Baldwin Hills CSD Inglewood Surface Monitoring Program: Evaluation of 2021 Survey, 2020-2021 Production Year, Results

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Contents

1. Executive Summary

This report summarizes InterAct's analysis of ground survey data, satellite data, and oilfield activities such as liquid injection/production, individual oil producing zones, and pressure data as it pertains to vertical and horizontal elevation change measured during the production period from July 2020 through June 2021.

Analysis of ground movement as it relates to the Baldwin Hills Community Standards District (BHCSD) began in Year 2010 with a baseline study. Each year since, oilfield operations in the Inglewood Field are evaluated with regard to ground movement data.

The area of investigation for the surveying extends approximately one mile in all directions from the field boundary and includes 57 active monuments as shown in **Figure 1.1.** In addition, satellite data is acquired over a 25-square-mile area centering the Inglewood Oil Field (IOF), currently operated by Sentinel Peak Resources (SPR).

We specifically analyzed the ground survey data (acquired August 5 through September 2, 2021 by Psomas, with leveling runs done from August 23 through September 30, 2021), the Interferometric Synthetic Aperture Radar surveys (InSAR; cumulative July 2020 through June 2021 by CGG), the IOF production/injection data from the Vickers Rindge (V/R) oil sands (cumulative July 2020 through June 2021 by SPR), and the reservoir pressure in the V/R oil sands, estimated from static fluid levels taken in May, 2021 by SPR. The V/R reservoir sands are the focus of the study because they comprise about 94% of field liquids production and are also highly porous with shallow burial depths. A comparison of the survey data was done for the data acquired in 2020 to the data acquired in 2021. We find that:

1. There were no monument changes over the 12 month period; all monitoring control points remained intact in 2021.
2. Overall field fluid replacement ratio is 101.8% for the V/R reservoirs. This indicates that fluid injection and withdrawal are essentially balanced.
3. Average V/R reservoir pressure in 2021 is 987 psi, higher than the 953 psi pressure (corrected for casing pressure) recorded in 2020, further validating that subsurface pressures are prevented from declining by injection activities.
4. Six of the monument locations as recorded by the ground survey moved more than 0.6 inches vertically, the threshold as specified in the BHCSD ordinance. All movements exceeding this threshold were in the positive (uplift) direction.
5. Max survey elevation increase was +1.16 at monument 308, near the center of **Fig 1.1**.
6. Max survey elevation decrease was -0.41 at monument 140, near the top of **Fig 1.1**.
7. There was a poor correlation between ground movement and operations at the fieldwide and local level. There appears to be a qualitative relationship on a larger regional level in some parts of the field.
8. The ground movements observed in the current and past Annual Ground Movement Surveys (AGMS) are relatively small and, taken in context with overall Los Angeles Basin ground movement, are not considered unusual or excessive. Ground movements also show significant variations in displacement (both magnitude and direction) from year to year. Field operations alone cannot account for this variation as they are essentially stable, suggesting several independent factors are involved in observed ground motion.

The geotechnical analysis can be found in Laguna Geoscience's report and the year 2021 survey data can be found in the report from Psomas; the results are incorporated in this report.

2. Introduction and Background

The BHCSD survey monitoring program began in 2010 and requires the operator to conduct ground movement surveys, including both vertical and horizontal surveys, once every 12 months. A variance was granted for the 12-month period to be extended to 18 months in 2020 due to the COVID-19 pandemic. The 2021 period is again a 12 month period, but the time frame has shifted from a calendar year to the July 2020-June 2021 time period. This is because the 18 month period in 2020 ended in June 2020.

The survey results are analyzed in relation to oil field activities, taking into consideration individual oil producing zones, production and injection volumes, and reservoir pressure. The intent of this program is to monitor subsidence, and where subsidence damage is found to be caused by oil operations, to adjust operations accordingly.

InterAct's review by a Registered Professional Engineer and a Licensed Professional Geologist, Laguna Geosciences, Inc. review by a Registered Geotechnical Engineer and Certified Engineering Geologist, and the inclusion of surveys by Psomas' licensed surveyor constitute SPR's current AGMS of the IOF, as required under the guidelines established by the BHCSD Environmental Impact Report (EIR) (Marine Research Specialists, 2008).

3. Monuments

Reference locations used for the AGMS include 57 actively monitored monuments both within and outside of the field boundaries. (**See Figure 1.1.)** Five monuments are older historical monuments (the 50000 series monuments). Thirty-five of the monuments were established by Psomas in 2010 both in and around the BHCSD (the 100 series monuments). Five monuments were established by Psomas in 2010 as benchmarks outside the BHCSD (the 200 series monuments). The twelve monuments installed in 2014 (the 300 series monuments) were driven to refusal to serve as twin monuments to those that could be unduly influenced by surface features such as hill slopes, tree roots, or other factors unrelated to actual ground movement.

The movement of these twinned monuments is relatively consistent with the original monument movement except for 2018, when there was essentially no correlation (see **Figure 3.1**). In 2018 and 2017-2020 displacements were relatively small, and the quality of the correlations may be at least partly attributed to a lower signal to noise ratio. It is recommended that in future years, only the 300 series monuments be incorporated into the analysis, as those monuments are considered to provide more accurate data on ground movement than the 12 original monuments they replaced.

No monument changes have occurred during the 12 month interval of this study; the 57 monuments used this year are intact from last year. (If the destroyed monuments are counted, there are 60 monuments, all of which are shown in **Figure 1.1**.)

4. InSAR

InSAR satellite data has been reviewed annually since 2010 as a complement to the annual survey data, although the BHCSD AGMS guidelines do not require it. The InSAR data is provided in 30 foot grid nodes throughout the area. These grid nodes are then grouped in 200 foot circles around each surveyed monument to compare InSAR data to survey data. As shown in **Figure 4.1**, the data correlates well; the R^2 correlation coefficient is the best observed to date. The size of the bubbles in the figure is proportional to the number of grid points in the 200 foot circle. The number of grid nodes around each monument ranges from 0-140, with the average being 112 grid nodes per monument. It is recommended that in future years, only the InSAR data be used to monitor ground movement, as it provides data for the entire BHCSD area rather than only at 57 discrete locations which survey data can provide. Also, InSAR data has an accuracy similar, in fact, slightly better this year, than that of GPS.

InSAR is also available to provide a regional view of ground movement in the Los Angeles Basin as shown in **Figure 4.2**. There is a noticeable band of local uplifts along the trace of the Newport Inglewood Fault, including the uplift seen in the BHCSD, indicating tectonism plays a role in ground movement in the study area this year.

For a 12-month period, the accuracy of the InSAR vertical displacement measurement is about +/- 0.24 inches. Details on the data acquisition, processing, and interpretation are given in CGG's 2021 report filed separately.

5. Oilfield Causes of Ground Movement

From the 1924 field discovery until the waterflood began in the 1950's, the Inglewood V/R interval was dominated by solution-gas drive (primary recovery), causing high reservoir pressure depletion and causally related ground subsidence. Once the waterflood began, ground movement due to oilfield causes declined accordingly. Relative to the five to ten feet of subsidence **recorded in the early years** of field development (and clearly attributed to oilfield operations), the cumulative ground movements observed in the 2010-2021 AGMS have been small, highly variable, and with a few exceptions, do not correlate well with field operational parameters. The relationship between the two has been examined at three different levels: local, regional, and fieldwide.

The production history from the V/R interval is shown in **Figure 5.1**, with the yearly production and waterflood injection volumes over the life of the field. The "net injection volume" is defined as the yearly waterflood *injection volume minus the liquid production volume* and has been positive for most of the last 25 years. The volume contribution of natural gas to this calculation is not considered to be significant. **Figure 5.2** provides a different perspective on the net injection volume by showing the *cumulative net fluid withdrawal* and the yearly *ratio of injection to production volume* over the life of the field for the V/R. The yearly injection volume first reached a balance with the yearly liquid production volume in 1972. Except for the value of 99.5% in 2010, the net injection ratio has been greater than 100% since 1995. It has been demonstrated in previous AGMS reports that this increase in net injection since the 1950's has reversed annual and cumulative subsidence caused by underbalanced production prior to that period. Since balance was permanently achieved in 1995, ground movement has been much smaller than in the early years of field development, and annual displacement has generally stabilized such that measurements tend to lie in a range comparable to the level of accuracy of the tools used to record them.

The 2017 engineering report (Minner Engineering, Inc., 2017) states that the original reservoir pressure gradient in the V/R was normal at 0.44 psi/foot subsea. When the large-scale installation of the waterflood was started in 1957, it was estimated that the pore pressure had dropped from the original 880 psi to 40-160 psi, a pressure gradient of 0.02-0.08 psi/foot (*Oefelein, 1963*) using a datum of 2000 feet below sea level (subsea). The fieldwide waterflood began in the Inglewood V/R interval to rebuild and stabilize reservoir pressure. The current average reservoir pressure is estimated to be 987 psi at 2000 feet subsea, with a gradient of 0.49 psi/foot, higher than the original reservoir pressure conditions, validating that the reservoir pressure has been re-established through water injection as shown in **Figure 5.3**. Static fluid levels and casing pressures taken in 2021 in the V/R were used to generate this isobaric map.

6. Ground Movement and Comparison to Previous Years

Survey Vertical Movement Results

The AGMS surveys were taken between August 2021 and September 2021, using both leveling and GPS conventional surveying techniques. This year's ground survey was conducted by Psomas, the same surveyor that conducted the survey from 2010-2017, and the 2020 survey. Survey accuracy depends on a number of factors; Psomas reports elevations within a 95% confidence interval, which is about +/- 0.29 inches. For reference, this compares to the +/- 0.24 inches reported above by CGG for InSAR. Additional technical detail can be found in the Psomas Survey Report.

Vertical ground movement results for 2021 are tabulated in **Table 6.1**. These results are shown as a gridded surface in **Figure 6.2a.** The change in elevation scale ranges from +1.5 inches (blue) to -1.5 inches (red), and the color scheme is designed to show abrupt color changes at +/- 0.6 inches (the BHCSD action trigger for follow-up of property damage claims). Note that this data is based only on the 57 monuments shown in the Figure. None of the monuments exceeded the 0.6 inch vertical movement in the negative direction (subsidence). Six of the monuments exceeded the BHCSD 0.6 inch vertical movement threshold in the positive direction (uplift).

Figure 6.2b shows the same area using InSAR recorded ground movement. The correlation between the two figures is apparent. The InSAR data is based on information taken every 30 feet, with the exception of the white areas where data is not available due to vegetation (which does not reflect for satellite data).

Figure 6.3 shows the topography of the area, with the InSAR zero vertical displacement contour line shown in red around the uplifted BHCSD area. Since the BHCSD area lies in a topographically high region as shown in **Figure 6.3**, tectonism indicates upward movement is normal for this area.

