WIPP
Subsidence Monument
Leveling Survey
2022

April 5, 2023

Waste Isolation Pilot Plant

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List of Acronyms

CFR	Code of Federal Regulations
DOE	Department of Energy
DOY	Day of year
FGCS	Federal Geodetic Control Subcommittee
NGS	National Geodetic Survey
WIPP	Waste Isolation Pilot Plant
WP	WIPP Procedure

References

Classification, Standards of Accuracy, and General Specifications of Geodetic Control Surveys, Federal Geodetic Control Committee (now Federal Geodetic Control Subcommittee), [1975] 1980, Reprint.

FGCS Specifications and Procedures to Incorporate Electronic Digital / Bar-Code Leveling Systems, Federal Geodetic Control Subcommittee, ver. 4.1, dated May 27, 2004.

WP 09-ES4001, Subsidence Survey Data Acquisition Report, September 2016, Rev. 4.

Software Screening Checklist, LGO w/Leveling Bundle and TPS Data Processing, April 2013

Software Quality Assurance Elements Check List, LGO w/Leveling and TPS Data Processing, April 2013

DOE/WIPP 98-2293, WIPP Subsidence Monument Leveling Surveys 1986-1997, June 1998

DOE/WIPP 99-2293, WIPP Subsidence Monument Leveling Survey 1998, October 1998

DOE/WIPP 00-2293, WIPP Subsidence Monument Leveling Survey 1999, October 1999

DOE/WIPP 01-2293, WIPP Subsidence Monument Leveling Survey 2000, October 2000

DOE/WIPP 02-2293, WIPP Subsidence Monument Leveling Survey 2001, October 2001

DOE/WIPP 03-2293, WIPP Subsidence Monument Leveling Survey 2002, October 2002

DOE/WIPP 04-2293, WIPP Subsidence Monument Leveling Survey 2003, October 2003

DOE/WIPP 05-2293, WIPP Subsidence Monument Leveling Survey 2004, December 2004

DOE/WIPP 06-2293, WIPP Subsidence Monument Leveling Survey 2005, December 2005

DOE/WIPP 07-2293, WIPP Subsidence Monument Leveling Survey 2006, December 2006

DOE/WIPP 08-2293, WIPP Subsidence Monument Leveling Survey 2007, December 2007

DOE/WIPP 09-2293, WIPP Subsidence Monument Leveling Survey 2008, December 2008

DOE/WIPP 10-2293, WIPP Subsidence Monument Leveling Survey 2009, December 2009

DOE/WIPP 11-2293, WIPP Subsidence Monument Leveling Survey 2010, December 2010

DOE/WIPP 12-2293, WIPP Subsidence Monument Leveling Survey 2011, December 2011

DOE/WIPP 12-3497, WIPP Subsidence Monument Leveling Survey 2012, December 2012

DOE/WIPP 13-3512, WIPP Subsidence Monument Leveling Survey 2013, November 2013

DOE/WIPP 14-3541, WIPP Subsidence Monument Leveling Survey 2014, December 2014

DOE/WIPP 15-3562, WIPP Subsidence Monument Leveling Survey 2015, December 2015

DOE/WIPP 16-3577, WIPP Subsidence Monument Leveling Survey 2016, November 2016

DOE/WIPP 17-3595, WIPP Subsidence Monument Leveling Survey 2017, November 2017

DOE/WIPP 18-3604, WIPP Subsidence Monument Leveling Survey 2018, December 2018

DOE/WIPP 19-3613, WIPP Subsidence Monument Leveling Survey 2019, January 2020

DOE/WIPP 20-3613, WIPP Subsidence Monument Leveling Survey 2020, January 2021

DOE/WIPP 22-3613, WIPP Subsidence Monument Leveling Survey 2021, February 2022

1. Introduction

Subsidence monitoring was chosen by DOE as a long-term monitoring tool because it effectively meets the requirements in 40 CFR Part 191.14(b), Assurance Requirements. Subsidence monitoring is conducted to detect substantial and detrimental deviations from expected repository performance by comparing measured subsidence to predicted subsidence.

Subsidence surveys are performed annually throughout the operational period. After closure of the repository, subsidence surveys will be performed at 10-year intervals for at least 100 years or until no further useful information may be obtained through continued monitoring.

WIPP's Mine Engineering group performs the annual subsidence leveling survey. The WIPP science advisor, Sandia, analyzes the subsidence data to evaluate the repository performance.

Sections 2 through 7 of this report summarizes the result of the 2022 subsidence leveling survey of the subsidence monuments at the WIPP site. Approximately 15 miles of leveling was completed through nine vertical control loops. The 2022 survey includes the determination of elevation for 44 of the 48 existing subsidence monuments and the WIPP baseline survey monuments, and 14 of the National Geodetic Survey's (NGS) vertical control points. Construction activities in the vicinity of four monuments precluded them from inclusion in this year's survey and report. The leveling surveys were completed during October 2022 through November 2022 by the WIPP Mine Engineering.

Digital leveling techniques are utilized to achieve better than Second Order Class II loop closures, as outlined by the Federal Geodetic Control Subcommittee (FGCS) 2004. WP 09-ES4001, Subsidence Survey Data Acquisition Report, is used to perform the subsidence survey.

Starting with the survey of the year 2001, Loop 1 and redundant survey connections among the various loops were removed from the survey and report. The redundant connections were used to spot gross errors in the field. After several years of surveying these loops, it was evident that no gross errors occur that are not also evident in the loop closures.

Section 8, Comparison of Elevations, contains Table F, Comparison of Elevations 1987-2022, which summarizes the elevations for all surveys from 1987 through 2022, inclusive. A detailed listing of the 1986 through 1997 surveys is contained in the report DOE/WIPP 98-2293, WIPP Subsidence Monument Leveling Surveys 1986-1997. A reference to the summary reports for each year after 1997 is listed in the reference section of this document.

2. Equipment

The observations were taken with the Leica LS15 Digital Level (Serial # 707592) manufactured by Leica, and bar coded leveling staffs. The calibration for the Digital Level is valid from June 26, 2021 through June 26, 2023. The data were recorded on the digital level's internal memory. In addition to the electronic record, a written field log was maintained to record information that is not stored in the electronic record.

3. Office Processing

The data were transferred from the digital level's internal memory to the survey group computer. The original raw data files were maintained intact while further processing was performed on a copy of the original raw data file. The data from each of the leveling loops was processed with Leica Infinity software. The results, as summarized below, were extracted from the Level Summary reports for each loop. The Leica Infinity software was tested, verified, and validated in accordance with WIPP procedures and is in the WIPP controlled software list.

4. Methodology

As in previous years, the subsidence survey was divided into nine loops. Each loop generally takes one day to complete. This allows a loop to be completed in one surveying session and results in a lower probability of error.

The leveling surveys began on October 11, 2022 and completed on November 22, 2022. The weather conditions on days that the leveling surveys were performed were generally mild with moderate temperatures and light to moderate breezes.

The elevations for the 2022 survey are computed from the adjusted observations based on the elevation of the subsidence monument, S-37 (3,423.874 feet). Originally, S-37 was the WIPP monument furthest from the influence of the underground excavations. S-37 has been held fixed for all of the subsidence leveling surveys since 1993. The condition of the individual monuments was substantially the same as the previous subsidence survey. However, the condition of the four monuments in the vicinity of the construction activities could not be determined.

In the 2004 survey, it was noted that the brass cap of monument PT-31 came loose making it unusable. Monument PT-31 was not replaced because it was a triangulation station and was positioned about 1,000 feet west of the bounds of the subsidence grid.

Monuments S-17 and S-18 no longer exist due to construction of the new salt storage/disposal pad. These monuments cannot be replaced due to the active storage/disposal of salt from mining operations on the new pad. The salt disposal/storage pads are bound on the south by monuments S-14 and S-15 and bound on the north by monuments S-42 and S-43.

For visual reference, Figure 1 is a graphic display of the individual loops, the total survey, and the relationship to the underground excavations.

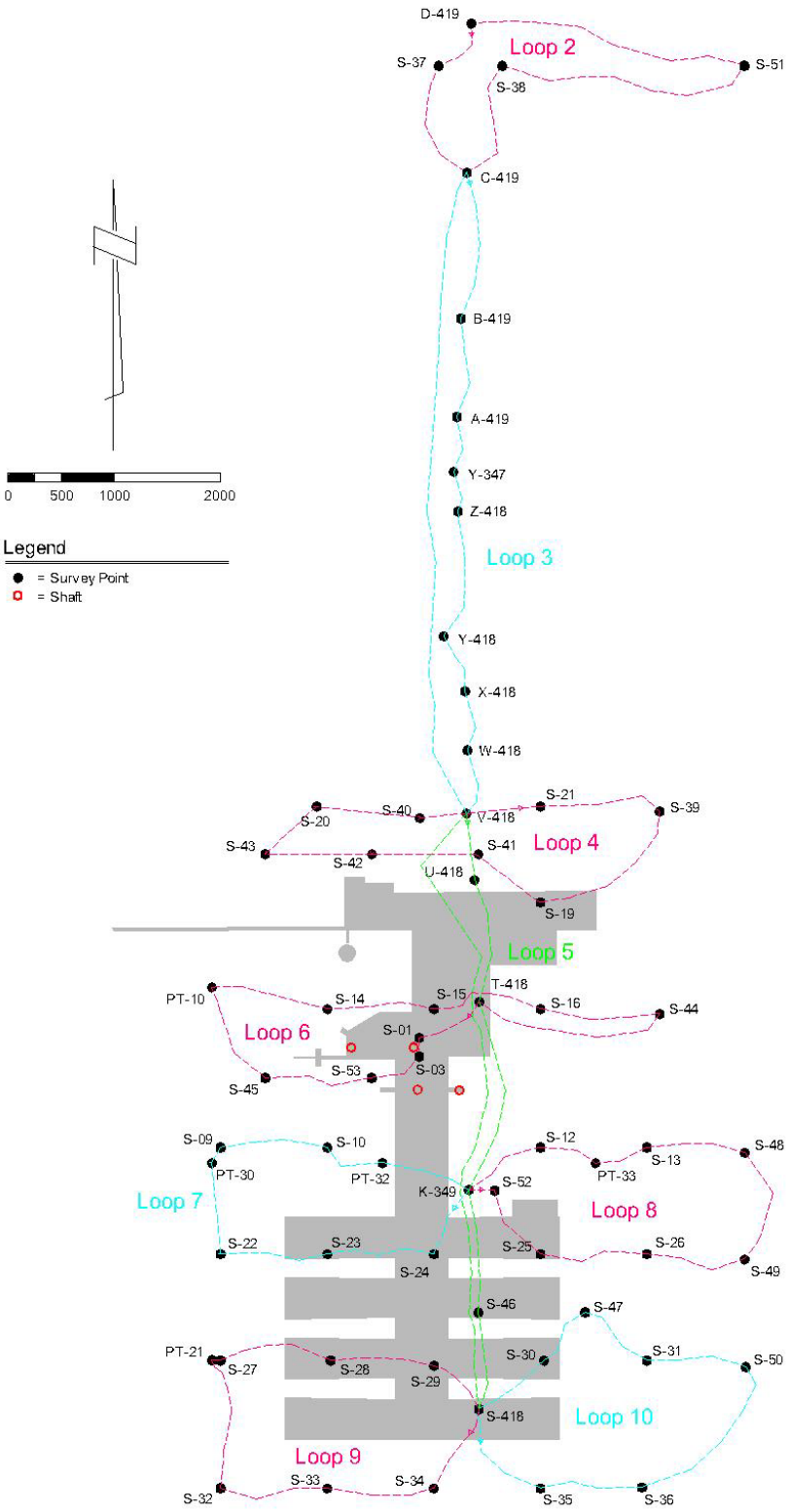


Figure 1. Individual Loops, Total Survey and Underground Excavations

5. General Summary of Results

Table A below describes the nine leveling loops that were measured to obtain the elevations of the subsidence monuments. The table contains the start date of the observations, a loop number, and the points that are contained within the loop. Due to construction east of the site, the nine loops were not surveyed in the usual order.

Table A. Description of 2022 Leveling Loops

Start Date (DOY)	Loop	Points
November 08, 2022 (312)	2	D-419, S-37, C-419, S-38, S-51, D-419
October 11, 2022 (284)	3	C-419, B-419, A-419, Y-347, Z-418, Y-418, X-418, W-418, V-418, C-419
October 13, 2022 (286)	4	V-418, S-21, S-39, S-19, S-41, S-42, S-43, S-20, S-40, V-418
October 18, 2022 (291)	5	V-418, U-418, T-418, K-349, S-46, S-418, V-418
November 22, 2022 (326)	6	T-418, S-16, S-44, S-15,S-14, S-45, S-53, S-03, S-01, T-418
October 20, 2022 (293)	7	K-349, S-24, S-23, S-22, PT-30, S-09, S-10, PT-32, K-349
October 26, 2022 (299)	8	K-349, S-52, S-25, S-26, S-49, S-48, K-349
October 27, 2022 (300)	9	S-418, S-34, S-33, S-32, PT-21, S-27, S-28, S-29 S-418
November 02,2022 (306)	10	S-418, S-35, S-36, S-50, S-31, S-47, S-30, S-418

Table B summarizes the results of the leveling loops in terms of vertical closure and accuracy. The requirement for Second Order Class II loop closure accuracy was achieved in all cases.

Table B. Summary of Distance and Accuracy for 2022 Leveling Loops

Loop	Cumulative Distance (ft.)	Vertical Closure (ft.)	Accuracy (ft.√mile)	Allowable Accuracy (ft.√mile)
2	7,852.08	-0.0010	0.001	0.040
3	12,724.19	-0.0023	0.001	0.051
4	8,299.41	-0.0126	0.010	0.041
5	12,039.25	-0.0068	0.005	0.050
6	8,494.43	-0.0017	0.001	0.042
7	6,617.53	0.0058	0.005	0.037
8	6,968.58	-0.0035	0.003	0.038
9	7,516.79	-0.0034	0.003	0.039
10	6,889.54	-0.0066	0.006	0.038

5.1 Accuracy Summary by Loop

Table C displays a detailed summary of the observations in the leveling loops for the 2022 survey. All results are displayed in feet. The information in the table for each loop includes:

Between each benchmark in the loop:

- The distance leveled between benchmarks along the loop.
- The number of instrument setups between each of the benchmarks.
- The difference in adjusted elevation from each benchmark to the next.

For each loop as a whole:

- The cumulative, or total, distance of each loop.
- The vertical closure of the loop.
- The accuracy of leveling.
- Allowable accuracy for each loop.

The accuracy of the leveling is given in terms of feet times the square root of the length of the loop in miles. The actual accuracy of leveling is computed by hand, and is based on the actual vertical closure of the loop. The maximum allowable accuracy is based on the allowable accuracy of a loop as stated in the FGCS specification for digital leveling. The FGCS specification for Second Order Class II loop closure permits a maximum of 8mm$\sqrt{}$km (8mm times the square root of the length of the loop in km). This converts to 0.033 ft.$\sqrt{}$mile (0.033 feet times the square root of the length of the loop in miles) when stated in the US customary units of length. All values indicated in this summary are expressed in feet.

Inspection of the following tables displays that in every case the actual accuracy is well below the maximum allowable accuracy for each loop. The column in each table that is labeled “Elev. Diff.” is the vertical difference from one point to the next. It is important to note that the vertical difference figures are calculated from the adjusted point elevations and because of rounding, the algebraic sum of the column may not be zero. The adjusted point elevations are the elevations of each monument with the closure error distributed to each set up of the leveling survey to recalculate the point elevations.

Table C. Detailed Loop Measurements

Loop 2

From	To	Distance	Setups	Elev. Diff.
D-419	S-37	506.50	4	0.612
S-37	C-419	1203.65	8	13.807
C-419	S-38	1091.24	8	-7.912
S-38	S-51	2308.85	14	7.933
S-51	D-419	2741.85	16	-14.440
Cumulative Distance:		7852.08		
Vertical Closure:				-0.0010
Accuracy of Leveling:				0.001
Allowable Accuracy:				0.040

Loop 3

From	To	Distance	Setups	Elev. Diff.
C-419	B-419	1444.89	10	12.166
B-419	A-419	965.10	6	4.891
A-419	Y-347	539.38	4	0.556
Y-347	Z-418	390.57	4	5.799
Z-418	Y-418	1296.26	8	4.001
Y-418	X-418	623.91	4	-9.114
X-418	W-418	577.52	4	-6.701
W-418	V-418	626.48	4	-12.830
V-418	C-419	6260.08	40	1.232
Cumulative Distance:		12724.19		
Vertical Closure:				-0.0023
Accuracy of Leveling:				0.001
Allowable Accuracy:				0.051

Loop 4

From	To	Distance	Setups	Elev. Diff.
V-418	S-21	733.43	4	5.457
S-21	S-39	1129.39	6	-3.780
S-39	S-19	1450.21	8	-12.071
S-19	S-41	773.64	4	4.770
S-41	S-42	1077.40	6	-2.621
S-42	S-43	1001.56	6	-4.401
S-43	S-20	670.22	4	10.503
S-20	S-40	1019.17	6	0.088
S-40	V-418	444.38	4	2.055
Cumulative Distance:		8299.41		
Vertical Closure:				-0.0126
Accuracy of Leveling:				0.010
Allowable Accuracy:				0.041

Loop 5

From	To	Distance	Setups	Elev. Diff.
V-418	U-418	1014.65	8	-10.248
U-418	T-418	1295.11	8	-9.481
T-418	K-349	1792.25	10	-12.893
K-349	S-46	1217.08	8	-4.635
S-46	S-418	962.51	6	2.041
S-418	V-418	5757.66	34	35.216
Cumulative Distance:		12039.25		
Vertical Closure:				-0.0068
Accuracy of Leveling:				0.005
Allowable Accuracy:				0.050

Loop 6

From	To	Distance	Setups	Elev. Diff.
T-418	S-16	589.86	4	4.484
S-16	S-44	1126.84	8	6.868
S-44	S-15	2148.00	12	-15.143
S-15	S-14	1002.48	6	-1.711
S-14	S-45	938.26	6	-10.868
S-45	S-53	1173.21	8	8.180
S-53	S-03	569.38	4	0.044
S-03	S-01	179.55	2	0.803
S-01	T-418	766.85	6	7.342
Cumulative Distance:		8494.43		
Vertical Closure:				-0.0017
Accuracy of Leveling:				0.001
Allowable Accuracy:				0.042

Loop 7

From	To	Distance	Setups	Elev. Diff.
K-349	S-24	949.17	6	-2.328
S-24	S-23	1116.53	8	-6.030
S-23	S-22	1045.89	8	-7.753
S-22	PT-30	858.87	6	4.963
PT-30	S-09	169.20	2	1.313
S-09	S-10	1028.37	6	8.230
S-10	PT-32	539.89	4	1.685
PT-32	K-349	909.62	6	-0.080
Cumulative Distance:		6617.53		
Vertical Closure:				0.0058
Accuracy of Leveling:				0.005
Allowable Accuracy:				0.037

Loop 8

From	To	Distance	Setups	Elev. Diff.
K-349	S-52	252.28	2	3.390
S-52	S-25	862.85	6	0.244
S-25	S-26	1007.02	8	12.328
S-26	S-49	977.31	6	12.791
S-49	S-48	1108.63	8	0.711
S-48	K-349	2760.48	16	-29.464
Cumulative Distance:		6968.58		
Vertical Closure:				-0.0035
Accuracy of Leveling:				0.003
Allowable Accuracy:				0.038

Table C continued on next page…

Table C. Detailed Loop Measurements (continued)

Loop 9				
From	**To**	**Distance**	**Setups**	**Elev. Diff.**
S-418	S-34	1093.20	8	-9.347
S-34	S-33	1066.46	8	-12.989
S-33	S-32	1076.05	8	-5.498
S-32	PT-21	1346.37	10	10.388
PT-21	S-27	102.32	2	3.349
S-27	S-28	1054.80	8	5.649
S-28	S-29	980.08	6	6.635
S-29	S-418	797.51	6	1.814
Cumulative Distance:		7516.79		
Vertical Closure:				-0.0034
Accuracy of Leveling:				0.003
Allowable Accuracy:				0.039

Loop 10				
From	**To**	**Distance**	**Setups**	**Elev. Diff.**
S-418	S-35	1271.64	8	-0.843
S-35	S-36	984.82	6	9.120
S-36	S-50	1523.11	10	16.318
S-50	S-31	959.03	6	-13.655
S-31	S-47	749.74	6	-3.251
S-47	S-30	595.11	4	-5.364
S-30	S-418	806.07	6	-2.326
Cumulative Distance:		6889.54		
Vertical Closure:				-0.0066
Accuracy of Leveling:				0.006
Allowable Accuracy:				0.038

6. Adjusted Level Loops

Table D is a summary of the adjusted elevations for the nine loops measured in 2022. They have been extracted from the output of the Leica Infinity software. These are adjusted elevations within each loop. All elevations are shown in feet. These final adjusted elevations also appear in Table E.

Table D. Adjusted Elevations by Loop

Loop 2	
D-419	3,423.262
S-37	3,423.874
C-419	3,437.680
S-38	3,429.768
S-51	3,437.701
D-419	3,423.262

Loop 3	
C-419	3,437.680
B-419	3,449.847
A-419	3,454.738
Y-347	3,455.293
Z-418	3,461.092
Y-418	3,465.093
X-418	3,455.979
W-418	3,449.277
V-418	3,436.447
C-419	3,437.680

Loop 4	
V-418	3,436.447
S-21	3,441.902
S-39	3,438.121
S-19	3,426.048
S-41	3,430.817
S-42	3,428.195
S-43	3,423.792
S-20	3,434.294
S-40	3,434.380
V-418	3,436.447

Loop 5	
V-418	3,436.447
U-418	3,426.198
T-418	3,416.716
K-349	3,403.822
S-46	3,399.187
S-418	3,401.227
V-418	3,436.447

Loop 6	
T-418	3,416.716
S-16	3,421.200
S-44	3,428.068
S-15	3,412.926
S-14	3,411.215
PT-10	(1)
S-45	3,400.347
S-53	3,408.527
S-03	3,408.571
S-01	3,409.374
T-418	3,416.716

Loop 7	
K-349	3,403.822
S-24	3,401.495
S-23	3,395.466
S-22	3,387.713
S-09	3,393.991
S-10	3,402.222
PT-32	3,403.908
K-349	3,403.822

Loop 8	
K-349	3,403.822
S-52	3,407.212
S-25	3,407.455
S-26	3,419.783
S-49	3,432.574
S-48	3,433.284
S-13	(1)
PT-33	(1)
S-12	(1)
K-349	3,403.822

Loop 9	
S-418	3,401.227
S-34	3,391.879
S-33	3,378.890
S-32	3,373.391
PT-21	3,383.779
S-27	3,387.127
S-28	3,392.775
S-29	3,399.410
S-418	3,401.227

Loop 10	
S-418	3,401.227
S-35	3,400.383
S-36	3,409.502
S-50	3,425.819
S-31	3,412.163
S-47	3,408.911
S-30	3,403.547
S-418	3,401.227

Note: (1) Construction activity in the vicinity of the monument precluded its use in the 2022 annual survey.

7. Adjusted Elevations (2022)

Table E displays the adjusted elevations for the subsidence monuments and the NGS points contained within the 2022 survey. These elevations are normalized to the monument, S-37. All elevations are shown in feet and are within the WIPP local coordinate system.

Table E. 2022 Adjusted Elevations

Point	Elevation (ft.)	Point	Elevation (ft.)
S-01	3,409.374	S-41	3,430.817
S-03	3,408.571	S-42	3,428.195
S-09	3,393.991	S-43	3,423.792
S-10	3,402.222	S-44	3,428.068
S-12	(1)	S-45	3,400.347
S-13	(1)	S-46	3,399.187
S-14	3,411.215	S-47	3,408.911
S-15	3,412.926	S-48	3,433.284
S-16	3,421.200	S-49	3,432.574
S-19	3,426.048	S-50	3,425.819
S-20	3,434.294	S-51	3,437.701
S-21	3,441.902	S-52	3,407.212
S-22	3,387.713	S-53	3,408.527
S-23	3,395.466	PT-10	(1)
S-24	3,401.495	PT-21	3,383.779
S-25	3,407.455	PT-32	3,403.908
S-26	3,419.783	PT-33	(1)
S-27	3,387.127	S-418	3,401.227
S-28	3,392.775	T-418	3,416.716
S-29	3,399.410	U-418	3,426.198
S-30	3,403.547	V-418	3,436.447
S-31	3,412.163	W-418	3,449.277
S-32	3,373.391	X-418	3,455.979
S-33	3,378.890	Y-347	3,455.293
S-34	3,391.879	Y-418	3,465.093
S-35	3,400.383	Z-418	3,461.092
S-36	3,409.502	A-419	3,454.738
S-37	3,423.874	B-419	3,449.847
S-38	3,429.768	C-419	3,437.680
S-39	3,438.121	D-419	3,423.262
S-40	3,434.380	K-349	3,403.822

Note: (1) Construction activity in the vicinity of the monument precluded its use in the 2022 annual survey.

8. Comparison of Elevations*

Table F compares the elevations from all of the subsidence leveling surveys from 1987 through 2022**.** All elevations are displayed in feet.

Table F. Comparison of Elevations 1987-2022

	S-01	S-02	S-03	S-09	S-10	S-11	S-12	S-13	S-14
1987	3,409.738	3,408.219	3,408.914	3,394.056	3,402.466	3,406.437	3,411.790	3,422.428	3,411.500
1989	3,409.719	3,411.907	3,408.900	3,394.046	3,402.459	3,406.408	3,411.739	3,422.413	3,411.483
1992	3,409.695	3,411.904	3,408.875	3,394.053	3,402.440	3,406.372	3,411.727	3,422.412	3,411.439
1993	3,409.616	(1) (2)	3,408.797	3,393.969	3,402.365	(3)	3,411.630	3,422.324	3,411.382
1994	3,409.626		3,408.806	3,393.988	3,402.374		3,411.653	3,422.348	3,411.372
1995	3,409.613		3,408.795	3,393.986	3,402.373		3,411.650	3,422.345	3,411.376
1996	3,409.615		3,408.795	3,393.994	3,402.373		3,411.645	3,422.340	3,411.369
1997	3,409.610		3,408.793	3,394.002	3,402.379		3,411.656	3,422.349	3,411.368
1998	3,409.617		3,408.802	3,394.011	3,402.388		3,411.653	3,422.352	3,411.374
1999	3,409.613		3,408.798	3,394.004	3,402.385		3,411.650	3,422.358	3,411.365
2000	3,409.607		3,408.792	3,394.003	3,402.381		3,411.644	3,422.352	3,411.364
2001	3,409.599		3,408.786	3,394.006	3402.378		3,411.636	3,422.350	3,411.361
2002	3,409.595		3,408.783	3,394.012	3,402.381		3,411.637	3,422.354	3,411.357
2003	3,409.583		3,408.771	3,394.007	3,402.372		3,411.629	3,422.307	3,411.351
2004	3,409.575		3,408.762	3,394.006	3,402.373		3,411.630	3,422.310	3,411.329
2005	3,409.551		3,408.739	3,393.997	3,402.357		3,411.611	3,422.274	3,411.307
2006	3,409.539		3,408.727	3,393.992	3,402.349		3,411.603	3,422.274	3,411.301
2007	3,409.546		3,408.734	3,394.012	3,402.356		3,411.609	3,422.281	3,411.301
2008	3,409.533		3,408.722	3,394.006	3,402.350		3,411.606	3,422.284	3,411.297
2009	3,409.531		3,408.721	3,394.008	3,402.344		3,411.596	3,422.279	3,411.294
2010	3,409.513		3,408.701	3,393.999	3,402.329		3,411.586	3,422.268	3,411.287
2011	3,409.519		3,408.707	3,394.005	3,402.333		3,411.586	3,422.282	3,411.297
2012	3,409.509		3,408.699	3,393.996	3,402.319		3,411.584	3,422.273	3,411.295
2013	3,409.503		3,408.694	3,394.017	3,402.331		3,411.587	3,422.280	3,411.290
2014	3,409.481		3,408.671	3,394.012	3,402.321		3,411.577	3,422.275	3,411.279
2015	3,409.466		3,408.658	3,394.013	3,402.309		3,411.571	3,422.273	3,411.268
2016	3,409.446		3,408.639	3,394.003	3,402.295		3,411.555	3,422.262	3,411.256
2017	3,409.445		3,408.639	3,394.010	3,402.292		3,411.555	3,422.263	3,411.257
2018	3,409.429		3,408.625	3,394.002	3,402.279		3,411.546	3,422.256	3,411.247
2019	3,409.426		3,408.622	3,394.005	(9)		(9)	(9)	3,411.246
2020	3,409.409		3,408.612	3,393.995	3,402.251		(9)	3,422.254	3,411.244
2021	3,409.411		3,408.613	3,394.008	3,402.250		(9)	(9)	(9)
2022	3,409.374		3,408.571	3,393.991	3,402.222		(9)	(9)	3,411.215

Note: (1) The subsidence monument, S-02 was relocated in 1989.
(2) The subsidence monument, S-02, no longer exists after the 1992 survey.
(3) The subsidence monument, S-11, no longer exists after the 1992 survey.
(9) Construction activity in the vicinity of the monument precluded its use in the noted year's annual survey.

Table F continued on next page…

Table F. Comparison of Elevations 1987-2022 (continued)

	S-15	S-16	S-17	S-18	S-19	S-20	S-21	S-22	S-23
1987	3,413.291	3,421.378	3,422.519	3,425.010	3,426.235	3,434.464	3,442.030	3,387.786	3,395.914
1989	3,413.291	3,421.341	3,422.482	3,424.974	3,426.217	3,434.452	3,442.005	3,387.795	3,395.970
1992	3,413.263	3,421.331	3,422.469	3,424.964	3,426.223	3,434.364	3,441.956	3,387.788	3,396.028
1993	3,413.185	3,421.256	3,422.404	3,424.859	3,426.136	3,434.332	3,441.919	3,387.701	3,395.853
1994	3,413.188	3,421.261	3,422.402	3,424.852	3,426.134	3,434.339	3,441.932	3,387.732	3,395.886
1995	3,413.189	3,421.261	3,422.418	3,424.864	3,426.143	3,434.342	3,441.936	3,387.727	3,395.877
1996	3,413.182	3,421.263	3,422.419	3,424.860	3,426.138	3,434.345	3,441.935	3,387.727	3,395.885
1997	3,413.178	3,421.268	3,422.431	3,424.864	3,426.141	3,434.346	3,441.937	3,387.738	3,395.889
1998	3,413.184	3,421.271	3,422.436	3,424.869	3,426.150	3,434.355	3,441.946	3,387.744	3,395.887
1999	3,413.177	3,421.275	3,422.435	3,424.865	3,426.152	3,434.362	3,441.959	3,387.729	3,395.873
2000	3,413.172	3,421.278	3,422.440	3,424.864	3,426.140	3,434.362	3,441.956	3,387.727	3,395.861
2001	3,413.167	3,421.277	3,422.434	3,424.858	3,426.138	3,434.363	3,441.956	3,387.728	3,395.857
2002	3,413.159	3,421.275	3,422.434	3,424.855	3,426.132	3,434.361	3,441.950	3,387.731	3,395.857
2003	3,413.152	3,421.279	3,422.430	3,424.849	3,426.117	3,434.350	3,441.939	3,387.728	3,395.850
2004	3,413.142	3,421.281	(4)	(5)	3,426.128	3,434.359	3,441.955	3,387.727	3,395.841
2005	3,413.118	3,421.268			3,426.107	3,434.343	3,441.941	3,387.720	3,395.826
2006	3,413.109	3,421.269			3,426.101	3,434.338	3,441.937	3,387.711	3,395.815
2007	3,413.113	3,421.280			3,426.105	3,434.346	3,441.947	3,387.730	3,395.823
2008	3,413.099	3,421.274			3,426.104	3,434.344	3,441.945	3,387.721	3,395.810
2009	3,413.093	3,421.283			3,426.107	3,434.347	3,441.950	3,387.726	3,395.802
2010	3,413.083	3,421.271			3,426.088	3,434.331	3,441.936	3,387.716	3,395.768
2011	3,413.088	3,421.280			3,426.095	3,434.345	3,441.944	3,387.724	3,395.748
2012	3,413.073	3,421.274			3,426.092	3,434.345	3,441.945	3,387.715	3,395.724
2013	3,413.065	3,421.273			3,426.085	3,434.340	3,441.935	3,387.735	3,395.727
2014	3,413.042	3,421.259			3,426.073	3,434.334	3,441.927	3,387.721	3,395.694
2015	3,413.028	3,421.252			3,426.074	3,434.333	3,441.931	3,387.730	3,395.674
2016	3,413.007	3,421.237			3,426.061	3,434.320	3,441.919	3,387.736	3,395.643
2017	3,413.005	3,421.241			3,426.068	3,434.325	3,441.924	3,387.752	3,395.632
2018	3,412.985	3,421.232			3,426.059	3,434.317	3,441.919	3,387.742	3,395.609
2019	3,412.978	3,421.227			3,426.066	3,434.318	3,441.924	3,387.740	3,395.569
2020	3,412.969	3,421.218			3,426.064	3,434.316	3,441.920	3,387.726	3,395.528
2021	3,412.960	3,421.221			3,426.065	3,434.319	3,441.919	3,387.737	3,395.505
2022	3,412.926	3,421.200			3,426.048	3,434.294	3,441.902	3,387.713	3,395.466

Note: (4) The subsidence monument, S-17, no longer exists after the 2003 survey.
(5) The subsidence monument, S-18, no longer exists after the 2003 survey.

