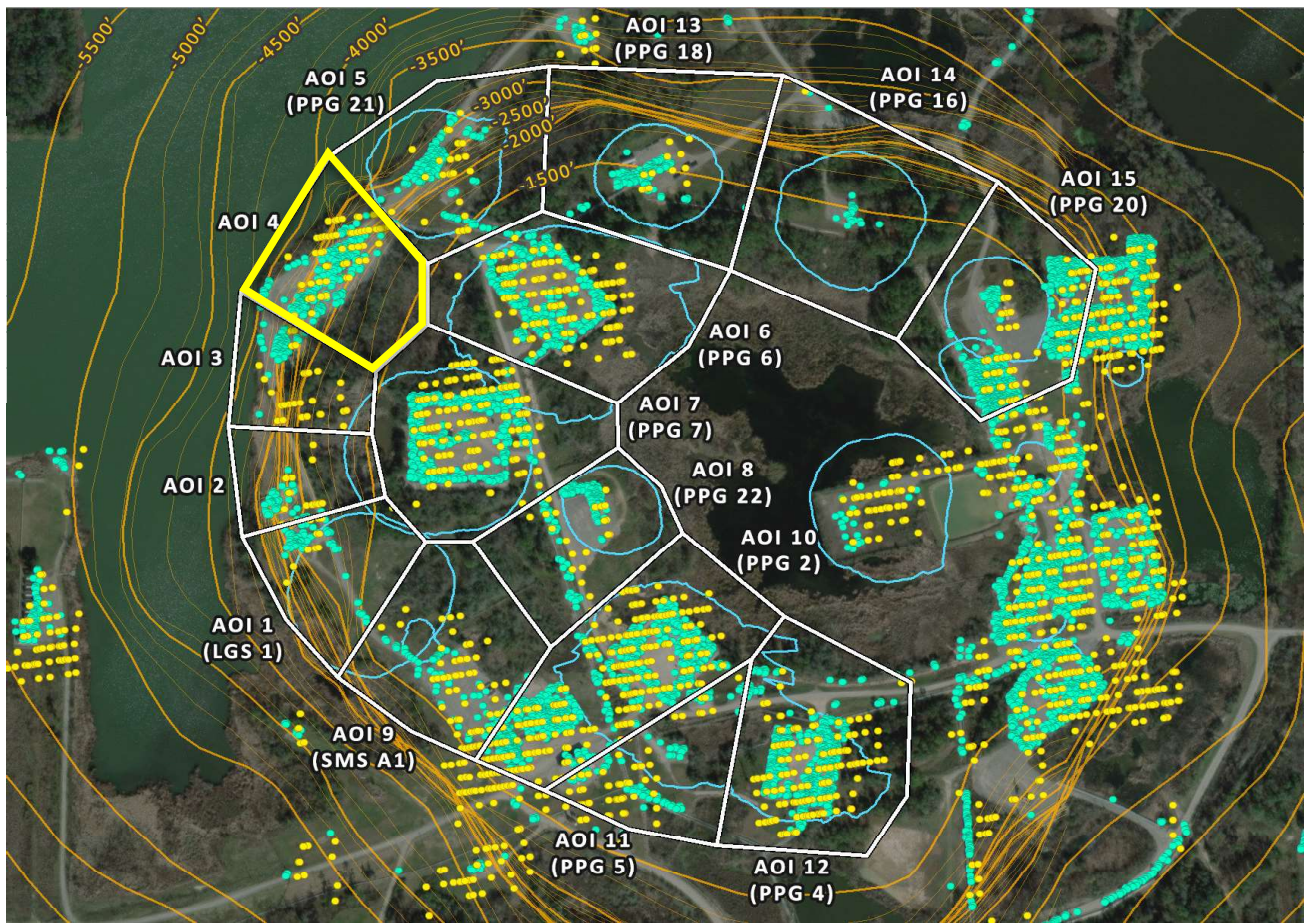
AOI 4 - Displacement Time Series   TSX/PAZ (4/10/2025) Point Count: **224**

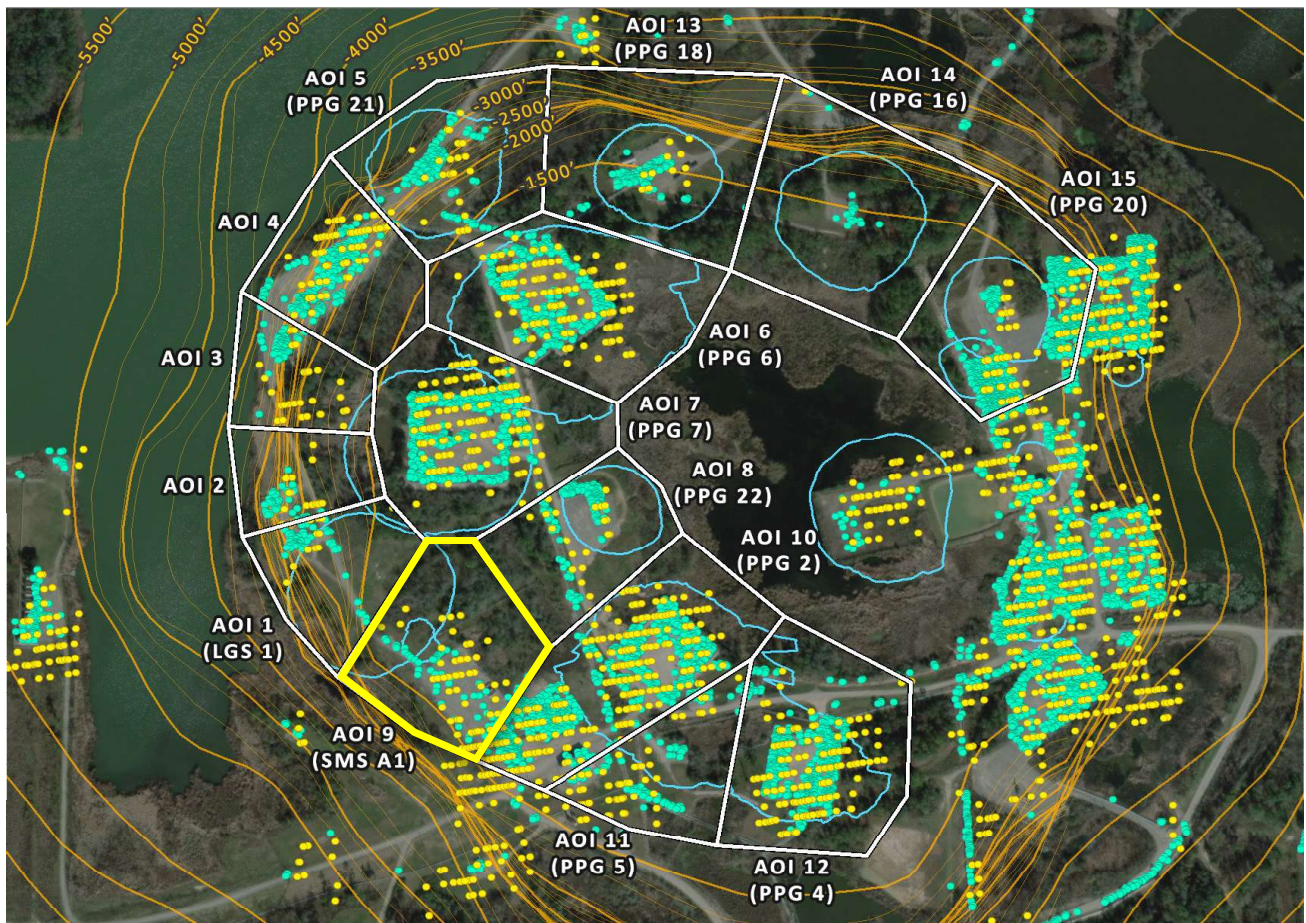|	Nonlinear Trend	Linear Trend
Velocity:	-0.02 in/yr	-0.12 in/yr
Acceleration:	+0.09 in/yr^2	0.00 in/yr^2