Figure 4.2 provides regional perspective on the movement in the Baldwin Hills area relative to the Los Angeles Basin, based on InSAR elevation changes. The same color scale is used, and oilfields are outlined in light green. The uplift areas (shown as light green and blue) are prominent along the Newport Inglewood Fault trace. (The trace is shown as blue dashed line in the figure.)

Survey Horizontal Movement Results

Horizontal ground movement is also measured in the monument surveys. A full listing of the annualized horizontal data for 2020-2021 is given in **Table 6.2.** The maximum annualized horizontal displacement was 1.05 inches for Monument 117. The average annualized horizontal movement for all 57 monuments was 0.41 inches.

As discussed in Section 7 below, the movement observed in the monument data does not appear to have any clearly defined correlation to oilfield operations, although some qualitative relationships may exist at a regional level. The east-west displacement vectors recorded by InSAR are consistent with the established right-lateral slip along the Newport-Inglewood Fault zone.

7. Ground Movement and Oilfield Operations

The historical impact of oilfield operations on ground movement prior to the 1980's, before full volume balance was achieved, is well documented and is not the focus of this analysis. Overall vertical displacement after this point has been mostly stable (less than 0.6 inches per year). Much work has been done on causation in previous years: the focus here is on new observations and conclusions for the 2020-2021 production year. The study has historically included fieldwide, local, and regional perspectives. Each of these perspectives is discussed below to further investigate the potential relationship between oilfield operations and ground movement in the BHCSD.

Fieldwide Volume Balance

Table 7.1 shows that the fieldwide net injection ratio, as defined by the ratio of total fluids injected to fluids produced (in reservoir barrels), was 101.8% for the production year ending June 30, 2021. The cumulative fieldwide net injection ratio for the BHCSD program which began in 2010 is 102.3%. With the exception of 2010, the yearly field-wide net injection ratio has been greater than 100% since 1995 (26 years), as can be seen **in Figures 5.1** and **5.2**.

A cross-plot of fieldwide yearly net injection volume and average yearly infield monument movement over the period from 2010-2021 shows no correlation, as seen in **Figure 7.1**. An infield monument is defined as a monument that has had an active producer or injector within a 1000-foot radius in 2021.

The IOF remains in positive volume balance. Therefore, based on historical observations, significant displacement at a fieldwide level above the threshold, due directly to volume imbalance, is considered to be very unlikely.

Local Monument Balance

Table 7.2 shows the 'local' net injection volume for the cumulative time period 2020-2021 for *each* monument, which is defined as the total V/R waterflood injection volume *minus* the total V/R liquid production for wells with a bottom hole location within a 1000-foot radius of the monument. The list of monuments is ranked by the magnitude of survey vertical elevation change.

The table also shows the total number of V/R wells (waterflood injection or production) within the 1000 foot radius in the data set. There are 22 monuments with non-zero net injection volumes; the remainder were over 1000 feet from any active well. Note that the original monuments were used for this analysis rather than the twin monuments.

Figure 7.2 presents a cross-plot of the annualized elevation change of the infield monuments versus their associated net injection volume for the corresponding time period. The data shows that there was essentially no correlation between these two measurements.

These figures suggest that ground movement cannot be explained solely by net injection, since other factors (either real or noise-related) must be present to explain the large amount of scatter observed. At the scale of ground movement observed at IOF, the local annual net injection volume is a poor predictor of local annual vertical displacement.

The relationship between surface displacement and net injection within 1000 feet of monuments observed this year is very similar to that seen in previous years since the beginning of the BHCSD program: there has been no discernable correlation between the two variables. For this reason we recommend discontinuing this analysis in future years of the program.

Regional Volume Balance

Finally, there are three different regions of the BHCSD, as shown in **Figure 7.3**, which are defined by internally consistent movement characteristics as recorded by InSAR over the 2020-2021 period. These regions exist at an intermediate or regional level, in between the fieldwide and local levels discussed above. Each of the three regions was analyzed and their associated production and injection figures are shown in **Table 7.3.** Note that all three regions experienced uplift.

The north area has been uplifted over this time interval, coinciding with a positive injection. For the northern region then, a qualitative relationship appears to exist between net injection and vertical displacement for the period of data coverage. Similarly, the southern area has been uplifted and also has a positive net injection. However, despite a regional negative net injection, the central area has also experienced uplift, although less than the northern and southern regions. This reduced uplift is consistent with the negative net injection in that region. **Figure 7.4** shows the correlation between regional ground movement and regional net injection. While the correlation factor for the three data points is strong, the trendline does not go through the origin, but rather intercepts the zero net injection line at 0.47". *Clearly, ground movement at the regional level is not simply a function of volume balance.*

We conclude that even at the regional level, other factors apart from field operations must be important contributors to ground movement based on the inconsistent correlation observed between average ground movement and net injection for each region. The observations are consistent with regional tectonic uplift over the entire Baldwin Hills area, but with regional overprints related to field operations.

Summary of Ground Movement and Oilfield Operations Analysis

Evaluation of surface survey results relative to the V/R net injection volume balance and reservoir pressure does not indicate a quantitative relationship exists between ground movement and oilfield operations at the fieldwide and local levels. However, a relationship may exist at the regional level, although it is not consistently observed every year. At the scale of ground movement observed in recent years, any relationship between field operations and subsidence, if it does exist, appears to be masked by other factors. Our conclusions are summarized below:

1. There is low confidence in using the monument displacement trends to provide clear guidance for fieldwide, local, or regional replacement ratio targets.
2. There are significant mechanisms not directly related to volume balance affecting ground movement at the scales analyzed.
3. There is no relationship discernable with survey measurements between the yearly fieldwide *net injection ratio* and the *number of monuments* that cross the 0.6 inches elevation change threshold and/or their *movement direction*.

8. Summary and Recommendations

The amount of movement observed in the BHCSD is relatively small and not unique. It is recognized that significant ground movement occurred due to oilfield operations prior to the start of the waterflood in the 1950, but since the maintenance of net injection near or above 100% was established in 1995, the ground movement on average has been relatively stable (<0.6 inches/year) on a fieldwide basis.

There does not appear to be a consistent relationship between the yearly waterflood injection ratio and vertical displacement observed in monument leveling surveys. No statistically significant trends were identified in the annualized 2021 monument elevation changes plotted against the fieldwide, local (1000 foot radius), or regional net waterflood injection volumes, although volume balance does appear to be qualitatively related to ground movement at the regional level in some parts of the field. The lack of a simple connection between the net injection volume and surface monument movement is likely *due to more than one mechanism impacting the surface survey results* at the current scale of ground movement under volume balanced conditions. Other possible contributors to ground movement are discussed in the Laguna Geosciences report. Additionally, the amount of displacement at near volume balance conditions may be at the limit of tool resolution, and both random and systematic noise are probably also impacting the measurements.

It is recommended that SPR continue its practice of 100% net injection ratio and monitoring of the BHCSD as outlined in the EIR. It is also recommended that the twin monuments be incorporated in this report rather than the original monuments, and that only the twin monuments are used in the local movement analysis, as the twin monuments are considered a more accurate data point due to the surface conditions of the original monuments identified as unstable. Finally, it is recommended that InSAR be considered for this annual survey instead of GPS data as it affords a similar level of accuracy but includes many more data points than the 57 monuments used for the GPS data. The 11 years of data gathered during the period of the AGMS (since 2010) has proven the good correlation between the twin monuments and the original monuments, as well as the good correlation between the InSAR data and the GPS data.

References

References used are the same as those listed in the 2018 report, updated as appropriate.

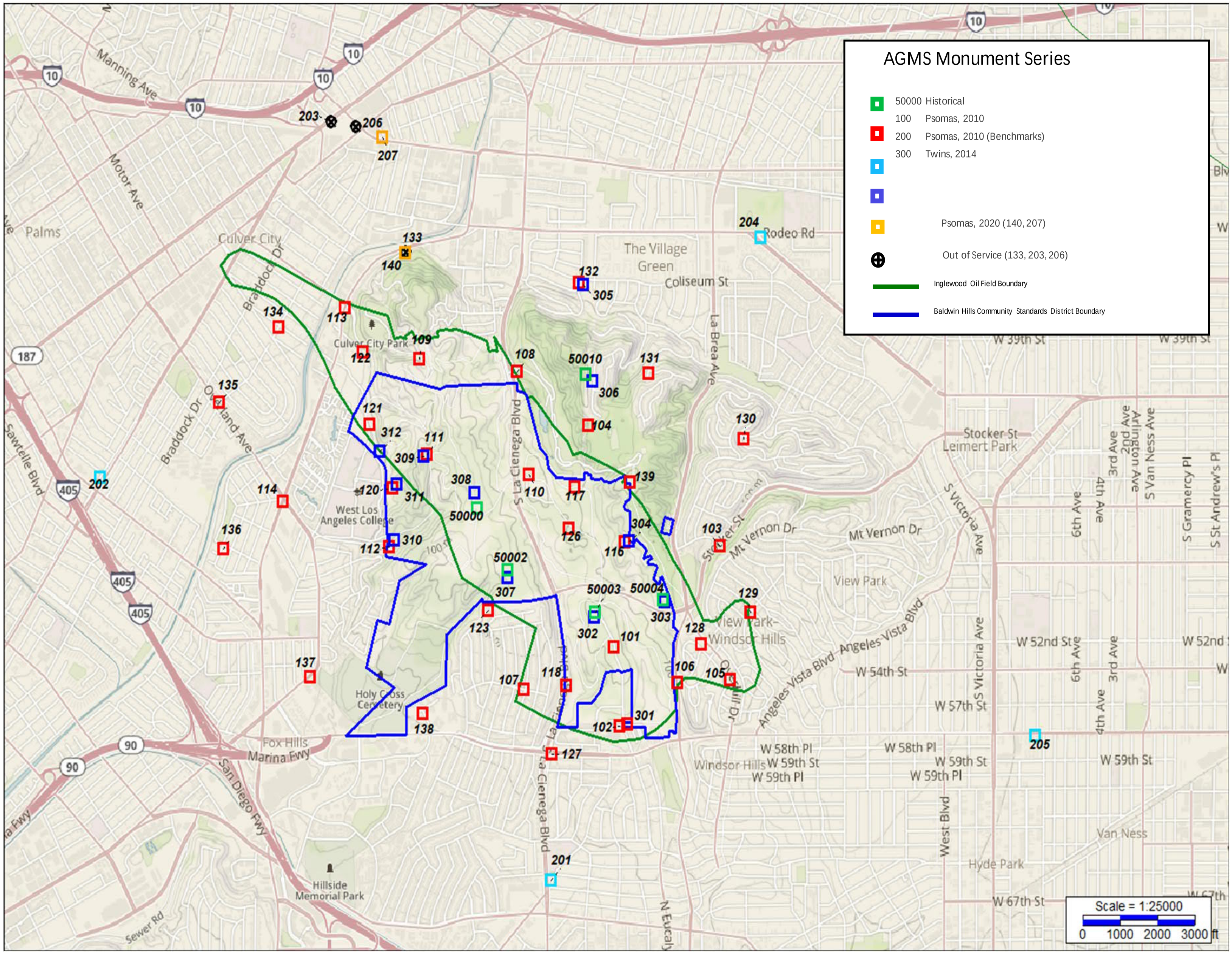

Figure 1.1. AGMS monument network.