Table F continued on next page…

Table F. Comparison of Elevations 1987-2022 (continued)

	S-24	S-25	S-26	S-27	S-28	S-29	S-30	S-31	S-32
1987	3,402.201	3,408.036	3,420.010	3,387.280	3,393.414	3,400.111	3,404.082	3,412.315	3,373.513
1989	3,402.167	3,408.005	3,419.978	3,387.287	3,393.400	3,400.098	3,404.064	3,412.302	3,373.498
1992	3,402.159	3,407.974	3,419.948	3,387.310	3,393.421	3,400.113	3,404.073	3,412.303	3,373.533
1993	3,402.042	3,407.870	3,419.854	3,387.181	3,393.287	3,400.008	3,403.958	3,412.206	3,373.396
1994	3,402.072	3,407.907	3,419.883	3,387.225	3,393.312	3,400.038	3,403.984	3,412.234	3,373.427
1995	3,402.062	3,407.895	3,419.871	3,387.216	3,393.309	3,400.031	3,403.978	3,412.230	3,373.425
1996	3,402.074	3,407.897	3,419.875	3,387.213	3,393.316	3,400.037	3,403.979	3,412.221	3,373.411
1997	3,402.077	3,407.897	3,419.883	3,387.229	3,393.330	3,400.050	3,403.994	3,412.248	3,373.438
1998	3,402.076	3,407.902	3,419.883	3,387.248	3,393.338	3,400.059	3,403.998	3,412.248	3,373.452
1999	3,402.067	3,407.898	3,419.886	3,387.229	3,393.322	3,400.053	3,403.990	3,412.252	3,373.429
2000	3,402.051	3,407.876	3,419.871	3,387.226	3,393.316	3,400.045	3,403.980	3,412.252	3,373.428
2001	3,402.035	3,407.862	3,419.872	3,387.231	3,393.318	3,400.040	3,403.972	3,412.255	3,373.431
2002	3,402.029	3,407.858	3,419.877	3,387.231	3,393.316	3,400.034	3,403.968	3,412.258	3,373.433
2003	3,402.012	3,407.840	3,419.871	3,387.233	3,393.311	3,400.016	3,403.951	3,412.252	3,373.433
2004	3,401.995	3,407.822	3,419.870	3,387.231	3,393.310	3,399.996	3,403.932	3,412.254	3,373.439
2005	3,401.976	3,407.786	3,419.853	3,387.221	3,393.294	3,399.961	3,403.902	3,412.235	3,373.426
2006	3,401.956	3,407.762	3,419.857	3,387.207	3,393.278	3,399.930	3,403.870	3,412.221	3,373.413
2007	3,401.958	3,407.764	3,419.850	3,387.226	3,393.280	3,399.928	3,403.872	3,412.237	3,373.431
2008	3,401.929	3,407.739	3,419.850	3,387.217	3,393.260	3,399.910	3,403.848	3,412.222	3,373.421
2009	3,401.910	3,407.725	3,419.840	3,387.218	3,393.235	3,399.888	3,403.834	3,412.225	3,373.423
2010	3,401.868	3,407.700	3,419.832	3,387.202	3,393.190	3,399.846	3,403.811	3,412.218	3,373.413
2011	3,401.836	3,407.685	3,419.835	3,387.200	3,393.153	3,399.819	3,403.795	3,412.223	3,373.423
2012	3,401.804	3,407.663	3,419.830	3,387.191	3,393.118	3,399.780	3,403.768	3,412.215	3,373.413
2013	3,401.795	3,407.662	3,419.837	3,387.212	3,393.112	3,399.767	3,403.767	3,412.226	3,373.442
2014	3,401.752	3,407.634	3,419.828	3,387.190	3,393.068	3,399.718	3,403.735	3,412.216	3,373.432
2015	3,401.732	3,407.617	3,419.829	3,387.191	3,393.044	3,399.688	3,403.722	3,412.227	3,373.433
2016	3,401.694	3,407.586	3,419.816	3,387.174	3,393.000	3,399.639	3,403.688	3,412.200	3,373.424
2017	3,401.678	3,407.573	3,419.819	3,387.175	3,392.976	3,399.613	3,403.677	3,412.208	3,373.419
2018	3,401.642	3,407.549	3,419.811	3,387.162	3,392.938	3,399.572	3,403.655	3,412.201	3,373.410
2019	3,401.609	3,407.525	3,419.811	3,387.157	3,392.896	3,399.538	3,403.632	3,412.197	3,373.410
2020	3,401.568	3,407.493	3,419.794	3,387.148	3,392.846	3,399.495	3,403.603	3,412.183	3,373.399
2021	3,401.539	3,407.480	3419.799	3,387.153	3,392.822	3,399.468	3,403.589	3,412.192	3,373.412
2022	3,401.495	3,407.455	3,419.783	3,387.127	3,392.775	3,399.410	3,403.547	3,412.163	3,373.391

Table F continued on next page…

Table F. Comparison of Elevations 1987-2022 (continued)

	S-33	S-34	S-35	S-36	S-37	S-38	S-39	S-40	S-41
1987	3,379.093	3,392.128	3,400.597	3,409.583	(10)	(10)	(10)	(10)	(10)
1989	3,379.073	3,392.137	3,400.583	3,409.584	3,423.888	3,429.736	(10)	(10)	(10)
1992	3,379.090	3,392.138	3,400.591	3,409.605	3,423.874	(10)	3,438.146	3,434.469	3,430.931
1993	3,378.975	3,392.026	3,400.478	3,409.504	3,423.874	3,429.736	3,438.110	3,434.430	3,430.888
1994	3,379.006	3,392.042	3,400.490	3,409.518	3,423.874	3,429.740	3,438.115	3,434.425	3,430.888
1995	3,379.009	3,392.042	3,400.495	3,409.520	3,423.874	3,429.739	3,438.124	3,434.437	3,430.899
1996	3,378.992	3,392.028	3,400.483	3,409.501	3,423.874	3,429.744	3,438.118	3,434.436	3,430.891
1997	3,379.019	3,392.057	3,400.516	3,409.533	3,423.874	3,429.745	3,438.127	3,434.444	3,430.894
1998	3,379.028	3,392.066	3,400.516	3,409.539	3,423.874	3,429.750	3,438.134	3,434.442	3,430.901
1999	3,379.011	3,392.056	3,400.507	3,409.539	3,423.874	3,429.751	3,438.149	3,434.445	3,430.900
2000	3,379.012	3,392.053	3,400.505	3,409.541	3,423.874	3,429.754	3,438.145	3,434.445	3,430.902
2001	3,379.014	3,392.057	3,400.509	3,409.546	3,423.874	3,429.756	3,438.145	3,434.436	3,430.898
2002	3,379.017	3,392.060	3,400.513	3,409.550	3,423.874	3,429.757	3,438.142	3,434.437	3,430.897
2003	3,379.016	3,392.057	3,400.511	3,409.546	3,423.874	3,429.760	3,438.130	3,434.425	3,430.892
2004	3,379.020	3,392.055	3,400.514	3,409.549	3,423.874	3429.761	3,438.152	3,434.449	3,430.900
2005	3,379.011	3,392.035	3,400.505	3,409.536	3,423.874	3,429.757	3,438.144	3,434.449	3,430.882
2006	3,378.994	3,392.017	3,400.484	3,409.524	3,423.874	3,429.757	3,438.145	3,434.448	3,430.881
2007	3,379.001	3,392.022	3,400.492	3,409.536	3,423.874	3,429.763	3,438.143	3,434.450	3,430.882
2008	3,378.988	3,392.006	3,400.476	3,409.530	3,423.874	3,429.759	3,438.145	3,434.442	3,430.878
2009	3,378.979	3,391.999	3,400.469	3,409.535	3,423.874	3,429.758	3,438.150	3,434.439	3,430.884
2010	3,378.961	3,391.982	3,400.464	3,409.532	3,423.874	3,429.751	3,438.135	3,434.426	3,430.864
2011	3,378.962	3,391.981	3,400.454	3,409.540	3,423.874	3,429.760	3,438.145	3,434.411	3,430.872
2012	3,378.949	3,391.967	3,400.446	3,409.532	3,423.874	3,429.760	3,438.152	3,434.416	3,430.871
2013	3,378.972	3,391.982	3,400.457	3,409.543	3,423.874	3,429.757	3,438.142	3,434.416	3,430.862
2014	3,378.959	3,391.965	3,400.451	3,409.537	3,423.874	3,429.757	3,438.148	3,434.422	3,430.859
2015	3,378.957	3,391.961	3,400.451	3,409.538	3,423.874	3,429.763	3,438.142	3,434.426	3,430.854
2016	3,378.937	3,391.939	3,400.439	3,409.522	3,423.874	3,429.761	3,438.139	3,434.426	3,430.846
2017	3,378.935	3,391.937	3,400.434	3,409.527	3,423.874	3,429.762	3,438.134	3,434.424	3,430.846
2018	3,378.923	3,391.923	3,400.426	3,409.524	3,423.874	3,429.762	3,438.134	3,434.416	3,430.839
2019	3,378.916	3,391.918	3,400.410	3,409.523	3,423.874	3,429.765	3,438.133	3,434.397	3,430.841
2020	3,378.900	3,391.901	3,400.389	3,409.515	3,423.874	3,429.762	3,438.131	3,434.402	3,430.837
2021	3,378.912	3,391.905	3,400.398	3,409.524	3,423.874	3,429.769	3,438.137	3,434.409	3,430.834
2022	3,378.890	3,391.879	3,400.383	3,409.502	3,423.874	3,429.768	3,438.121	3,434.380	3,430.817

Note: (10) The monument was not use in the noted year's annual survey.

Table F continued on next page…

Table F. Comparison of Elevations 1987-2022 (continued)

	S-42	S-43	S-44	S-45	S-46	S-47	S-48	S-49	S-50
1987	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1989	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1992	3,428.279	3,423.849	3,428.146	3,400.501	3,399.946	3,409.236	3,433.308	3,432.635	3,425.868
1993	3,428.230	3,423.813	3,428.070	3,400.406	3,399.837	3,409.133	3,433.238	3,432.572	3,425.809
1994	3,428.228	3,423.820	3,428.066	3,400.419	3,399.865	3,409.163	3,433.264	3,432.596	3,425.830
1995	3,428.238	3,423.826	3,428.071	3,400.424	3,399.856	3,409.158	3,433.258	3,432.588	3,425.830
1996	3,428.238	3,423.823	3,428.078	3,400.423	3,399.856	3,409.157	3,433.256	3,432.585	3,425.816
1997	3,428.249	3,423.815	3,428.084	3,400.428	3,399.877	3,409.181	3,433.274	3,432.600	3,425.846
1998	3,428.252	3,423.822	3,428.086	3,400.440	3,399.876	3,409.178	3,433.276	3,432.598	3,425.838
1999	3,428.255	3,423.825	3,428.091	3,400.435	3,399.866	3,409.176	3,433.289	3,432.611	3,425.851
2000	3,428.254	3,423.820	3,428.095	3,400.434	3,399.842	3,409.168	3,433.288	3,432.606	3,425.854
2001	3,428.247	3,423.818	3,428.094	3,400.433	3,399.824	3,409.163	3,433.290	3,432.606	3,425.858
2002	3,428.246	3,423.815	3,428.097	3,400.435	3,399.818	3,409.160	3,433.297	3,432.613	3,425.863
2003	3,428.236	3,423.805	3,428.090	3,400.430	3,399.790	3,409.147	3,433.294	3,432.610	3,425.857
2004	3,428.254	3,423.814	3,428.105	3,400.440	3,399.770	3,409.149	3,433.311	3,432.620	3,425.876
2005	3,428.243	3,423.798	3,428.093	3,400.421	3,399.745	3,409.114	3,433.297	3,432.603	3,425.855
2006	3,428.242	3,423.795	3,428.097	3,400.415	3,399.718	3,409.096	3,433.310	3,432.617	3,425.854
2007	3,428.244	3,423.802	3,428.099	3,400.417	3,399.705	3,409.095	3,433.306	3,432.612	3,425.866
2008	3,428.242	3,423.802	3,428.100	3,400.415	3,399.675	3,409.079	3,433.321	3,432.623	3,425.859
2009	3,428.245	3,423.818	3,428.099	3,400.414	3,399.643	3,409.064	3,433.306	3,432.611	3,425.856
2010	3,428.227	3,423.819	3,428.087	3,400.399	3,399.605	3,409.048	3,433.301	3,432.608	3,425.852
2011	3,428.236	3,423.832	3,428.094	3,400.412	3,399.565	3,409.041	3,433.310	3,432.616	3,425.860
2012	3,428.236	3,423.833	3,428.097	3,400.414	3,399.526	3,409.027	3,433.308	3,432.610	3425.857
2013	3,428.228	3,423.830	3,428.096	3,400.419	3,399.519	3,409.030	3,433.307	3,432.611	3,425.860
2014	3,428.229	3,423.825	3,428.098	3,400.414	3,399.485	3,409.022	3,433.314	3,432.612	3,425.864
2015	3,428.224	3,423.823	3,428.100	3,400.405	3,399.453	3,409.020	3,433.309	3,432.611	3,425.876
2016	3,428.217	3,423.811	3,428.090	3,400.381	3,399.420	3,408.993	3,433.310	3,432.604	3,425.851
2017	3,428.218	3,423.817	3,428.094	3,400.380	3,399.386	3,408.981	3,433.306	3,432.606	3,425.852
2018	3,428.213	3,423.809	3,428.091	3,400.374	3,399.352	3,408.973	3,433.304	3,432.600	3,425.850
2019	3,428.209	3,423.811	3,428.095	3,400.373	3,399.305	3,408.957	3,433.310	3,432.601	3,425.843
2020	3,428.206	3,423.816	3,428.084	3,400.365	3,399.254	3,408.936	3,433.294	3,432.586	3,425.831
2021	3,428.200	3,423.815	3,428.083	3,400.374	3,399.234	3,408.937	3433.299	3432.587	3,425.837
2022	3,428.195	3,423.792	3,428.068	3,400.347	3,399.187	3,408.911	3,433.284	3,432.574	3,425.819

Note: (10) The monument was not use in the noted year's annual survey.

Table F continued on next page…

Table F. Comparison of Elevations 1987-2022 (continued)

	S-51	S-52	S-53	S-54	PT-10	PT-21	PT-30	PT-31	PT-32
1987	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1989	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1992	3,437.765	3,407.611	3,408.775	3,411.085	3,407.722	(10)	3,392.914	3,385.117	3,404.370
1993	3,437.746	3,407.523	3,408.670	(6)	3,407.664	3,383.821	3,392.823	3,385.027	3,404.296
1994	3,437.749	3,407.542	3,408.709		3,407.672	3,383.868	3,392.843	3,385.051	3,404.311
1995	3,437.746	3,407.542	3,408.702		3,407.671	3,383.862	3,392.844	3,385.050	3,404.322
1996	3,437.729	3,407.536	3,408.704		3,407.669	3,383.858	3,392.852	3,385.053	3,404.312
1997	3,437.725	3,407.544	3,408.702		3,407.675	3,383.874	3,392.857	3,385.063	3,404.321
1998	3,437.724	3,407.549	3,408.714		3,407.687	3,383.887	(7)	3,385.067	3,404.322
1999	3,437.729	3,407.544	3,408.709		3,407.689	3,383.868		3,385.053	3,404.315
2000	3,437.729	3,407.531	3,408.704		3,407.685	3,383.868		3,385.053	3,404.306
2001	3,437.731	3,407.522	3,408.701		3,407.687	3,383.874		3,385.053	3,404.259
2002	3,437.733	3,407.521	3,408.700		3,407.688	3,383.871		3,385.057	3,404.250
2003	3,437.731	3,407.507	3,408.690		3,407.685	3,383.874		3,385.054	3,404.234
2004	3,437.730	3,407.501	3,408.686		3,407.685	3,383.874		(8)	3,404.172
2005	3,437.720	3,407.473	3,408.667		3,407.669	3,383.862			3,404.152
2006	3,437.720	3,407.461	3,408.659		3,407.667	3,383.848			3,404.138
2007	3,437.720	3,407.458	3,408.666		3,407.670	3,383.866			3,404.146
2008	3,437.720	3,407.445	3,408.659		3,407.669	3,383.857			3,404.132
2009	3,437.721	3,407.432	3,408.656		3,407.673	3,383.858			3,404.124
2010	3,437.705	3,407.408	3,408.640		3,407.665	3,383.841			3,404.101
2011	3,437.717	3,407.407	3,408.650		3,407.678	3,383.838			3,404.097
2012	3,437.715	3,407.388	3,408.645		3,407.681	3,383.834			3,404.076
2013	3,437.708	3,407.386	3,408.644		3,407.685	3,383.857			3,404.079
2014	3,437.710	3,407.367	3,408.625		3,407.677	3,383.840			3,404.058
2015	3,437.708	3,407.342	3,408.614		3,407.673	3,383.841			3,404.045
2016	3,437.700	3,407.322	3,408.597		3,407.662	3,383.825			3,404.019
2017	3,437.704	3,407.307	3,408.597		3,407.668	3,383.823			3,404.013
2018	3,437.702	3,407.286	3,408.583		3,407.660	3,383.811			3,403.992
2019	3,437.705	3,407.272	3,408.584		(9)	3,383.805			(9)
2020	3,437.705	3,407.244	3,408.565		(9)	3,383.793			3,403.949
2021	3,437.713	3,407.242	3,408.567		(9)	3,383.801			3,403.942
2022	3,437.701	3,407.212	3,408.527		(9)	3,383.779			3,403.908

Note: (6) The subsidence monument, S-54, no longer exists after the 1992 survey.
(7) The monument, PT-30, has been physically disturbed and was removed from the 1998 survey.
(8) The monument, PT-31, has been physically disturbed and was removed from the 2004 survey.
(9) Construction activity in the vicinity of the monument precluded its use in the noted year's annual survey.
(10) The monument was not use in the noted year's annual survey.

Table F continued on next page…

Table F. Comparison of Elevations 1987-2022 (continued)

	PT-33	S-418	T-418	U-418	V-418	W-418	X-418	Y-347	Y-418
1987	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1989	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1992	3,419.939	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1993	3,419.853	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1994	3,419.884	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1995	3,419.869	(10)	(10)	(10)	(10)	(10)	(10)	(10)	(10)
1996	3,419.865	3,401.696	3,416.902	3,426.267	3,436.481	3,449.276	3,455.969	3,455.274	3,465.080
1997	3,419.873	3,401.708	3,416.906	3,426.272	3,436.487	3,449.282	3,455.976	3,455.281	3,465.091
1998	3,419.879	3,401.715	3,416.915	3,426.279	3,436.497	3,449.292	3,455.987	3,455.291	3,465.101
1999	3,419.880	3,401.707	3,416.913	3,426.275	3,436.500	3,449.304	3,456.000	3,455.304	3,465.117
2000	3,419.872	3,401.702	3,416.911	3,426.273	3,436.502	3,449.307	3,456.005	3,455.309	3,465.123
2001	3,419.866	3,401.702	3,416.905	3,426.270	3,436.502	3,449.310	3,456.007	3,455.312	3,465.125
2002	3,419.868	3,401.701	3,416.901	3,426.269	3,436.502	3,449.311	3,456.009	3,455.314	3,465.126
2003	3,419.866	3,401.685	3,416.892	3,426.264	3,436.500	3,449.308	3,456.007	3,455.312	3,465.125
2004	3,419.855	3,401.670	3,416.887	3,426.265	3,436.499	3,449.310	3,456.009	3,455.315	3,465.126
2005	3,419.789	3,401.634	3,416.868	3,426.252	3,436.485	3,449.295	3,455.993	3,455.301	3,465.113
2006	3,419.784	3,401.605	3,416.860	3,426.247	3,436.481	3,449.290	3,455.991	3,455.300	3,465.111
2007	3,419.788	3,401.604	3,416.865	3,426.258	3,436.491	3,449.302	3,456.003	3,455.311	3,465.122
2008	3,419.785	3,401.580	3,416.857	3,426.259	3,436.490	3,449.301	3,456.000	3,455.307	3,465.120
2009	3,419.783	3,401.562	3,416.853	3,426.261	3,436.493	3,449.307	3,456.006	3,455.312	3,465.125
2010	3,419.771	3,401.531	3,416.840	3,426.246	3,436.477	3,449.293	3,455.994	3,455.301	3,465.113
2011	3,419.778	3,401.515	3,416.841	3,426.259	3,436.487	3,449.306	3,456.006	3,455.317	3,465.125
2012	3,419.765	3,401.487	3,416.828	3,426.257	3,436.488	3,449.308	3,456.009	3,455.317	3,465.129
2013	3,419.776	3,401.480	3,416.819	3,426.249	3,436.479	3,449.296	3,455.995	3,455.303	3,465.110
2014	3,419.763	3,401.446	3,416.801	3,426.240	3,436.473	3,449.294	3,455.995	3,455.305	3,465.111
2015	3,419.754	3,401.426	3,416.789	3,426.235	3,436.473	3,449.291	3,455.992	3,455.302	3,465.109
2016	3,419.736	3,401.388	3,416.770	3,426.219	3,436.459	3,449.279	3,455.982	3,455.293	3,465.100
2017	3,419.736	3,401.372	3,416.772	3,426.226	3,436.466	3,449.286	3,455.989	3,455.299	3,465.105
2018	3,419.730	3,401.342	3,416.757	3,426.217	3,436.459	3,449.281	3,455.982	3,455.294	3,465.100
2019	(9)	3,401.316	3,416.754	3,426.222	3,436.464	3,449.287	3,455.990	3,455.301	3,465.108
2020	3,419.721	3,401.285	3,416.741	3,426.221	3,436.463	3,449.289	3,455.991	3,455.303	3,465.107
2021	(9)	3,401.270	3,416.739	3,426.217	3,436.462	3,449.288	3,455.990	3,455.306	3,465.107
2022	(9)	3,401.227	3,416.716	3,426.198	3,436.447	3,449.277	3,455.979	3,455.293	3,465.093

Note:

(9) Construction activity in the vicinity of the monument precluded its use in the noted year's annual survey.
(10) The monument was not use in the noted year's annual survey.

Table F continued on next page…

Table F. Comparison of Elevations 1987-2022 (continued)

	Z-418	A-419	B-419	C-419	D-419	K-349
1987	(10)	(10)	(10)	(10)	(10)	(10)
1989	(10)	(10)	(10)	(10)	(10)	(10)
1992	(10)	(10)	(10)	(10)	(10)	(10)
1993	(10)	(10)	(10)	(10)	(10)	(10)
1994	(10)	(10)	(10)	(10)	(10)	(10)
1995	(10)	(10)	(10)	(10)	(10)	(10)
1996	3,461.073	3,454.714	3,449.825	3,437.633	3,423.234	3,404.152
1997	3,461.082	3,454.720	3,449.829	3,437.642	3,423.238	3,404.162
1998	3,461.091	3,454.730	3,449.835	3,437.648	3,423.242	3,404.173
1999	3,461.105	3,454.744	3,449.848	3,437.657	3,423.247	3,404.169
2000	3,461.109	3,454.749	3,449.853	3,437.660	3,423.250	3,404.157
2001	3,461.111	3,454.752	3,449.856	3,437.663	3,423.254	3,404.152
2002	3,461.113	3,454.754	3,449.857	3,437.665	3,423.256	3,404.150
2003	3,461.112	3,454.752	3,449.856	3,437.665	3,423.256	3,404.137
2004	3,461.117	3,454.754	3,449.858	3,437.668	3,423.257	3,404.127
2005	3,461.108	3,454.742	3,449.848	3,437.663	3,423.243	3,404.105
2006	3,461.108	3,454.739	3,449.846	3,437.664	3,423.243	3,404.091
2007	3,461.117	3,454.749	3,449.855	3,437.673	3,423.248	3,404.096
2008	3,461.112	3,454.747	3,449.854	3,437.673	3,423.250	3,404.081
2009	3,461.117	3,454.752	3,449.857	3,437.675	3,423.251	3,404.073
2010	3,461.109	3,454.741	3,449.846	3,437.666	3,423.240	3,404.047
2011	3,461.122	3,454.757	3,449.861	3,437.682	3,423.253	3,404.042
2012	3,461.124	3,454.758	3,449.861	3,437.682	3,423.255	3,404.022
2013	3,461.106	3,454.744	3,449.850	3,437.674	3,423.251	3,404.020
2014	3,461.107	3,454.743	3,449.849	3,437.673	3,423.255	3,403.990
2015	3,461.106	3,454.742	3,449.849	3,437.677	3,423.254	3,403.971
2016	3,461.098	3,454.731	3,449.838	3,437.668	3,423.243	3,403.941
2017	3,461.104	3,454.740	3,449.848	3,437.679	3,423.253	3,403.932
2018	3,461.098	3,454.734	3,449.843	3,437.676	3,423.253	3,403.909
2019	3,461.105	3,454.744	3,449.851	3,437.684	3,423.257	3,403.894
2020	3,461.105	3,454.746	3,449.852	3,437.684	3,423.262	3,403.866
2021	3,461.106	3,454.751	3,449.851	3,437.688	3,423.264	3,403.859
2022	3,461.092	3,454.738	3,449.847	3,437.680	3,423.262	3,403.822

Note: (10) The monument was not use in the noted year's annual survey.

* The 1986 elevations that appear in all reports prior to the 2001 report are from a report filed by Jerry Williams (3/89), Geoscience Department. Those elevations were, in turn, taken from the 1987 data, rounded to two decimal places and referenced as 1986. When this was discovered it was decided to remove the 1986 information from all subsequent reports.

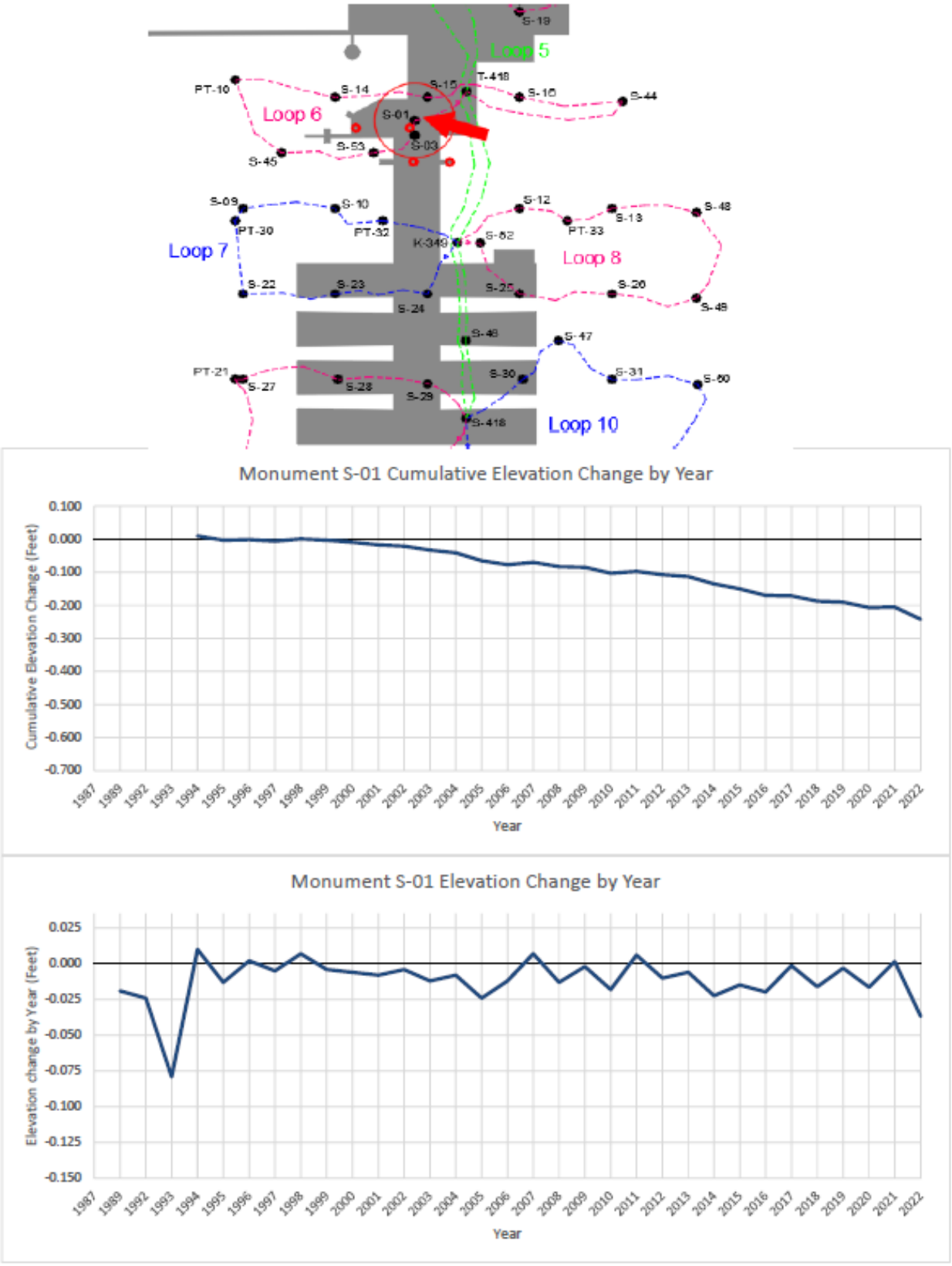


Figure 2. Monument S-01 Elevation Data Graphs

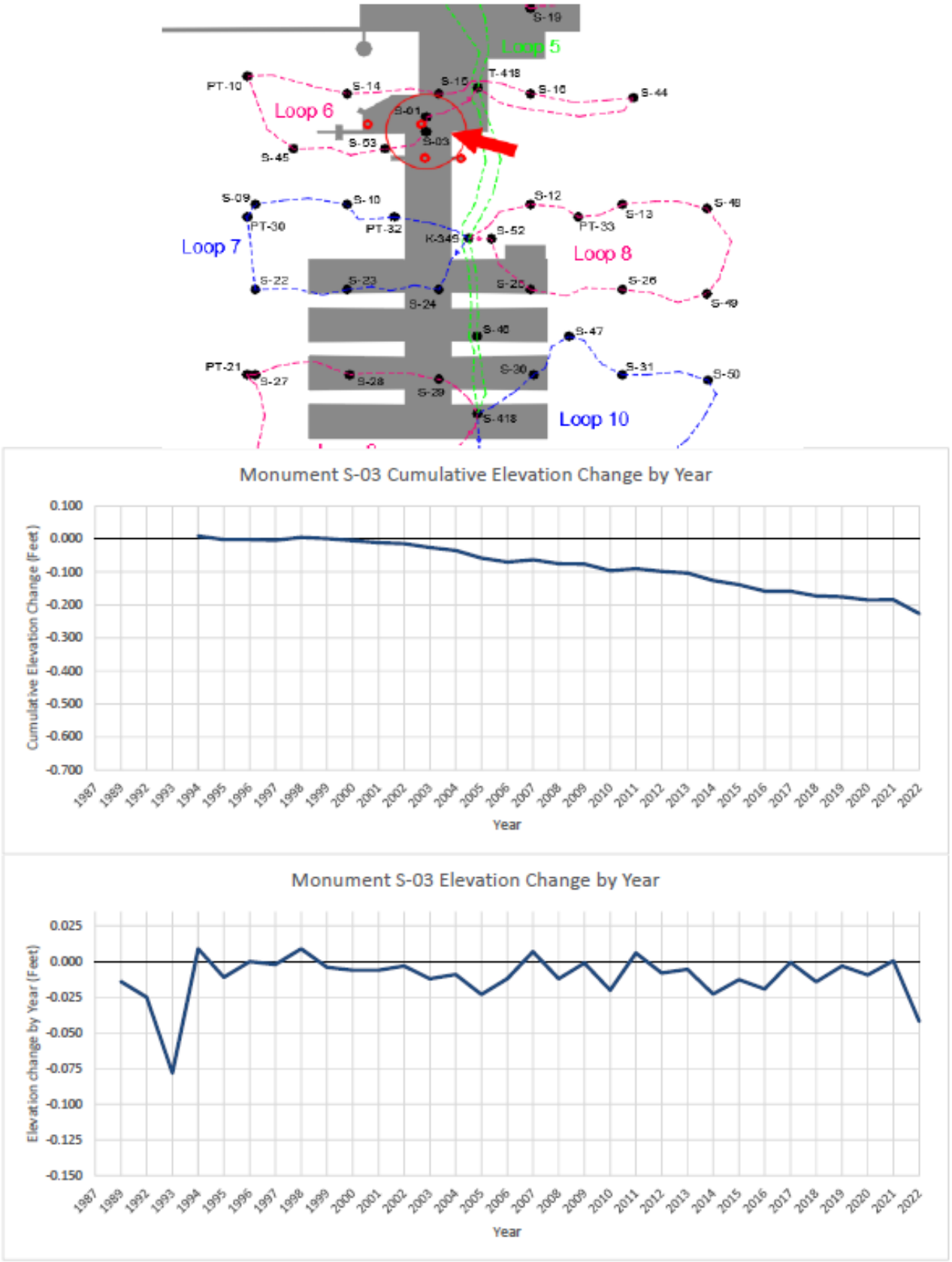


Figure 3. Monument S-03 Elevation Data Graphs

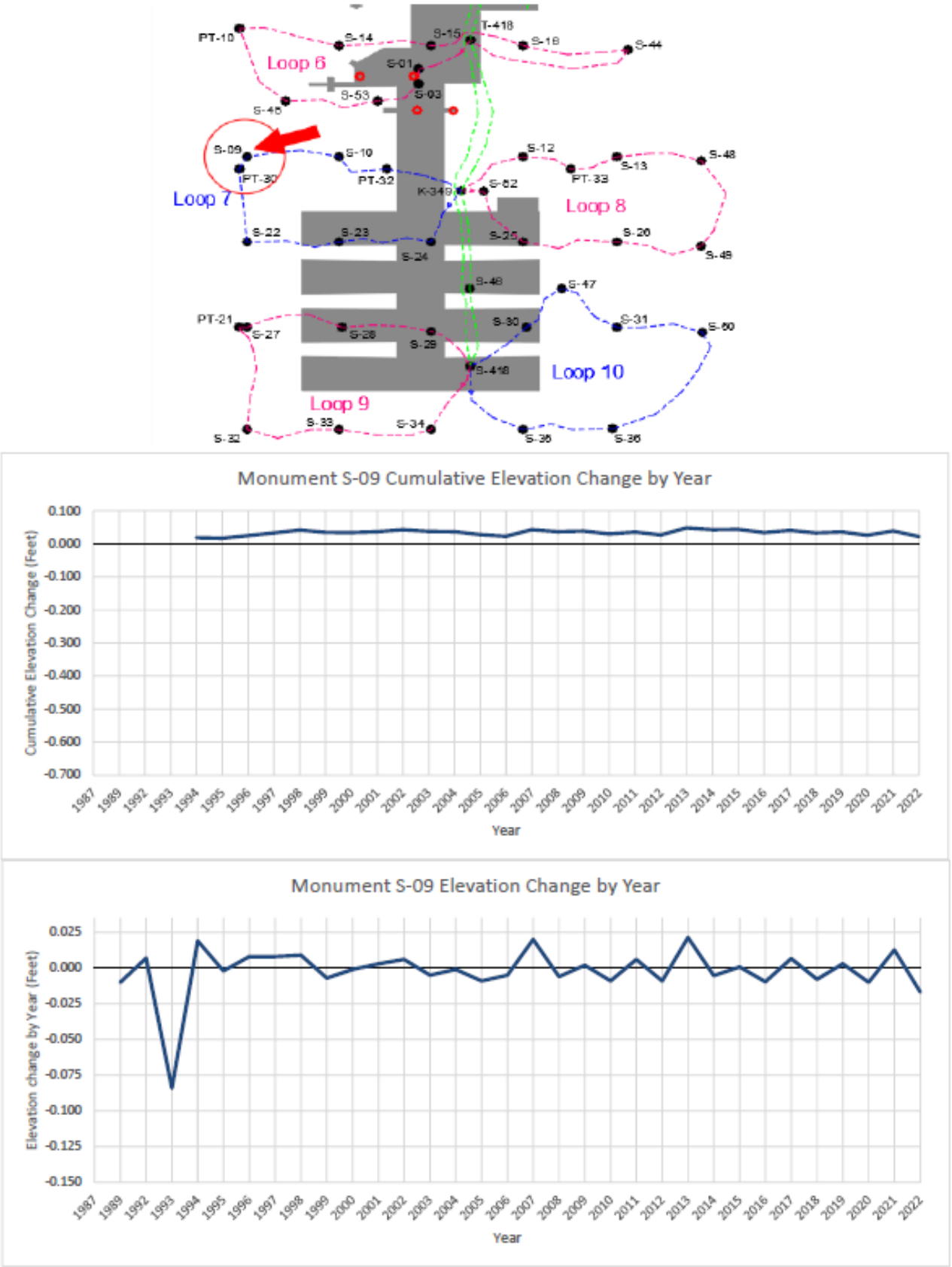
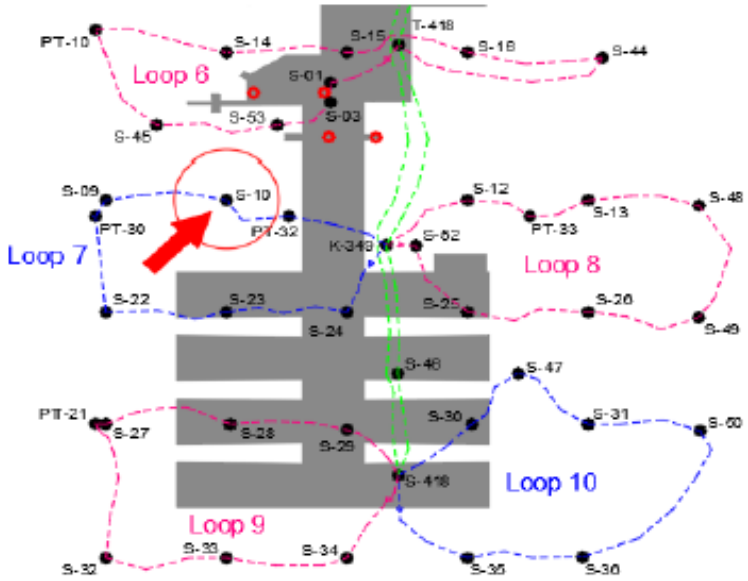


Figure 4. Monument S-09 Elevation Data Graphs



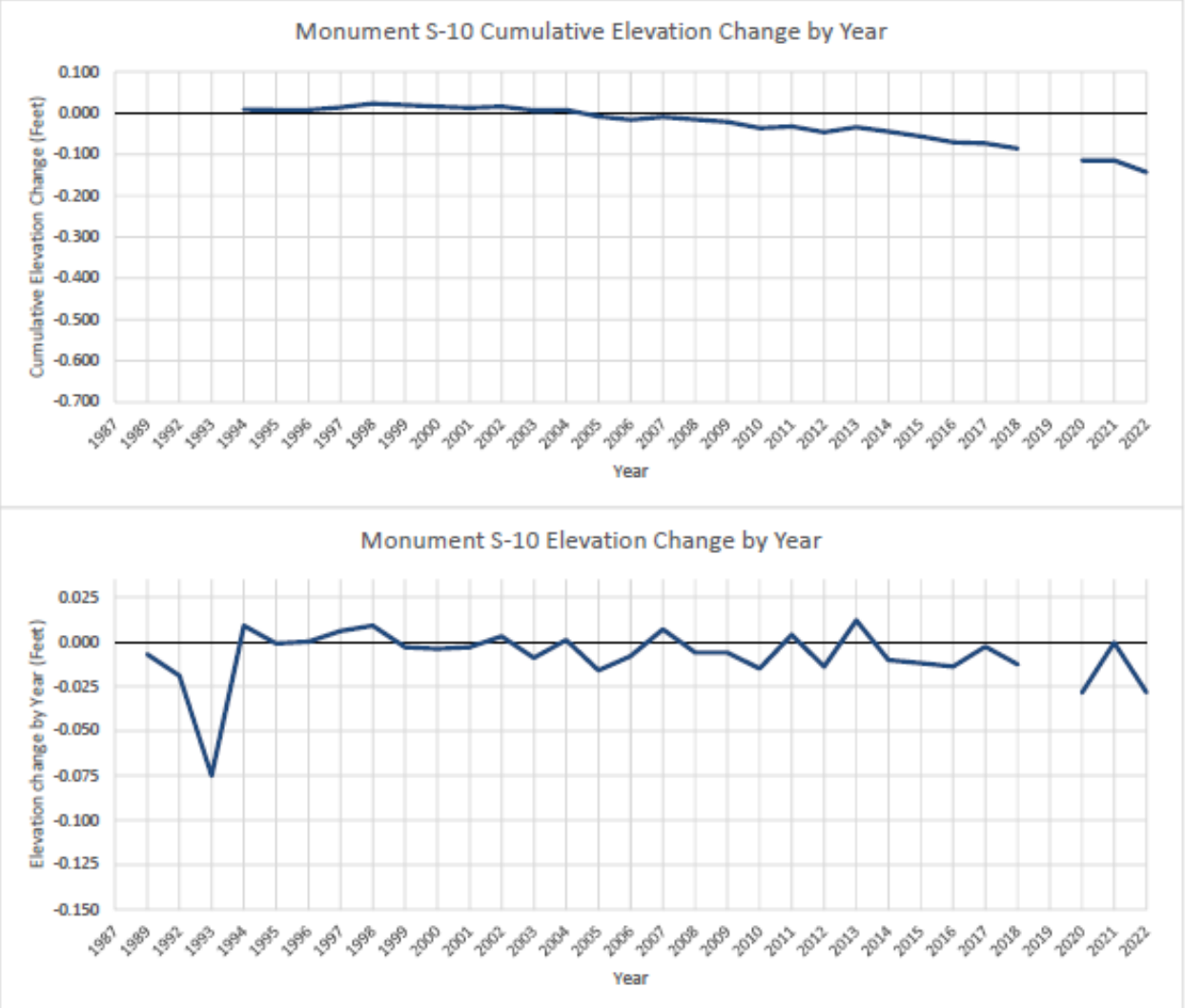
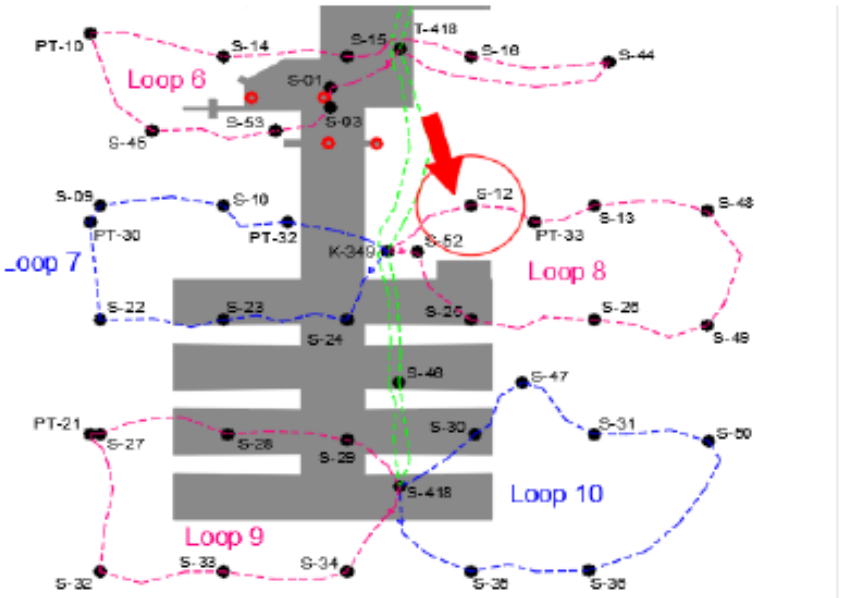