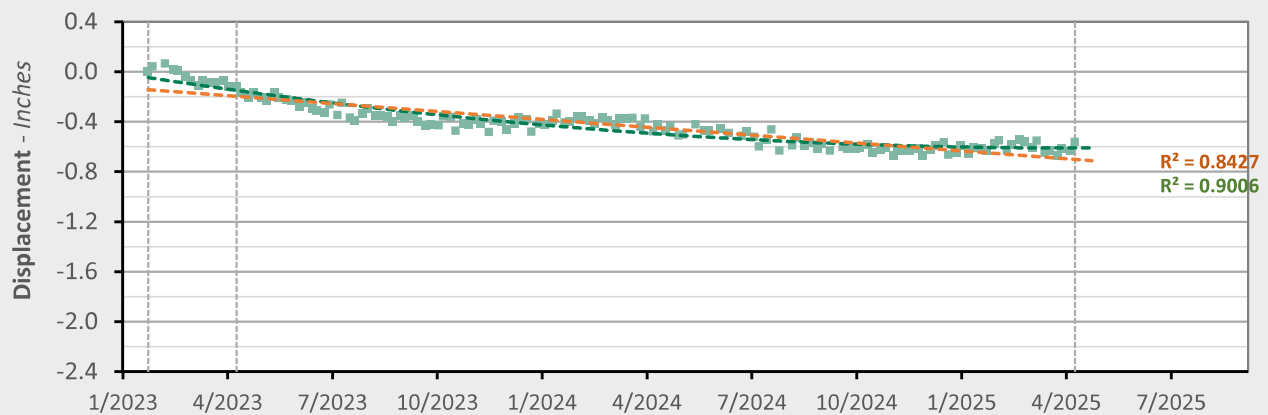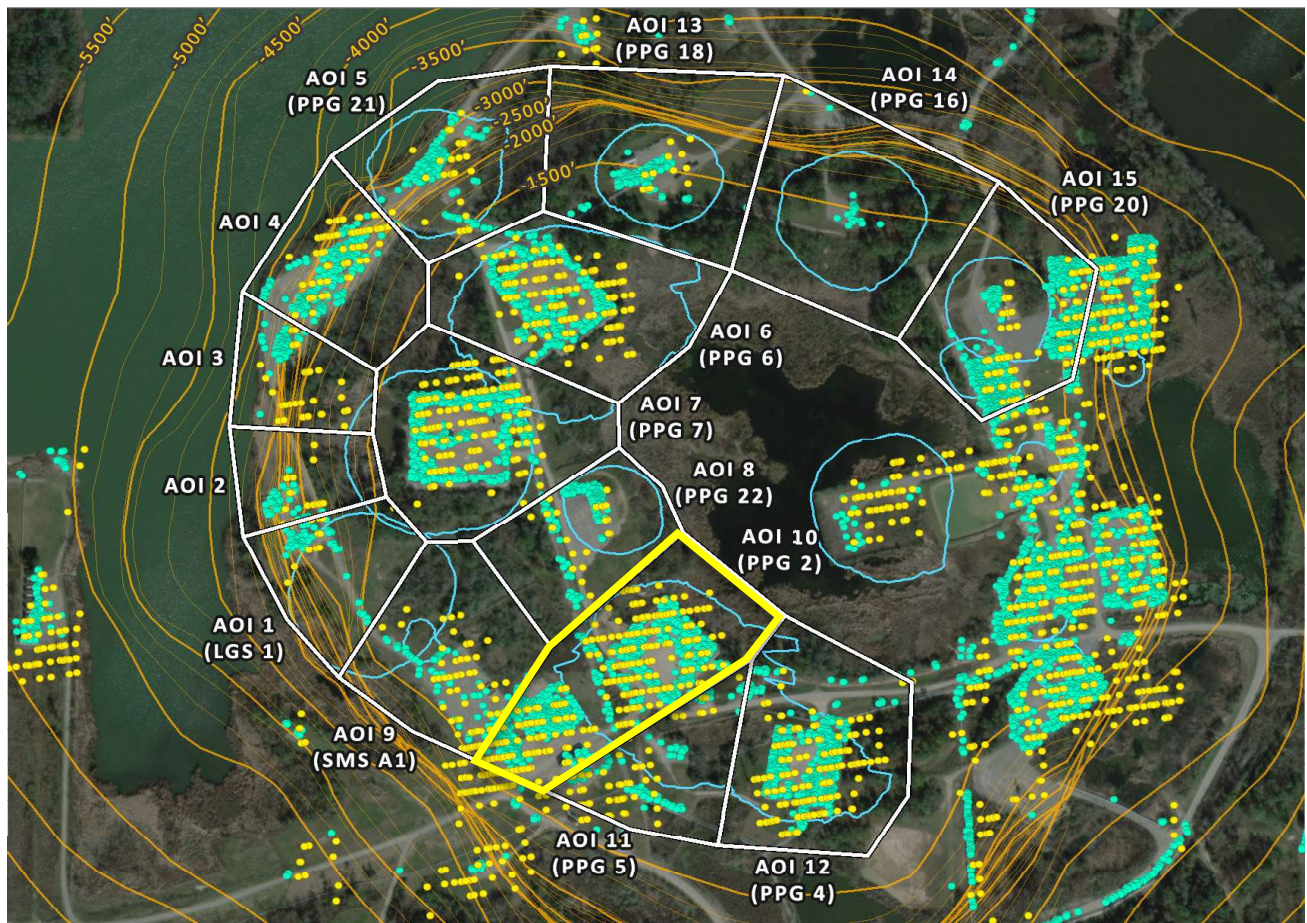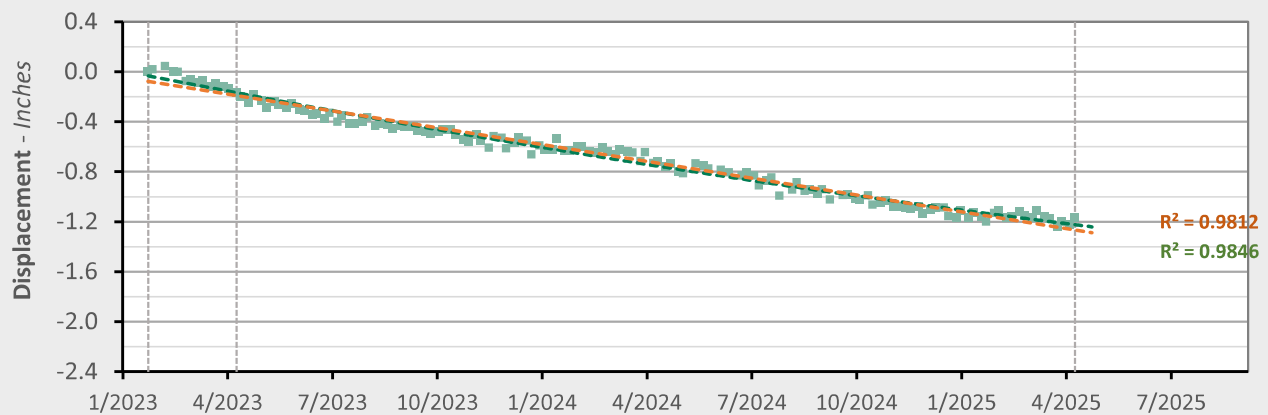■ LOS Displacement Measurement   - - - Nonlinear Trend Line (Quadratic Regression)   - - - Linear Trend Line (Linear Regression)

AOI 5 *(PPG 21)* - Location Map
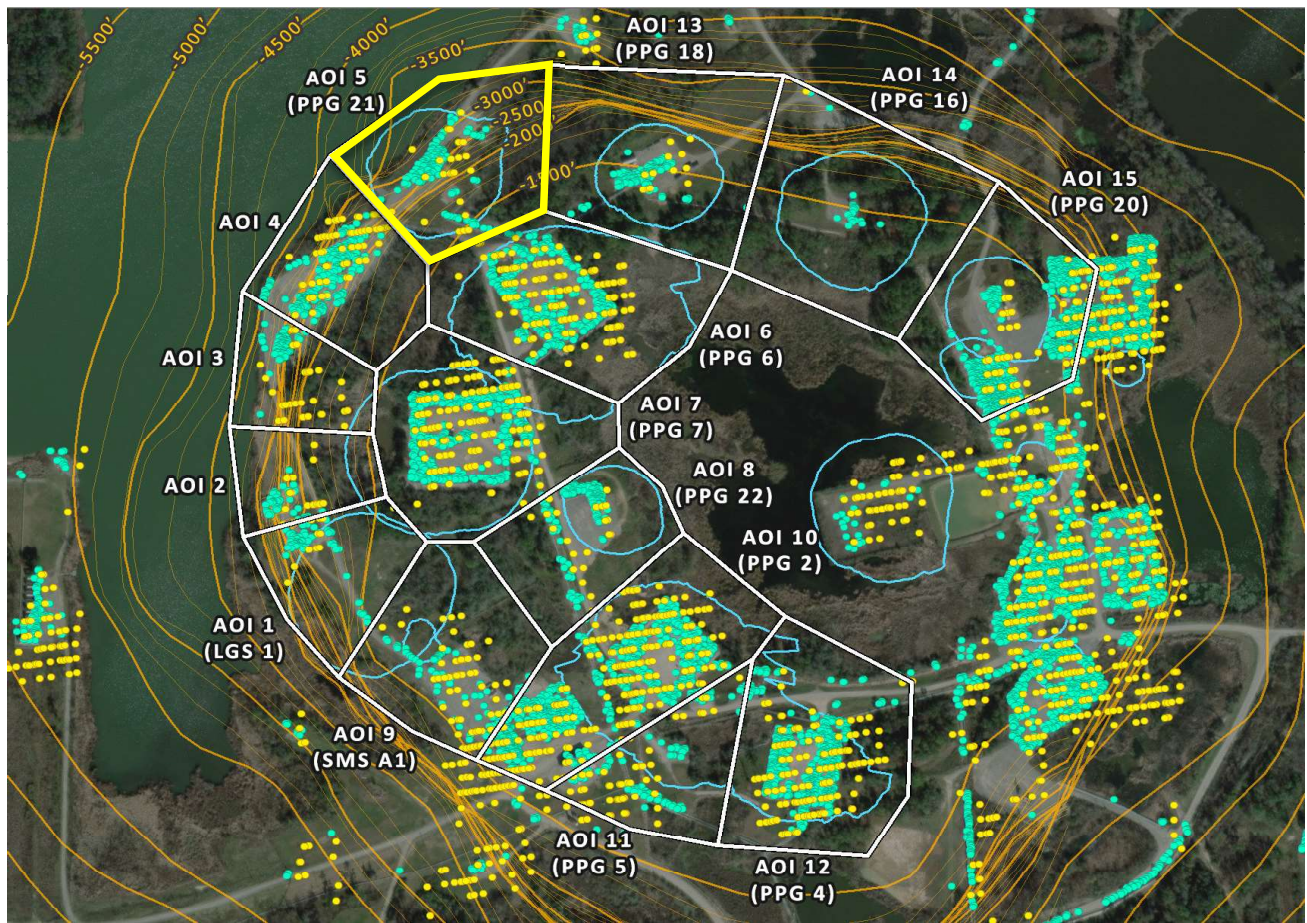
AOI 5 *(PPG 21)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **138**

$R^2 = 0.7938$

$R^2 = 0.8098$
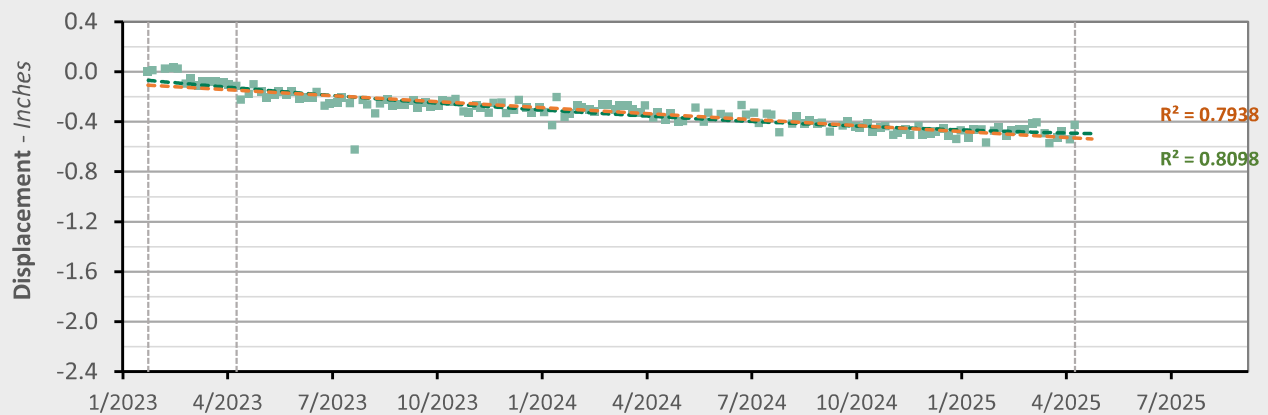
	Nonlinear Trend	Linear Trend
Velocity:	-0.09 in/yr	-0.19 in/yr
Acceleration:	+0.10 in/yr^2	0.00 in/yr^2