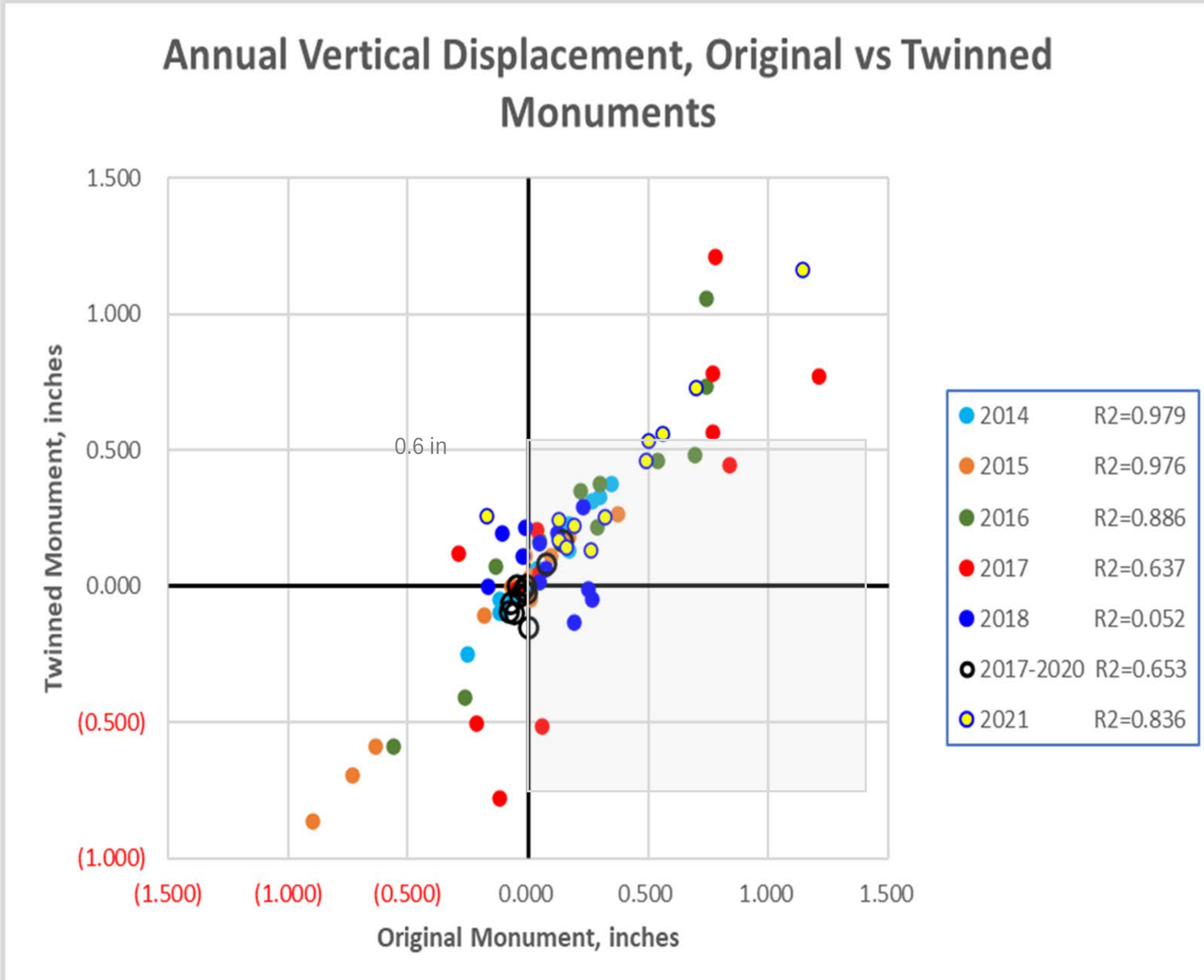

Figure 3.1. Annual vertical displacement for original monuments versus twinned monuments, 2014 through 2021. The 2018 data exhibits an anomalously high degree of scatter. Data for the period 2017-2020 was annualized to compare with other years. The correlation is generally good, except for the 2018 surveys, where the R^2 correlation factor dipped below 0.60.

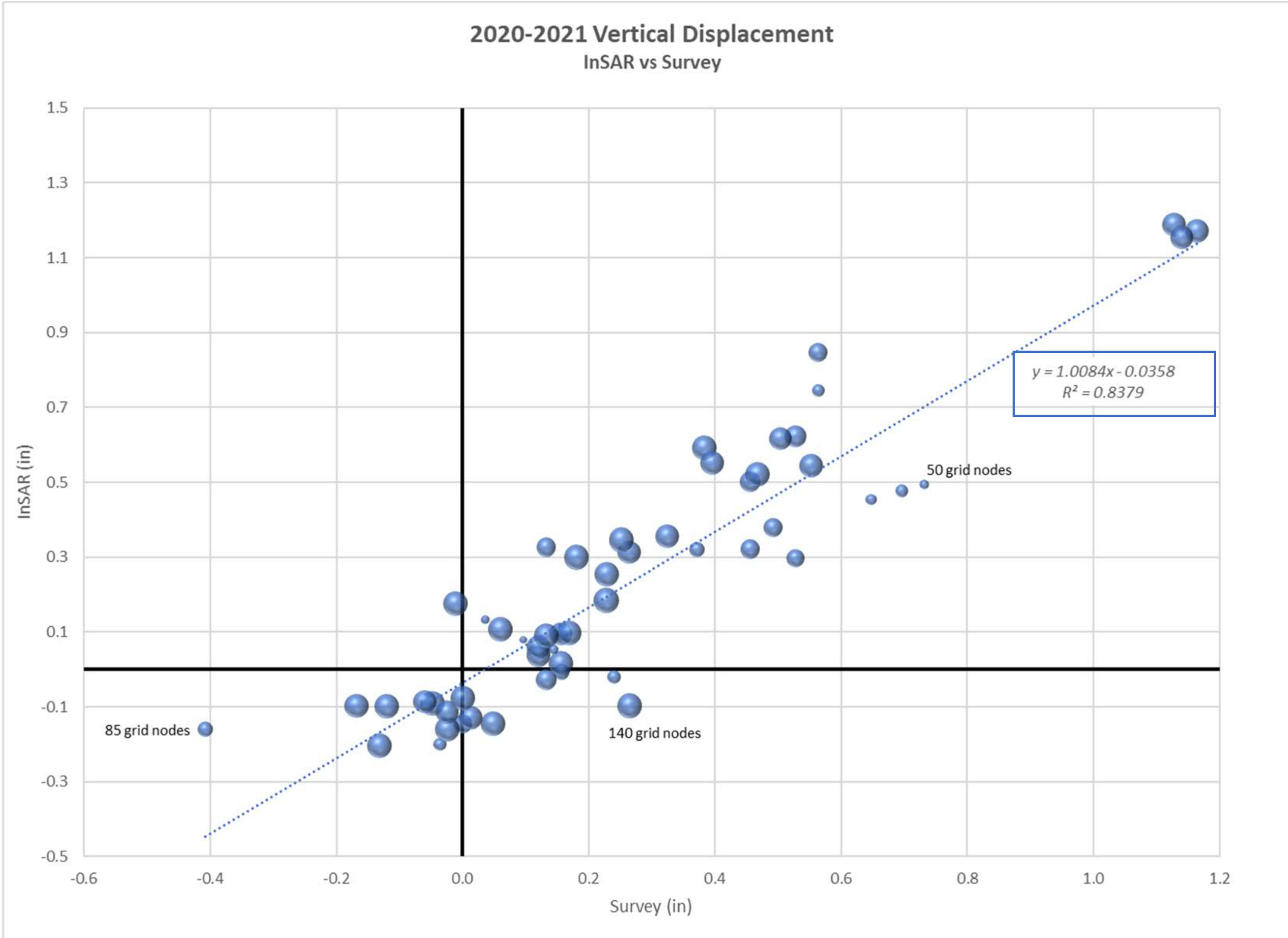

Figure 4.1. Survey versus InSAR ground movement comparisons for the period July 2020 through June 2021. Note that, as expected, the slope is very close to 1 and the y-intercept close to 0. The InSAR value is the average of all grid nodes (30 ft spacing) within 200 feet of each monument. The diameter of the datapoint is proportional to the number of grid nodes within the 200 ft radius of each monument. The number of grid nodes around each monument ranges from 0-140, with the average being 112 for the 57 monuments.