Figure 5. Monument S-10 Elevation Data Graphs



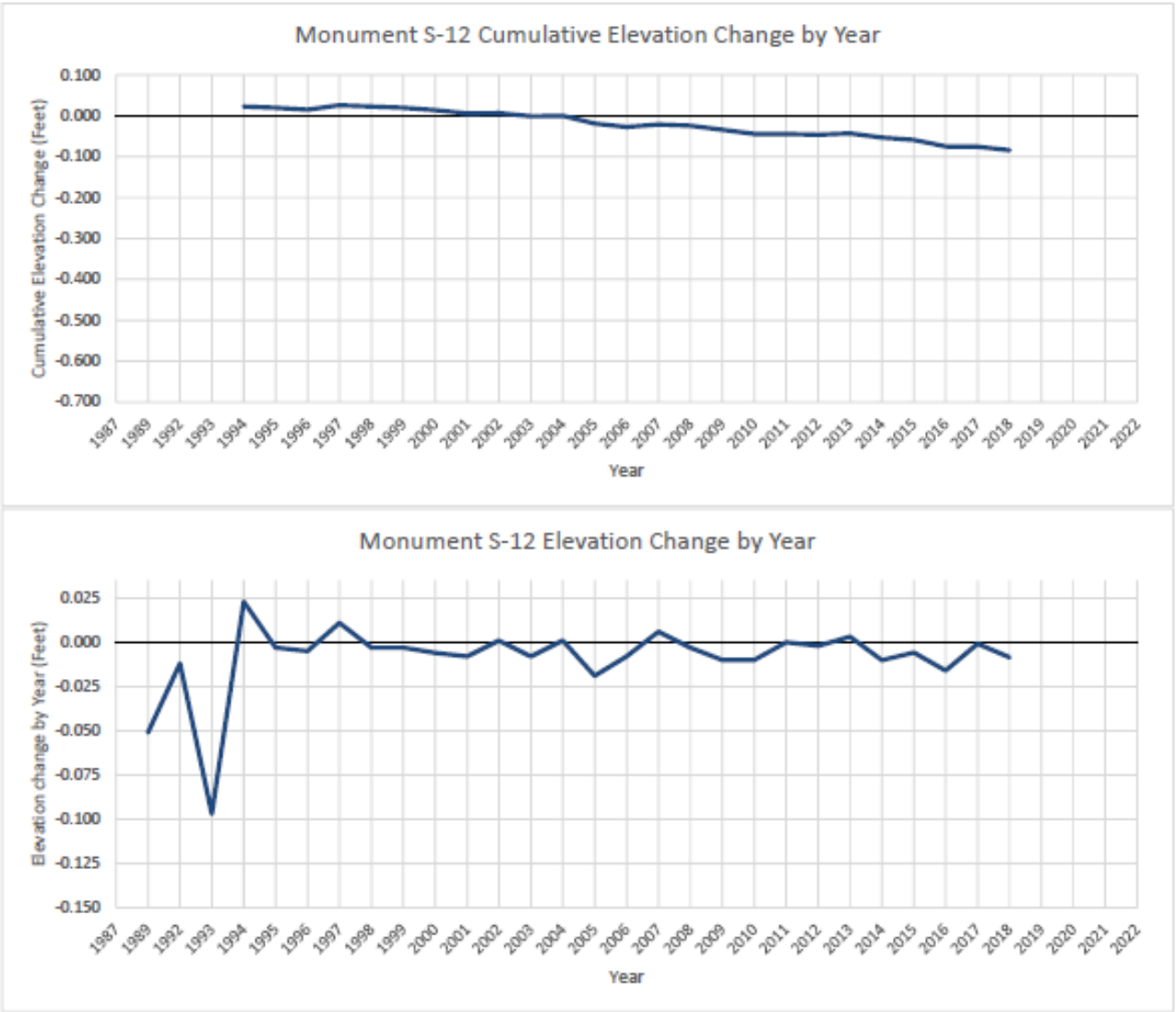
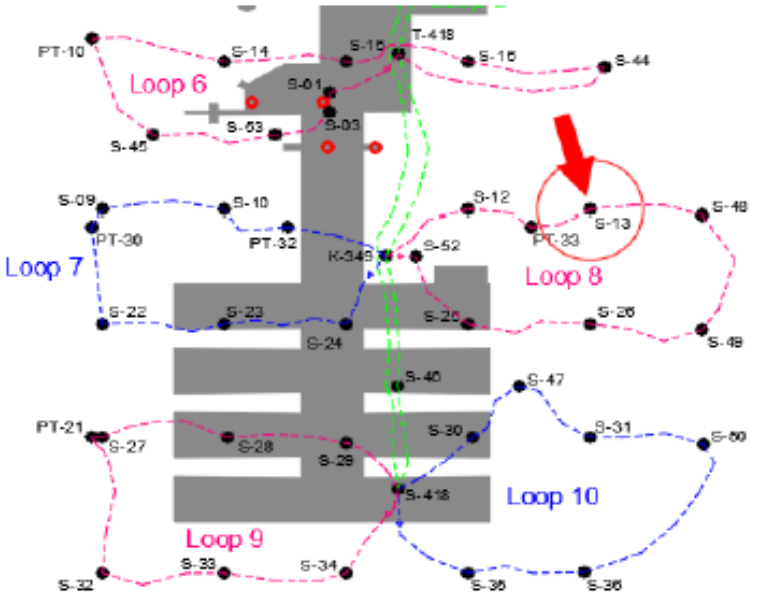


Figure 6. Monument S-12 Elevation Data Graphs



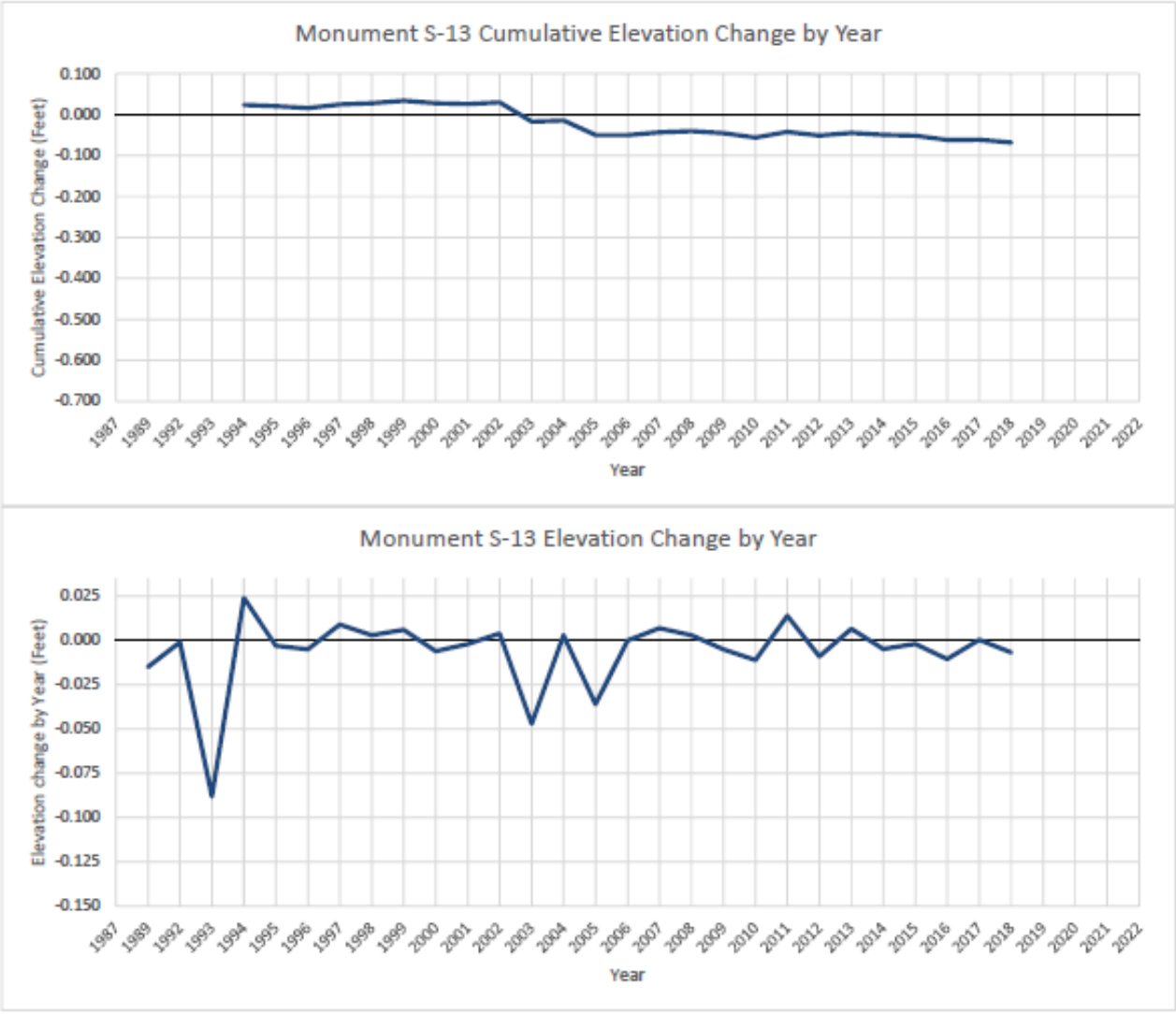


Figure 7. Monument S-13 Elevation Data Graphs

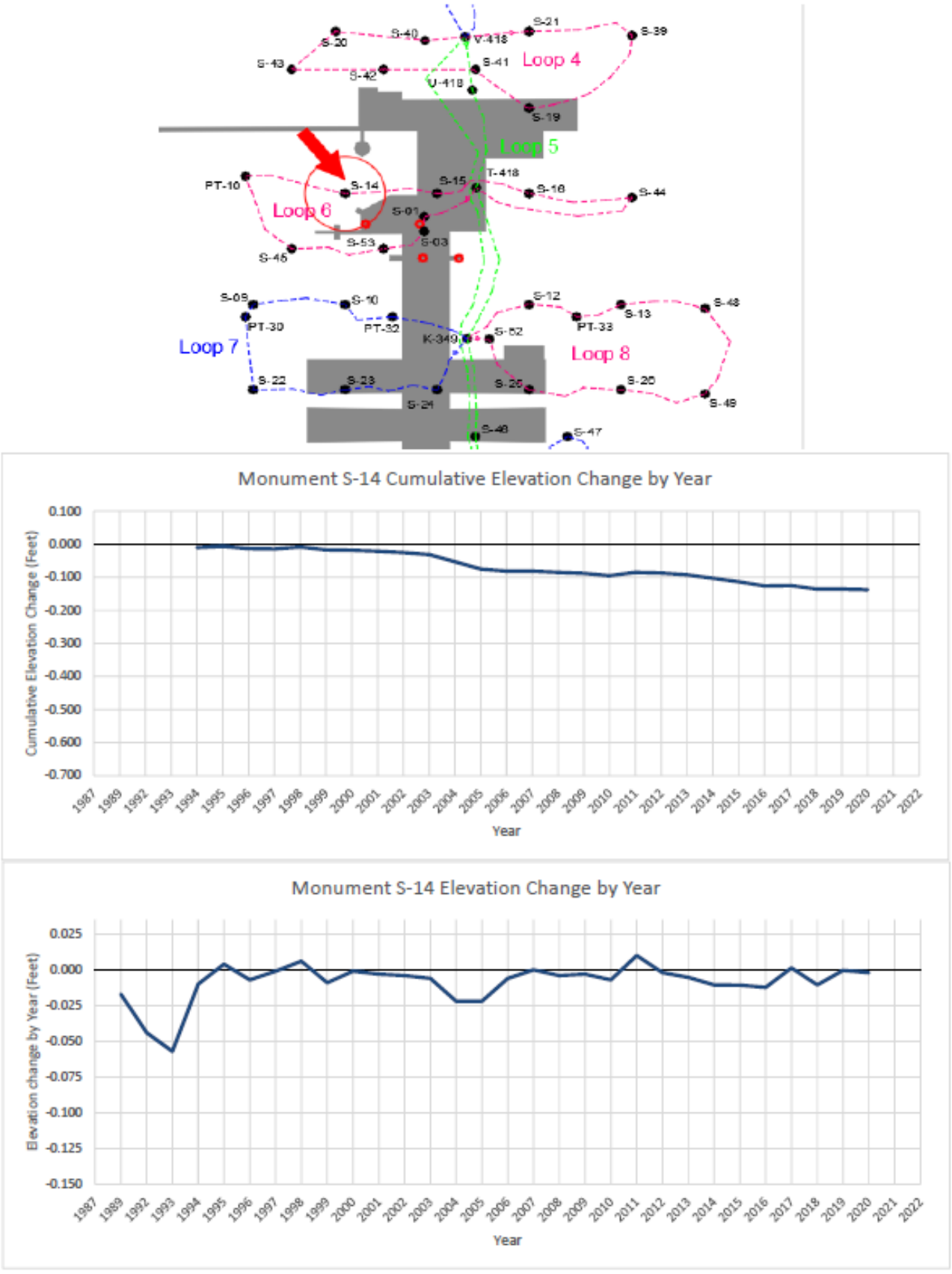
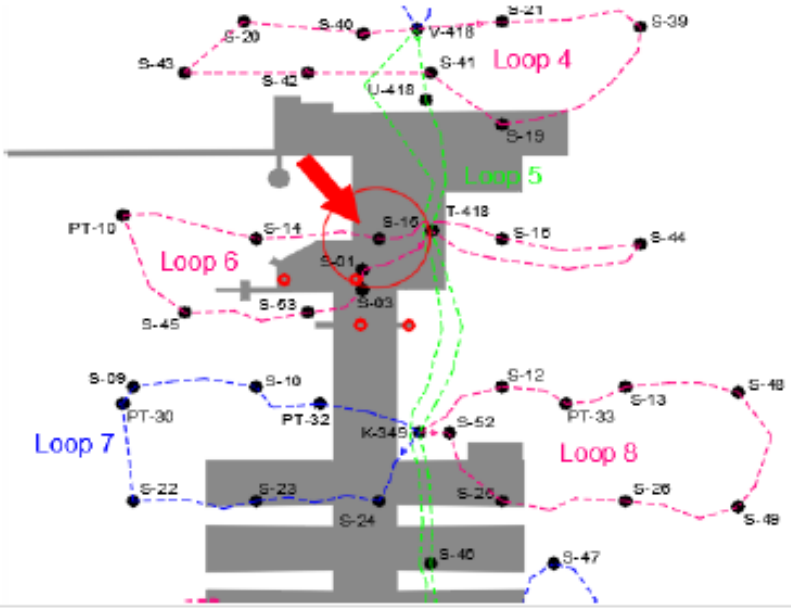