- ■ LOS Displacement Measurement
- ---- Nonlinear Trend Line (Quadratic Regression)
- ---- Linear Trend Line (Linear Regression)

AOI 6 *(PPG 6)* - Location Map

AOI 6 *(PPG 6)* - Displacement Time Series   TSX/PAZ (4/10/2025) Point Count: **356**

R² = 0.9716
R² = 0.9741

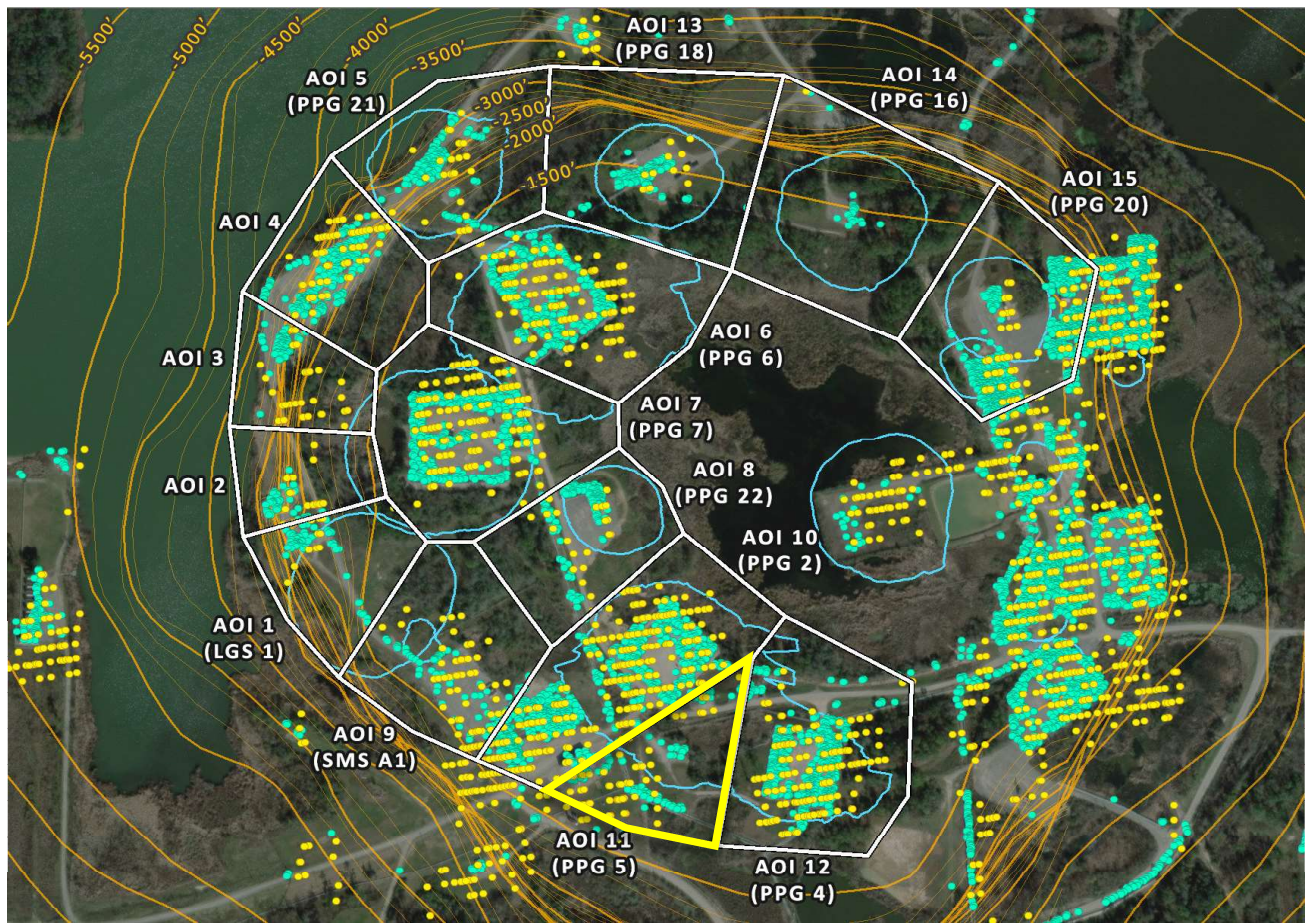|	Nonlinear Trend	Linear Trend
Velocity:	-0.37 in/yr	-0.46 in/yr
Acceleration:	+0.08 in/yr²	0.00 in/yr²

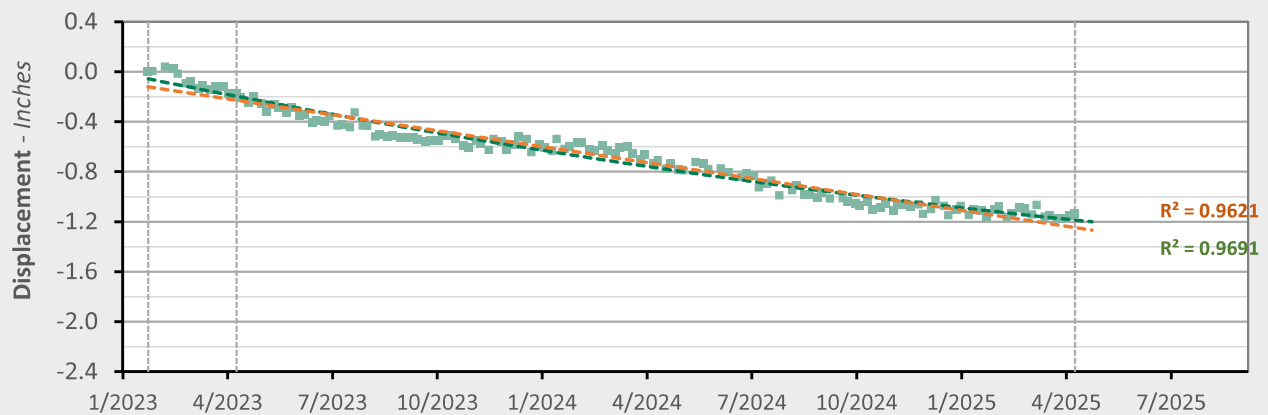■ LOS Displacement Measurement   ┄ Nonlinear Trend Line (Quadratic Regression)   ┄ Linear Trend Line (Linear Regression)

AOI 7 *(PPG 7)* - Location Map
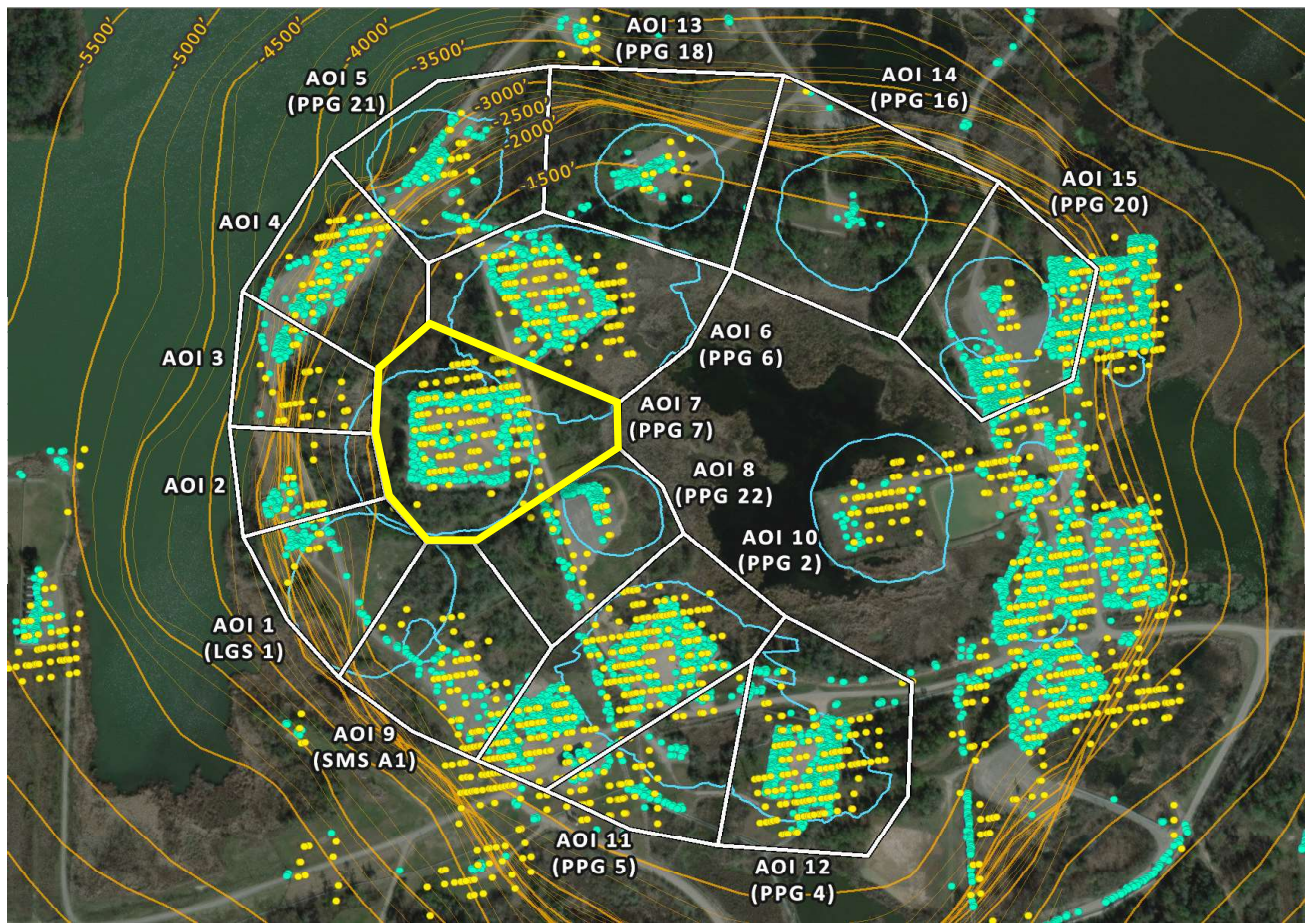
AOI 7 *(PPG 7)* - Displacement Time Series   TSX/PAZ (4/10/2025) Point Count: **396**