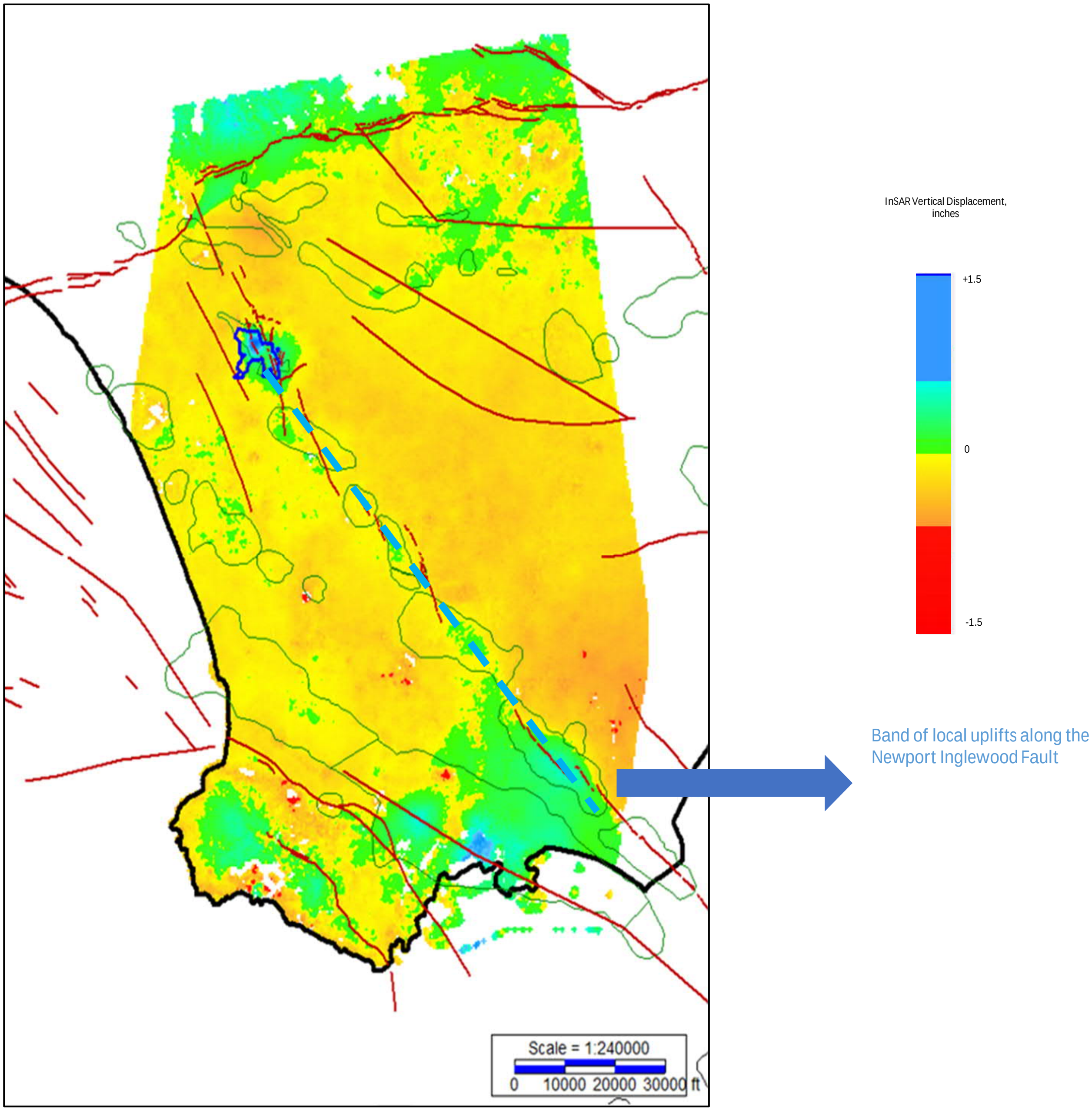

Figure 4.2. Gridded InSAR survey vertical displacement for July 2020-June 2021, LA Basin. Oil fields are indicated by green outlines. Uplift observed at IOF is comparable in magnitude to other uplift events in the LA Basin.

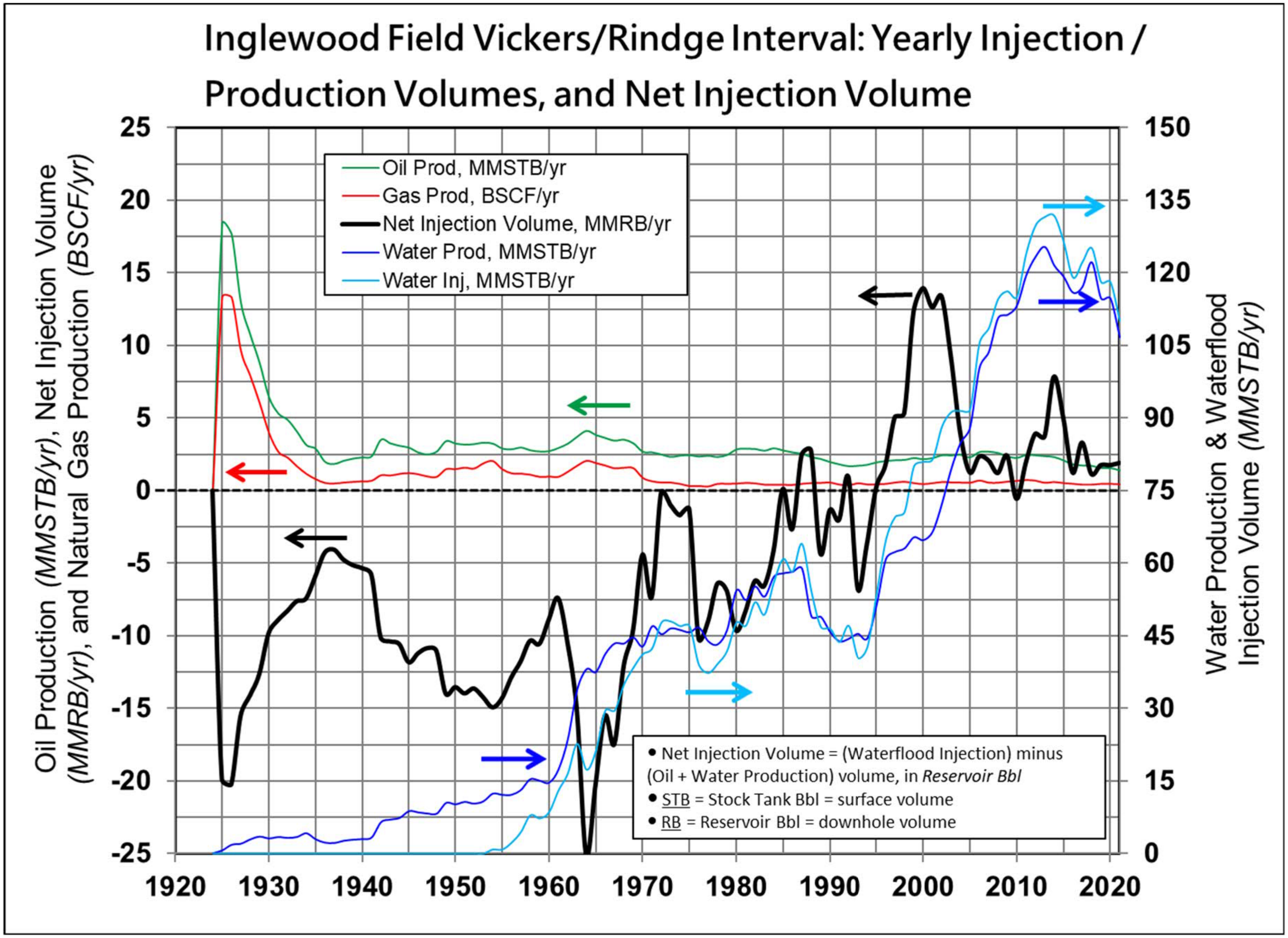

Figure 5.1. The Inglewood Vickers/Rindge cumulative net fluid withdrawal volume (total liquid production minus waterflood injection) and yearly ratio of waterflood injection to liquid production are shown over the life of the field, through June 2021. The net withdrawal stabilized in the early 1980's at about 600 MMBLS, and started on a downward trend in the mid-1990's. [Castle, 1976 (1924-1963); SPR, 2021 (1964 on)]

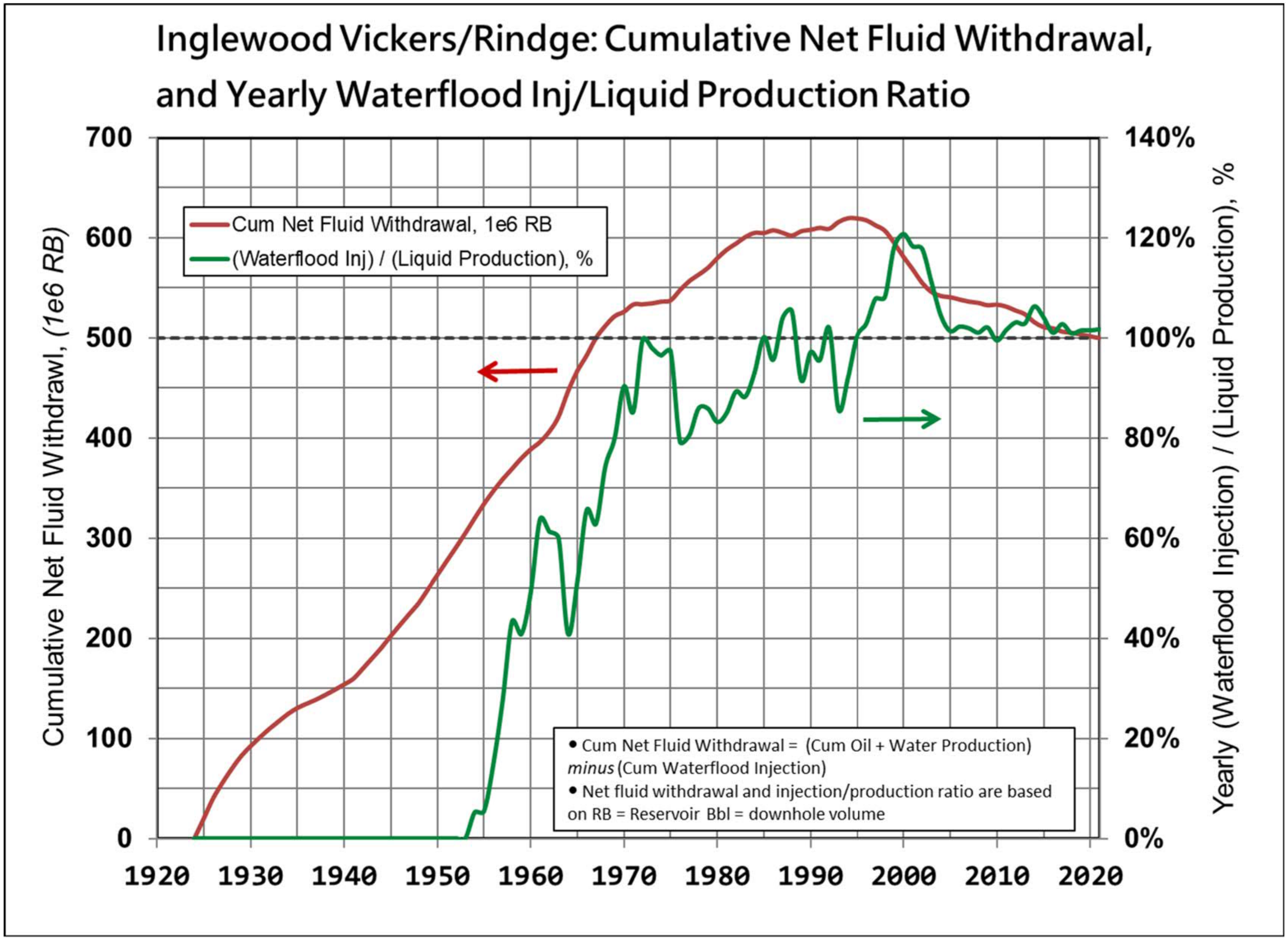

Figure 5.2. The Inglewood Vickers/Rindge cumulative net fluid withdrawal volume (total liquid production minus waterflood injection) and yearly ratio of waterflood injection to liquid production are shown over the life of the field, through June 2021. The net withdrawal stabilized in the early 1980's at about 600 MMBLS, and started on a downward trend in the mid-1990's. [Castle, 1976 (1924-1963); SPR, 2021 (1964 on)]