Figure 8. Monument S-14 Elevation Data Graphs



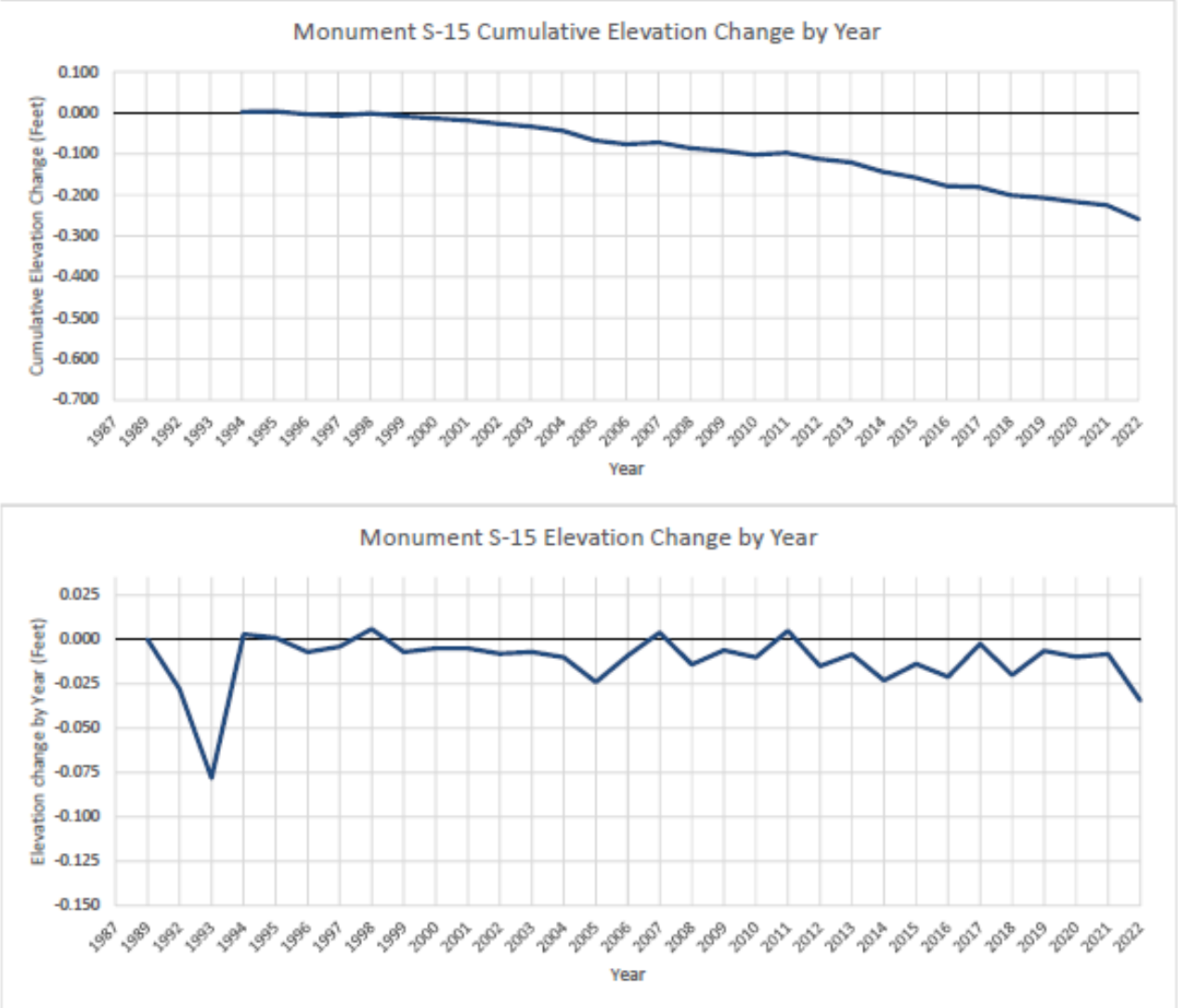


Figure 9. Monument S-15 Elevation Data Graphs

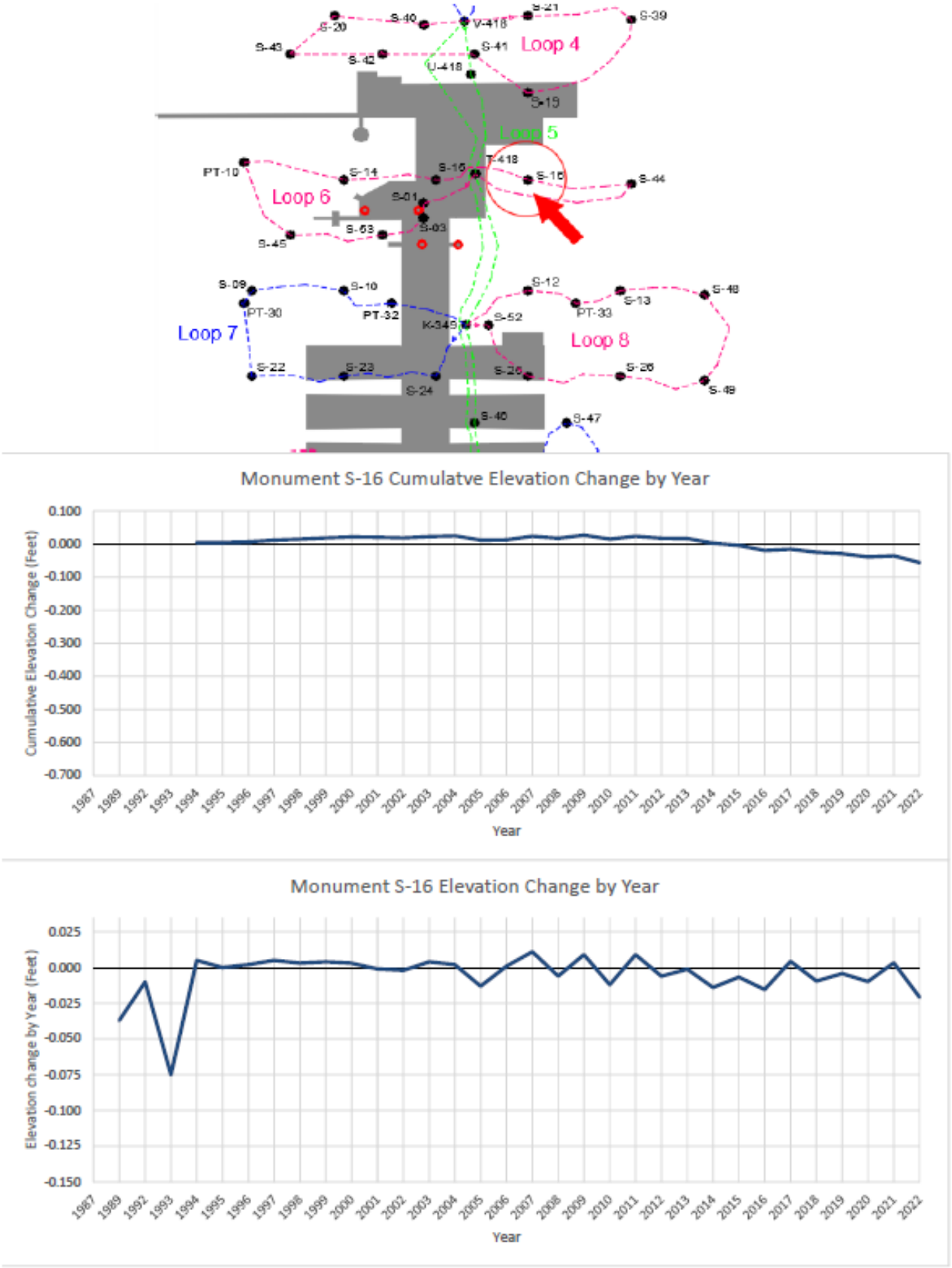


Figure 10. Monument S-16 Elevation Data Graphs

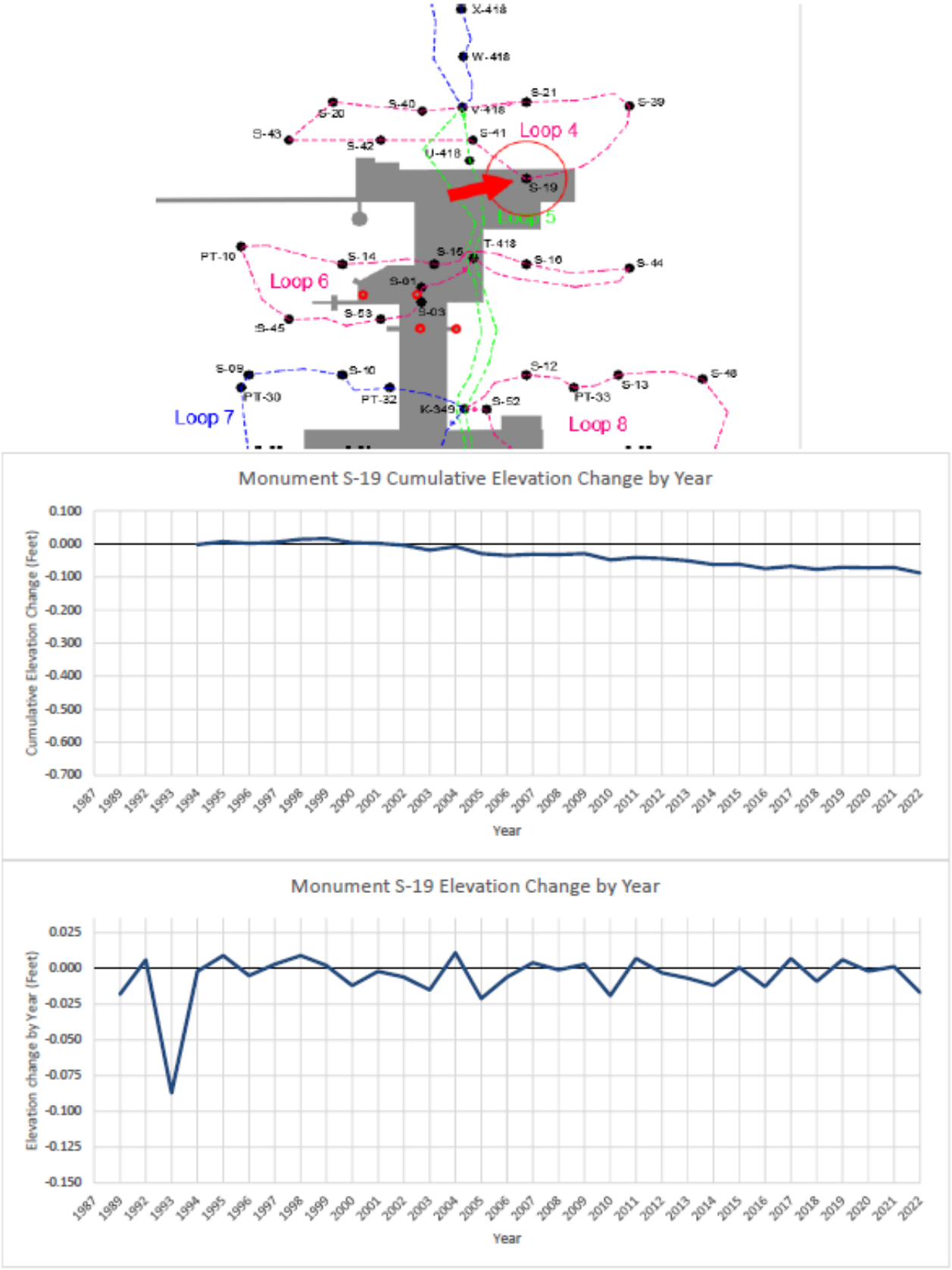


Figure 11. Monument S-19 Elevation Data Graphs

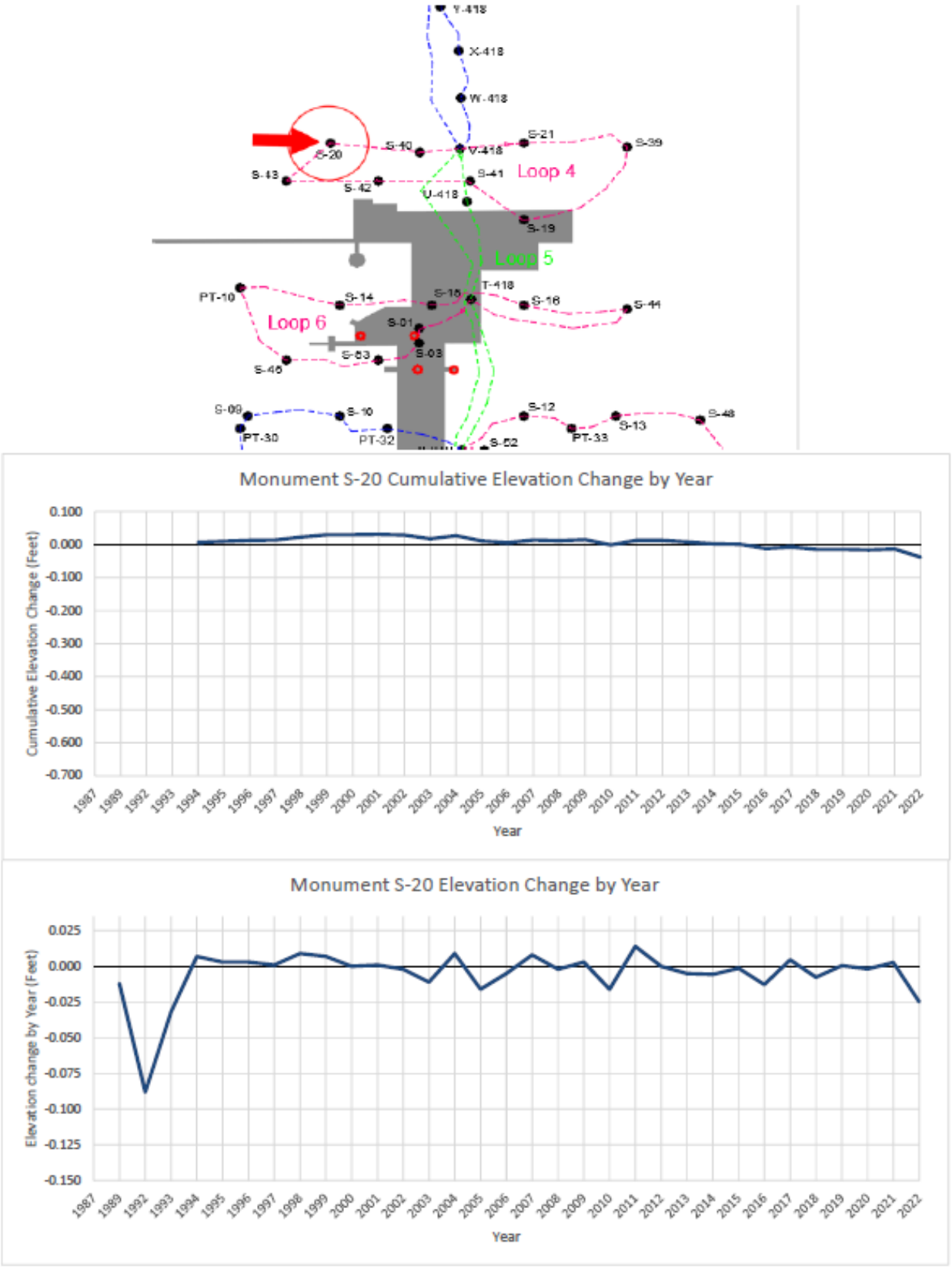


Figure 12. Monument S-20 Elevation Data Graphs

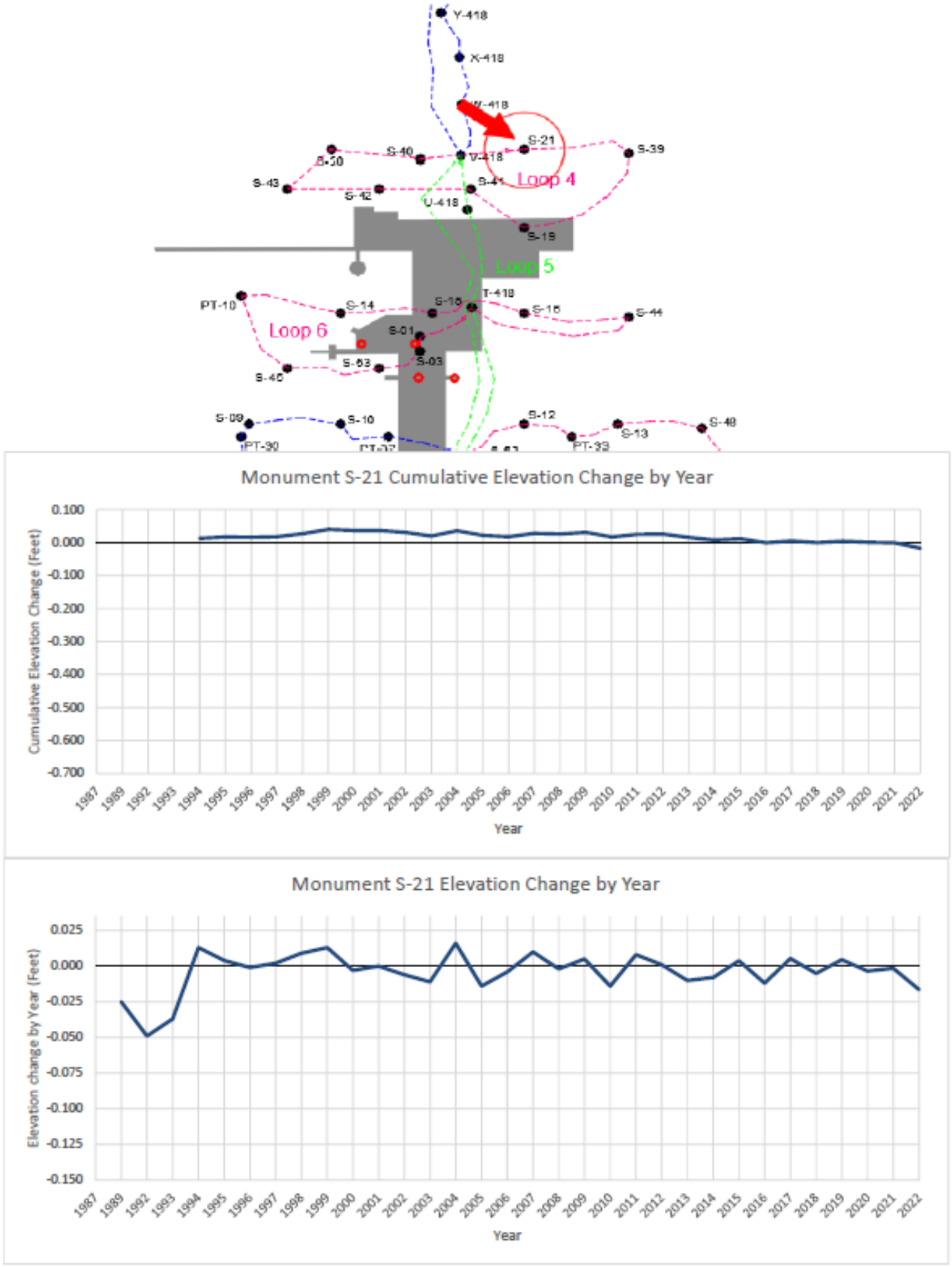


Figure 13. Monument S-21 Elevation Data Graphs

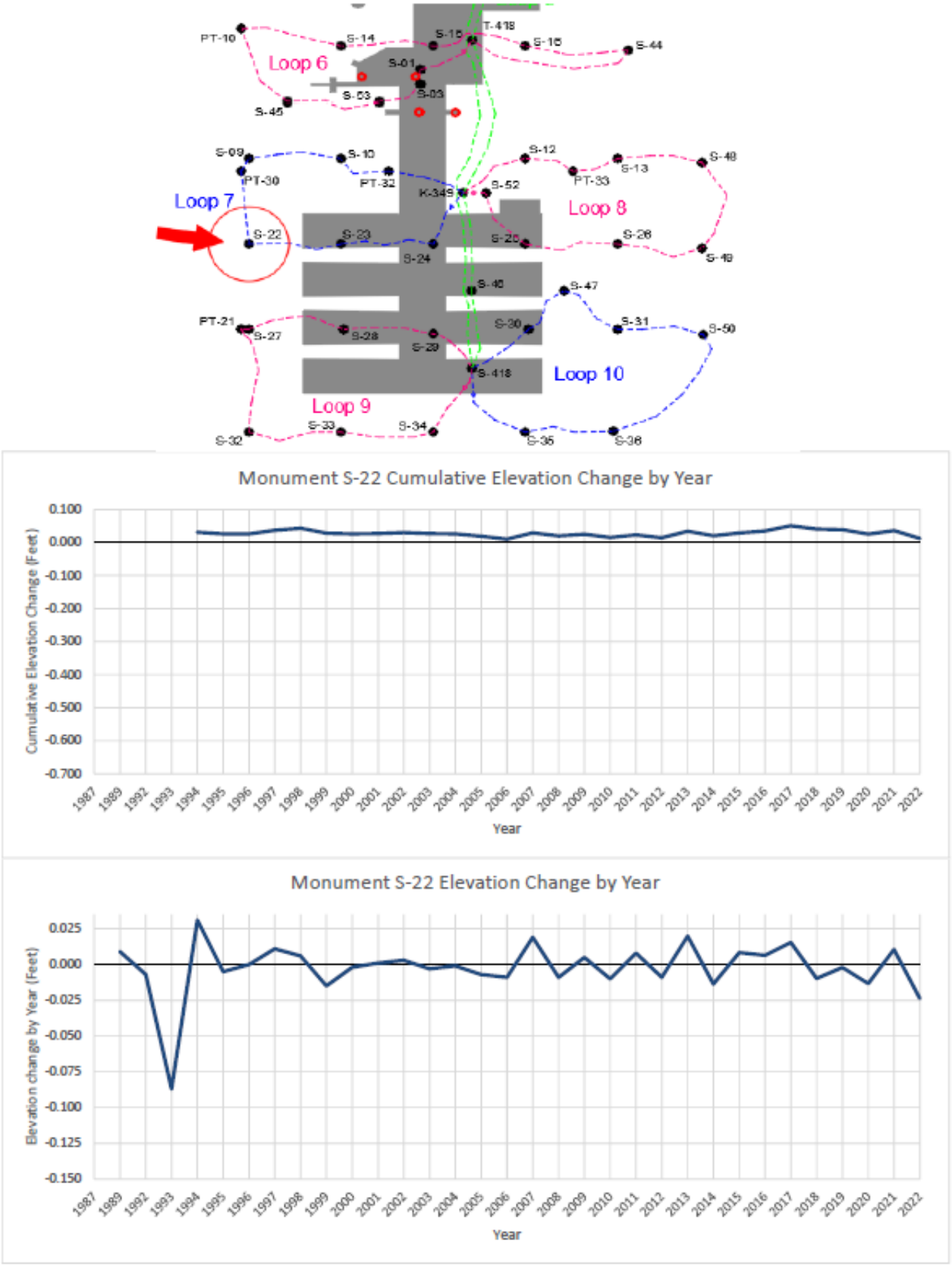
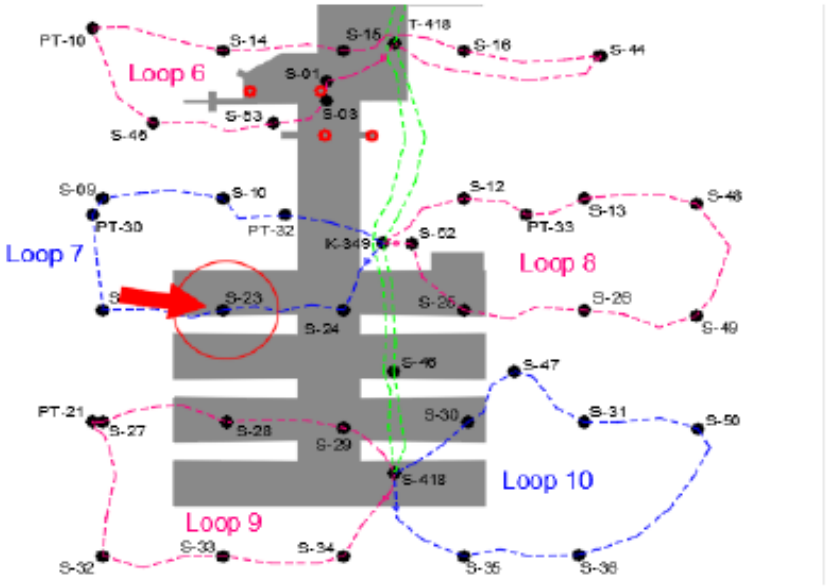
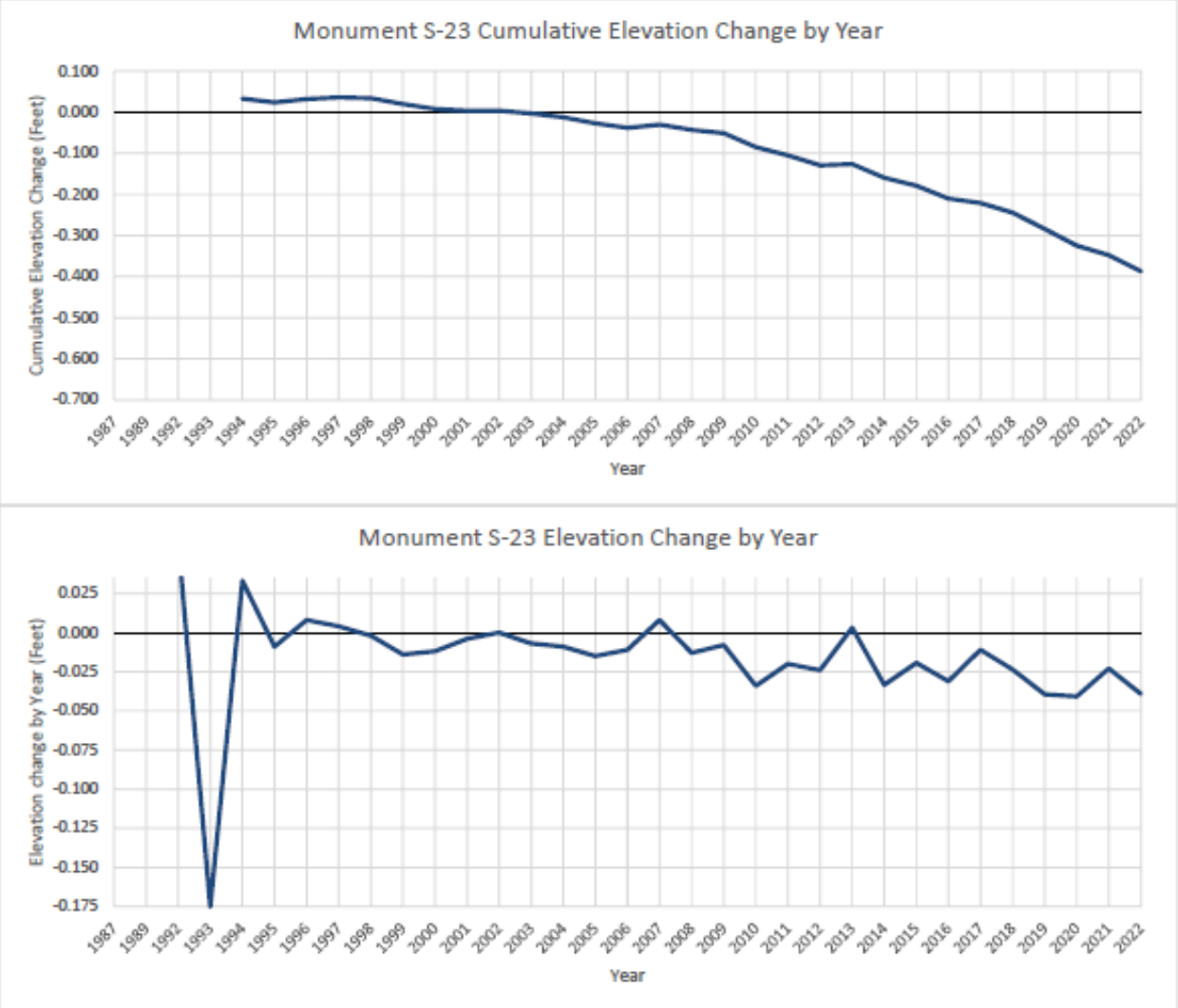


Figure 14. Monument S-22 Elevation Data Graphs





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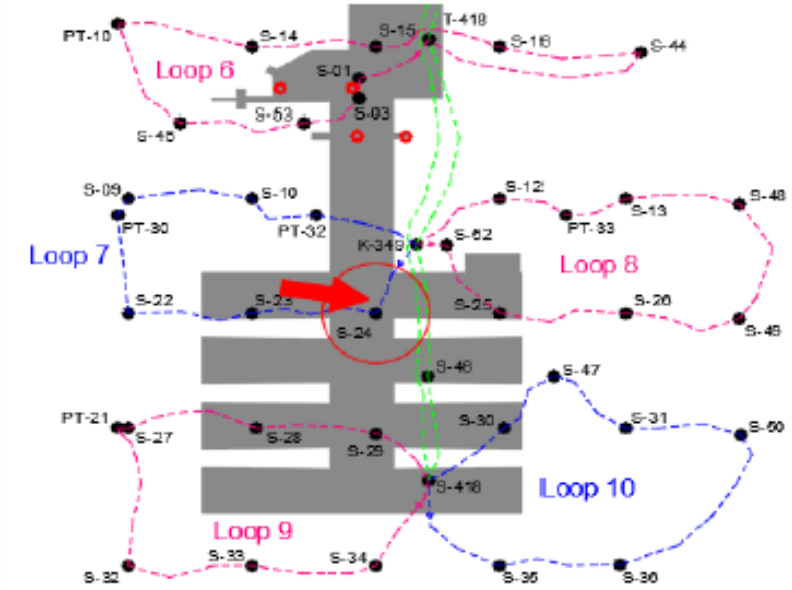

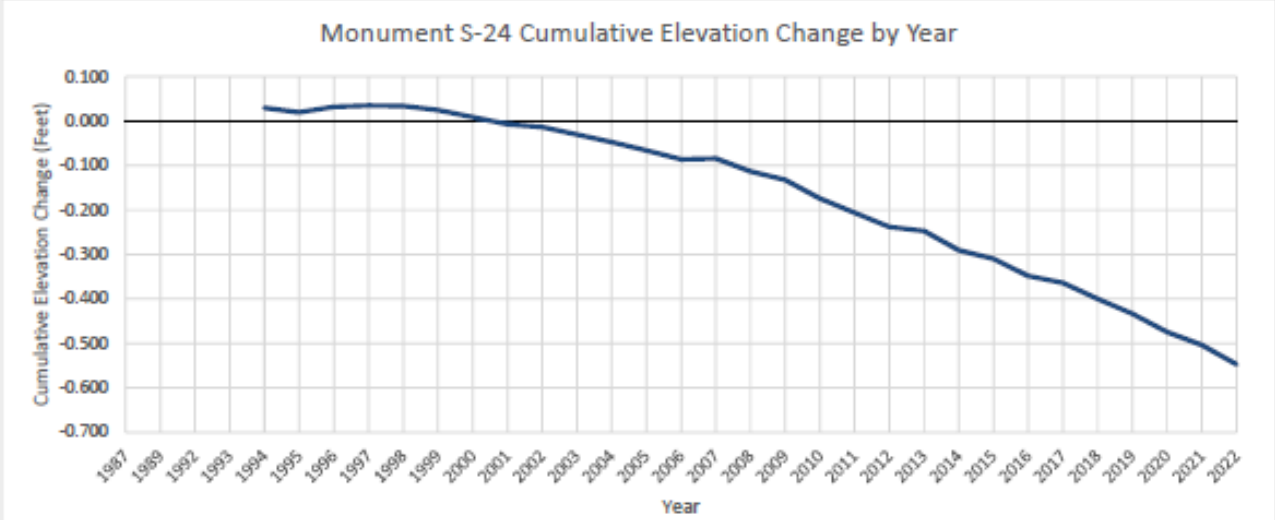

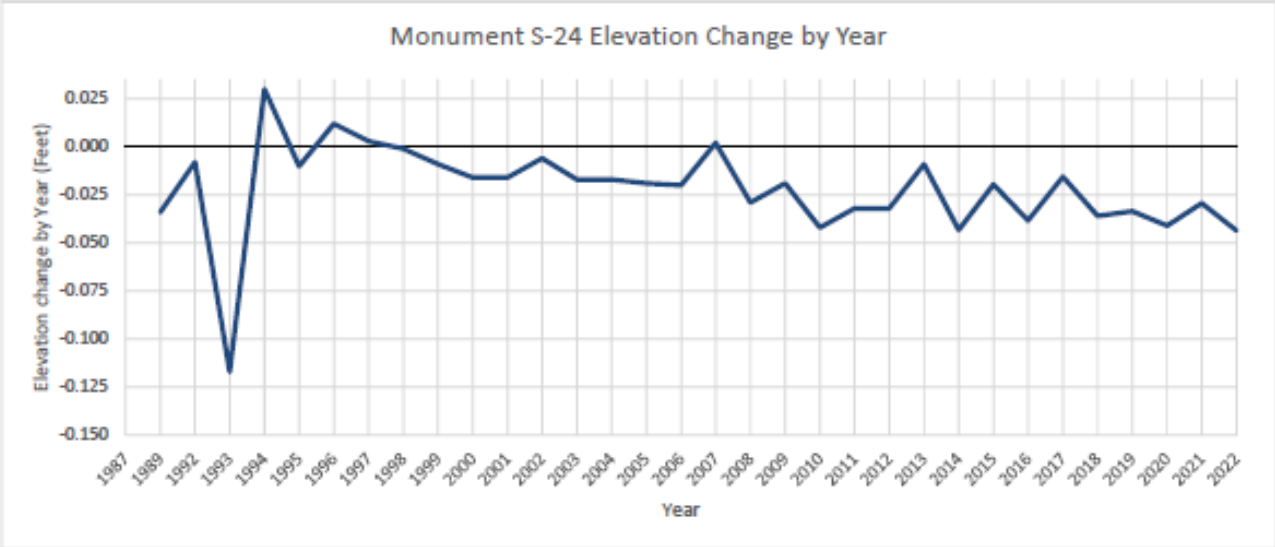

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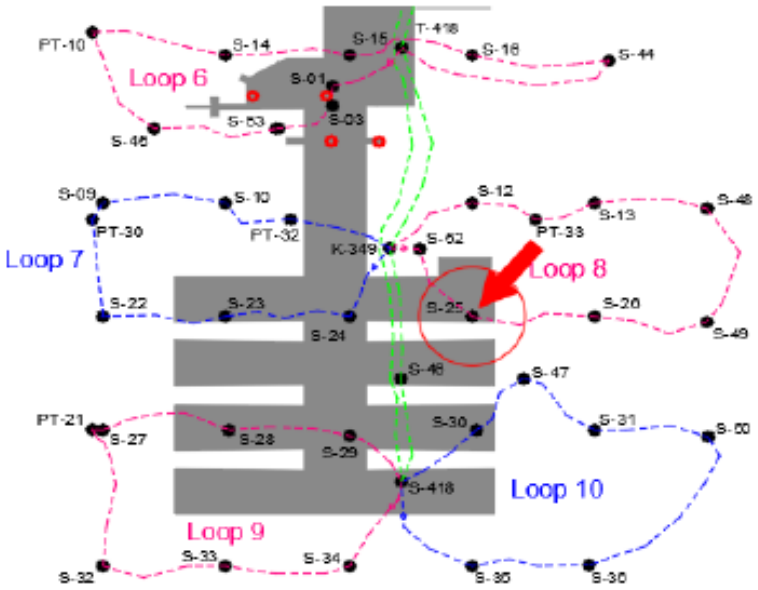

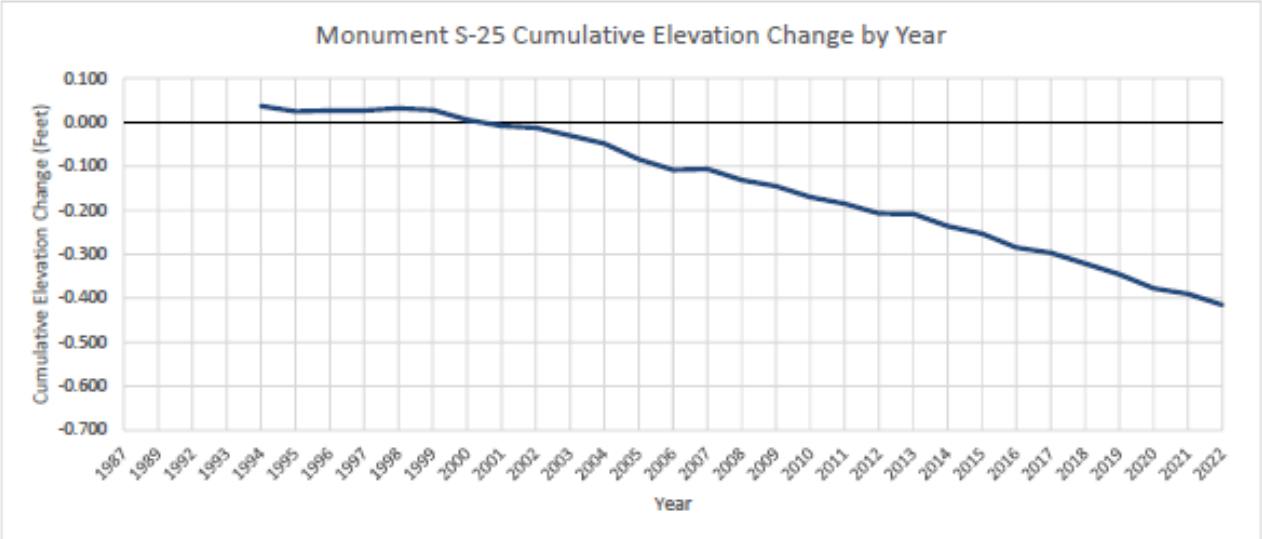

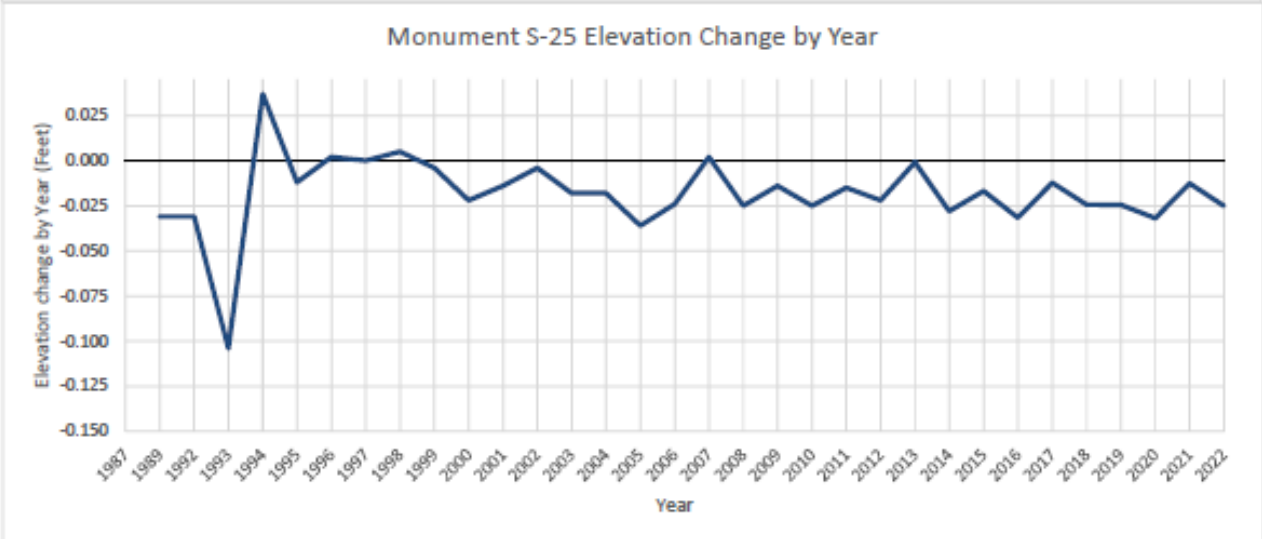

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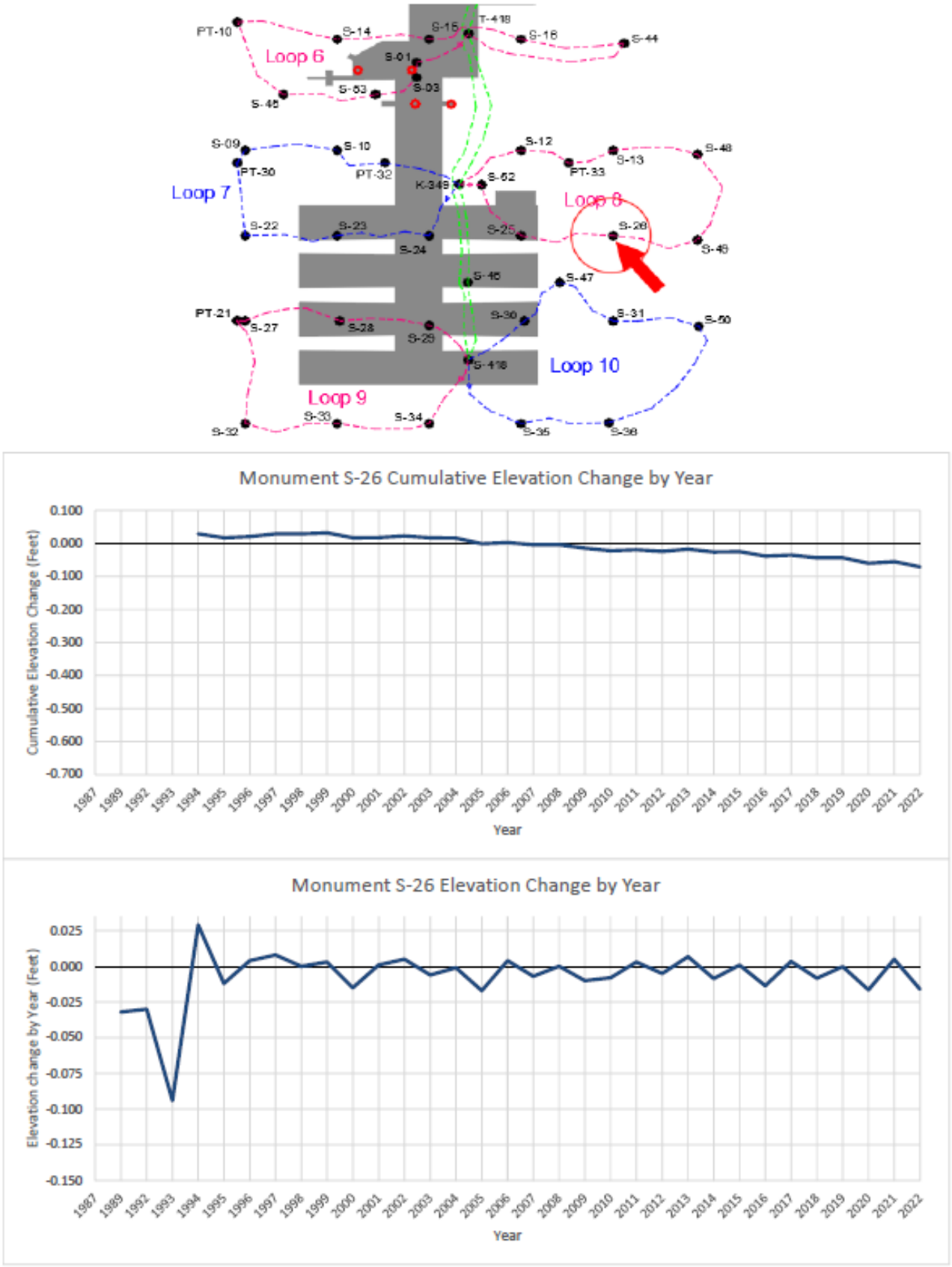

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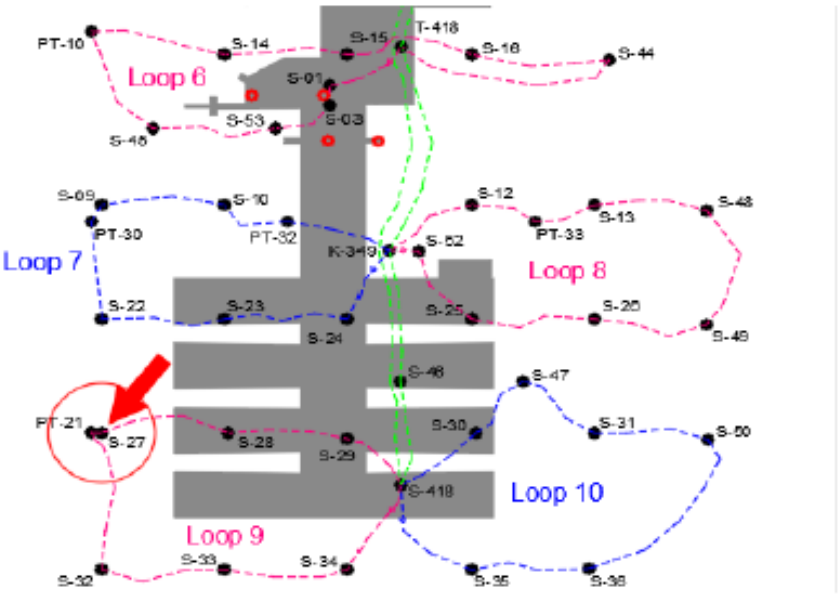

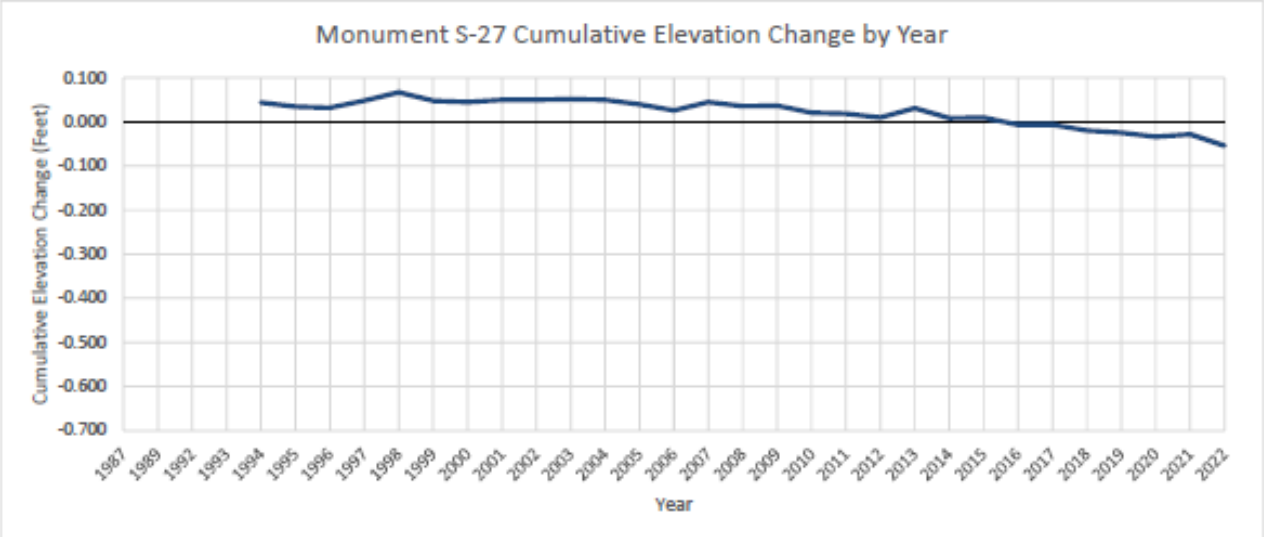

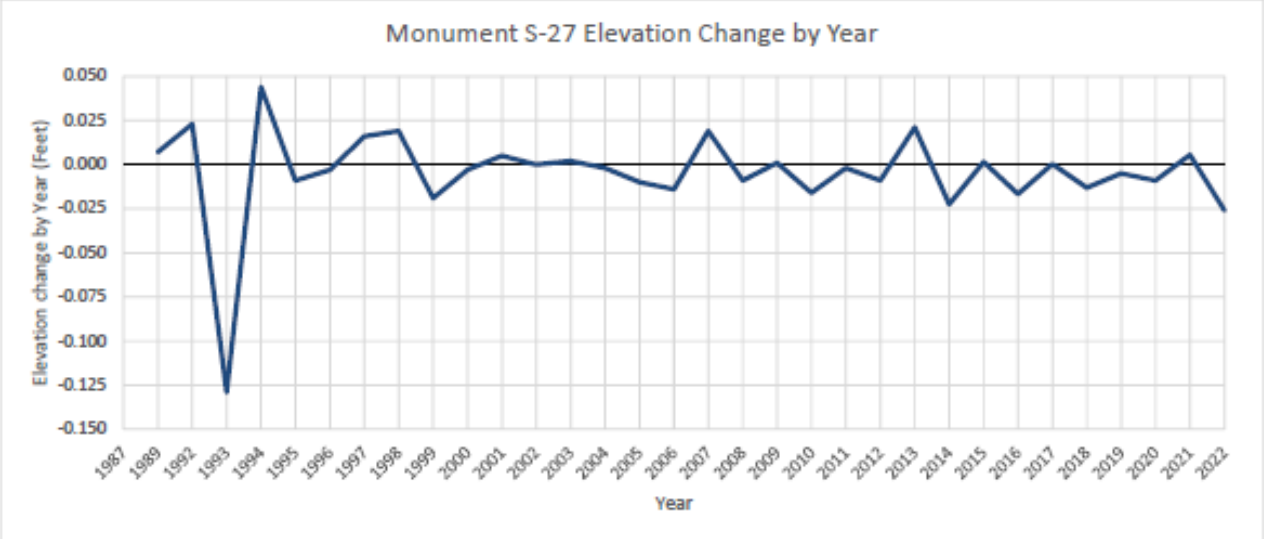

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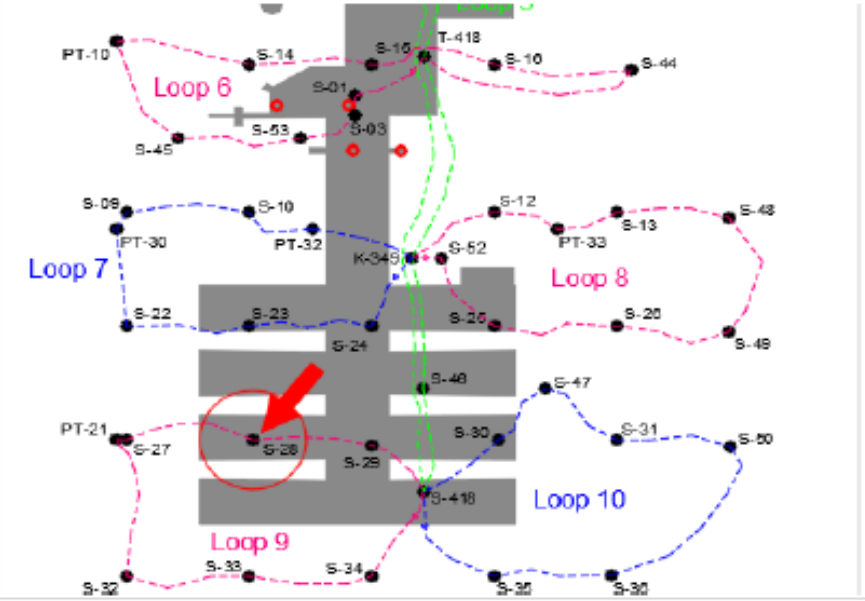

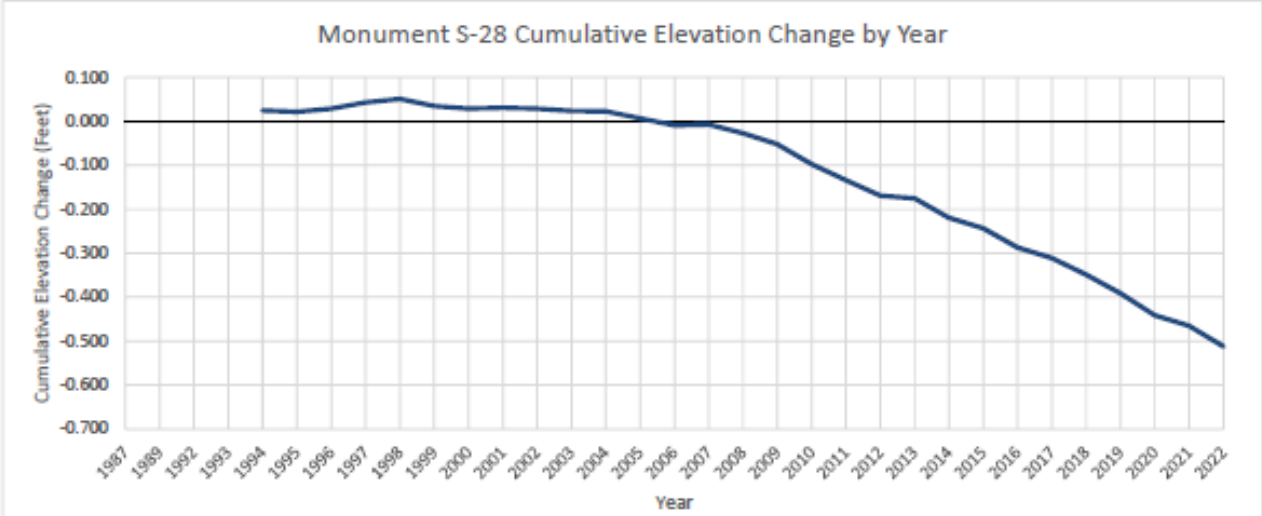

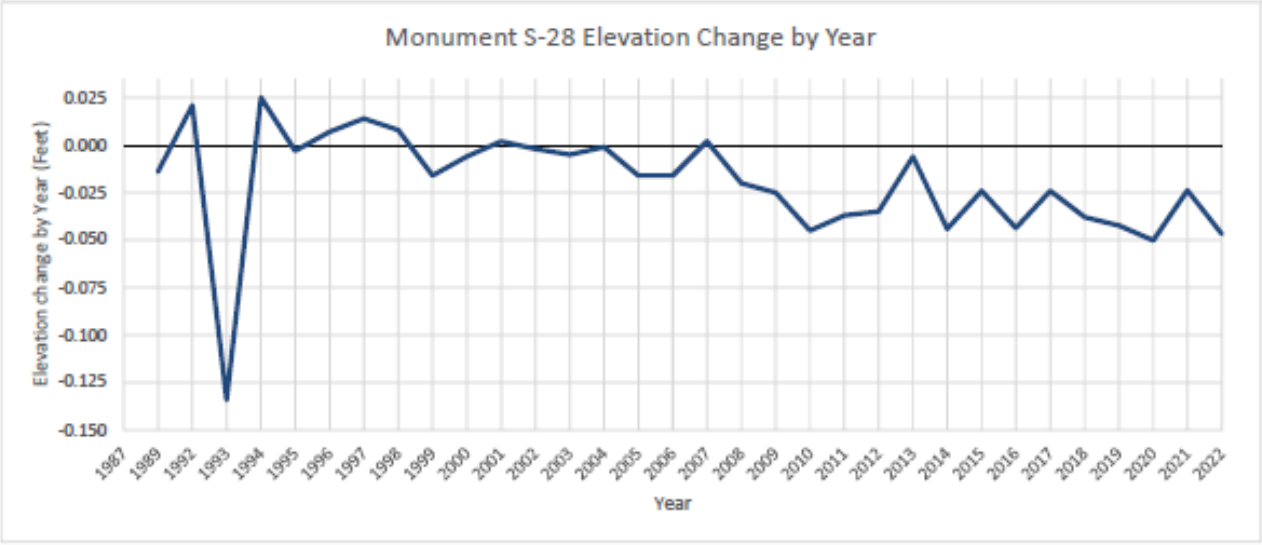

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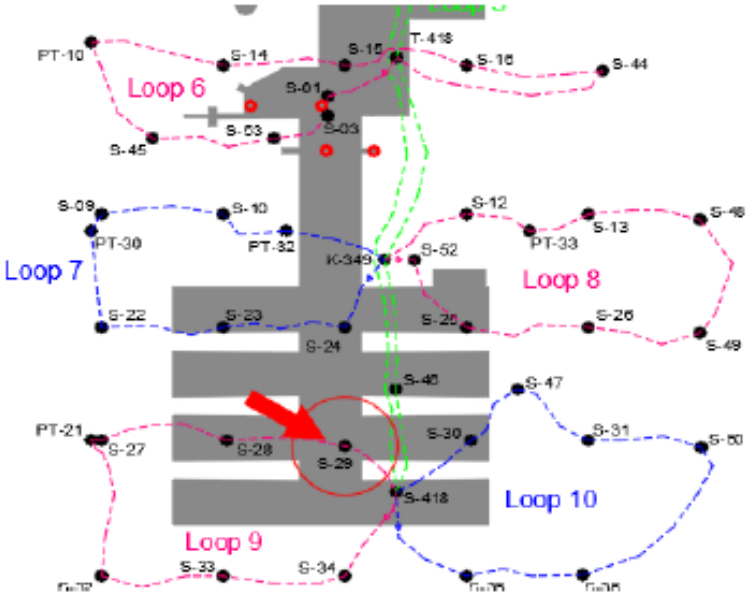