R² = 0.9553
R² = 0.9602

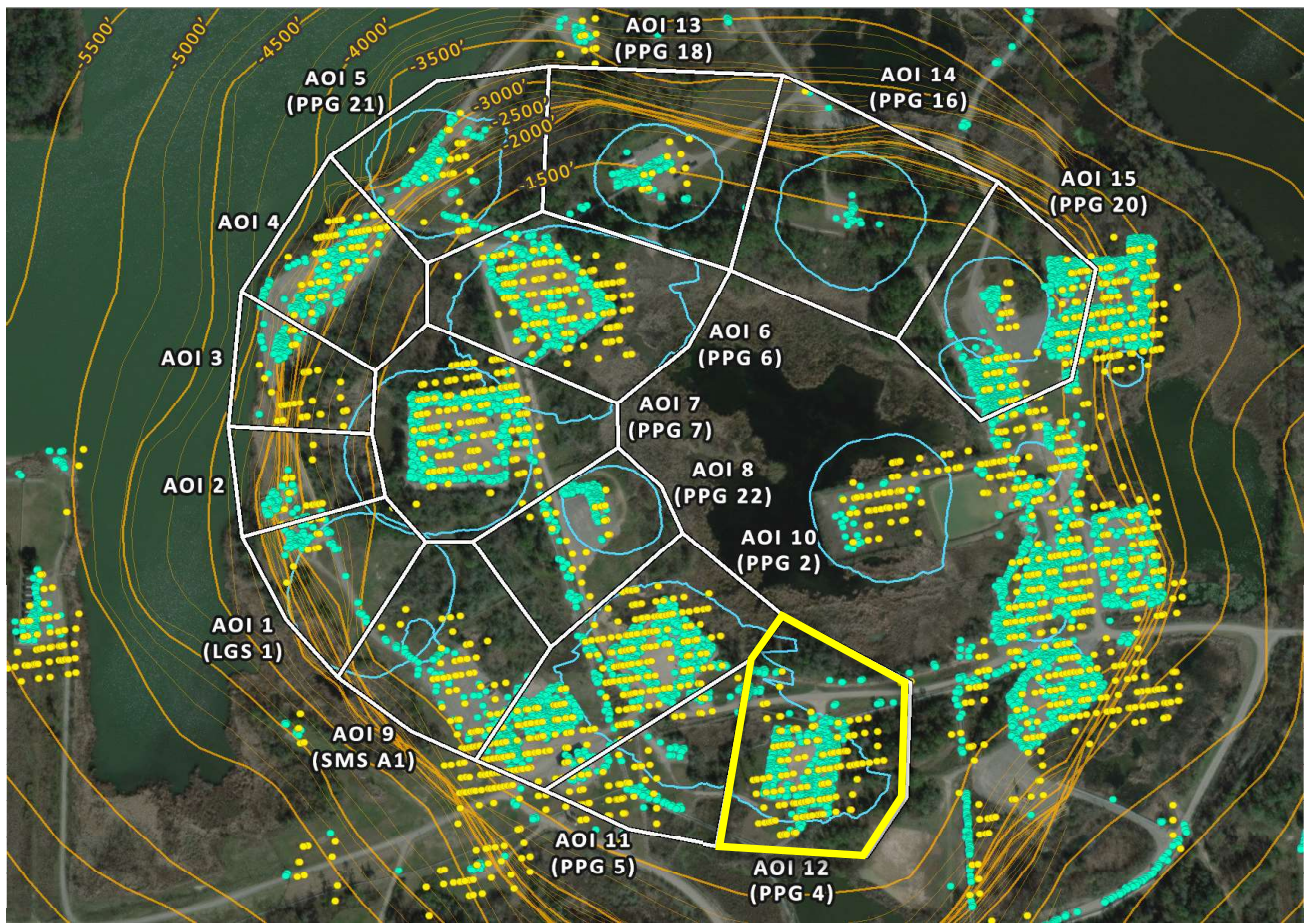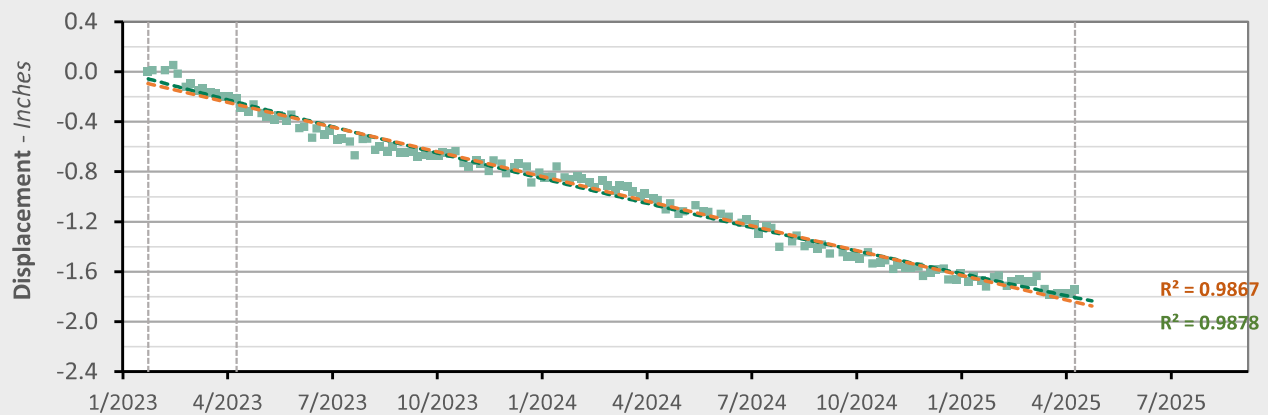|	Nonlinear Trend	Linear Trend
Velocity:	-0.25 in/yr	-0.35 in/yr
Acceleration:	+0.09 in/yr²	0.00 in/yr²

■ LOS Displacement Measurement   ---- Nonlinear Trend Line (Quadratic Regression)   ---- Linear Trend Line (Linear Regression)

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AOI 8 *(PPG 22)* - Location Map

AOI 8 *(PPG 22)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **127**

R² = 0.9778
R² = 0.9822

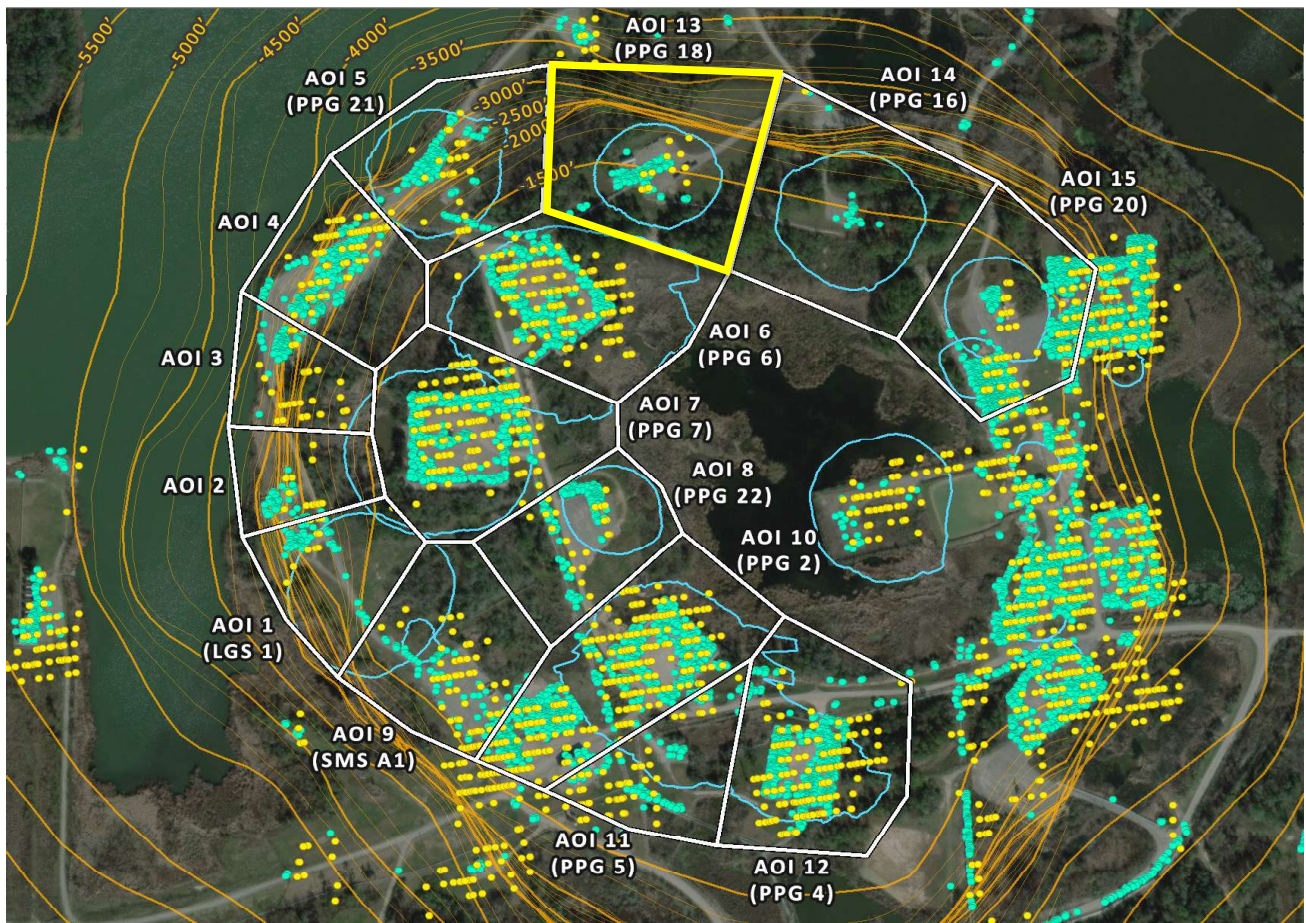|	Nonlinear Trend	Linear Trend
Velocity:	-0.48 in/yr	-0.66 in/yr
Acceleration:	+0.16 in/yr^2	0.00 in/yr^2