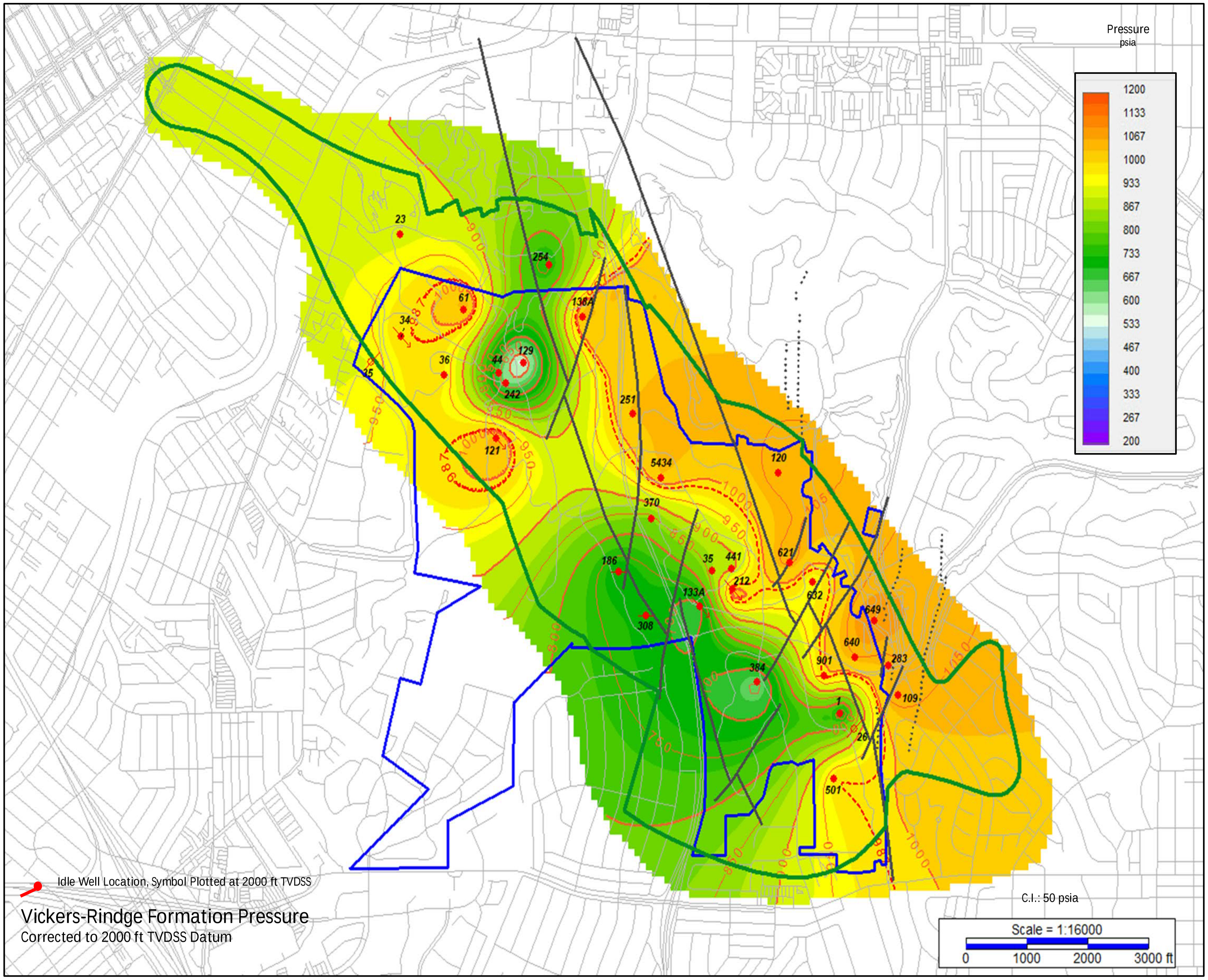

Figure 5.3. Pressure data normalized to 2000 feet True Vertical Depth Subsea (TVDSS). Fluid levels taken from idle wells only, shown in red with well symbol plotted at 2000 feet SS (or total depth if well TD is above 2000 feet TVDSS). Average pressure (987 psi) is shown by red dashed contour.

2021 Inglewood BHCSD Monitoring Program Survey Results			
• *Data sources: Psomas Survey 2020, 2021*			
• *For period 7/1/2020 through 6/30/2021 inclusive*			
			Sorted By...
Site Count	Monument Number	InSAR 2021-2020 Elevation Change, in.	Ground Survey 2021-2020 Elevation Change, in.
1	140	-0.160	-0.410
2	132	-0.097	-0.170
3	205	-0.204	-0.130
4	136	-0.099	-0.120
5	137	-0.087	-0.060
6	114	-0.090	-0.050
7	122	-0.201	-0.040
8	135	-0.159	-0.020
9	204	-0.115	-0.020
10	118	0.175	-0.010
11	113	-0.145	0.000
12	207	-0.076	0.000
13	202	-0.129	0.010
14	108	0.133	0.040
15	134	-0.146	0.050
16	130	0.107	0.060
17	104	0.079	0.100
18	131	0.039	0.120
19	138	0.059	0.120
20	121	-0.028	0.130
21	301	0.326	0.130
22	50010	0.089	0.130
23	310	0.054	0.140
24	109	-0.007	0.160
25	112	0.097	0.160
26	127	0.096	0.160
27	201	0.016	0.160
28	306	0.097	0.170
29	105	0.299	0.180
30	120	*	0.190
31	311	-0.020	0.220
32	107	0.185	0.230
33	129	0.254	0.230
34	312	-0.021	0.240
35	302	0.346	0.250
36	102	0.312	0.260
37	305	-0.098	0.260
38	50003	0.355	0.320
39	103	0.321	0.370
40	106	0.592	0.380
41	123	0.551	0.400
42	101	0.502	0.460
43	309	0.322	0.460
44	128	0.522	0.470
45	111	0.378	0.490
46	50004	0.616	0.500
47	139	0.296	0.530
48	303	0.623	0.530
49	126	0.545	0.550
50	307	0.746	0.560
51	50002	0.848	0.560
52	117	0.454	0.650
53	116	0.477	0.700
54	304	0.494	0.730
55	110	1.189	1.130
56	50000	1.154	1.140
57	308	1.171	1.160

Table 6.1. BHCSD 2021 survey results for all monuments, sorted by elevation change. Six of the monuments recorded vertical displacements exceeding the BHCSD threshold of 0.6 inches/year, all in the positive (uplift) direction.

NOTES

* Monument 120 does not have any InSAR data within a 200' radius.

• Monument 201 was the reference point for the 2020 survey. The North Park station was the reference point for InSAR.

• Peripheral site 203 was destroyed in 2014 (found in 2015); the replacement site 206 was first surveyed in 2015.

• Monuments 133 and 206 were both destroyed by surrounding construction since 2019.

• For the 2020 GMS we established two new monuments, #207 and #140.

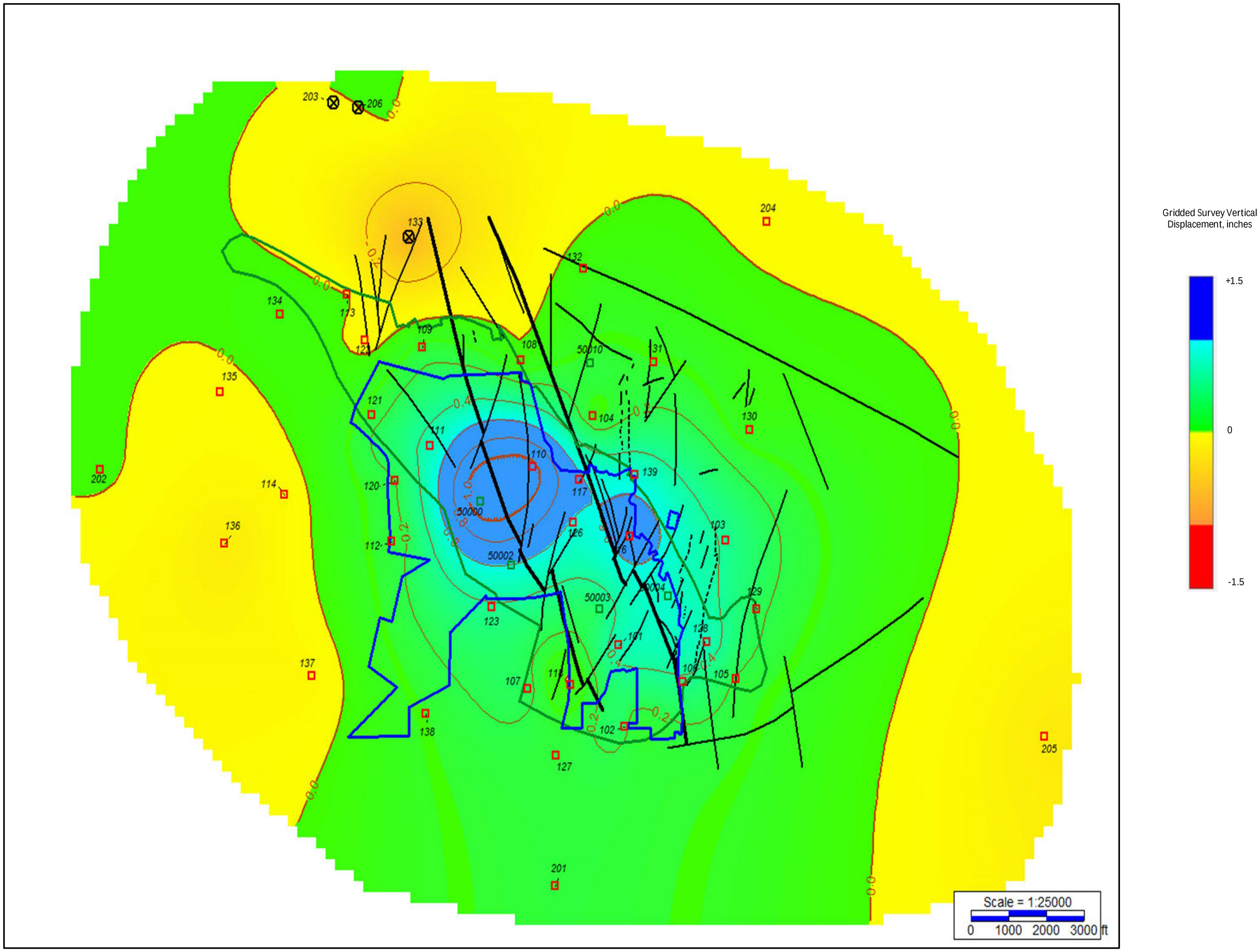

Figure 6.2a. Gridded survey annualized vertical displacement for July 2020 - June 2021. Subsidence in excess of the BHCSD threshold of 0.6” was not recorded in any of the 57 monuments for which data exists. Uplift in excess of the threshold were recorded in six of the monuments.