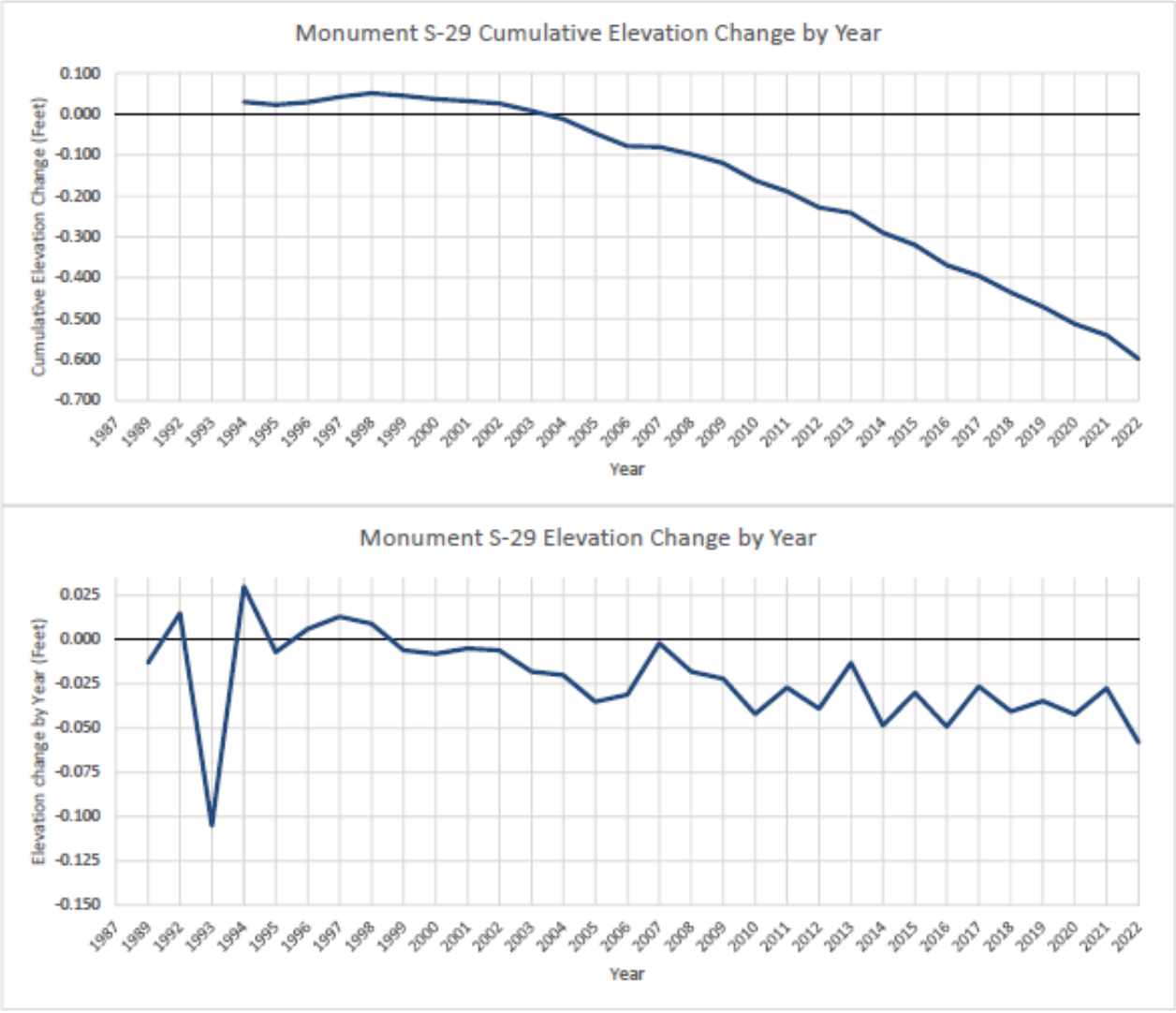

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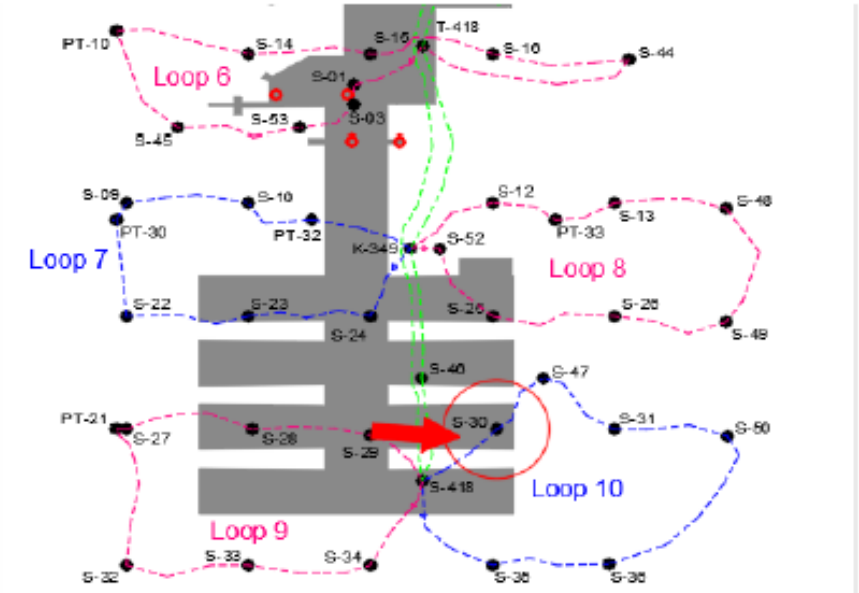


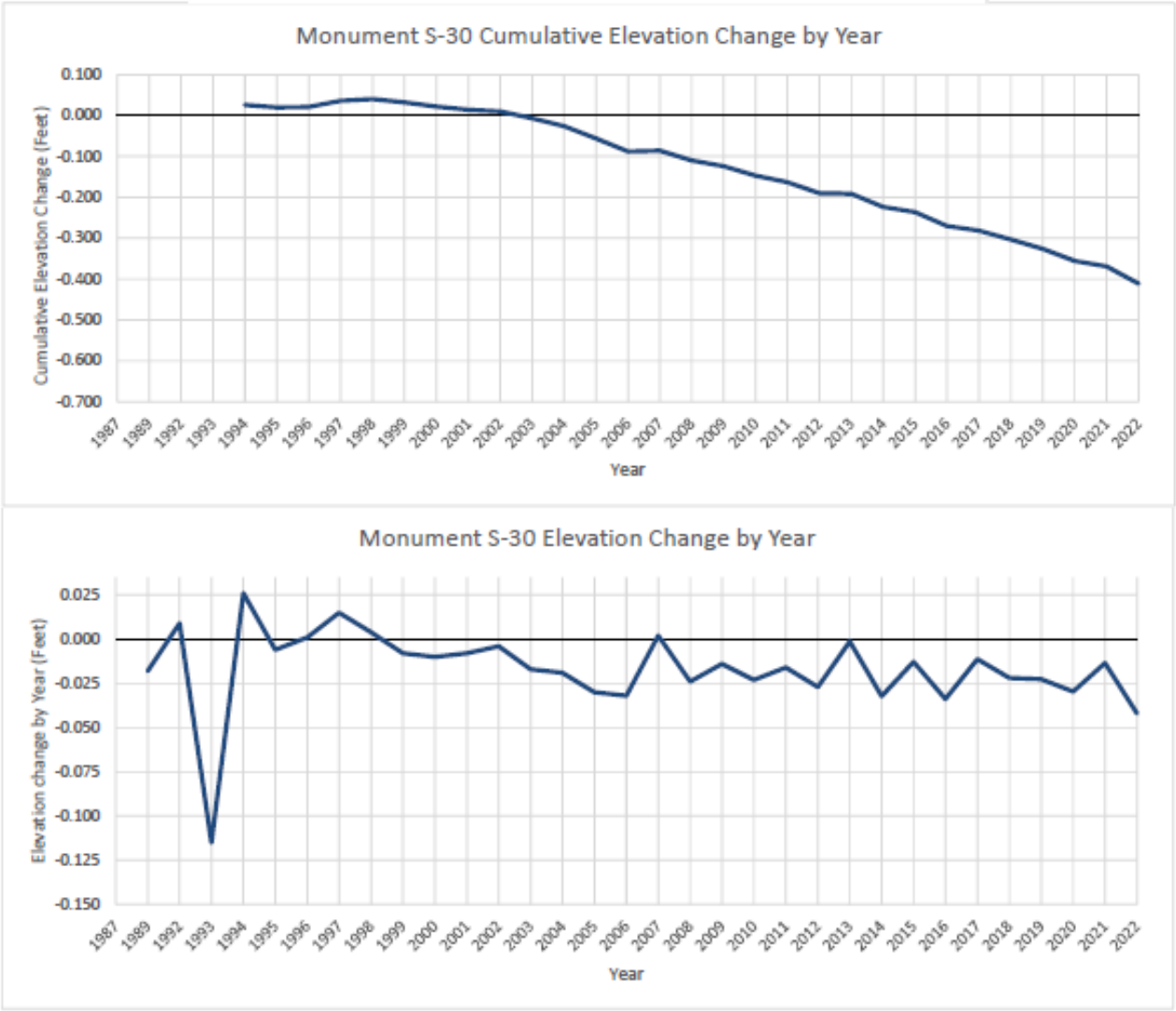
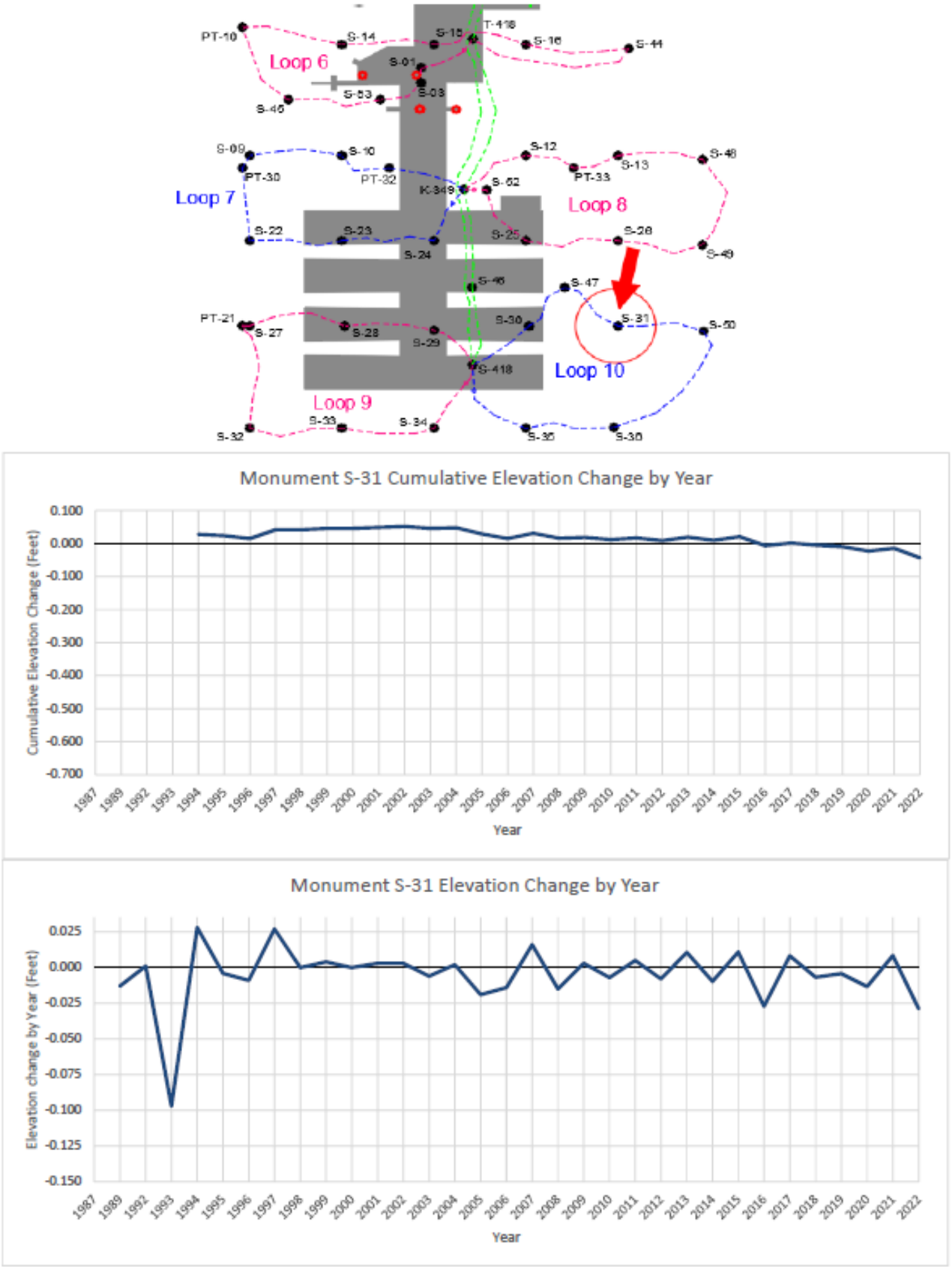


Figure 22. Monument S-30 Elevation Data Graphs



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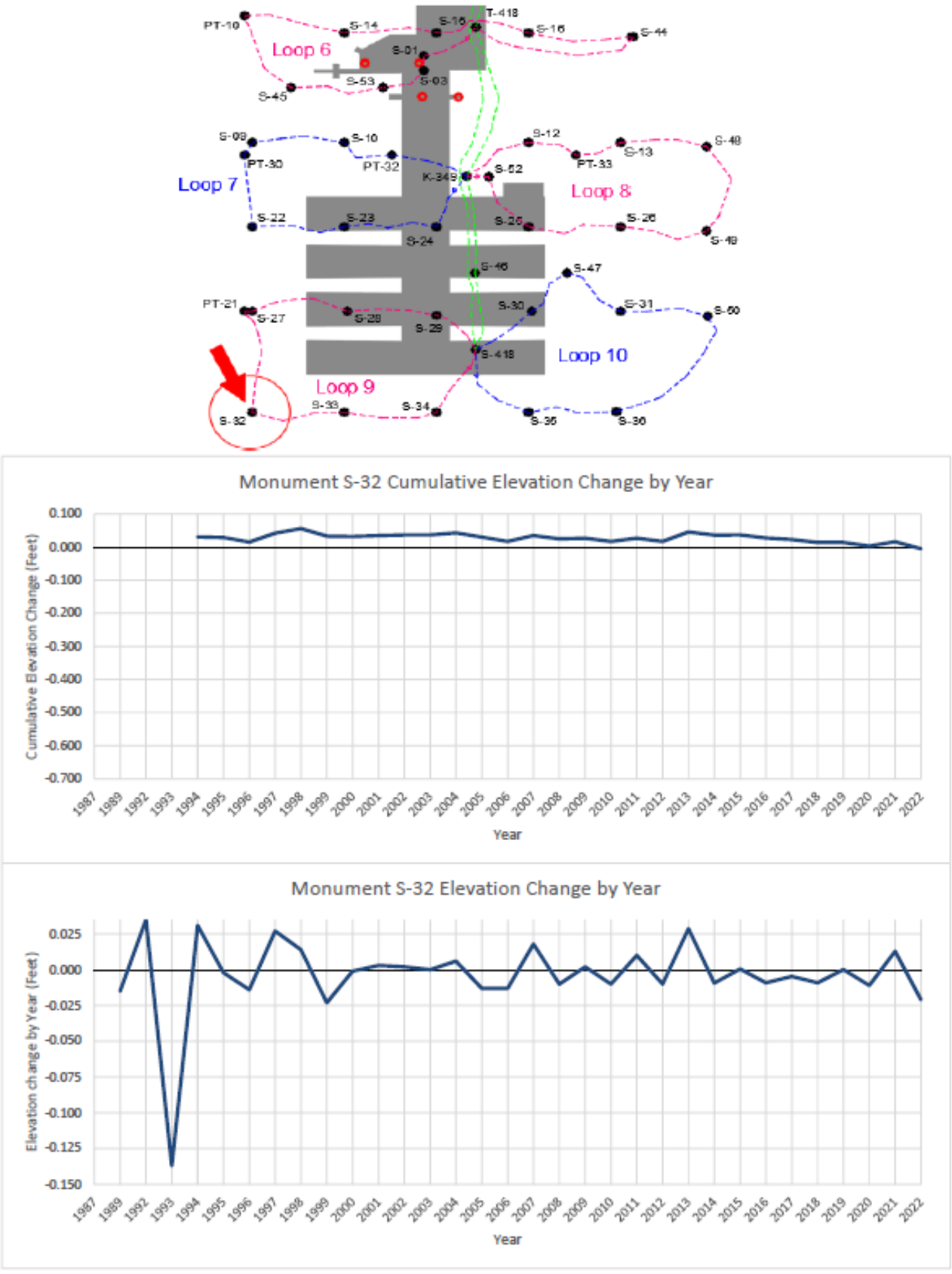

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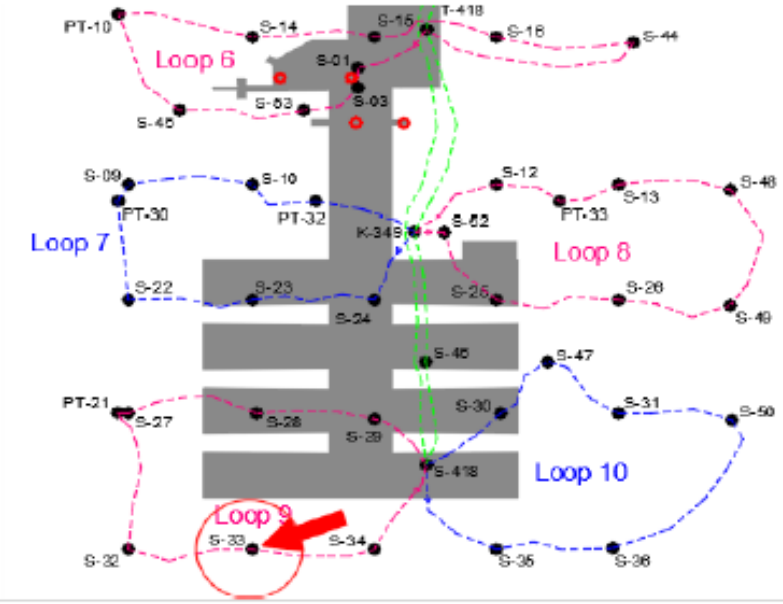

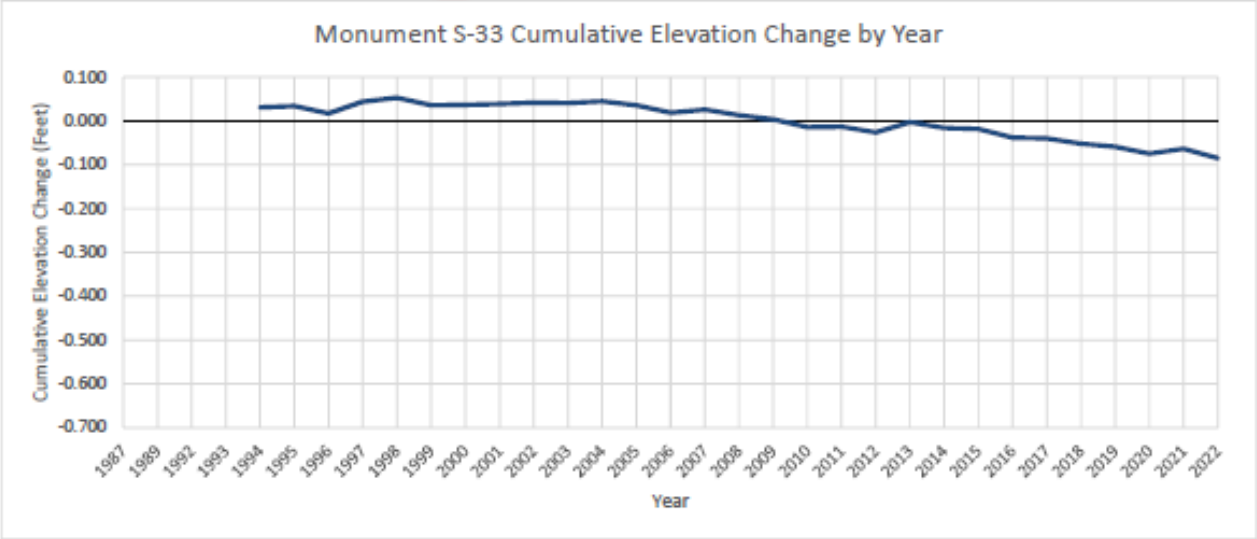

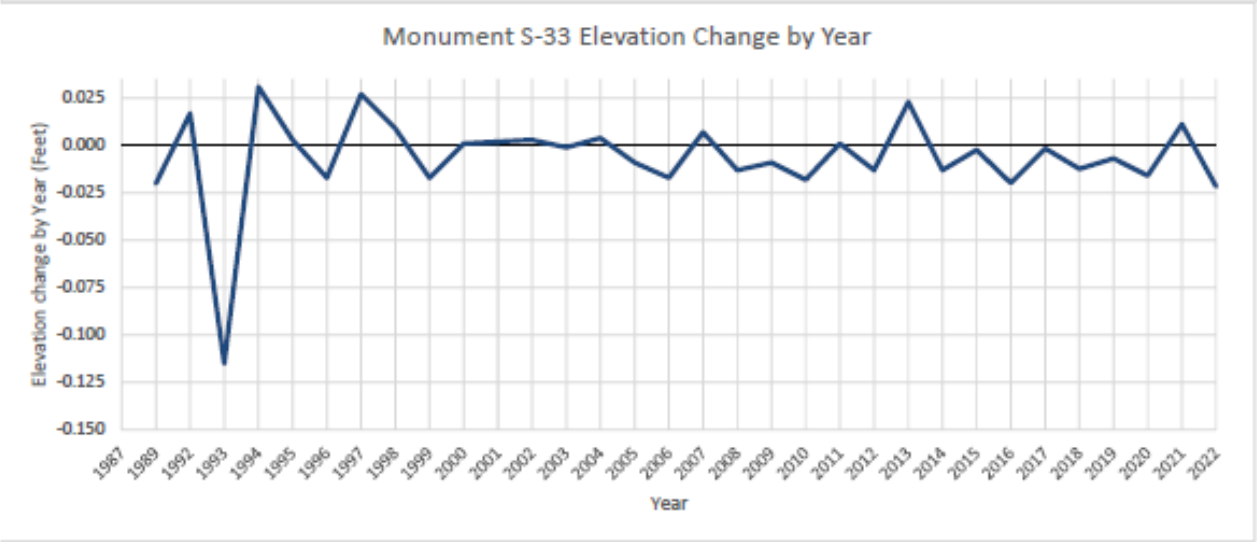

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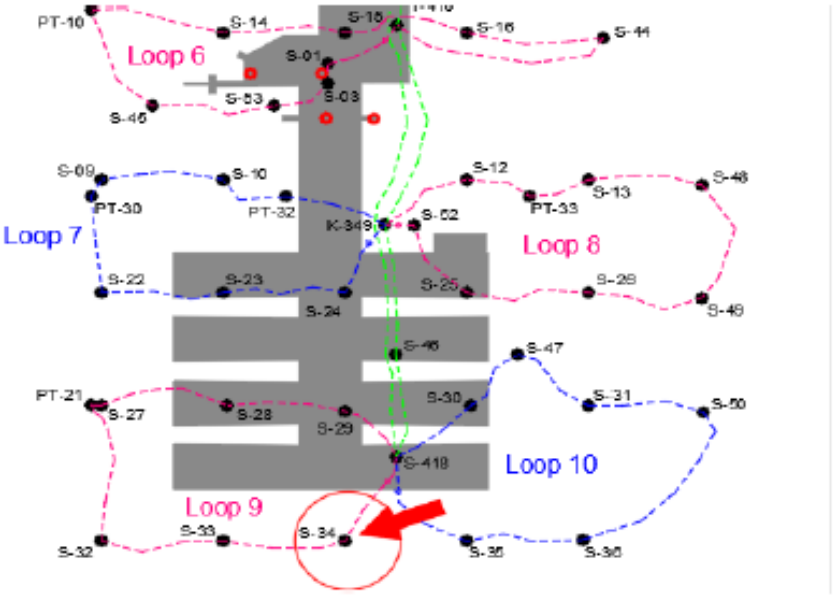