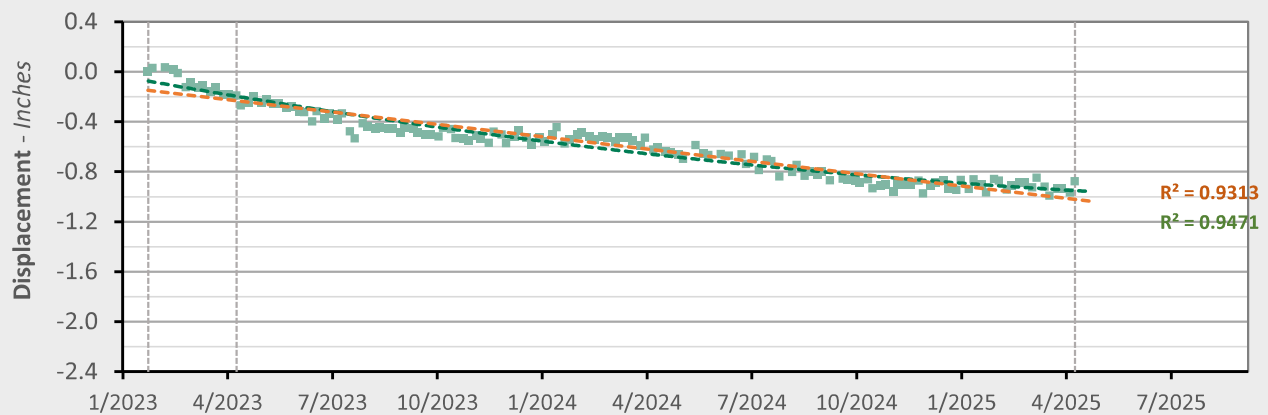■ LOS Displacement Measurement   - - - Nonlinear Trend Line (Quadratic Regression)   - - - Linear Trend Line (Linear Regression)

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AOI 9 *(PPG A1)* - Location Map

AOI 9 *(SMS A1)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **69**

R² = 0.8427
R² = 0.9006

	Nonlinear Trend	Linear Trend
Velocity:	+0.00 in/yr	-0.25 in/yr
Acceleration:	+0.23 in/yr²	0.00 in/yr²

■ LOS Displacement Measurement — — Nonlinear Trend Line (Quadratic Regression) — — Linear Trend Line (Linear Regression)

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AOI 10 *(PPG 2)* - Location Map

AOI 10 *(PPG 2)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **809**

R² = 0.9812
R² = 0.9846

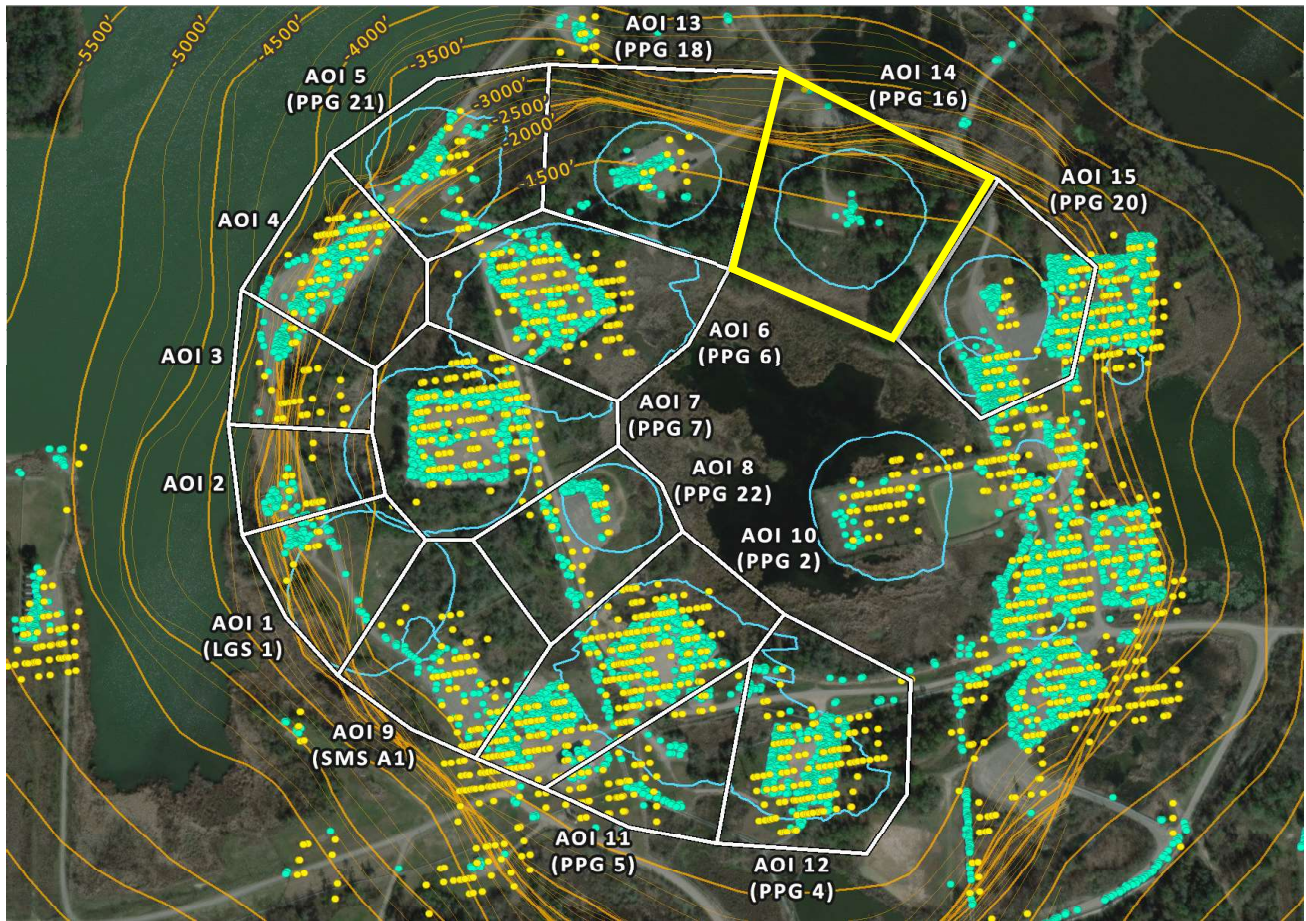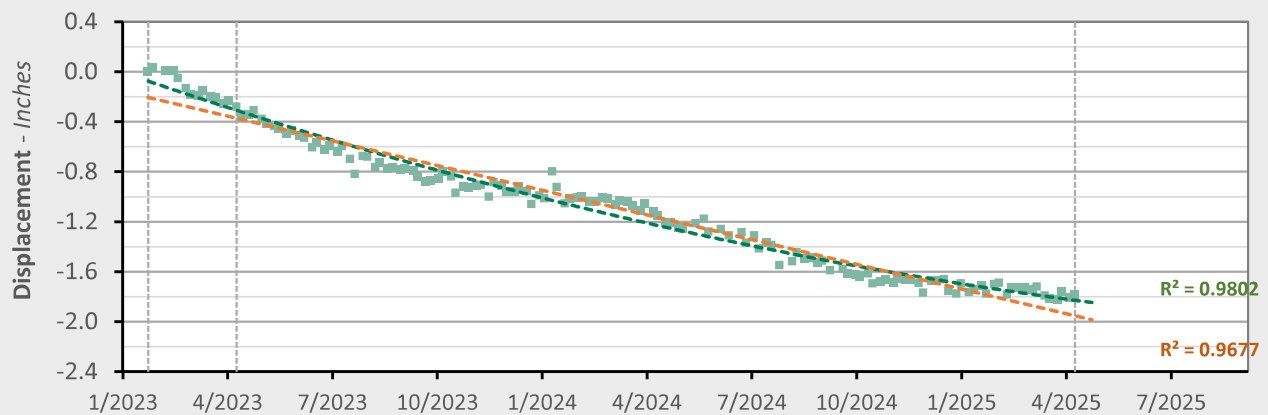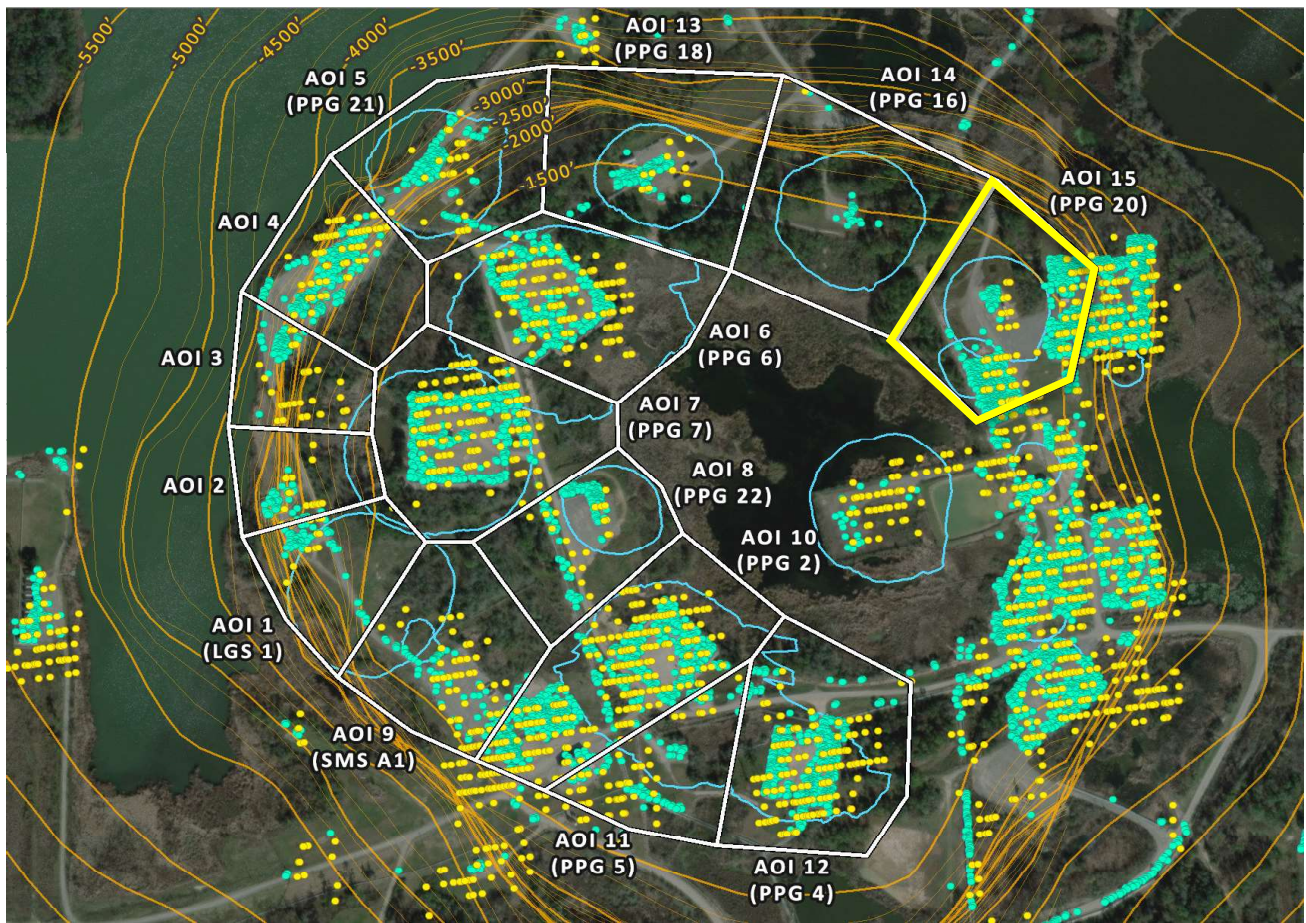|	Nonlinear Trend	Linear Trend
Velocity:	-0.42 in/yr	-0.54 in/yr
Acceleration:	+0.11 in/yr²	0.00 in/yr²