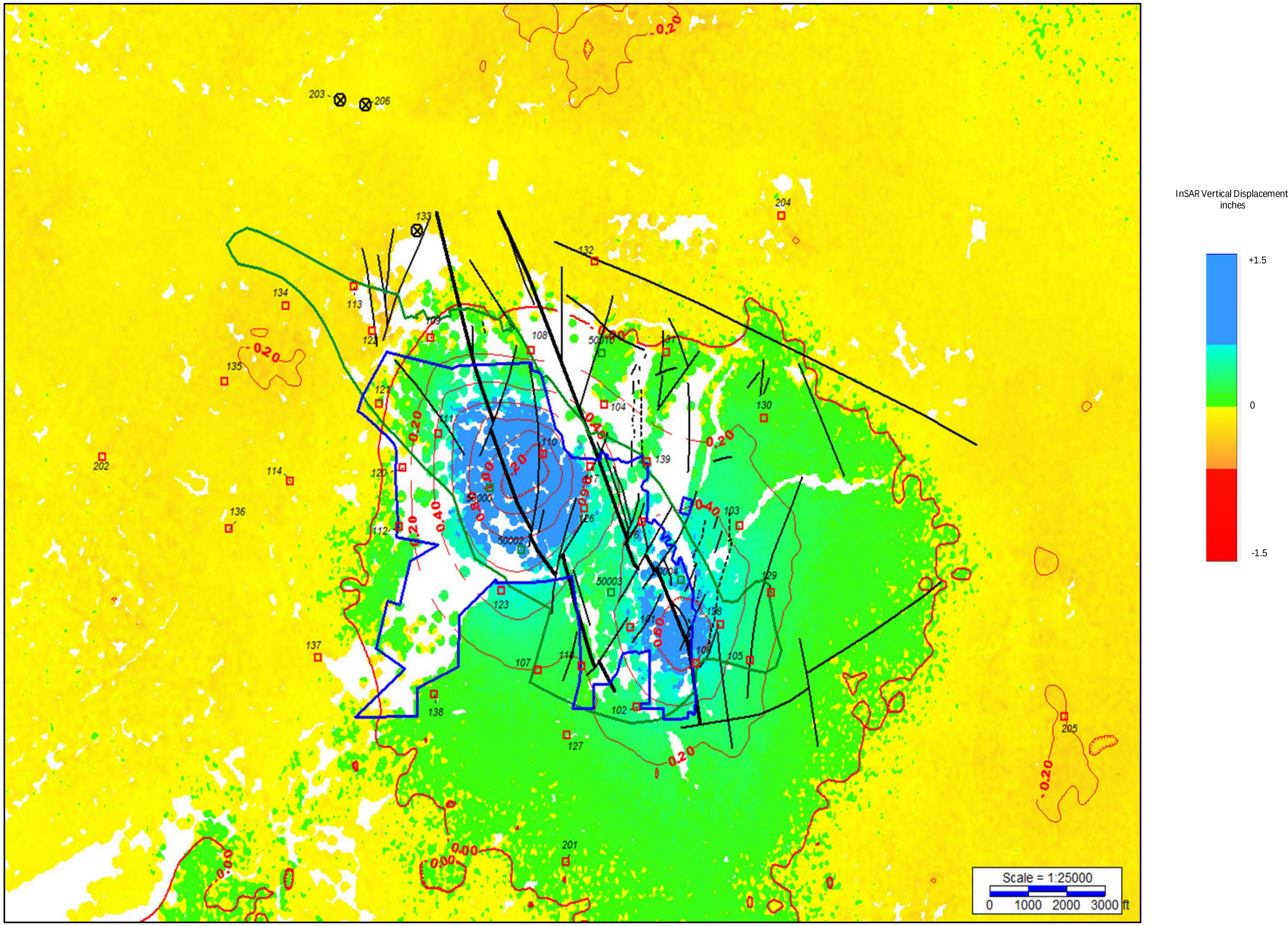

Figure 6.2b. InSAR vertical displacement for July 2020-June 2021. The grid cell size in this image is 30 feet, and no signal was recorded in the white areas. Subsidence in excess of the BHCSD threshold of 0.6” was not recorded in any of the InSAR grid nodes. Uplift in excess of the threshold was recorded in the areas shaded in blue.

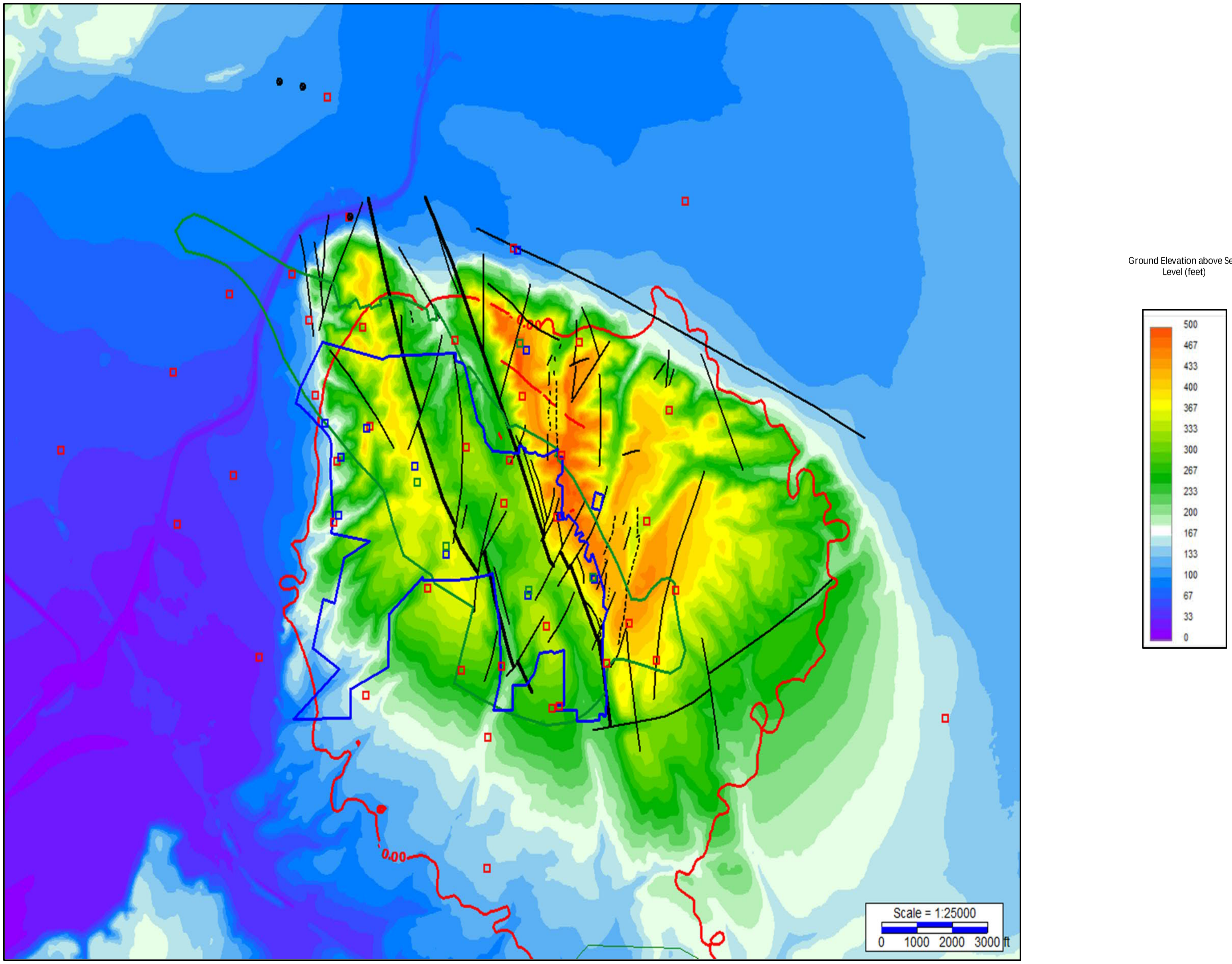

Figure 6.3. Lidar map showing 0’ contour from InSAR data around the uplifted BHCSD study area. All InSAR displacements inside the 0’ contour were positive. The recorded 2020-2021 InSAR vertical displacement correlates well with Baldwin Hills surface topography.

2021-2020 Inglewood BHCSD Monitoring				
• Data sources: Psomas Survey 2020 and 2021				
• For period July 2020 through June 2021				
				Sorted By...
		2021-2020		
Site Count	Monument Number	Delta X, in.	Delta Y, in.	Horizontal Vector, in
1	117	1.044	0.108	1.050
2	50004	0.900	0.216	0.926
3	104	0.828	0.180	0.847
4	126	0.756	-0.192	0.780
5	110	0.732	0.072	0.736
6	303	0.672	0.216	0.706
7	307	0.576	-0.216	0.615
8	108	0.564	0.240	0.613
9	128	0.600	-0.084	0.606
10	306	0.600	0.000	0.600
11	106	0.528	-0.276	0.596
12	139	0.564	-0.132	0.579
13	311	-0.576	0.048	0.578
14	116	0.576	0.024	0.576
15	50010	0.468	0.324	0.569
16	111	-0.552	0.084	0.558
17	129	0.540	-0.060	0.543
18	304	0.540	-0.024	0.541
19	103	0.516	-0.096	0.525
20	309	-0.492	-0.084	0.499
21	312	-0.468	0.144	0.490
22	301	0.348	-0.312	0.467
23	122	0.216	0.408	0.462
24	50002	0.312	-0.264	0.409
25	121	-0.192	0.336	0.387
26	102	0.324	-0.192	0.377
27	105	0.372	0.048	0.375
28	107	0.048	-0.372	0.375
29	101	0.276	-0.228	0.358
30	130	0.348	-0.072	0.355
31	131	0.324	0.132	0.350
32	305	0.300	-0.180	0.350
33	308	-0.180	0.300	0.350
34	127	-0.060	-0.336	0.341
35	132	0.288	-0.156	0.328
36	134	0.204	0.252	0.324
37	120	-0.300	0.024	0.301
38	207	0.300	0.000	0.300
39	109	0.072	0.288	0.297
40	113	0.144	0.252	0.290
41	140	0.216	-0.180	0.281
42	50000	-0.048	-0.276	0.280
43	123	0.108	-0.252	0.274
44	50003	0.252	0.108	0.274
45	310	-0.168	-0.216	0.274
46	118	0.180	-0.204	0.272
47	302	0.240	0.084	0.254
48	137	0.192	-0.144	0.240
49	204	0.144	-0.144	0.204
50	135	-0.048	0.180	0.186
51	138	0.132	-0.060	0.145
52	114	-0.012	-0.144	0.144
53	205	0.036	-0.072	0.080
54	112	-0.072	0.000	0.072
55	136	-0.048	0.024	0.054
56	202	0.024	-0.012	0.027
57	201	0.000	0.000	0.000

Table 6.2. BHCSD 2021 survey results listing horizontal displacement for all monuments, sorted by resultant vector length.

NOTES

- Monument 201 was the reference point for the 2020 survey.
- Peripheral site 203 was destroyed in 2014 (found in 2015); the replacement site 206 was first surveyed in 2015.
- Monuments 133 and 206 were both destroyed by surrounding construction since 2019.
- For the 2020 GMS we established two new monuments, #207 and #140.