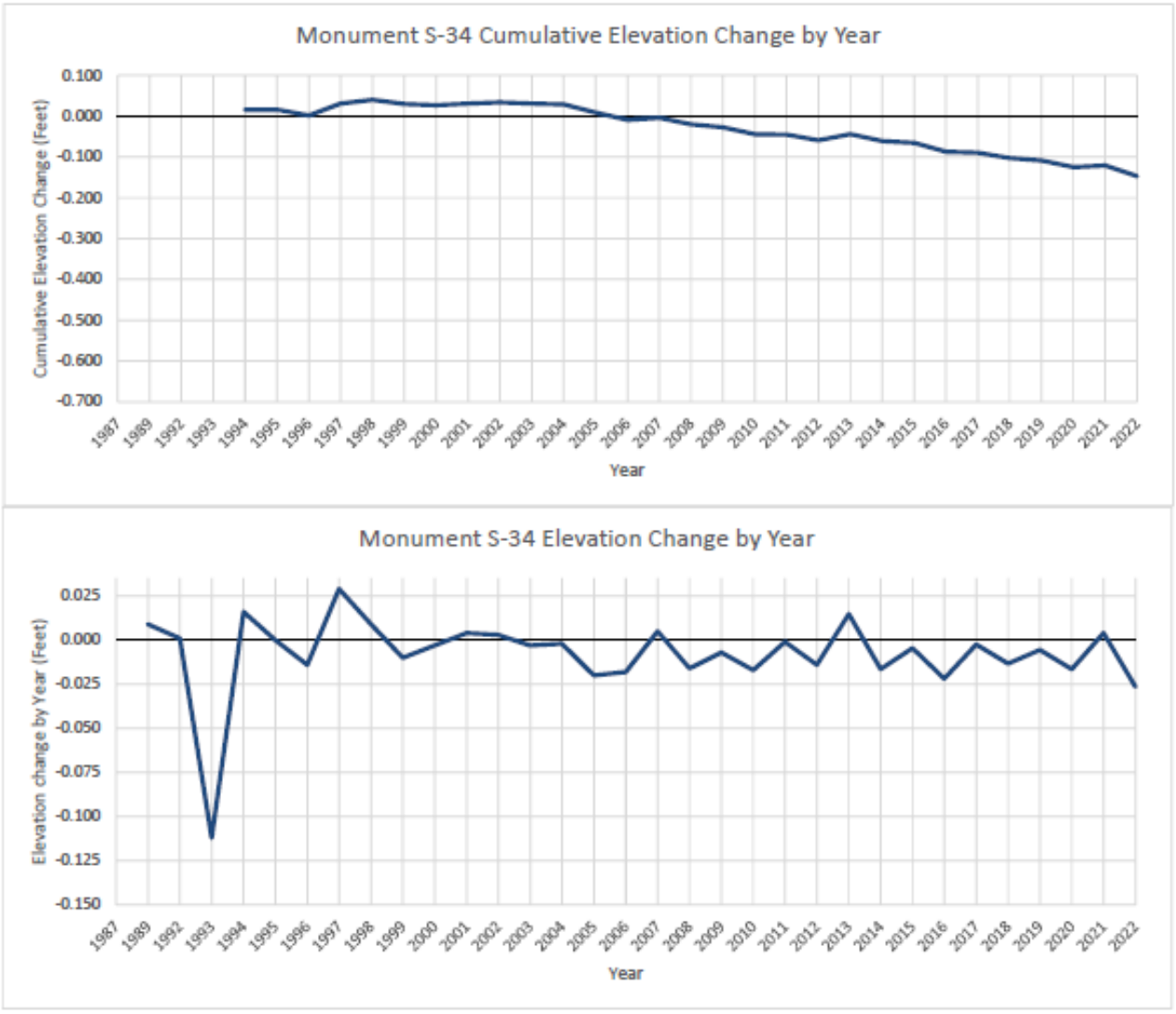


Figure 26. Monument S-34 Elevation Data Graphs

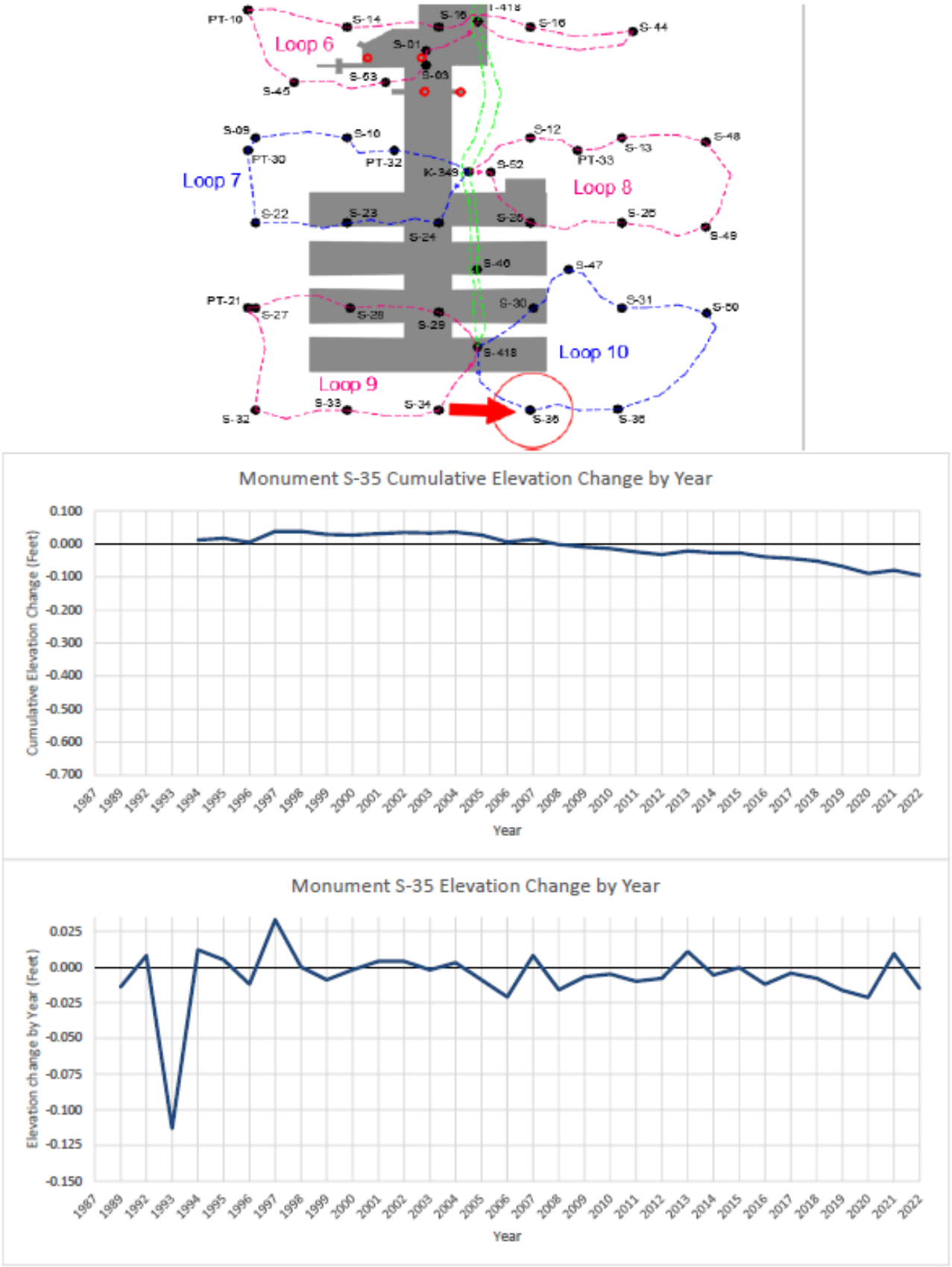


Figure 27. Monument S-35 Elevation Data Graphs

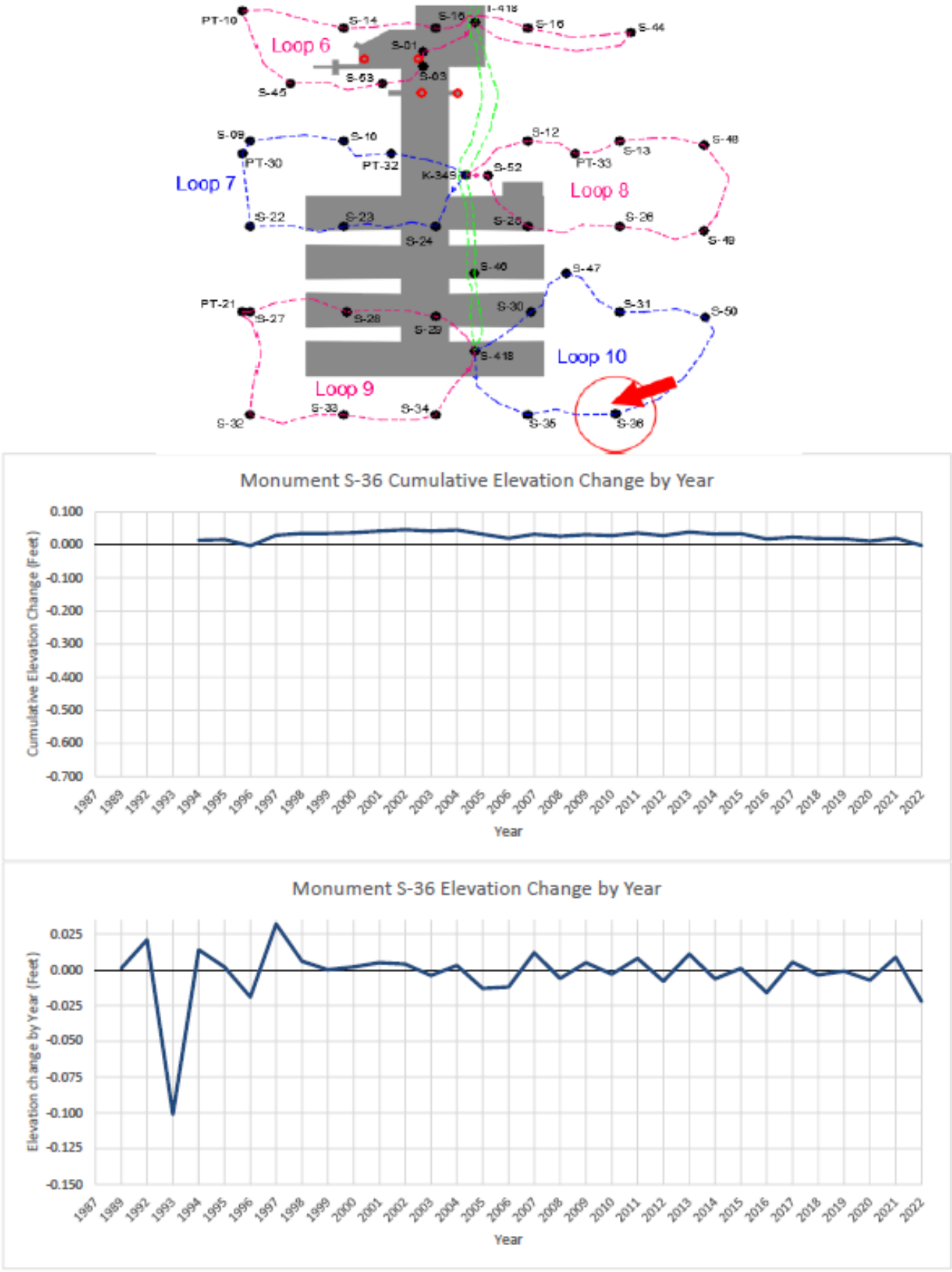


Figure 28. Monument S-36 Elevation Data Graphs

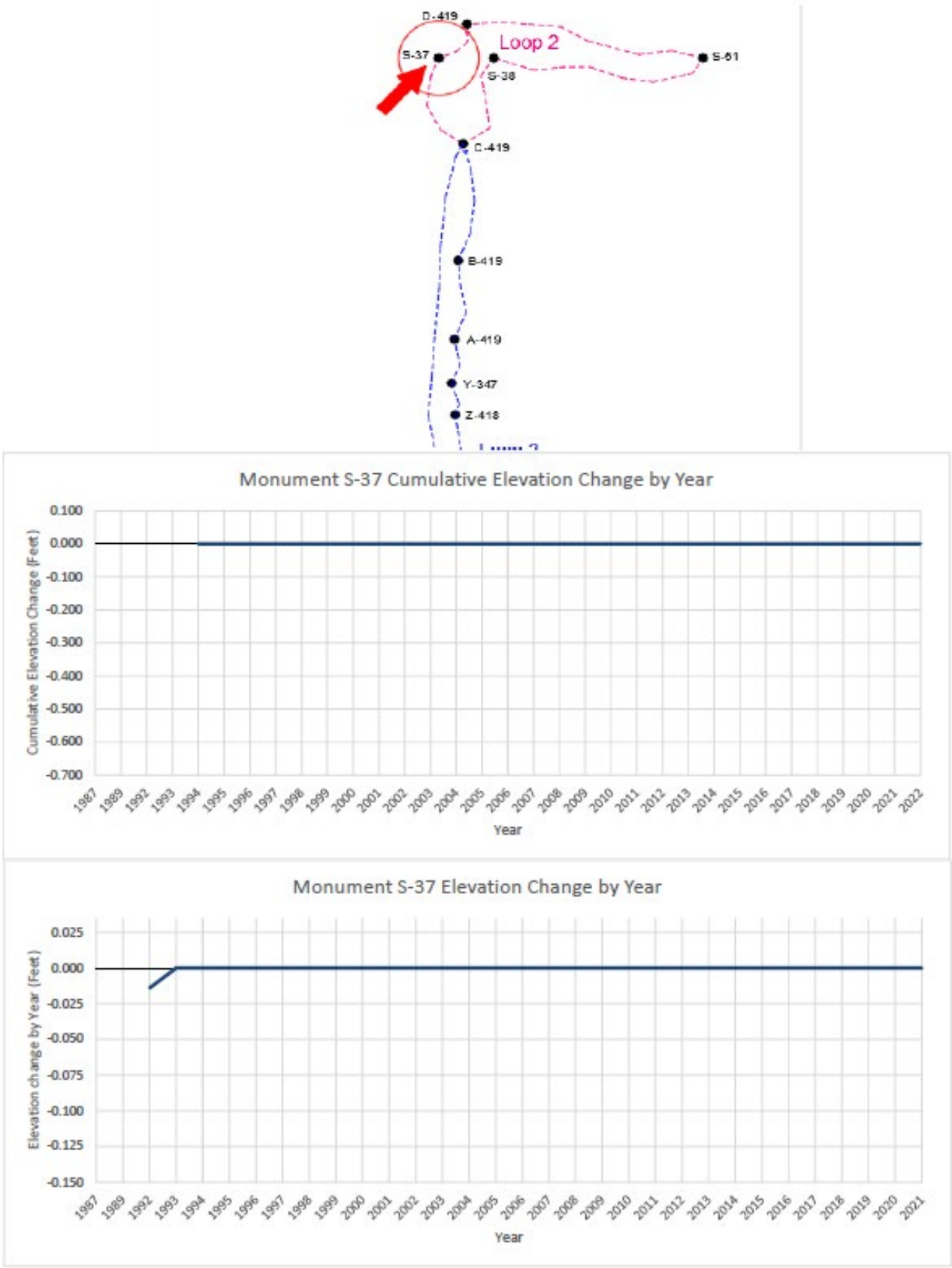


Figure 29. Monument S-37 Elevation Data Graphs

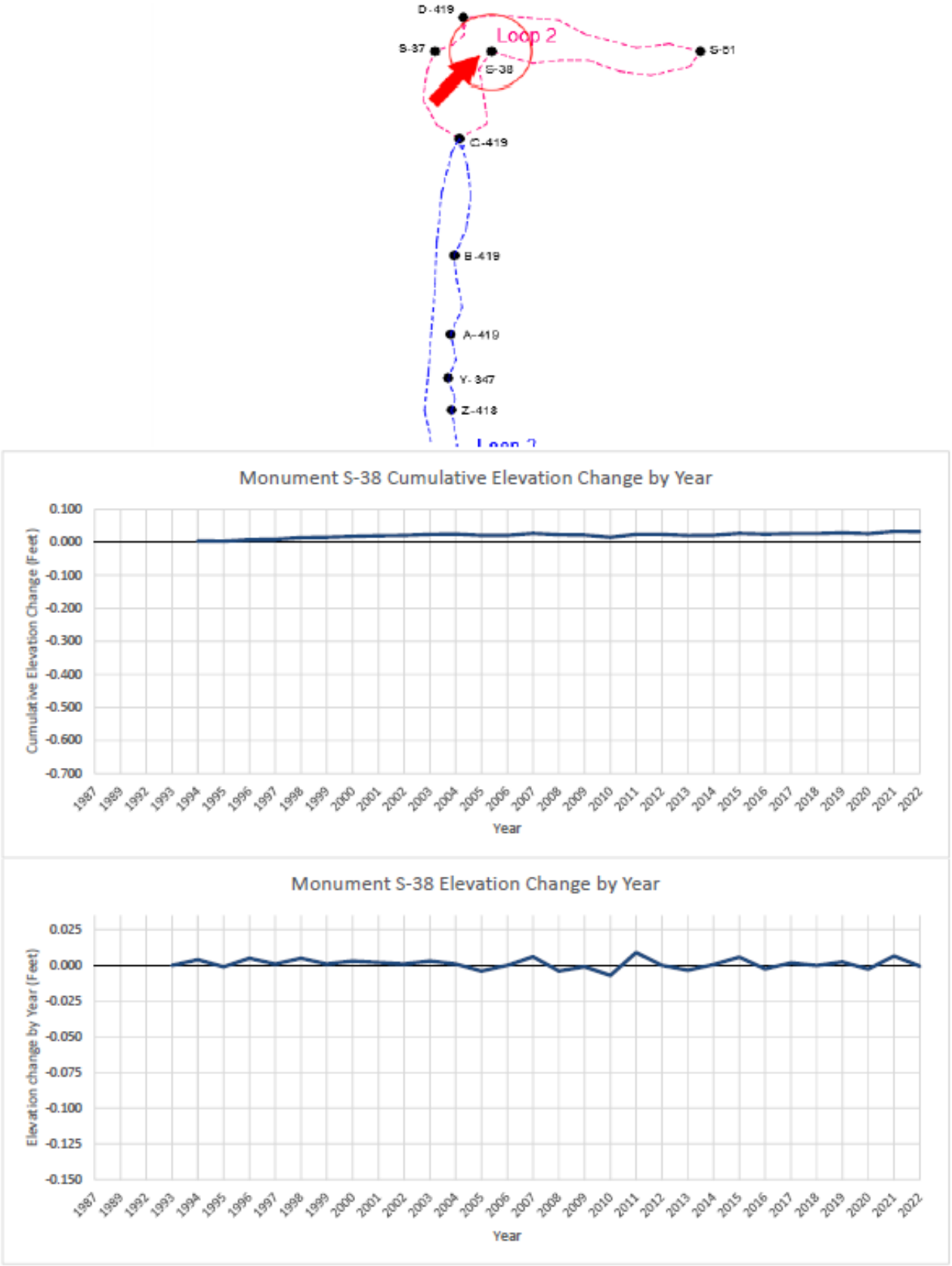


Figure 30. Monument S-38 Elevation Data Graphs

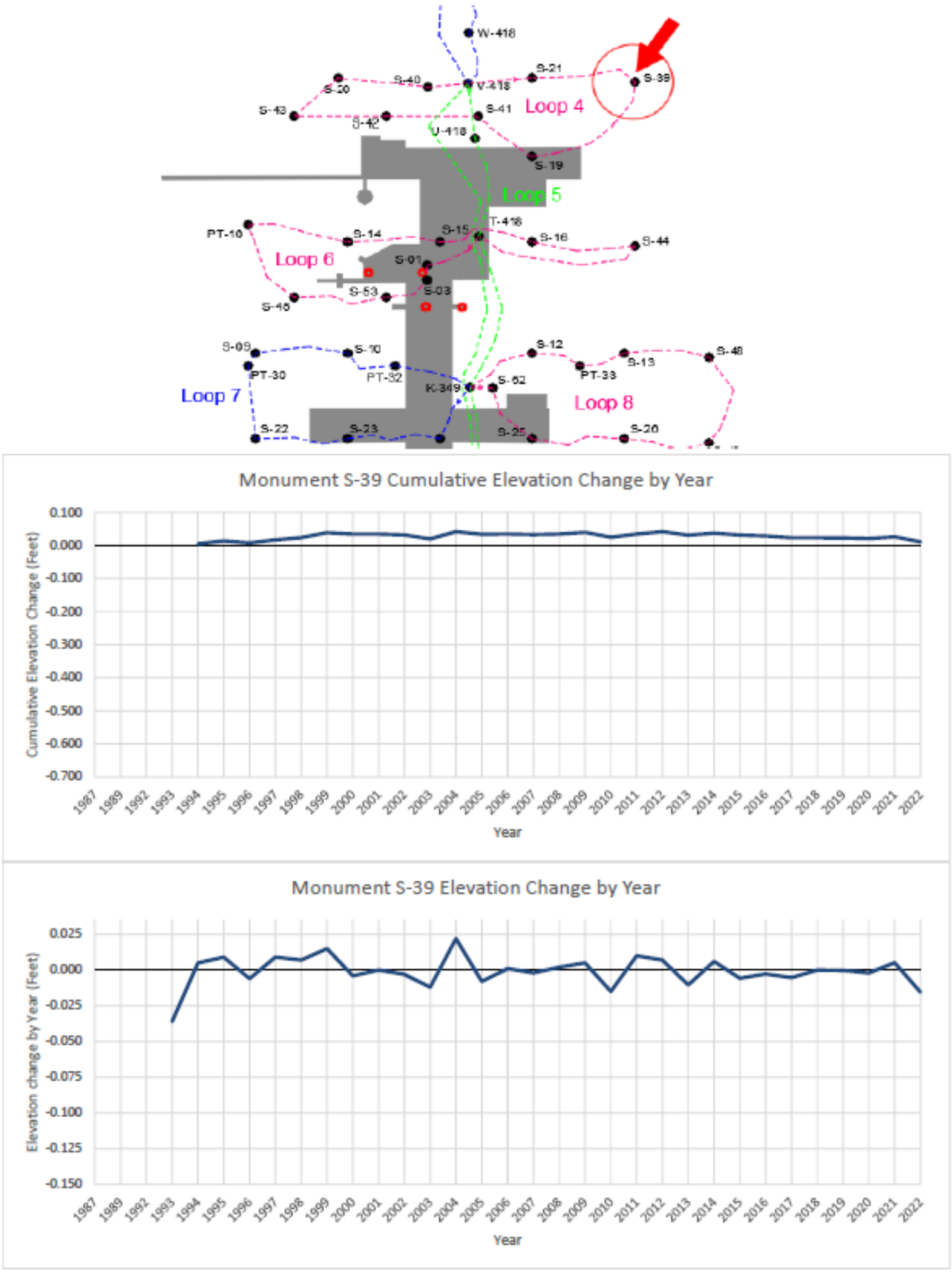
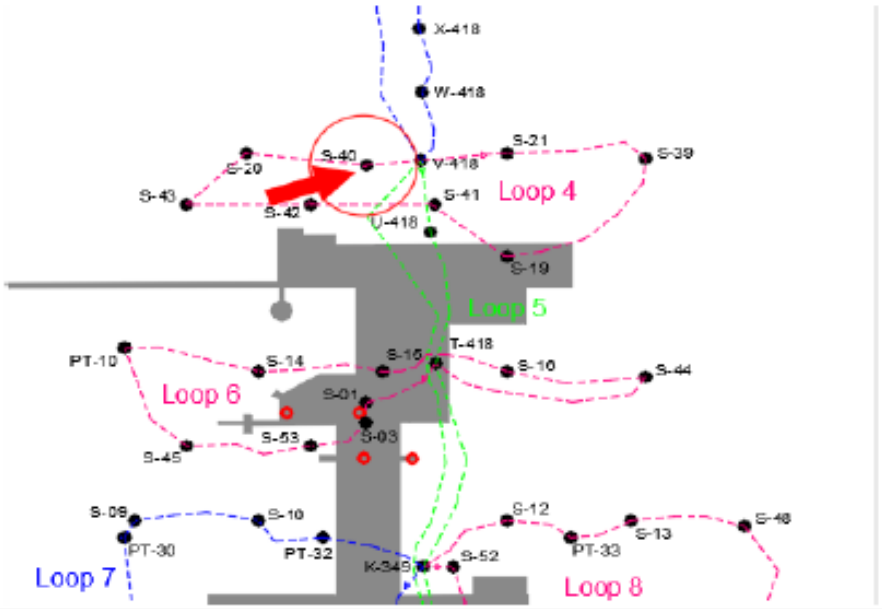
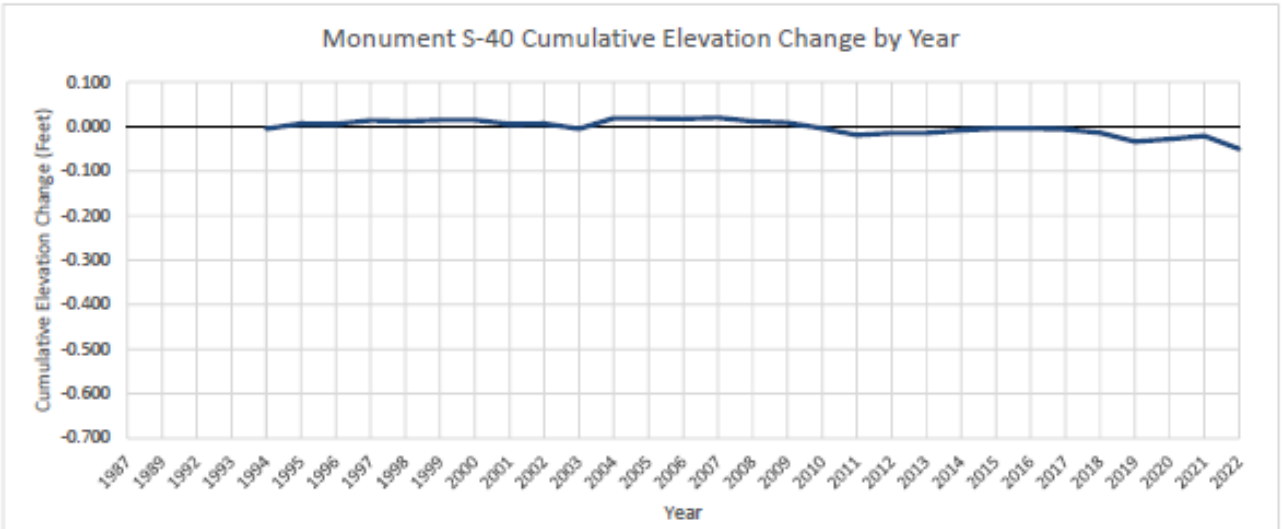


Figure 31. Monument S-39 Elevation Data Graphs





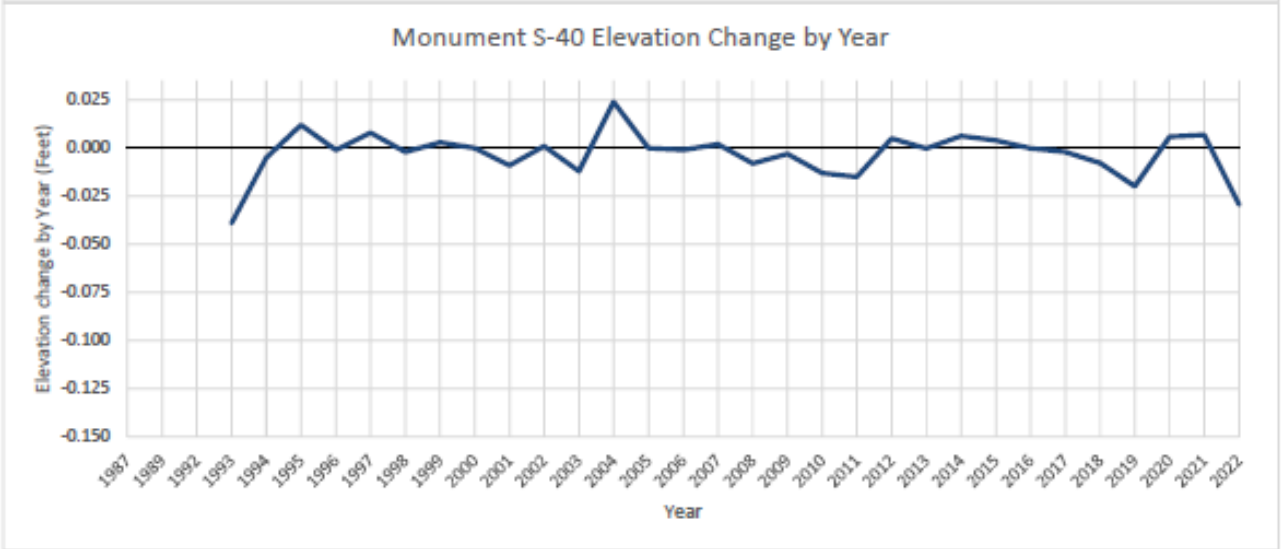


Figure 32. Monument S-40 Elevation Data Graphs

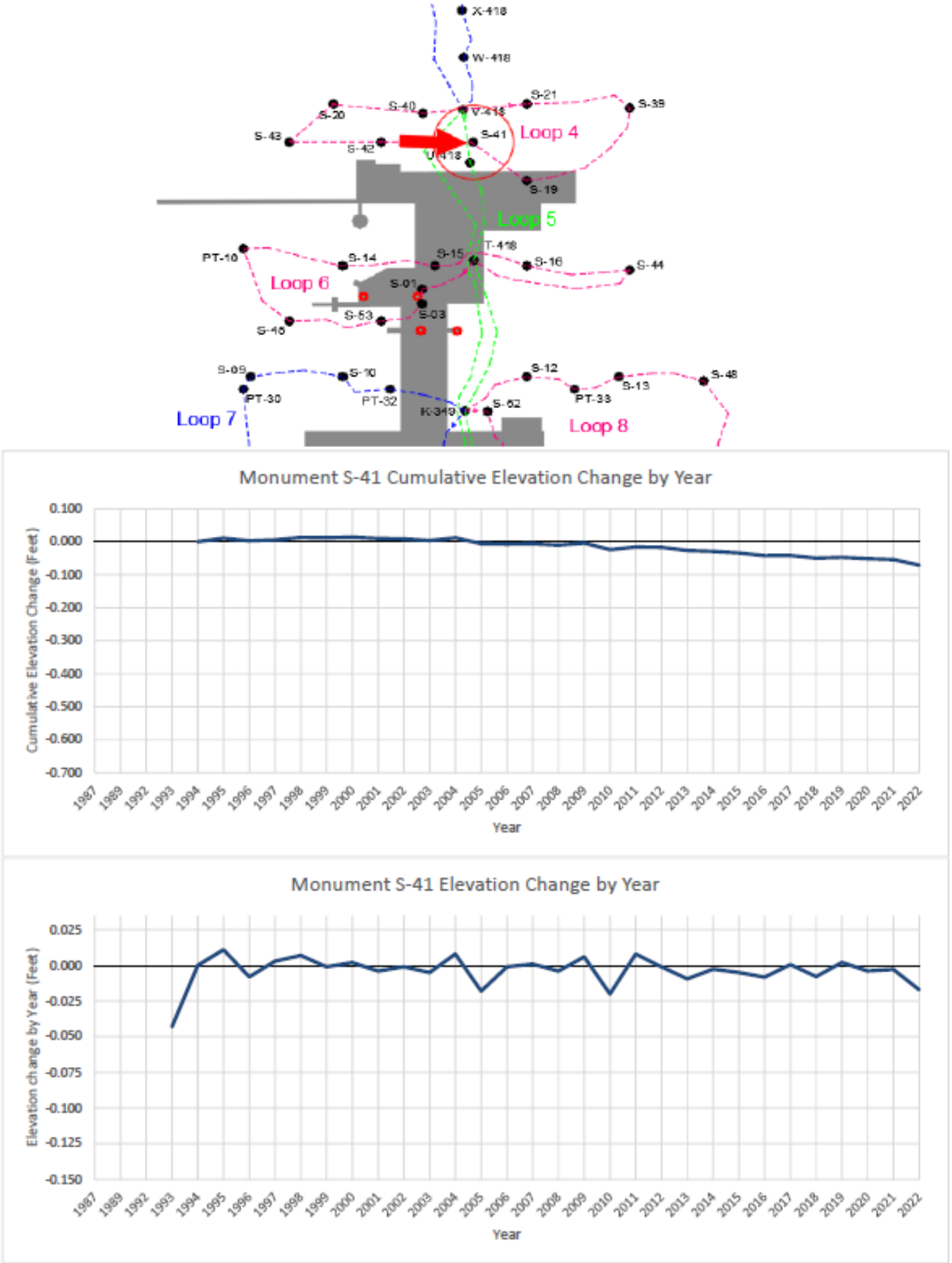


Figure 33. Monument S-41 Elevation Data Graphs

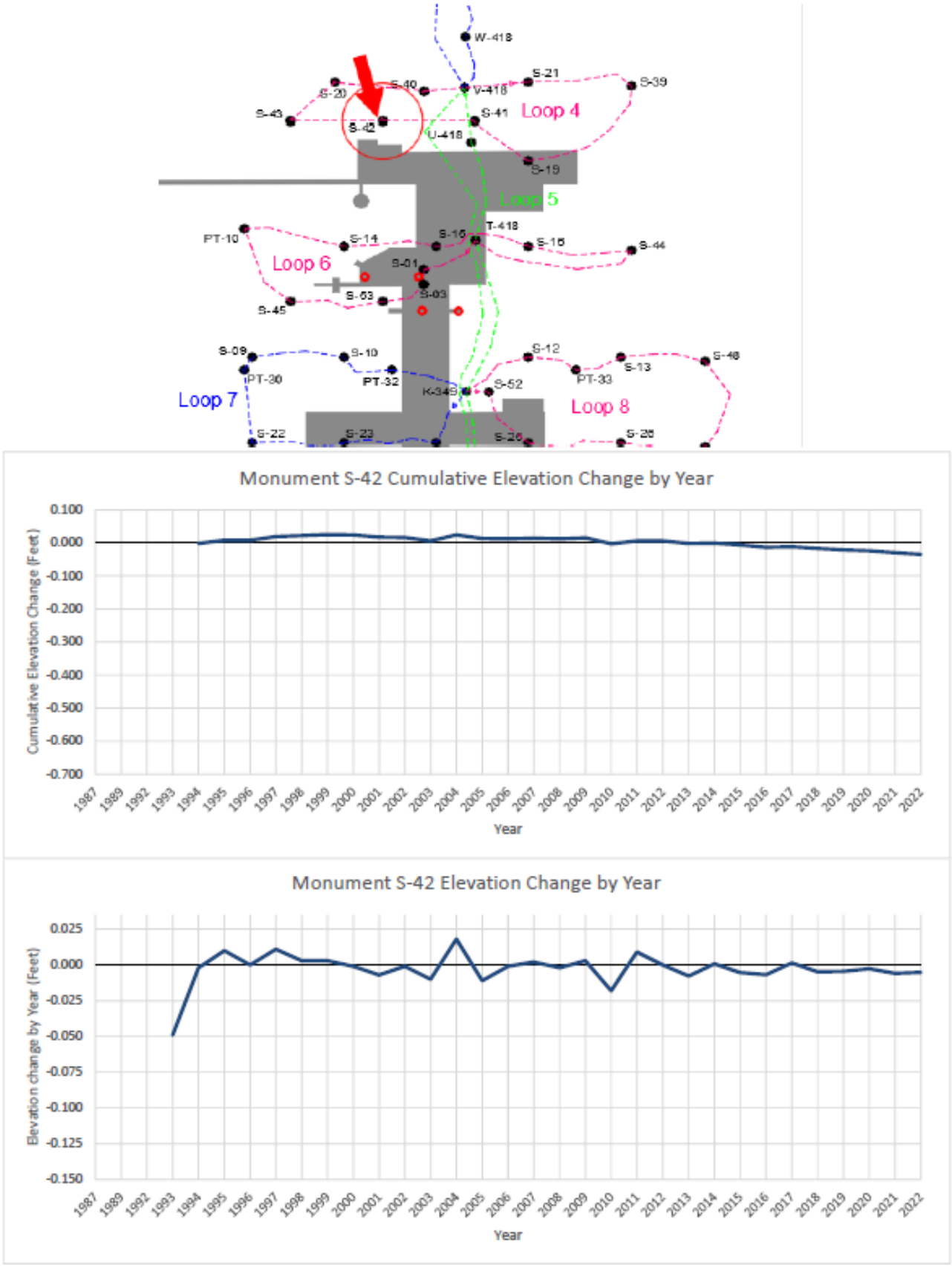


Figure 34. Monument S-42 Elevation Data Graphs

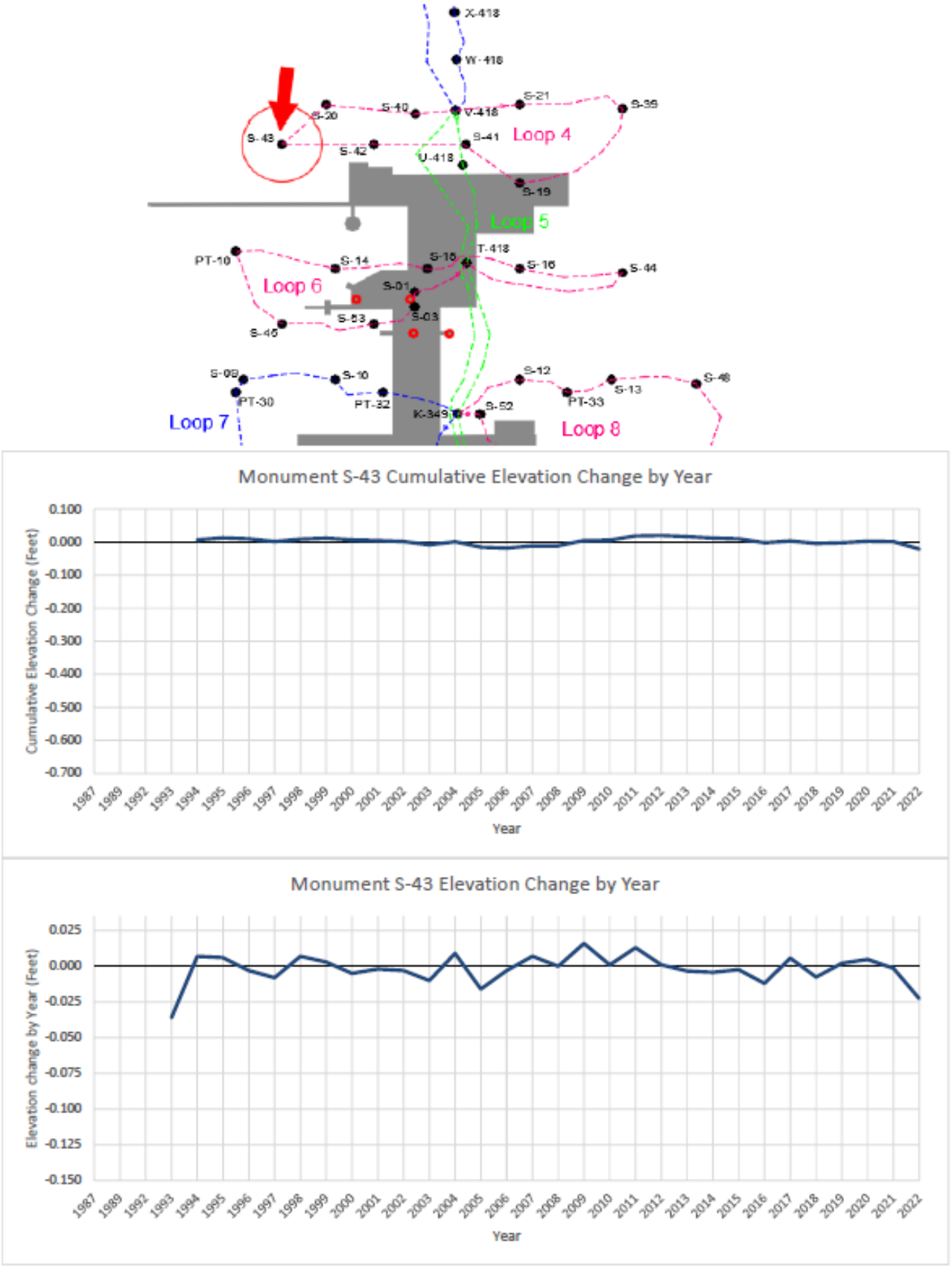
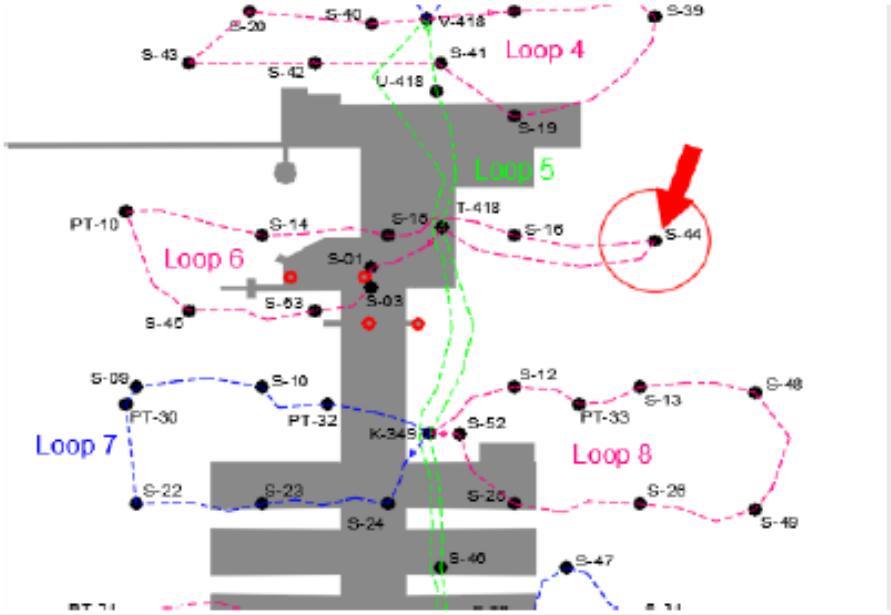
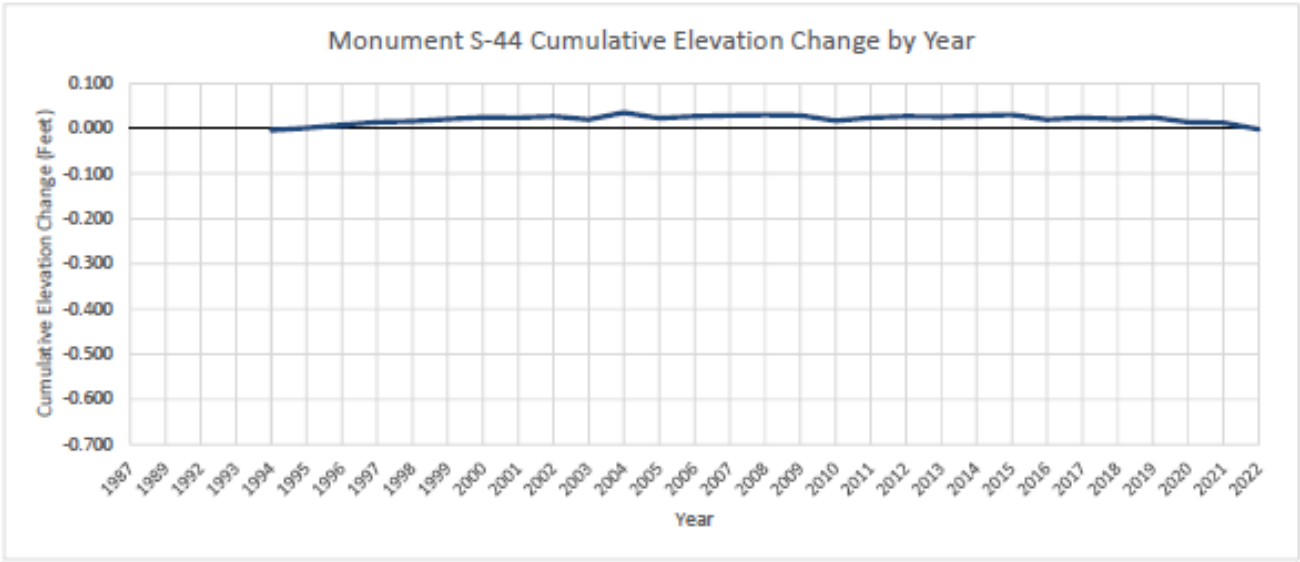
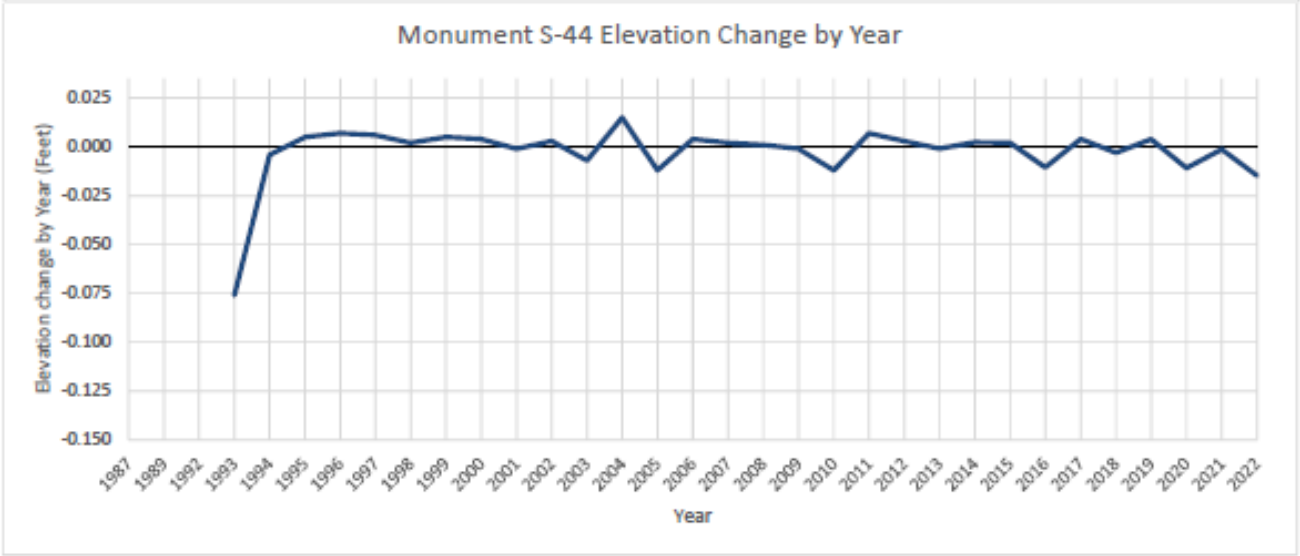


Figure 35. Monument S-43 Elevation Data Graphs







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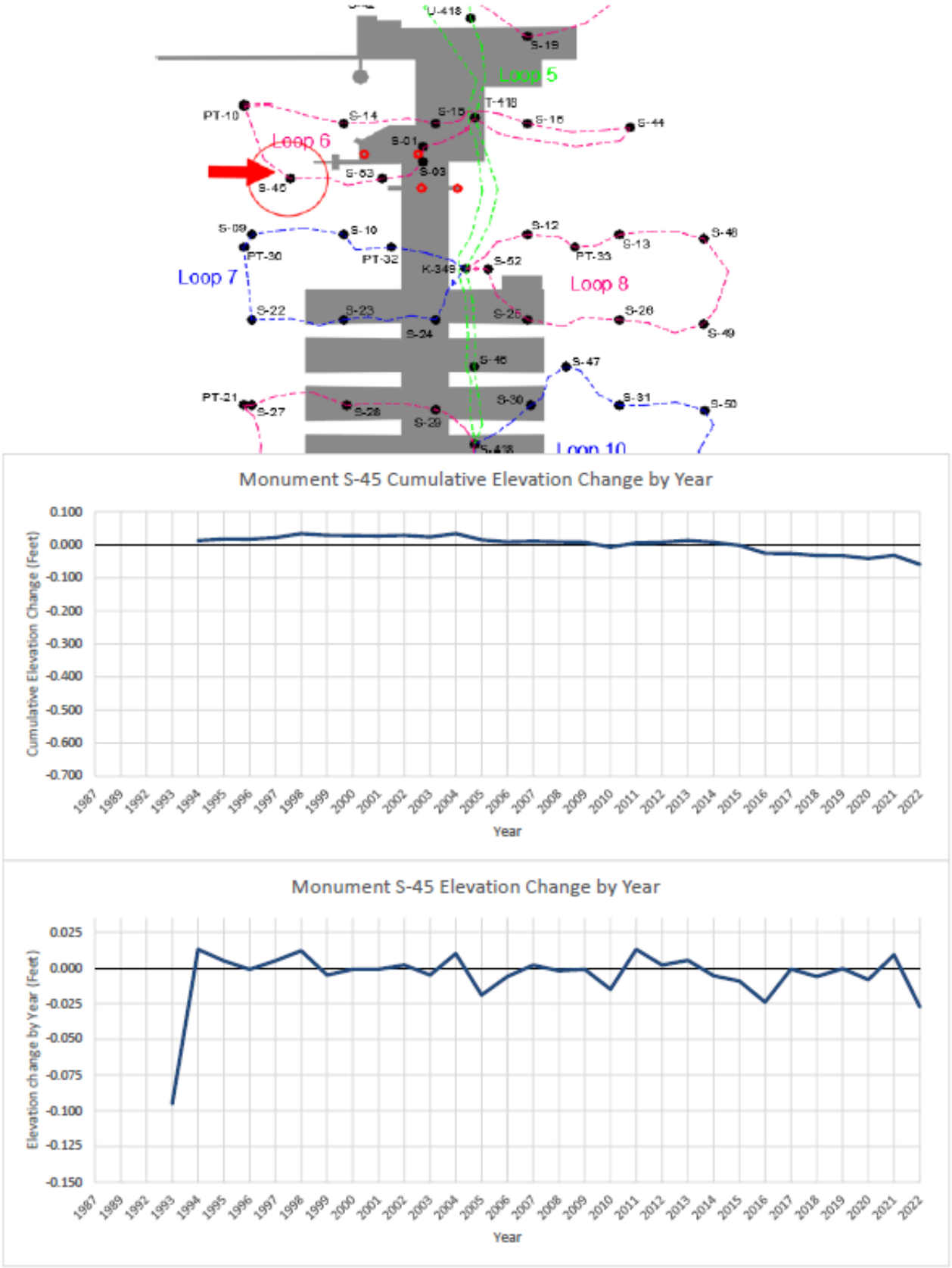