- ■ LOS Displacement Measurement
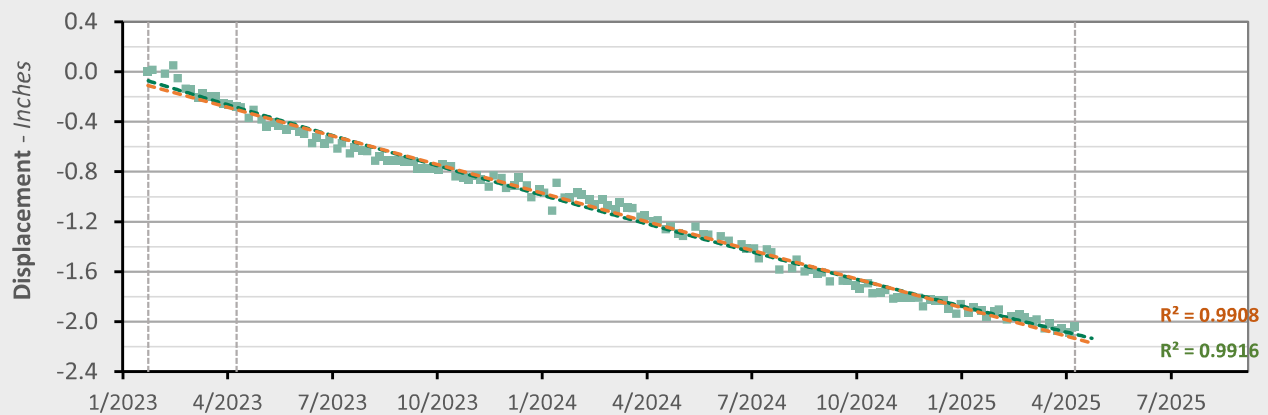- - - Nonlinear Trend Line (Quadratic Regression)
- - - Linear Trend Line (Linear Regression)

AOI 11 *(PPG 5)* - Location Map

AOI 11 *(PPG 5)* - Displacement Time Series   TSX/PAZ (4/10/2025) Point Count: **127**

	Nonlinear Trend	Linear Trend
Velocity:	-0.34 in/yr	-0.51 in/yr
Acceleration:	+0.15 in/yr^2	0.00 in/yr^2

■ LOS Displacement Measurement   ┅ Nonlinear Trend Line (Quadratic Regression)   ┅ Linear Trend Line (Linear Regression)

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AOI 12 *(PPG 4)* - Location Map

AOI 12 *(PPG 4)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **553**

R² = 0.9867
R² = 0.9878

	Nonlinear Trend	Linear Trend
Velocity:	-0.69 in/yr	-0.79 in/yr
Acceleration:	+0.09 in/yr^2	0.00 in/yr^2

■ LOS Displacement Measurement
- - - Nonlinear Trend Line (Quadratic Regression)
- - - Linear Trend Line (Linear Regression)

AOI 13 *(PPG 18)* - Location Map

AOI 13 *(PPG 18)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **108**

	Nonlinear Trend	Linear Trend
Velocity:	-0.20 in/yr	-0.39 in/yr
Acceleration:	+0.18 in/yr^2	0.00 in/yr^2

■ LOS Displacement Measurement   — — Nonlinear Trend Line (Quadratic Regression)   — — Linear Trend Line (Linear Regression)

AOI 14 *(PPG 16)* - Location Map

AOI 14 *(PPG 16)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **22**

$R^2 = 0.9802$

$R^2 = 0.9677$

	Nonlinear Trend	Linear Trend
Velocity:	-0.44 in/yr	-0.79 in/yr
Acceleration:	+0.32 in/yr^2	0.00 in/yr^2

- ■ LOS Displacement Measurement
- - - Nonlinear Trend Line (Quadratic Regression)
- - - Linear Trend Line (Linear Regression)

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AOI 15 *(PPG 20)* - Location Map

AOI 15 *(PPG 20)* - Displacement Time Series TSX/PAZ (4/10/2025) Point Count: **742**

$R^2 = 0.9908$
$R^2 = 0.9916$

	Nonlinear Trend	Linear Trend
Velocity:	-0.82 in/yr	-0.92 in/yr
Acceleration:	+0.09 in/yr^2	0.00 in/yr^2

- LOS Displacement Measurement
- Nonlinear Trend Line (Quadratic Regression)
- Linear Trend Line (Linear Regression)

TSX/PAZ Data (01/24/2023 - 04/10/2025)

Nonlinear Velocity Contours
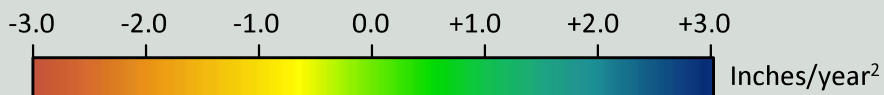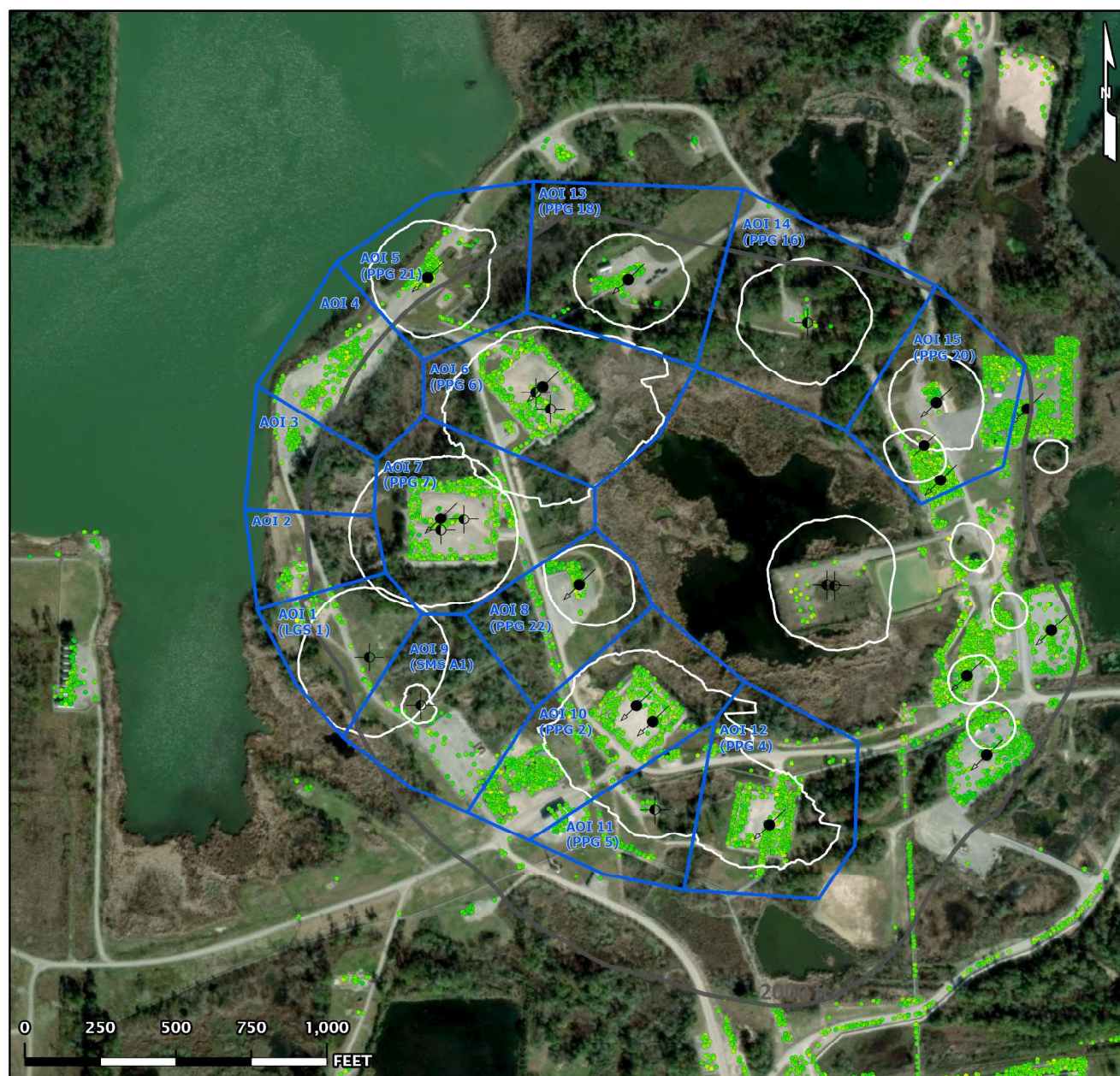As of date: 04/10/2025

Inches/year

AOI Boundary | InSAR LOS Measurement Point | Contour (0.2)
Historical Cavern Extent | Top of Dome (-2000 ft Contour)