Inglewood Waterflood Volume Balance

Field Wide Yearly Totals: Vickers/Rindge Reservoirs

Year	2019/2020	2021	Cumulative 2010-2021
Oil Production, STB	2,347,546	1,406,010	22,998,317
Water Production, STB	172,126,890	106,745,498	1,356,634,274
Gas Production, Mscf	721,654	449,779	6,340,333
Waterflood Injection, STB	177,212,810	110,121,658	1,412,771,155
Total Liquid Production, RB	174,587,118	108,218,996	1,380,736,510
Waterflood Injection, RB	177,212,810	110,121,658	1,412,771,155
Net Waterflood Injection*, RB	2,625,692	1,902,662	32,034,645
Water Inject/Liquids Production, %	101.5%	8%	102.3%

Table 7.1 Total field liquids production and injection, 2019 through June 2021 inclusive. The net injection ratio for this year was 101.8%. Cumulative net injection ratio during the AGMS study period (2010-2021) is 102.3%..

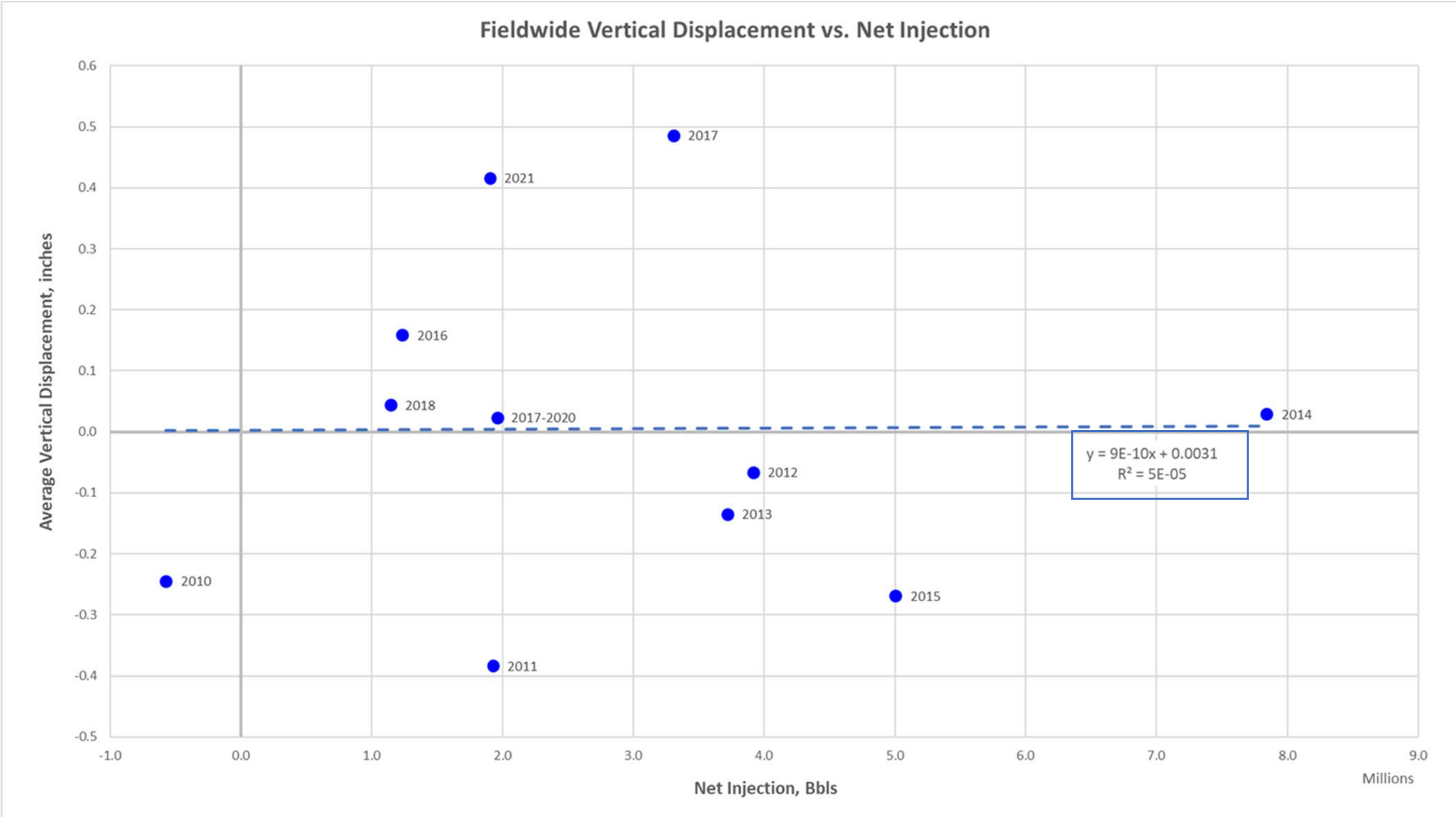

Figure 7.1. Annual Fieldwide Vertical displacement vs Net injection for infield monuments for the period 2010 through 2021. Net injection equals total injection less fluid production within 1000 feet of each monument. There is essentially no correlation.

2021 Inglewood BHCSD Monitoring Program Survey Results					
• *Data sources: Psomas Survey 2020, 2021; SPR internal production database, 2021*					
• *For period July 2020 through June 2021 inclusive*					
					Sorted By...
		July 2020 - June 2021			
				InSAR	Ground Survey
Site Count	Monument Number	V/R Wells within 1000 ft Radius (2020)	V/R Net Injection Volume in 1000' Radius, 1000 RB	Elevation Change, in.	Elevation Change, in.
1	140	0	0	-0.160	-0.410
2	132	0	0	-0.097	-0.170
3	205	0	0	-0.204	-0.130
4	136	0	0	-0.099	-0.120
5	137	0	0	-0.086	-0.060
6	114	0	0	-0.090	-0.050
7	122	13	-1499	-0.201	-0.040
8	135	0	0	-0.159	-0.020
9	204	0	0	-0.115	-0.020
10	118	1	-203	0.175	-0.010
11	113	0	0	-0.145	0.000
12	207	0	0	-0.076	0.000
13	202	0	0	-0.129	0.010
14	108	4	1757	0.133	0.040
15	134	0	0	-0.146	0.050
16	130	0	0	0.107	0.060
17	104	0	0	0.079	0.100
18	131	0	0	0.039	0.120
19	138	0	0	0.059	0.120
20	121	10	-424	-0.028	0.130
21	301			0.326	0.130
22	50010	0	0	0.089	0.130
23	310			0.054	0.140
24	109	28	-3806	-0.007	0.160
25	112	0	0	0.097	0.160
26	127	0	0	0.096	0.160
27	201	0	0	0.015	0.160
28	306			0.097	0.170
29	105	1	-56	0.299	0.180
30	120	3	1376	*	0.190
31	311			-0.020	0.220
32	107	0	0	0.185	0.230
33	129	1	-25	0.254	0.230
34	312			-0.021	0.240
35	302			0.346	0.250
36	102	0	0	0.312	0.260
37	305			-0.098	0.260
38	50003	55	-918	0.355	0.320
39	103	0	0	0.321	0.370
40	106	29	-324	0.592	0.380
41	123	1	440	0.551	0.400
42	101	47	-658	0.501	0.460
43	309			0.322	0.460
44	128	17	786	0.522	0.470
45	111	42	-435	0.378	0.490
46	50004	31	969	0.616	0.500
47	139	6	291	0.296	0.530
48	303			0.623	0.530
49	126	66	920	0.545	0.550
50	307			0.745	0.560
51	50002	26	2616	0.848	0.560
52	117	38	362	0.454	0.650
53	116	38	-1155	0.477	0.700
54	304			0.494	0.730
55	110	73	765	1.189	1.130
56	50000	52	-339	1.154	1.140
57	308			1.171	1.160

Table 7.2. BHCSD 2021-2020 survey results for all monuments, sorted by cumulative elevation change. The results include the local net waterflood injection volume and total producer plus injector well count within a 1000' radius for each monument.

NOTES

- V/R = Vickers/Rindge reservoirs; RB = in situ reservoir barrel
- The number of "Wells within 1000' Radius" for each monument includes producers and injectors.
- "Net Injection Volume in 1000' Radius" = (waterflood inj. Reservoir bbls) minus (liquids production, reservoir bbls)
- Monument 201 was the reference point for the 2020 survey. The North Park station was the reference point for InSAR.
- Peripheral site 203 was destroyed in 2014 (found in 2015); the replacement site 206 was first surveyed in 2015.
- Monuments 133 and 206 were both destroyed by surrounding construction since 2019.
- For the 2020 GMS we established two new monuments, #207 and #140.