Figure 37. Monument S-45 Elevation Data Graphs

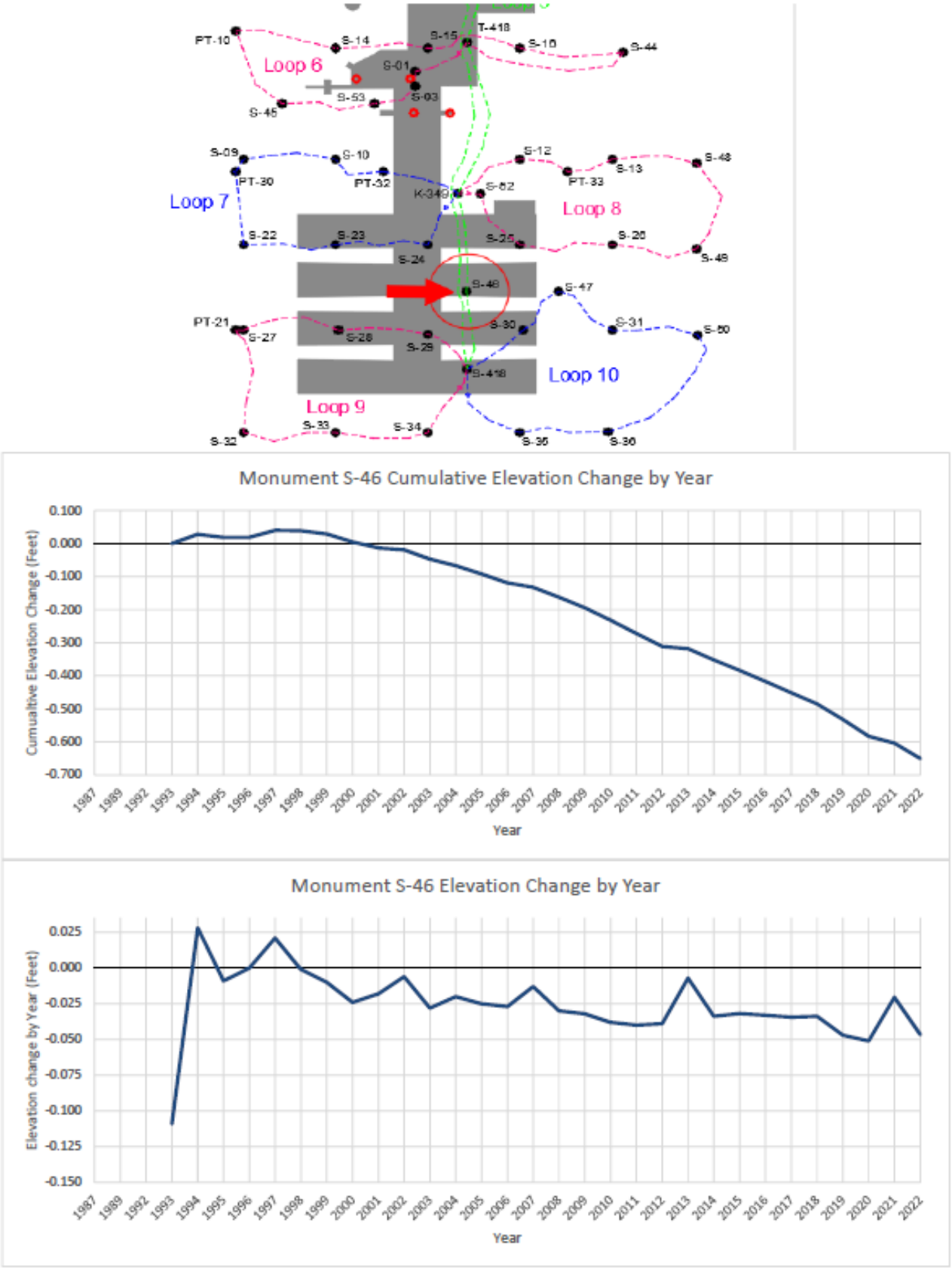


Figure 38. Monument S-46 Elevation Data Graphs

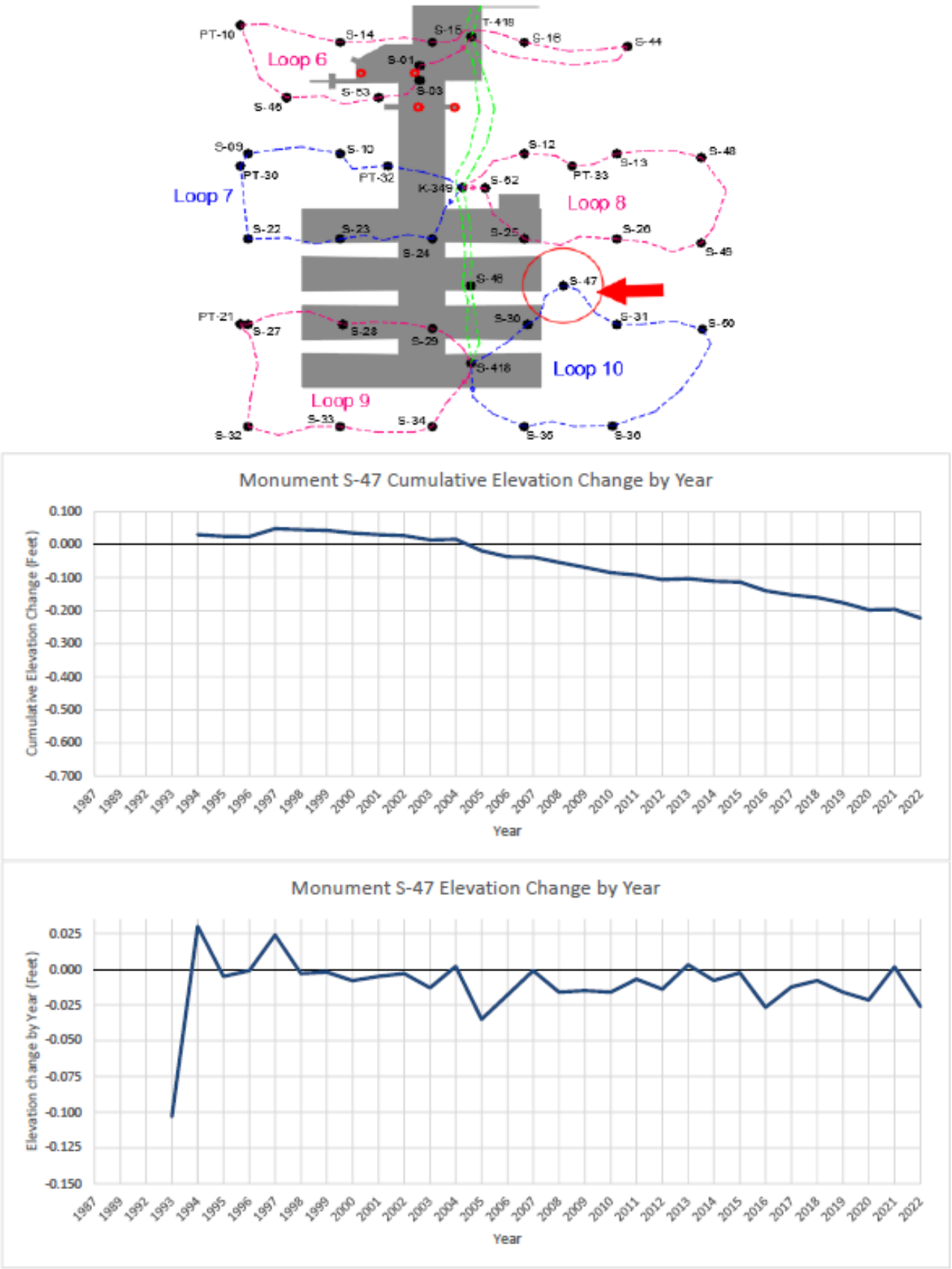


Figure 39. Monument S-47 Elevation Data Graphs

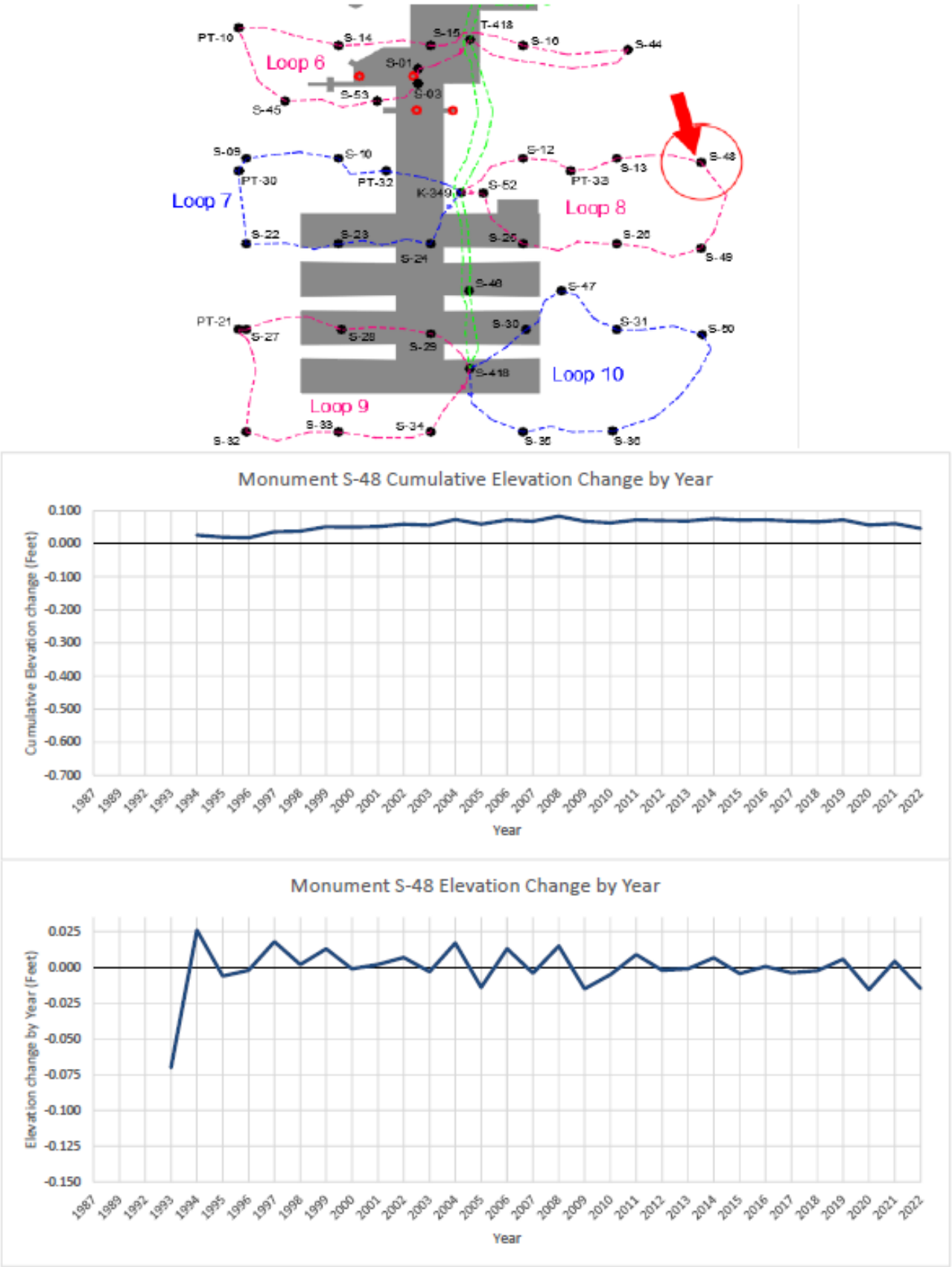


Figure 40. Monument S-48 Elevation Data Graphs

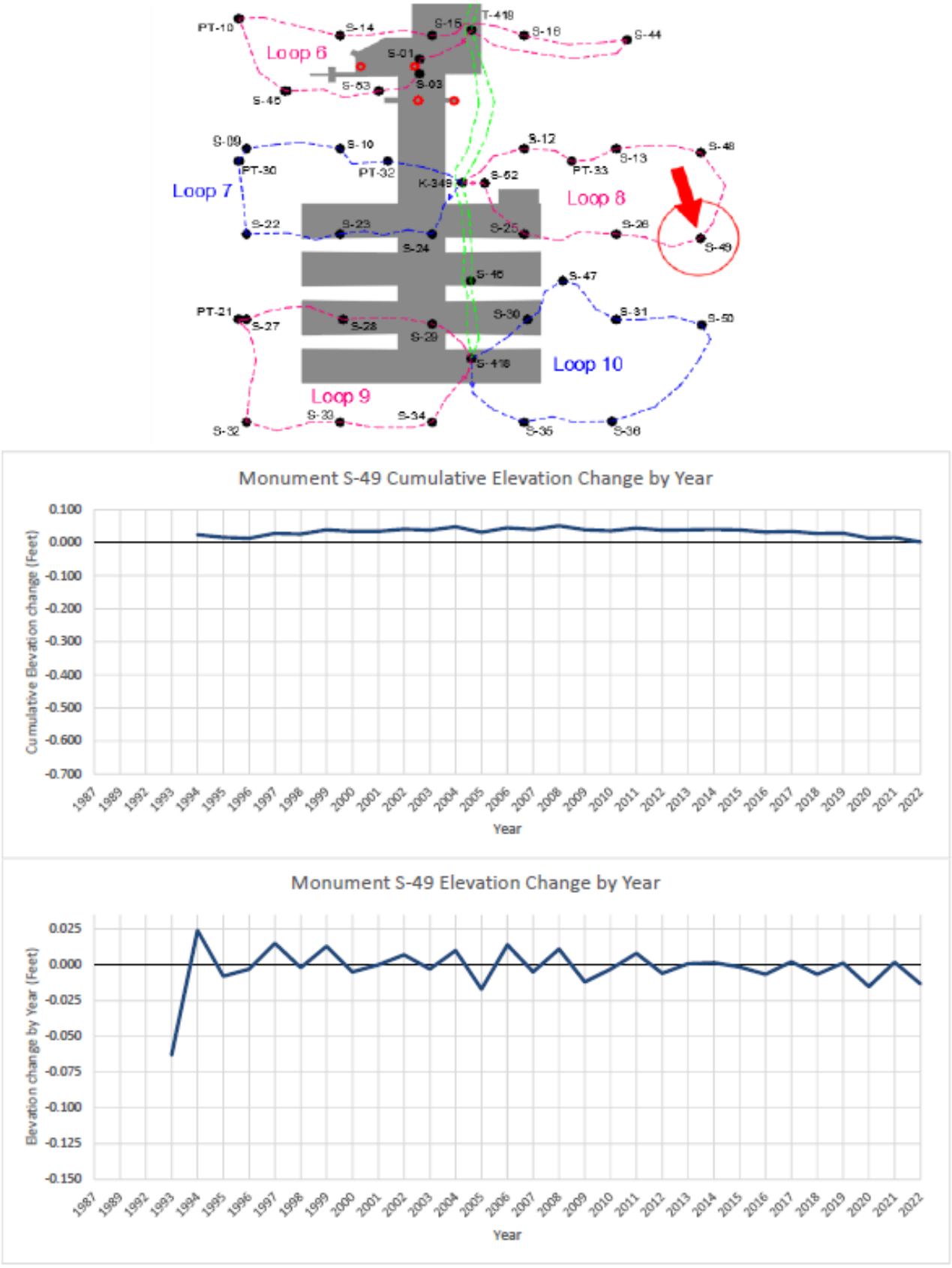


Figure 41. Monument S-49 Elevation Data Graphs

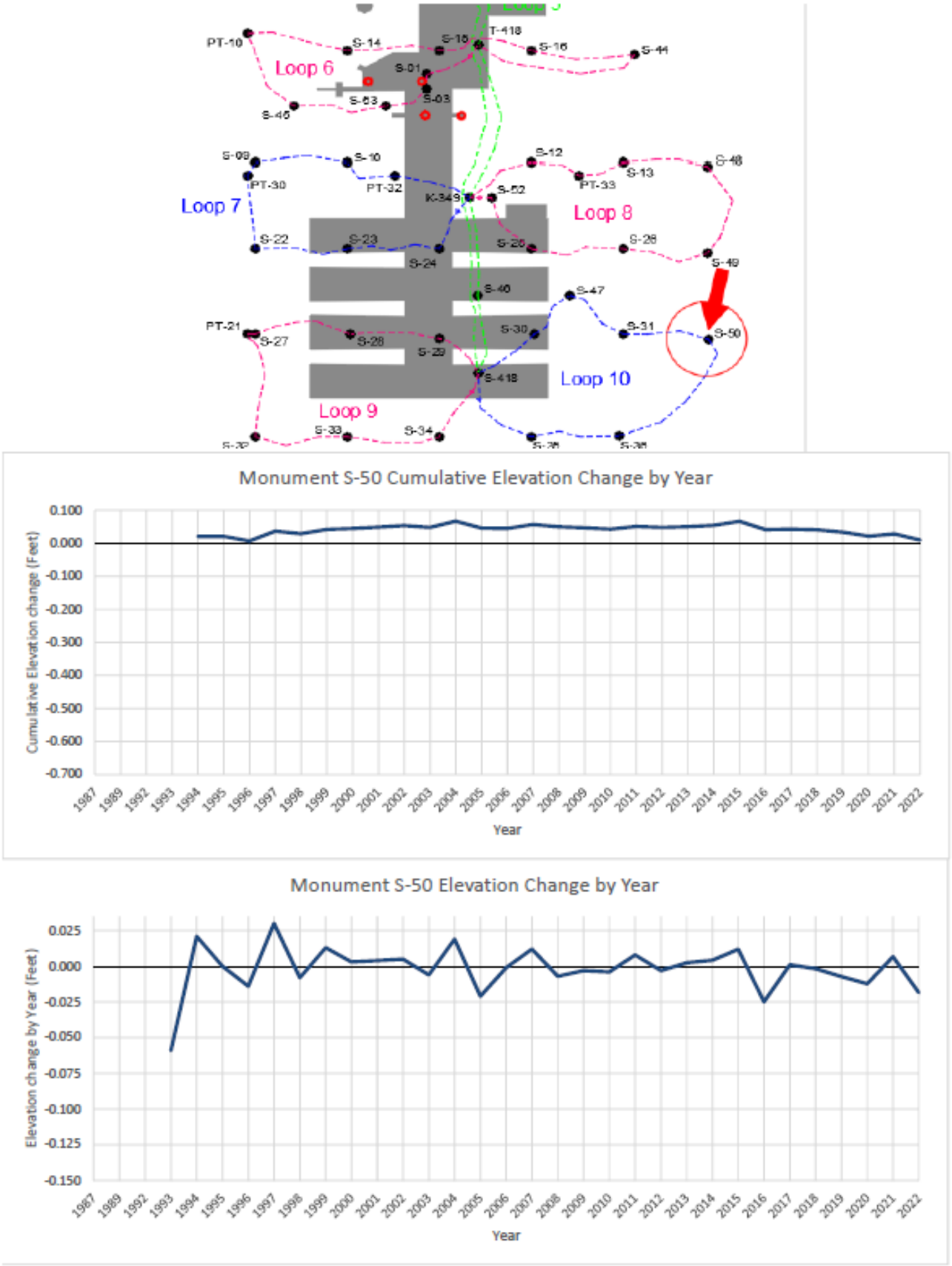


Figure 42. Monument S-50 Elevation Data Graphs

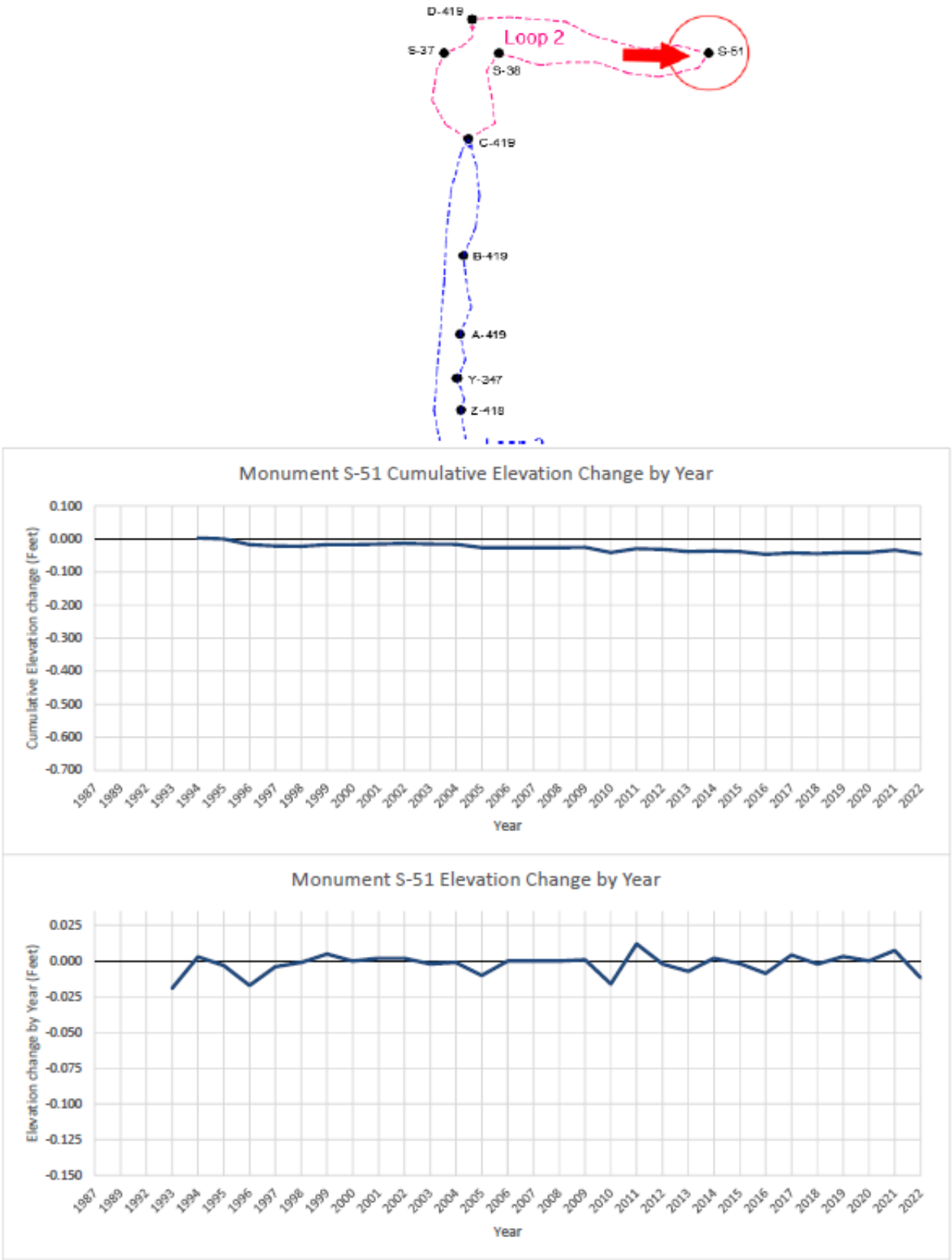


Figure 43. Monument S-51 Elevation Data Graphs

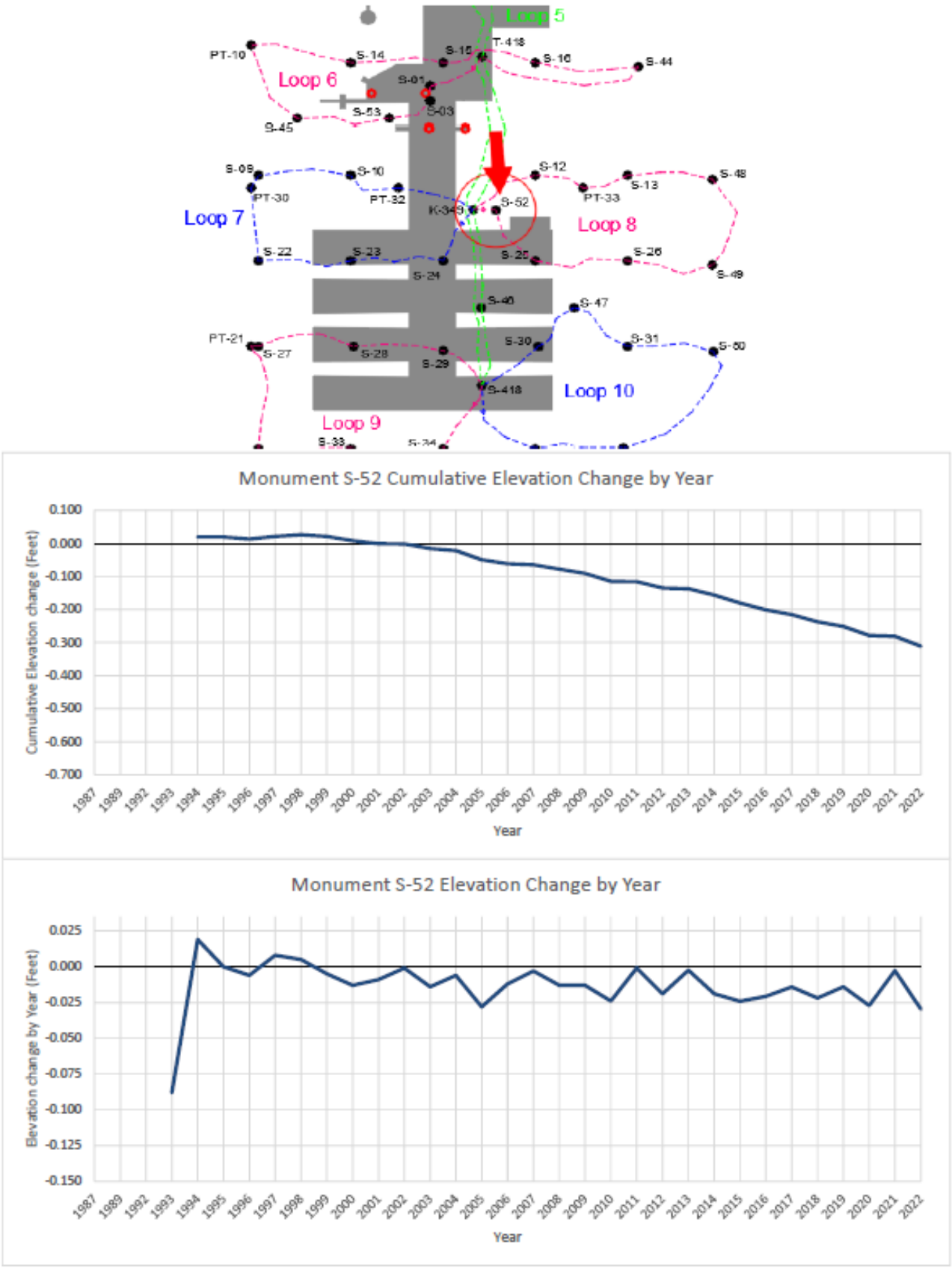


Figure 44. Monument S-52 Elevation Data Graphs

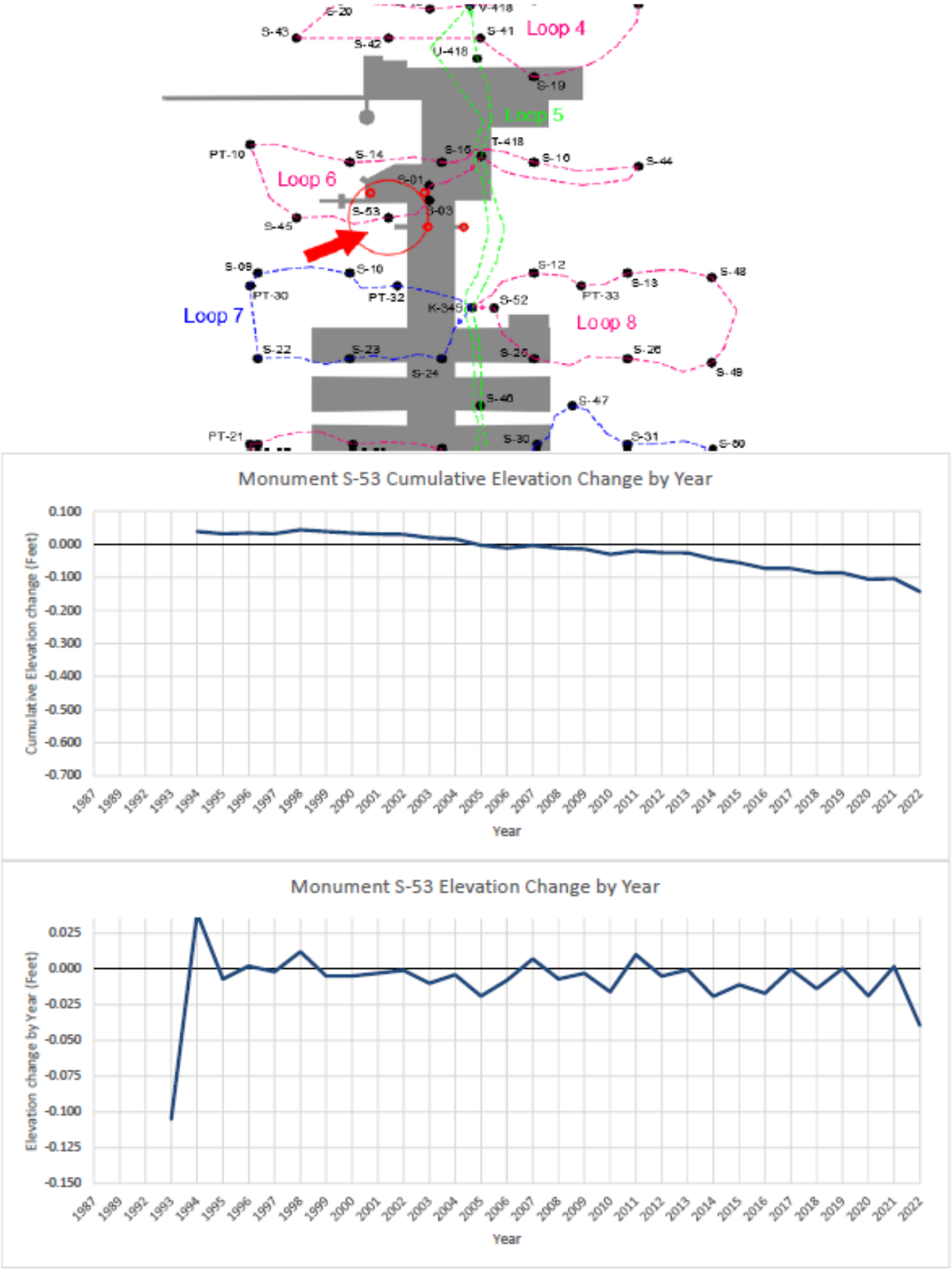


Figure 45. Monument S-53 Elevation Data Graphs

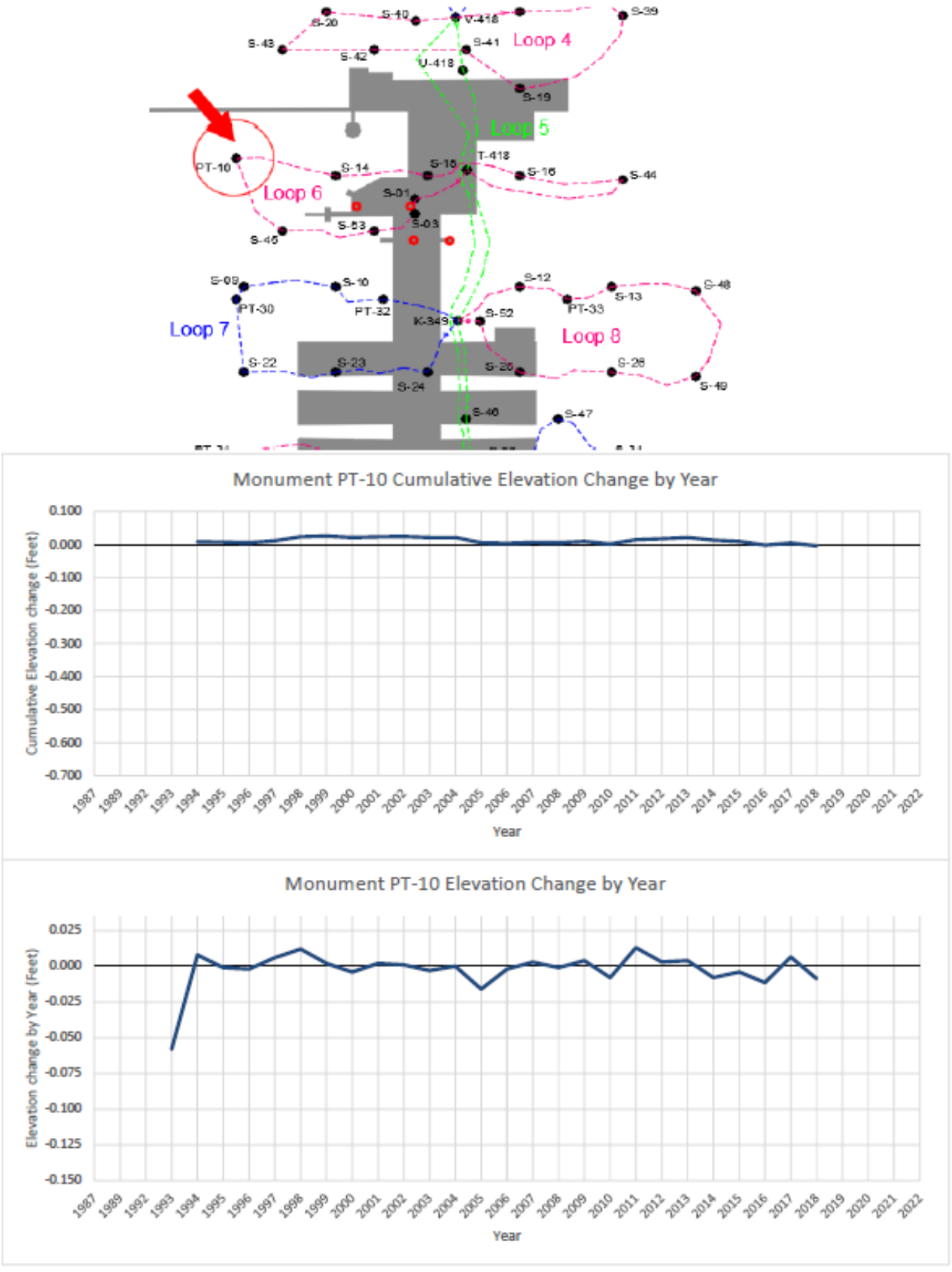


Figure 46. Monument PT-10 Elevation Data Graphs

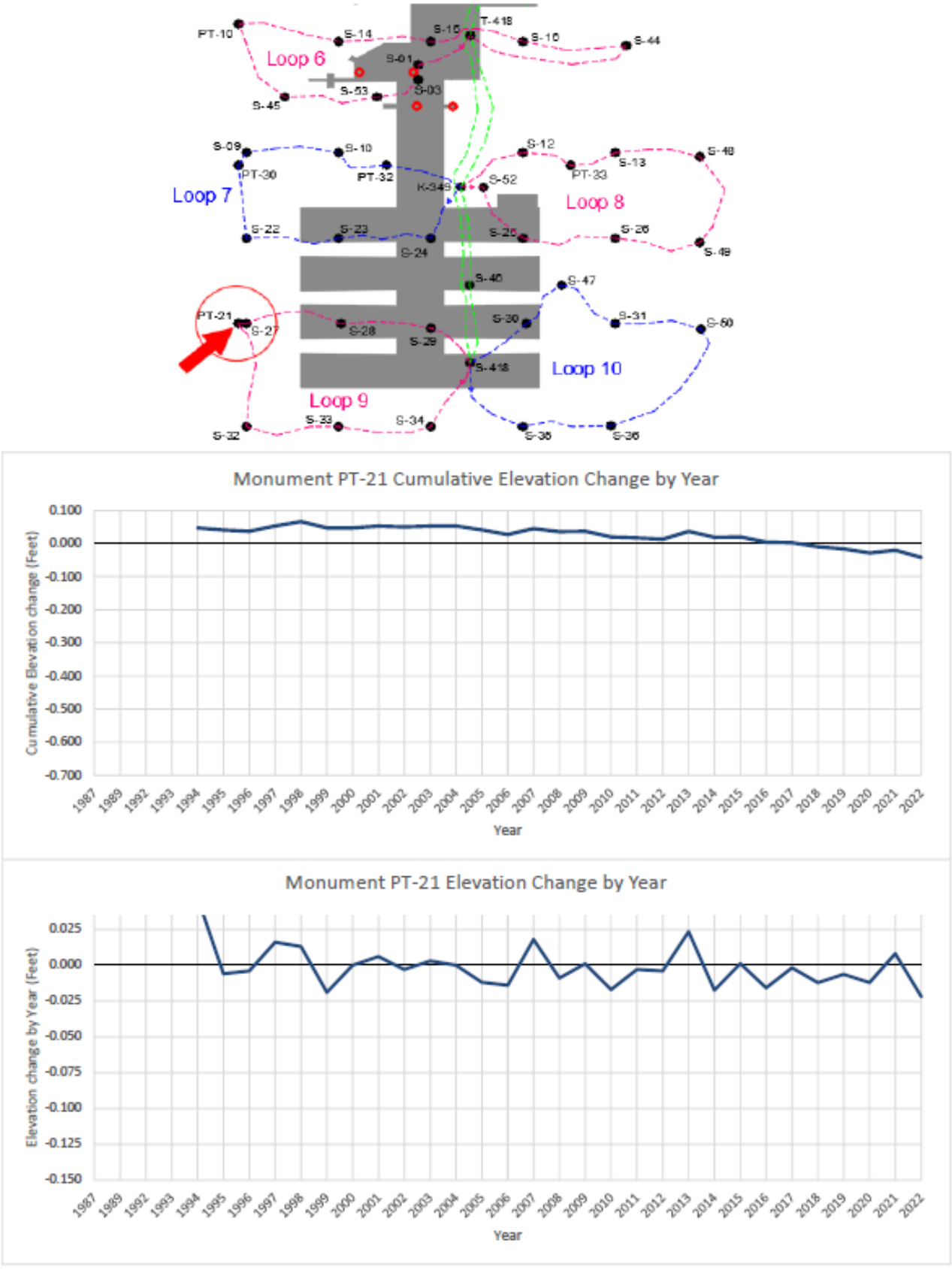


Figure 47. Monument PT-21 Elevation Data Graphs