Cavern Well Surface Locations
09 - Active - Injection | 29 - Dry and Plugged
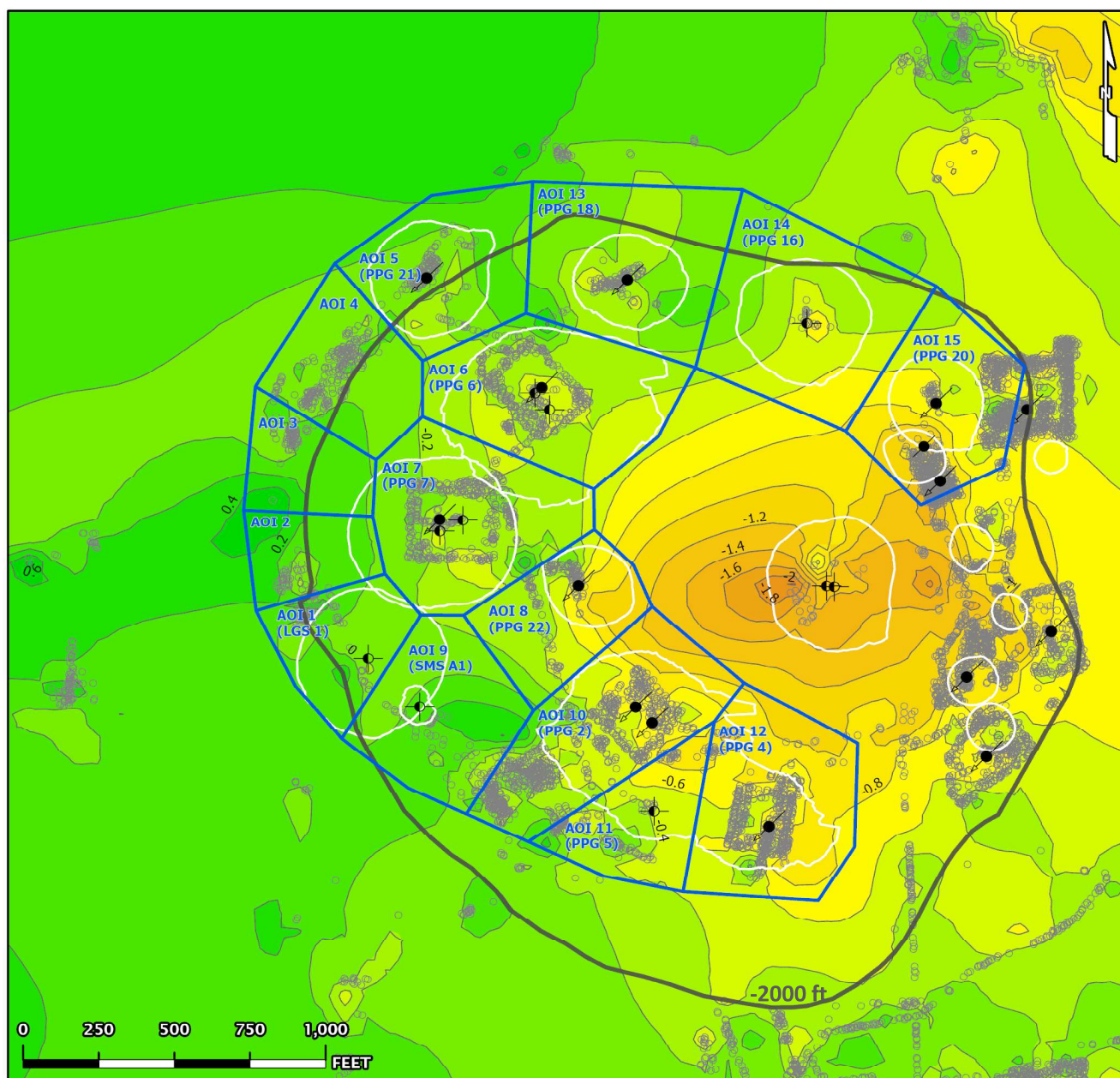
**TSX/PAZ Data (01/24/2023 - 04/10/2025)**

Nonlinear Acceleration Contours
Date range: 01/24/2023 - 04/10/2025

Inches/year^2

AOI Boundary — InSAR LOS Measurement Point — Contour (0.2)
Historical Cavern Extent — Top of Dome (-2000 ft Contour)

Cavern Well Surface Locations
09 - Active - Injection   29 - Dry and Plugged
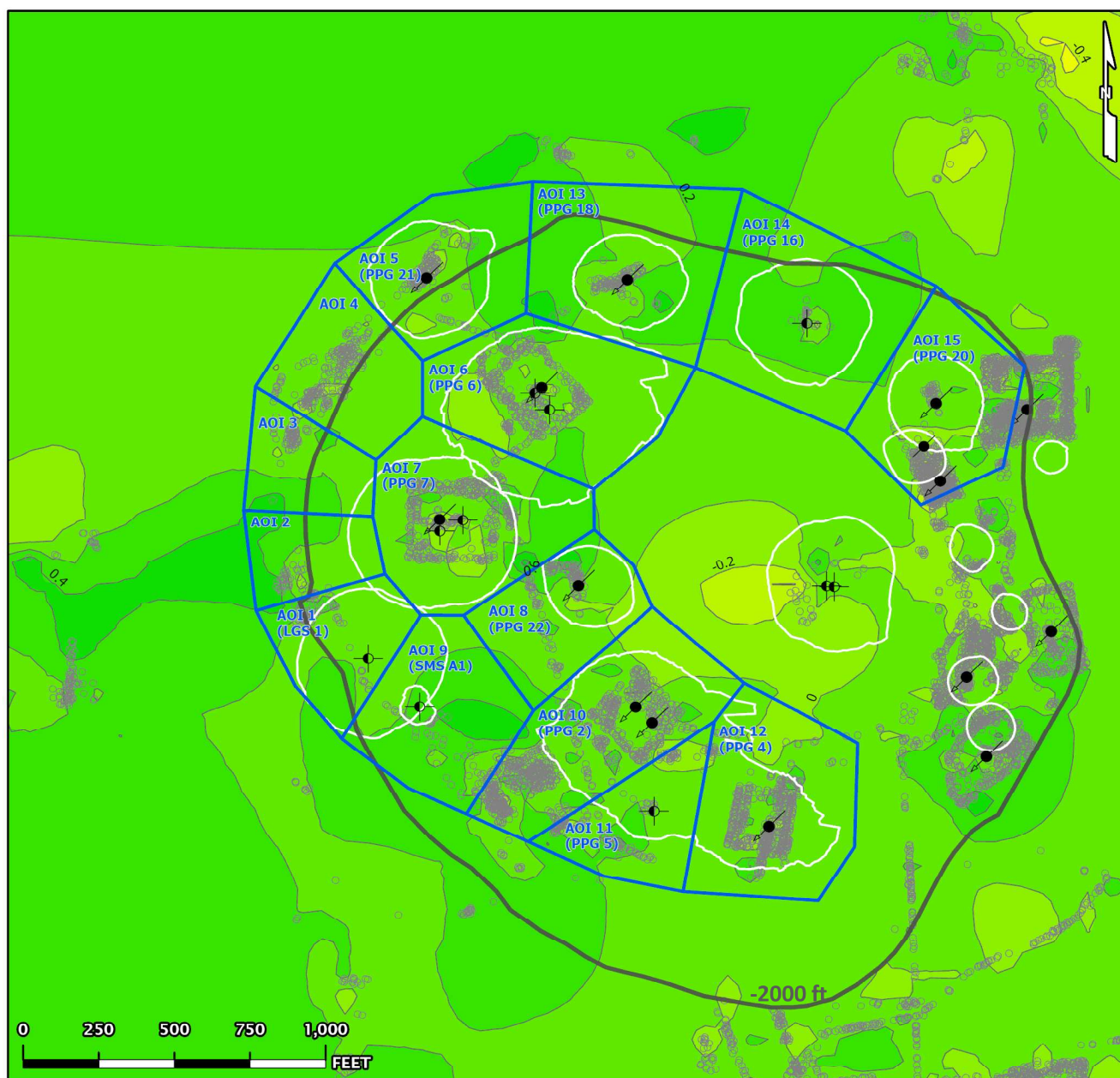
TSX/PAZ Data (01/24/2023 - 04/10/2025)

Linear Velocity Contours
Date range: 01/24/2023 - 04/10/2025
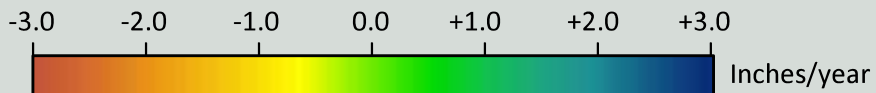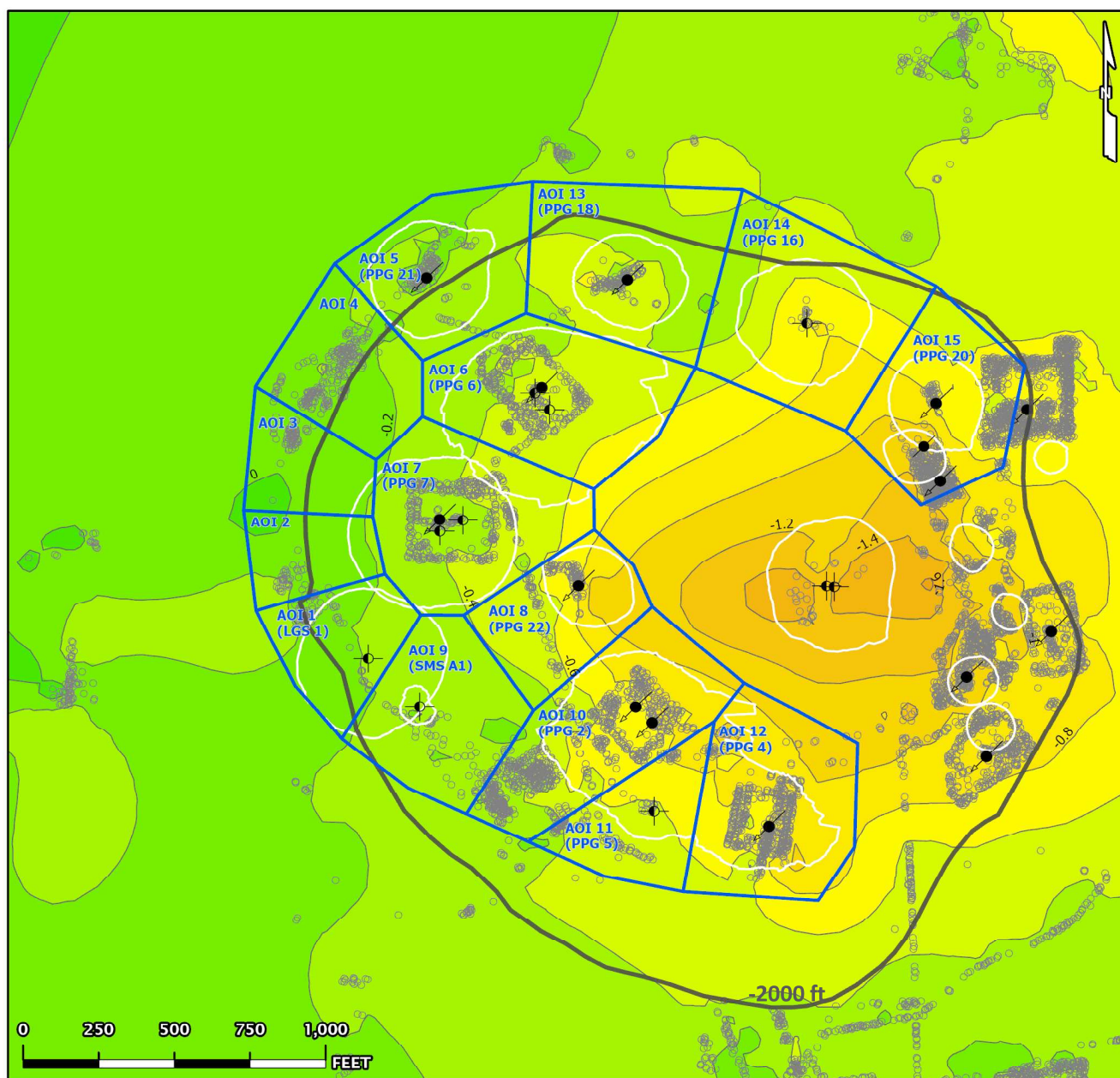
-3.0 -2.0 -1.0 0.0 +1.0 +2.0 +3.0