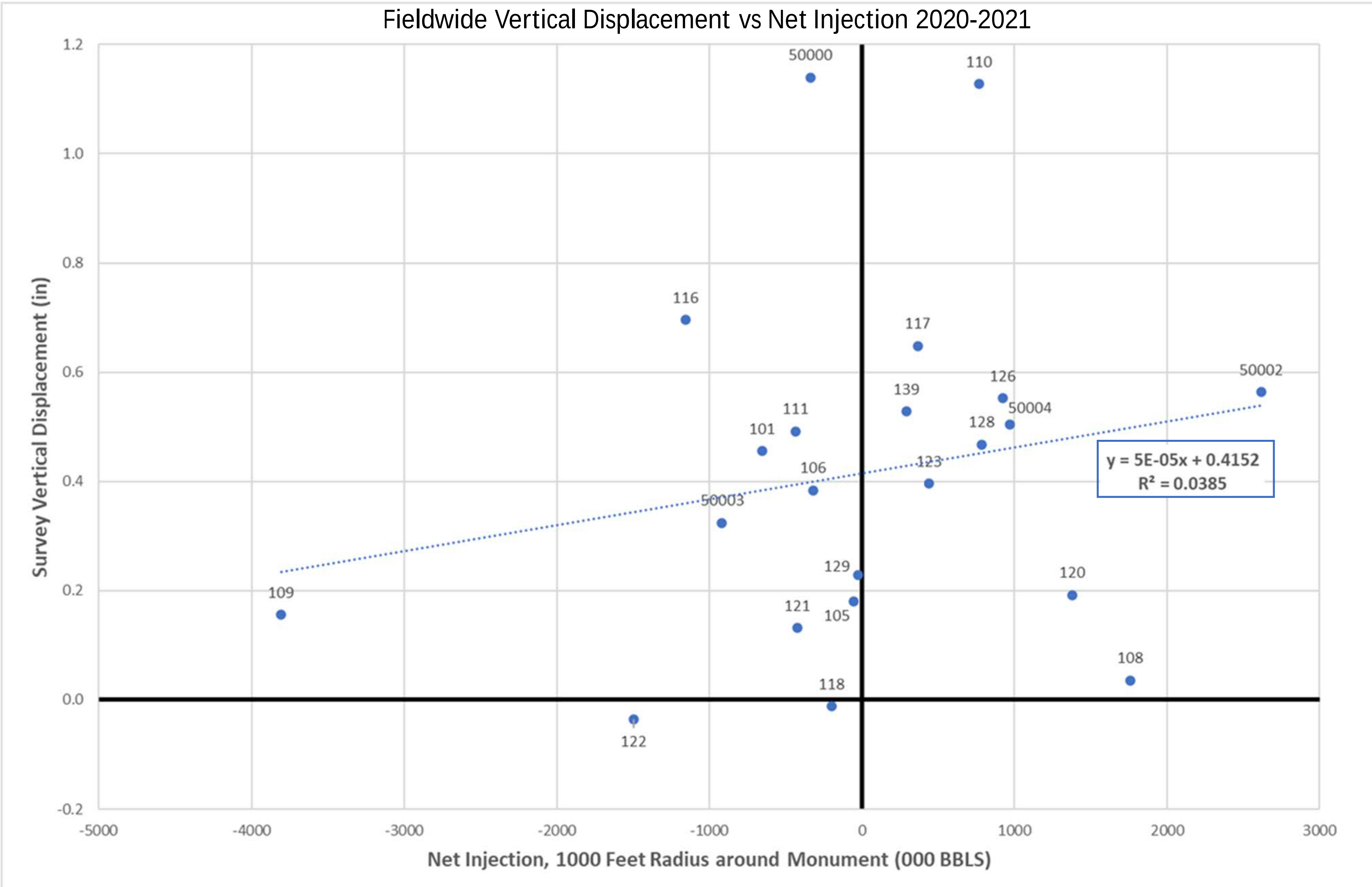

Figure 7.1. Vertical displacement vs Net injection for infield monuments for the period 2020 through 2021. Net injection equals total injection less fluid production within 1000 feet of each monument. There is essentially no correlation.

InSAR Vertical Displacement 2021

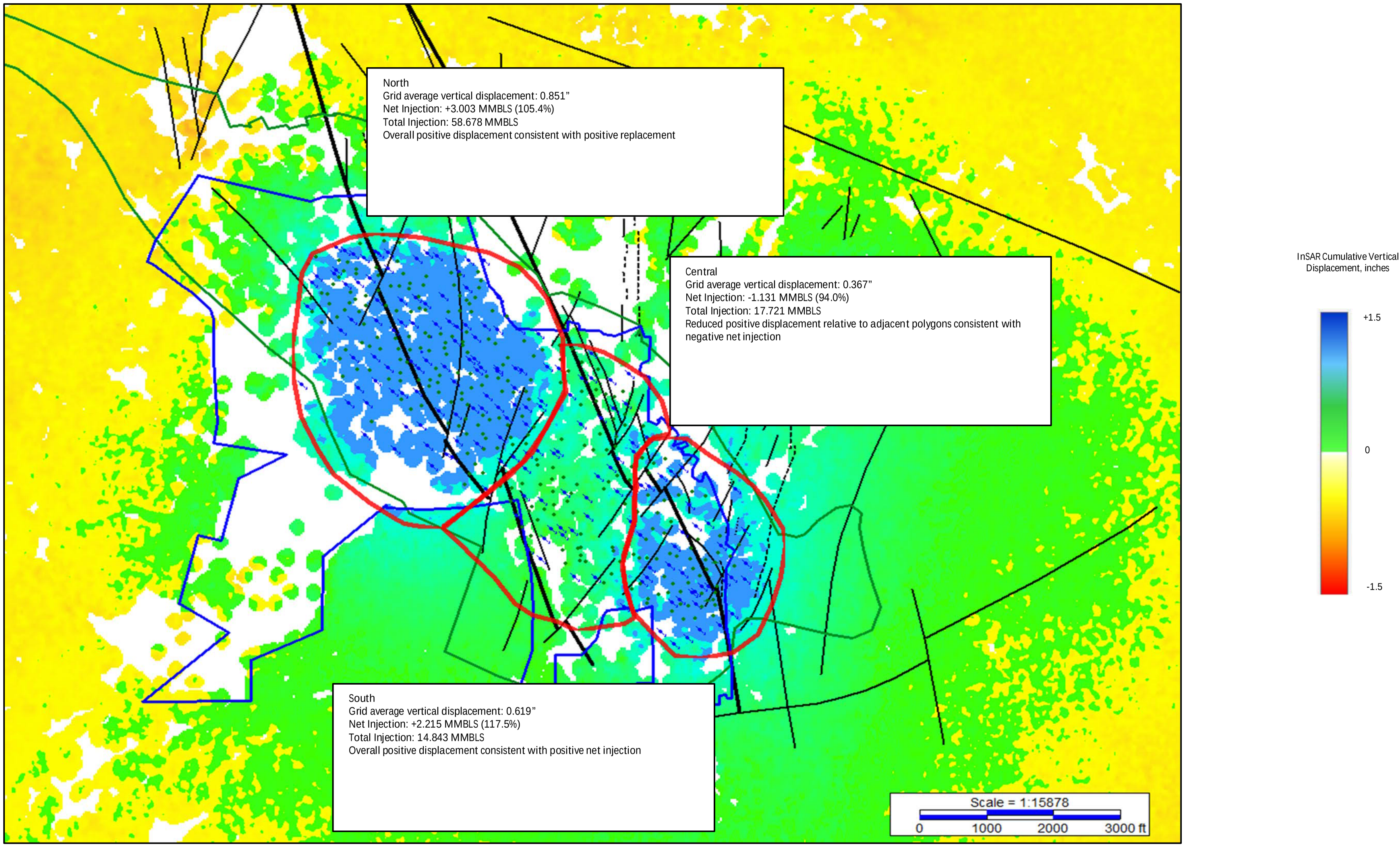

Figure 7.3. The three regions analyzed for volume balance are shown in blue. The polygons were selected to encompass areas of similar vertical ground movement behavior. All active Vickers-Rindge wells for the period July 2020 through June 2021 inclusive are plotted, with subtotal average vertical displacement, net injection, total injection, and net injection ratios for the period shown for each of the three regions.

Inglewood Waterflood Volume Balance by Region

Vickers/Rindge Reservoir: July 2020 through June 2021

Well Count	254	107	94
2020-2021	North	Central	South
Oil Production, STB	654,233	224,814	257,786
Water Production, STB	54,988,956	18,616,272	12,356,969
Gas Production, Mscf	201,182	97,596	100,782
Waterflood Injection, STB	58,677,845	17,721,325	14,842,692
Total Liquid Production, RB	55,674,592	18,851,877	12,627,129
Waterflood Injection, RB	58,677,845	17,721,325	14,842,692
Net Waterflood Injection*, RB	3,003,253	-1,130,552	2,215,563
Water Inject/Liquids Production, %	105.4%	94.0%	117.5%

*Net waterflood injection volume = [waterflood injection, resv Bbl] minus [oil + water production volume, resv Bbl]

Table 7.3. Vickers-Rindge production and injection by field region, July 2020 through June 2021.

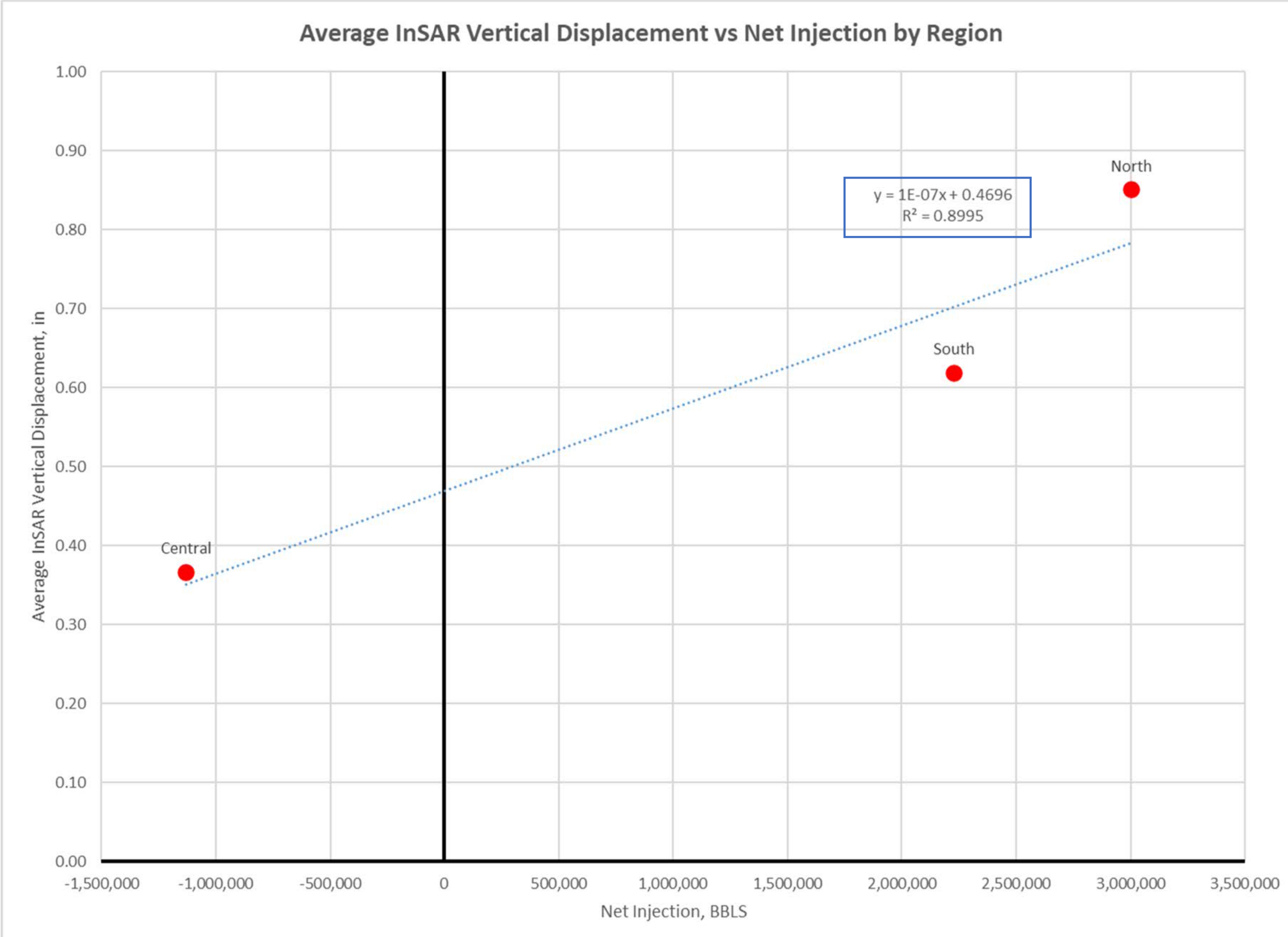

Figure 7.4. Average vertical displacement for the three regions versus their net injection for the 2021 year. Although there are only three data points, there appears to be a qualitative relationship between net injection and vertical displacement.