Inches/year

AOI Boundary   ○ InSAR LOS Measurement Point   — Contour (0.2)

Historical Cavern Extent   Top of Dome (-2000 ft Contour)

Cavern Well Surface Locations

09 - Active - Injection   29 - Dry and Plugged

TSX/PAZ Data (01/24/2023 - 04/10/2025)

Nonlinear Velocity Data Points
As of date: 04/10/2025
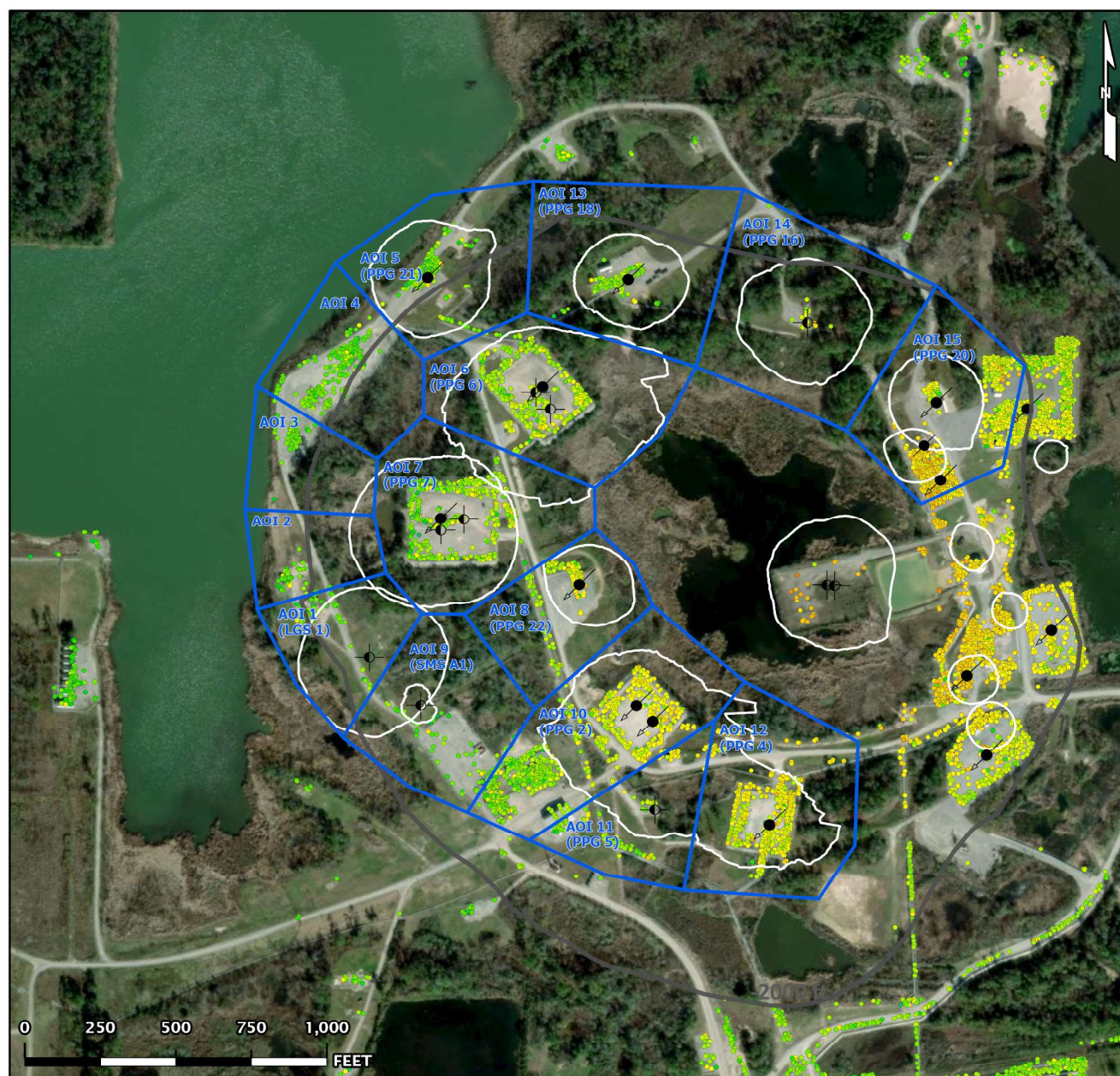
-3.0   -2.0   -1.0   0.0   +1.0   +2.0   +3.0

Inches/year

☐ AOI Boundary   ○ InSAR LOS Measurement Point

☐ Historical Cavern Extent   ▬ Top of Dome (-2000 ft Contour)

Cavern Well Surface Locations

09 - Active - Injection   29 - Dry and Plugged

TSX/PAZ Data (01/24/2023 - 04/10/2025)

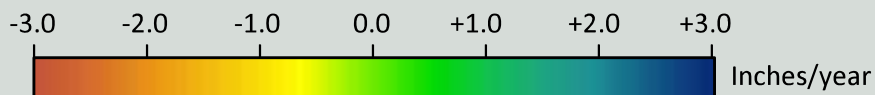### Nonlinear Acceleration Data Points
Date range: 01/24/2023 - 04/10/2025

-3.0 -2.0 -1.0 0.0 +1.0 +2.0 +3.0
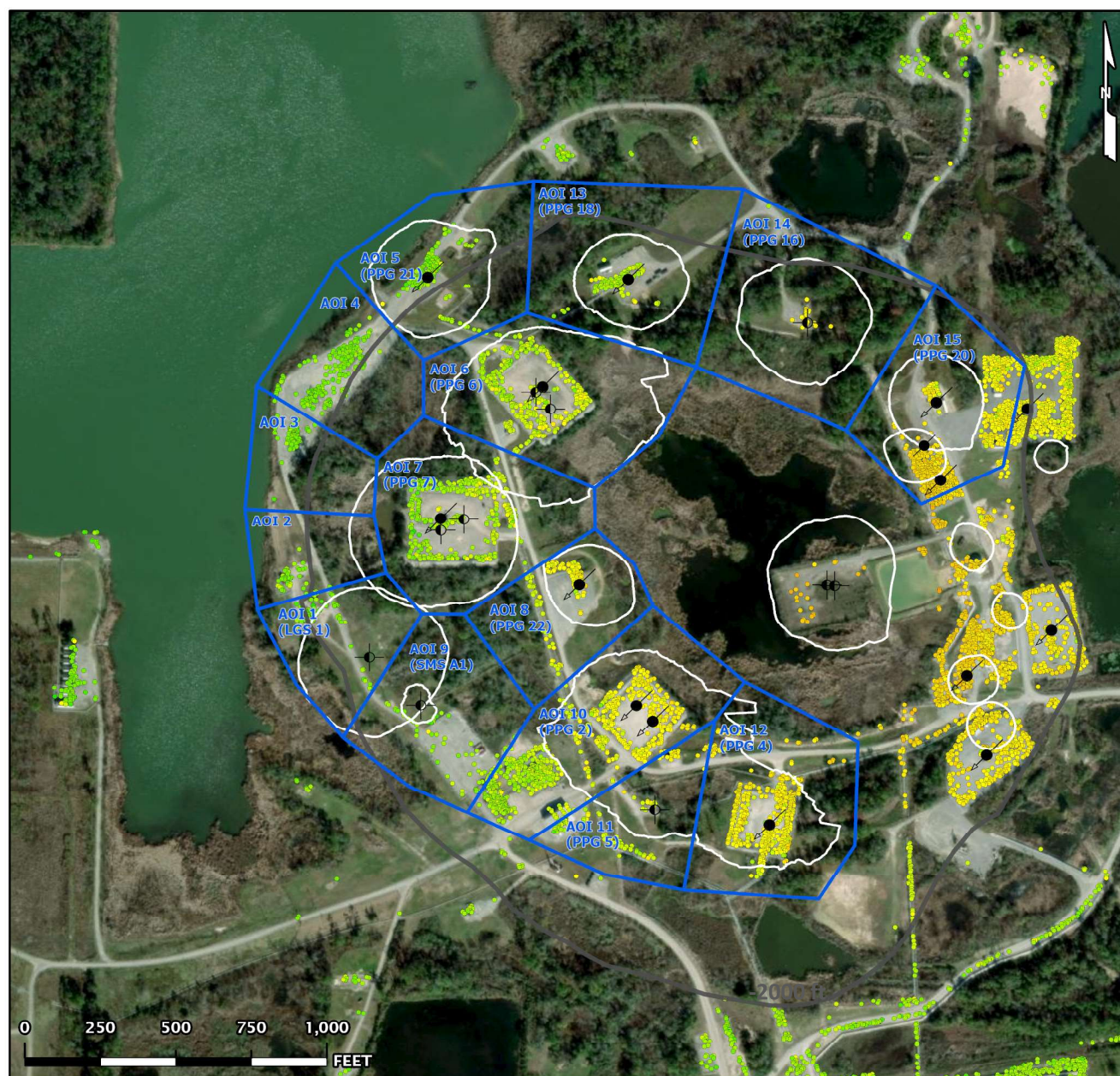
Inches/year^2

☐ AOI Boundary   ○ InSAR LOS Measurement Point
☐ Historical Cavern Extent   ▬ Top of Dome (-2000 ft Contour)

Cavern Well Surface Locations

✦ 09 - Active - Injection   ✛ 29 - Dry and Plugged

TSX/PAZ Data (01/24/2023 - 04/10/2025)

Linear Velocity Data Points
Date range: 01/24/2023 - 04/10/2025

-3.0   -2.0   -1.0   0.0   +1.0   +2.0   +3.0

Inches/year

☐ AOI Boundary   ○ InSAR LOS Measurement Point
☐ Historical Cavern Extent   ▬ Top of Dome (-2000 ft Contour)

Cavern Well Surface Locations

09 - Active - Injection   29 - Dry and Plugged