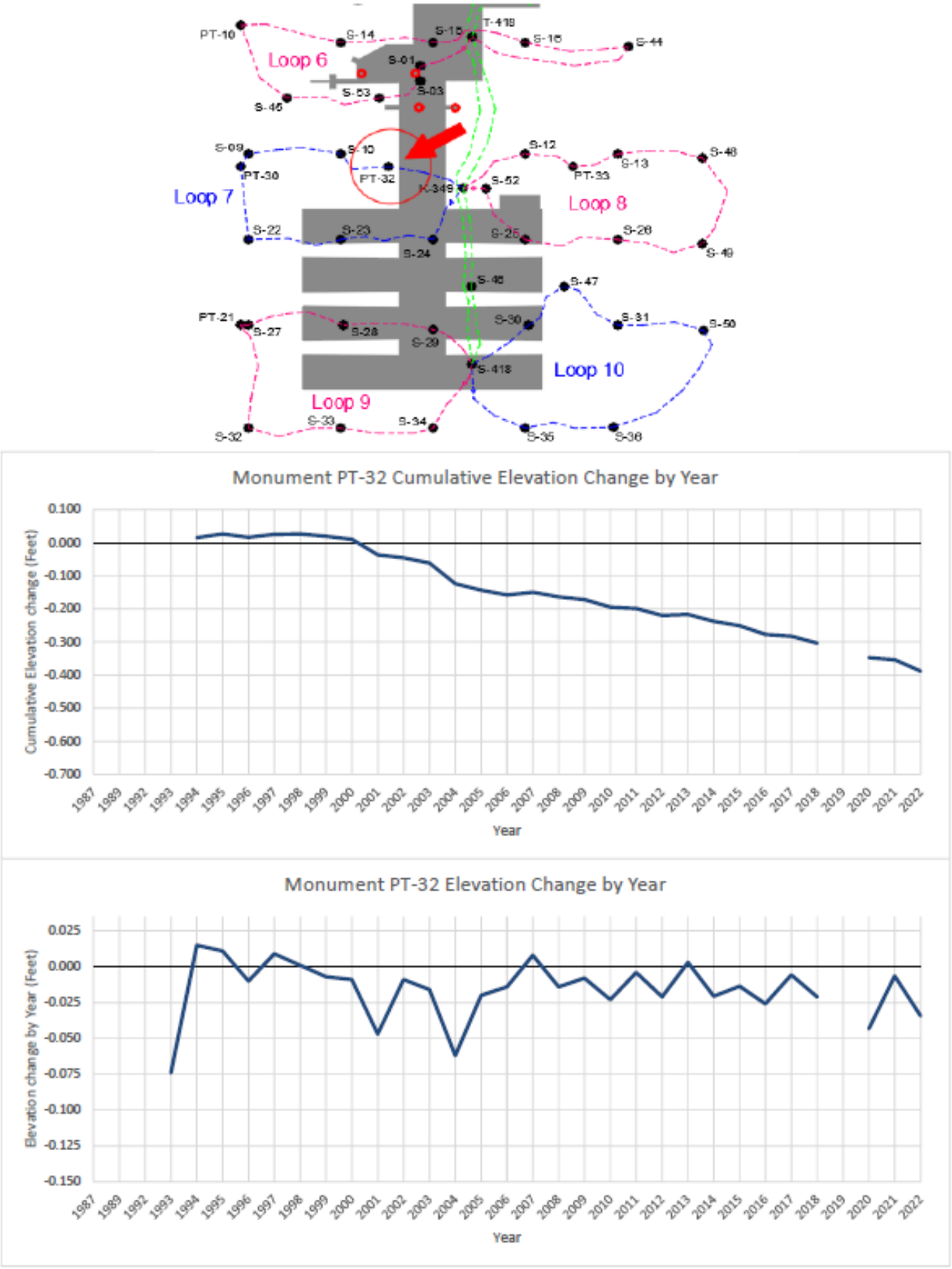


Figure 48. Monument PT-32 Elevation Data Graphs

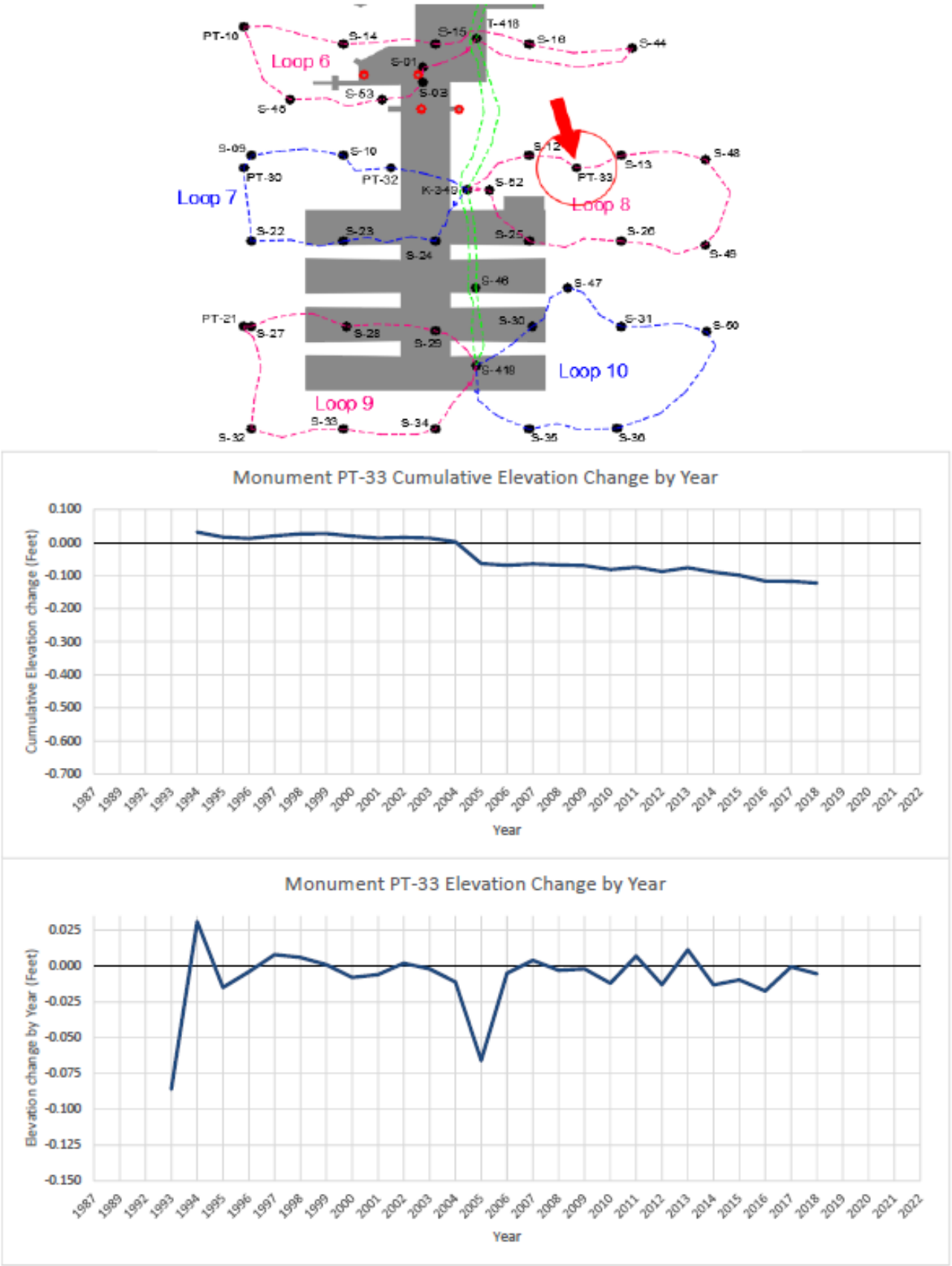


Figure 49. Monument PT-33 Elevation Data Graphs

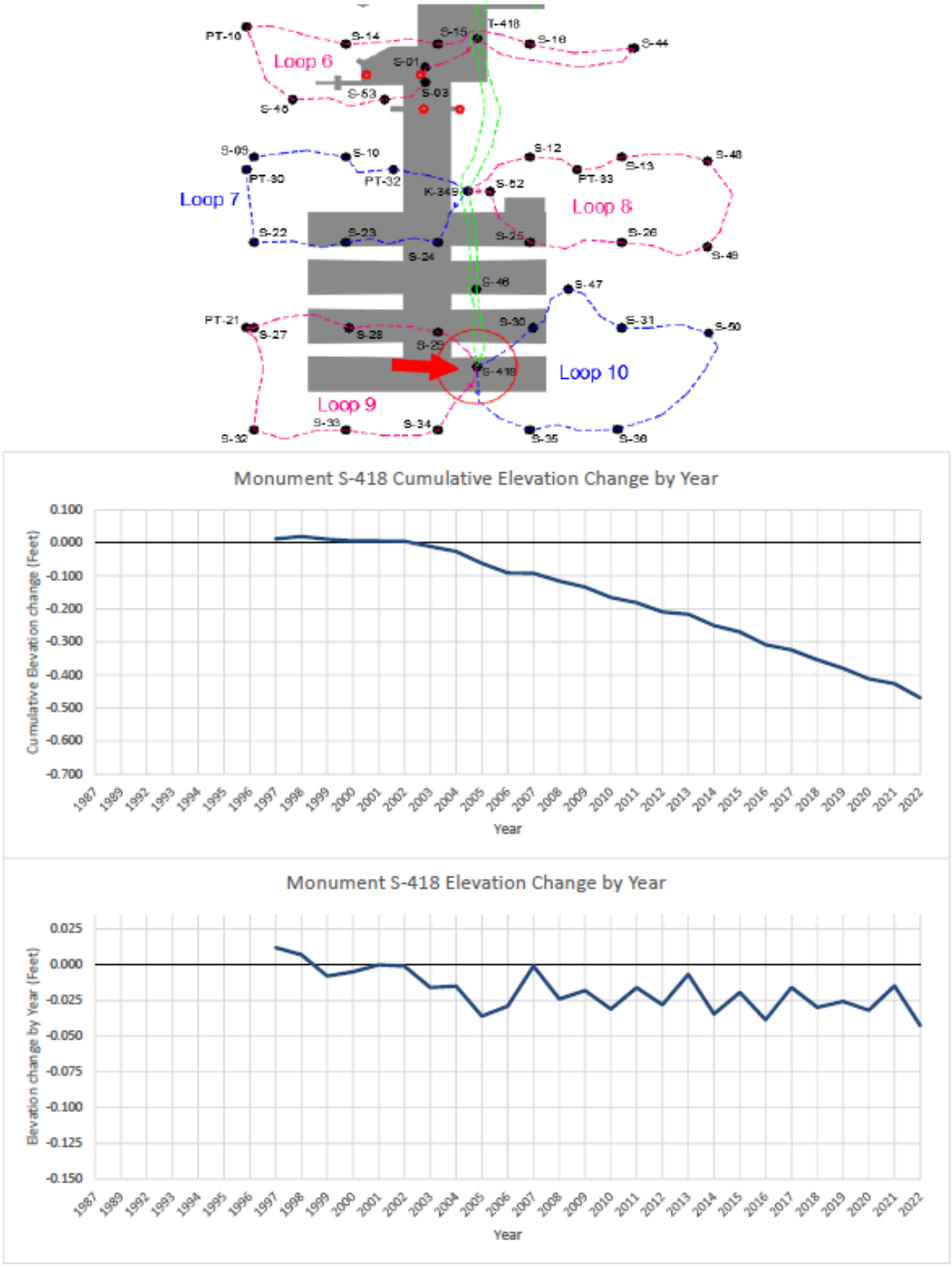
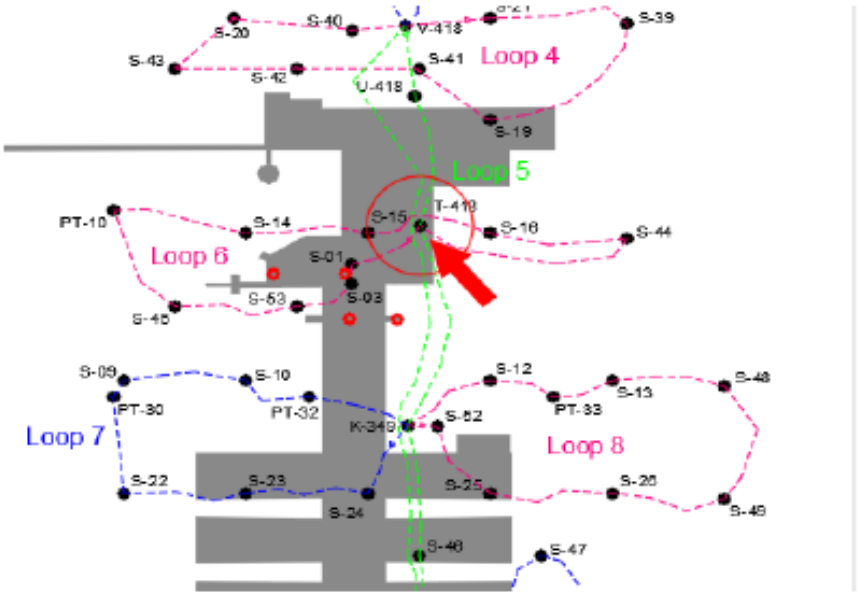
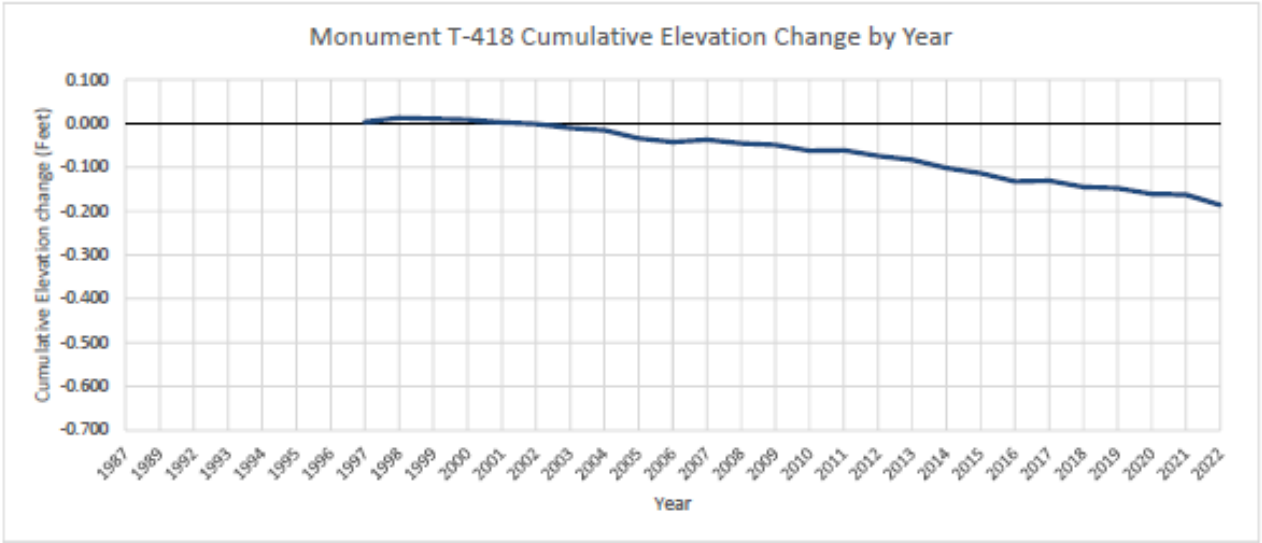


Figure 50. Monument S-418 Elevation Data Graphs





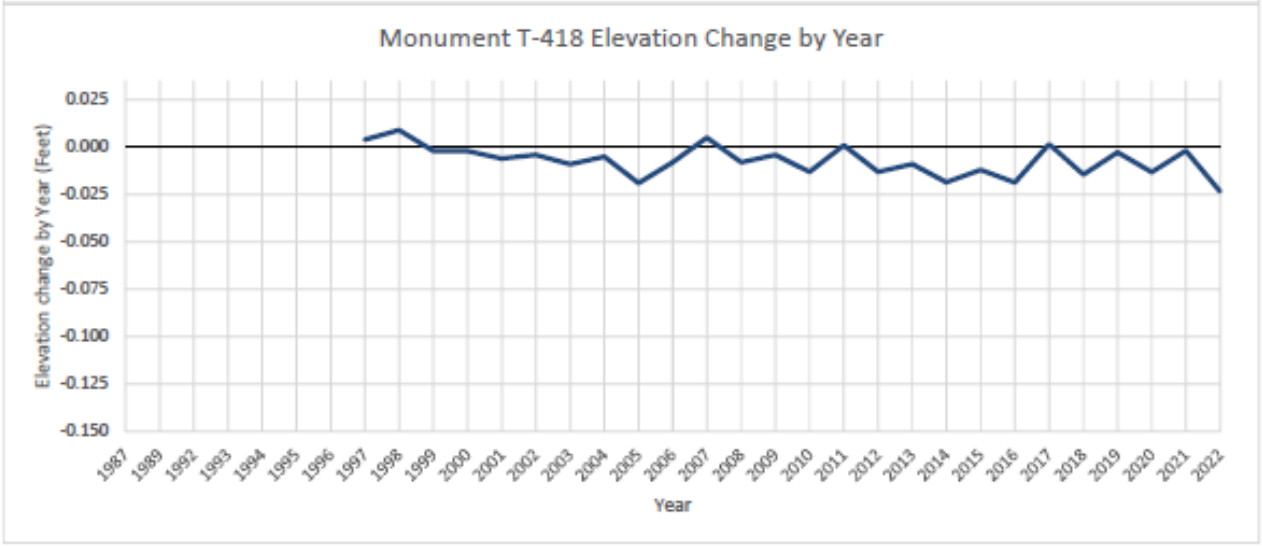


Figure 51. Monument T-418 Elevation Data Graphs

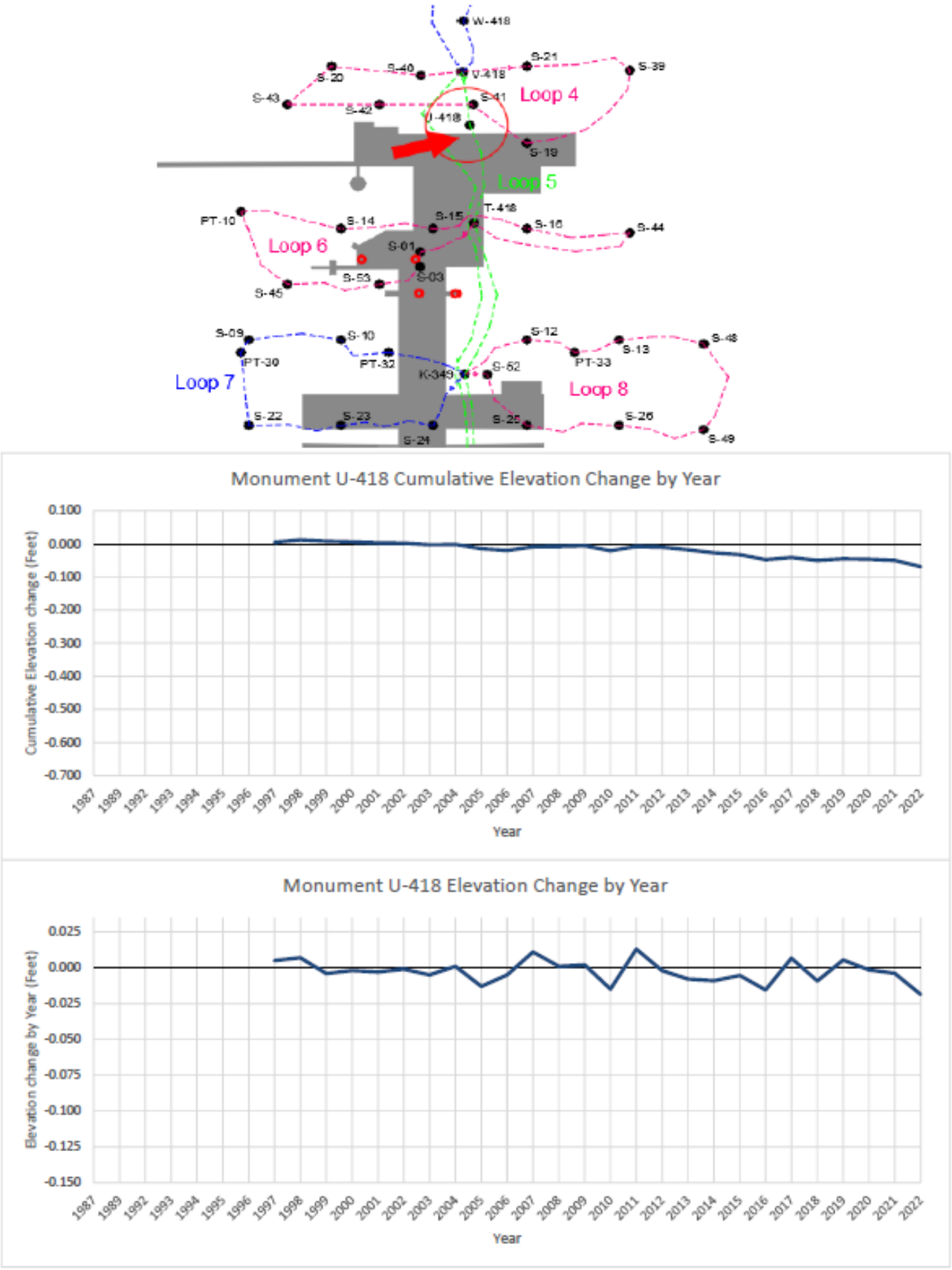


Figure 52. Monument U-418 Elevation Data Graphs

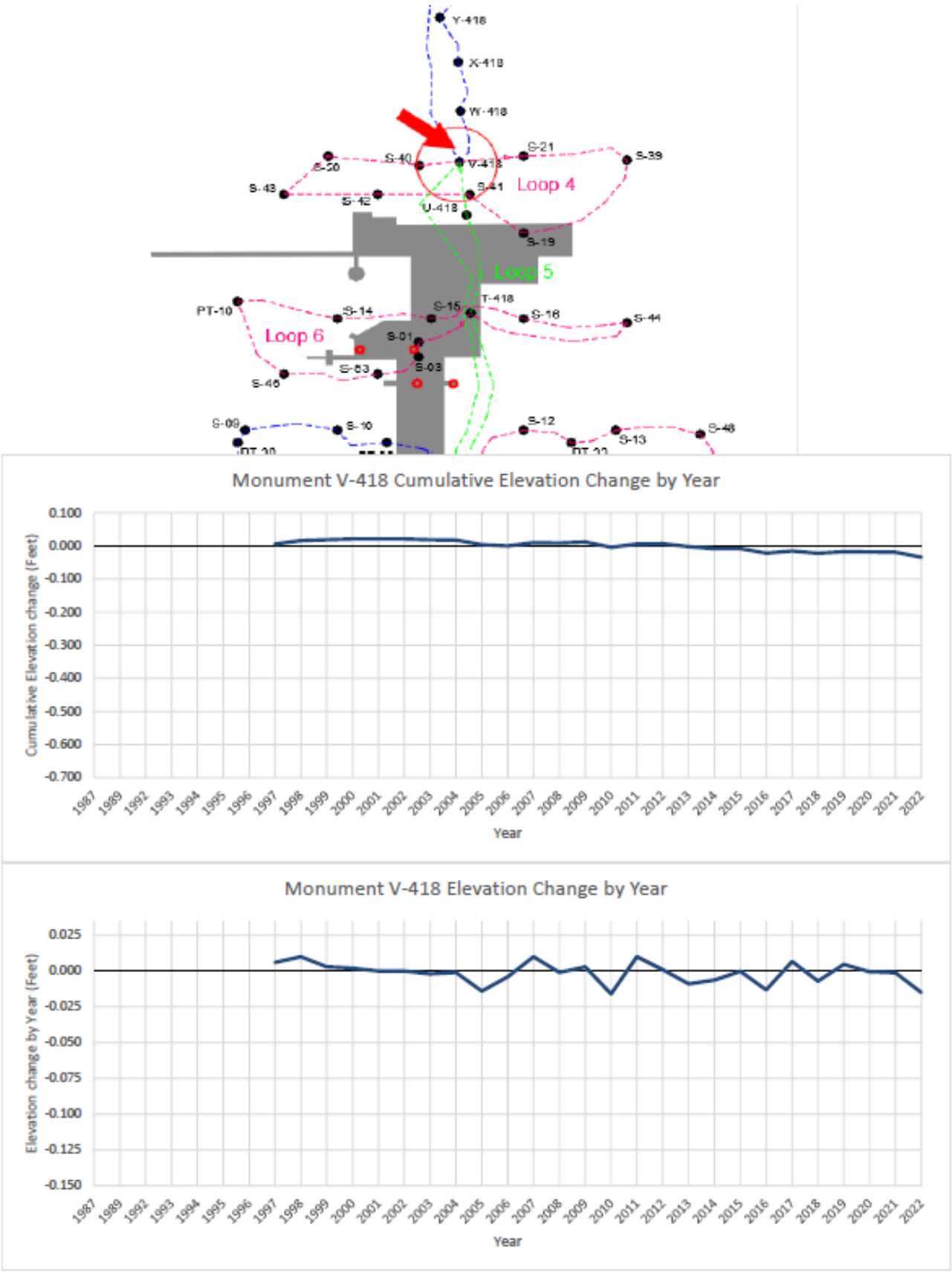


Figure 53. Monument V-418 Elevation Data Graphs

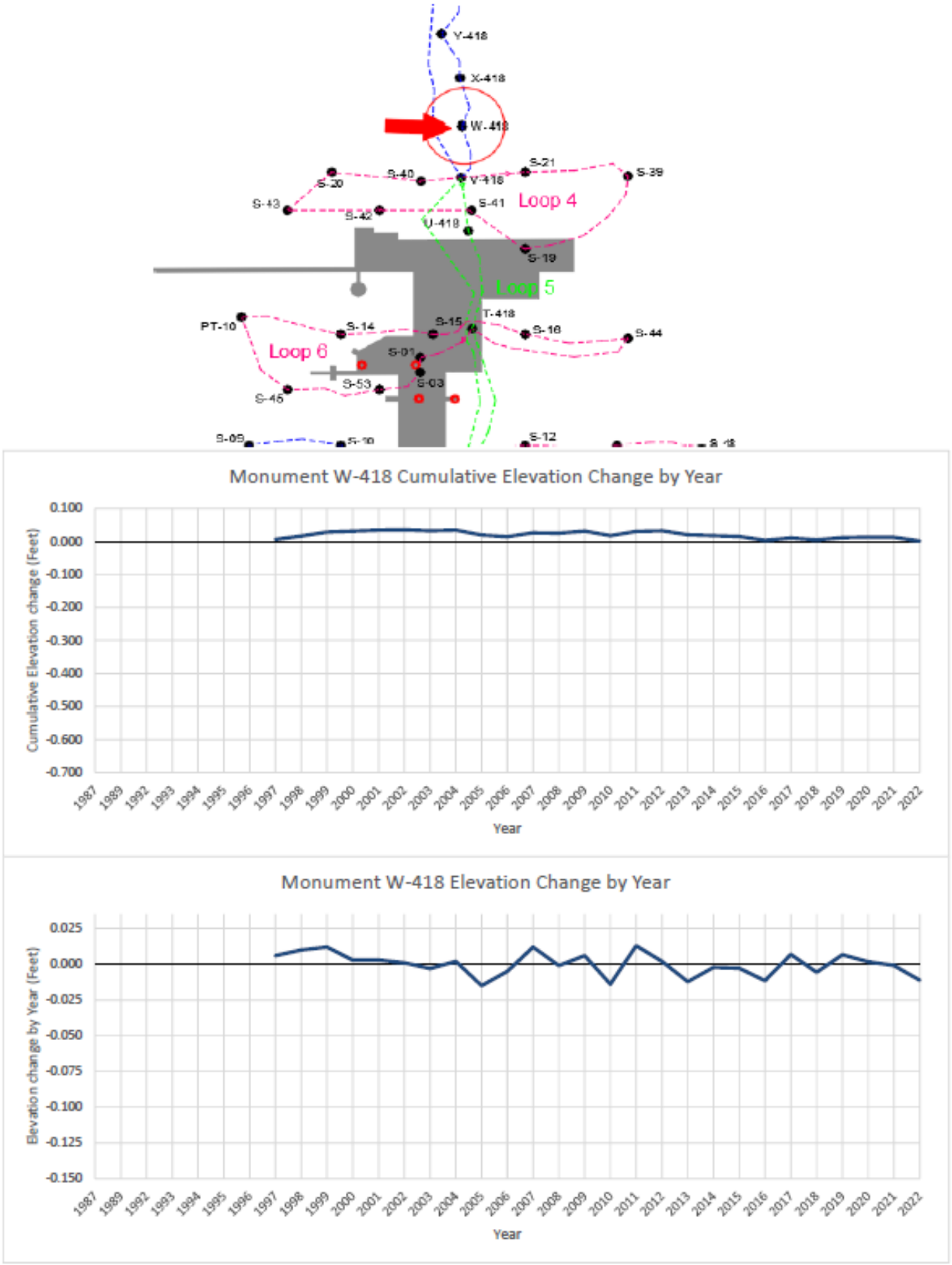


Figure 54. Monument W-418 Elevation Data Graphs

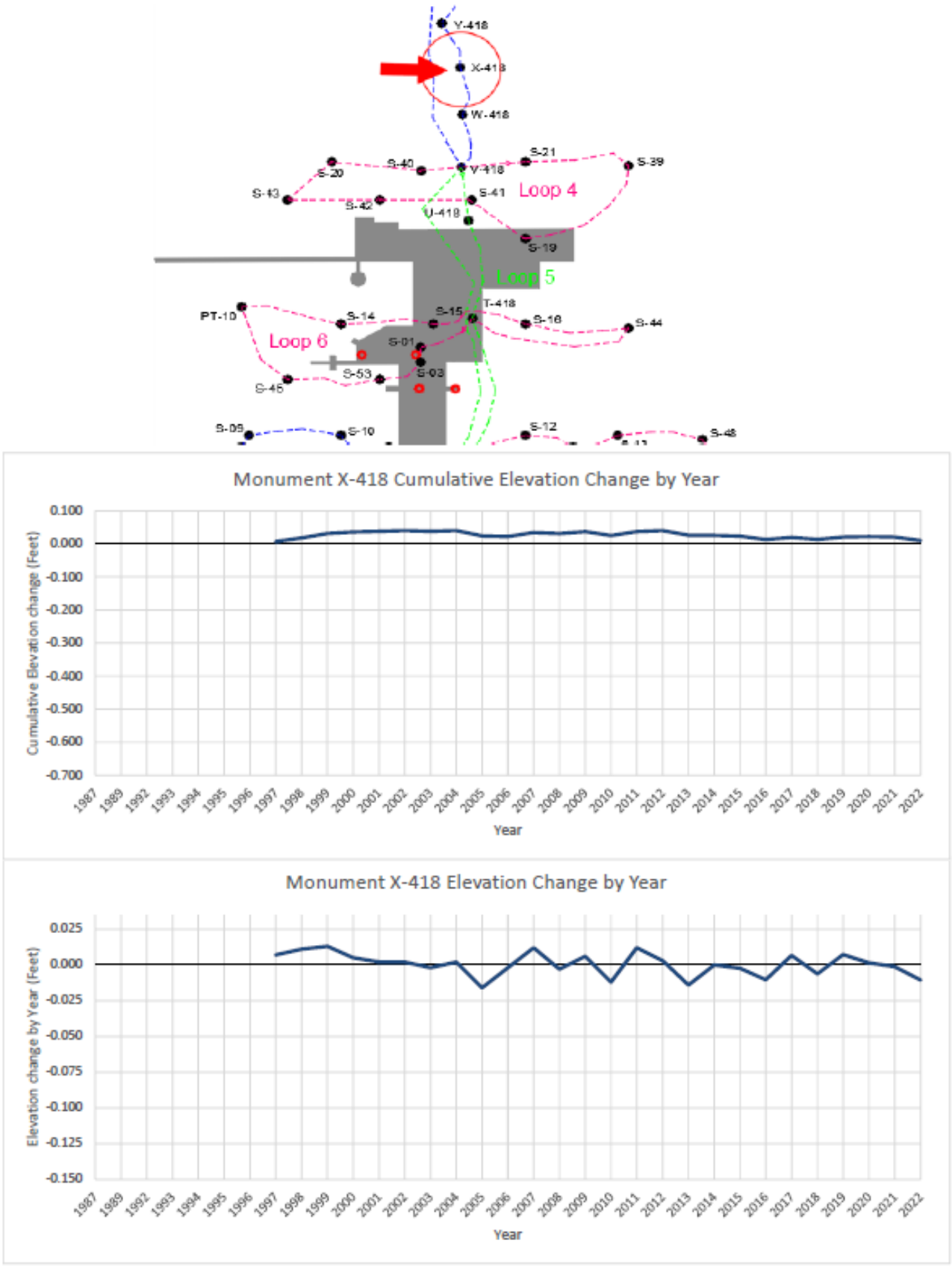


Figure 55. Monument X-418 Elevation Data Graphs

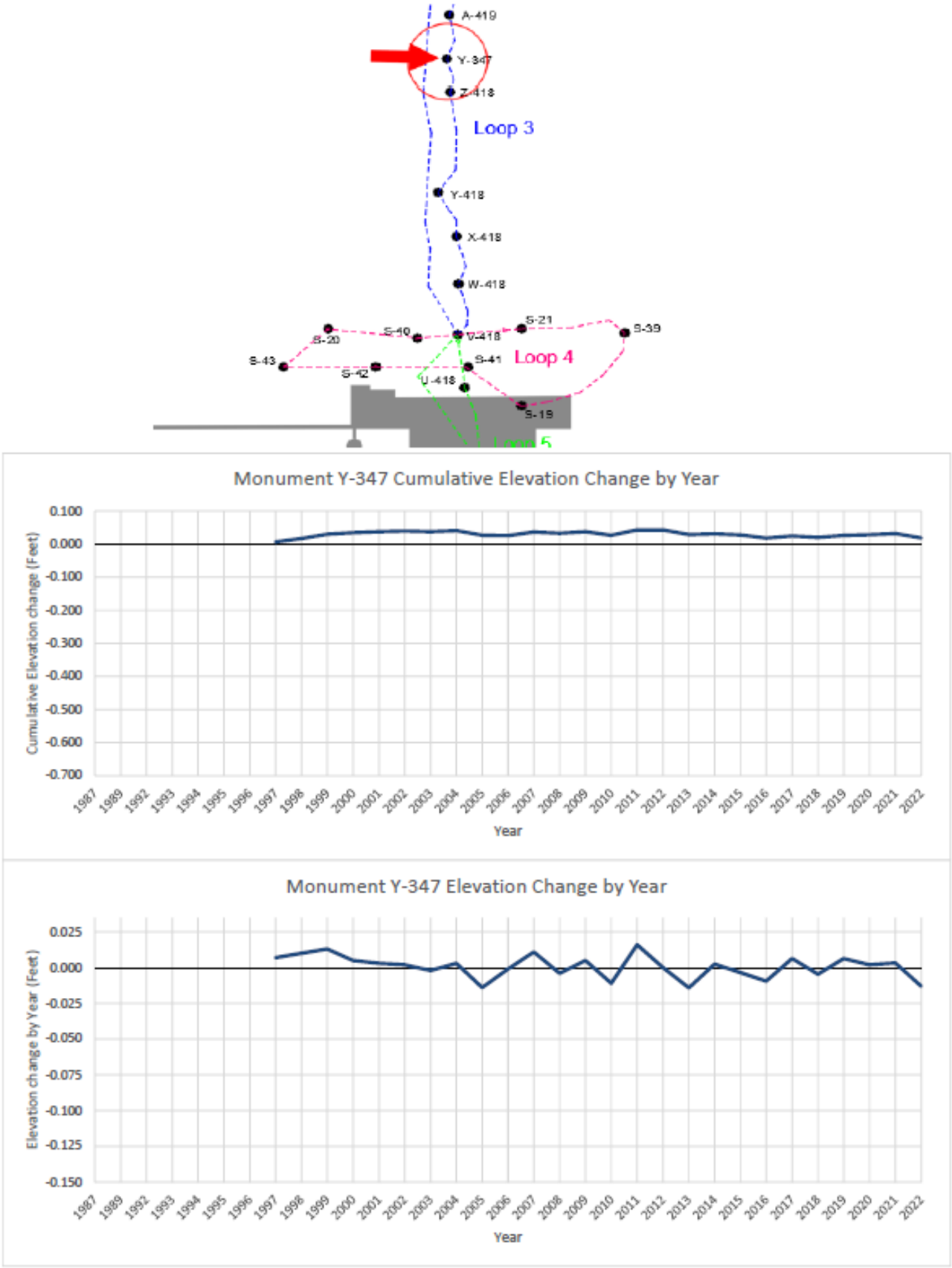


Figure 56. Monument Y-347 Elevation Data Graphs

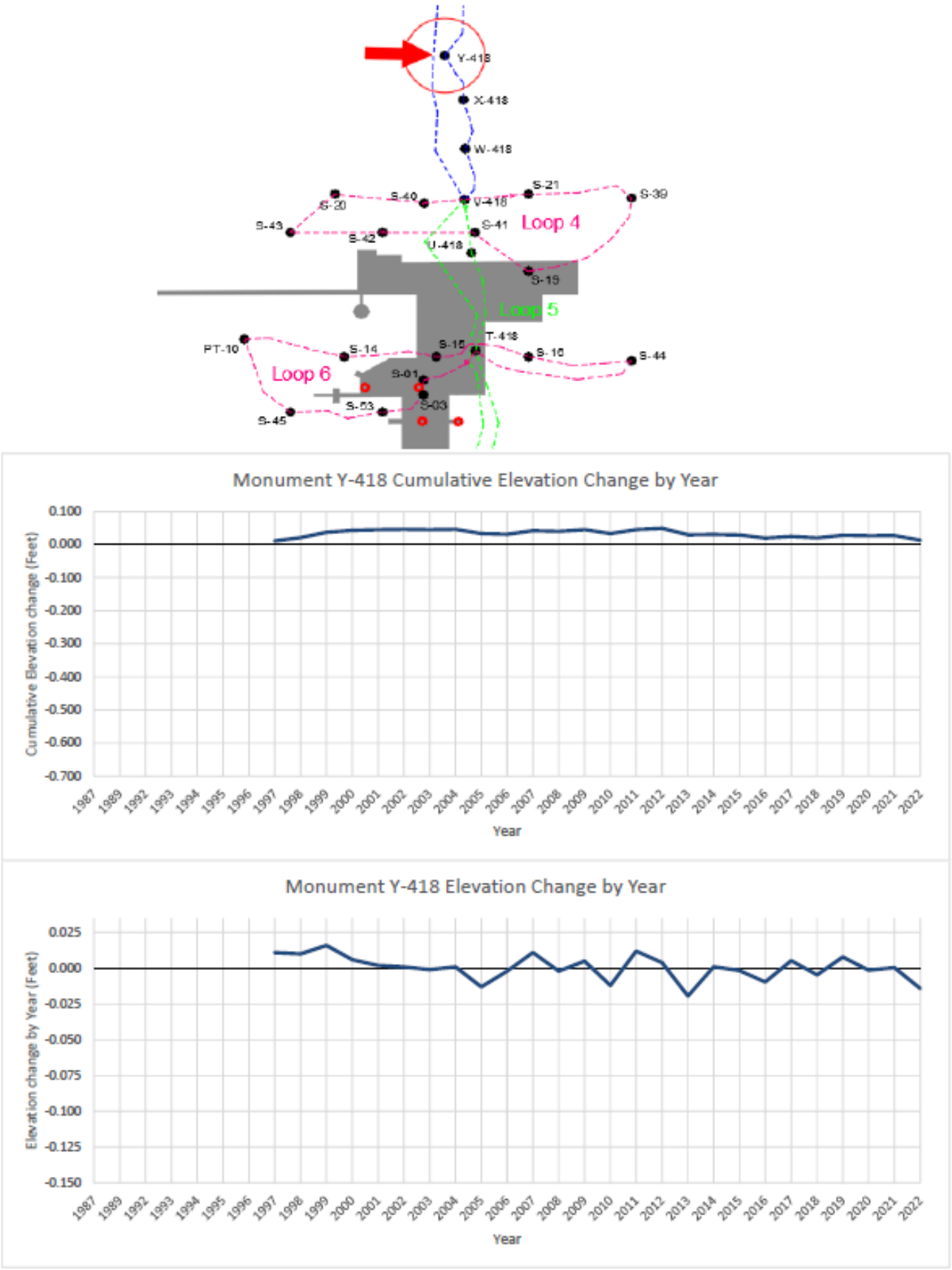
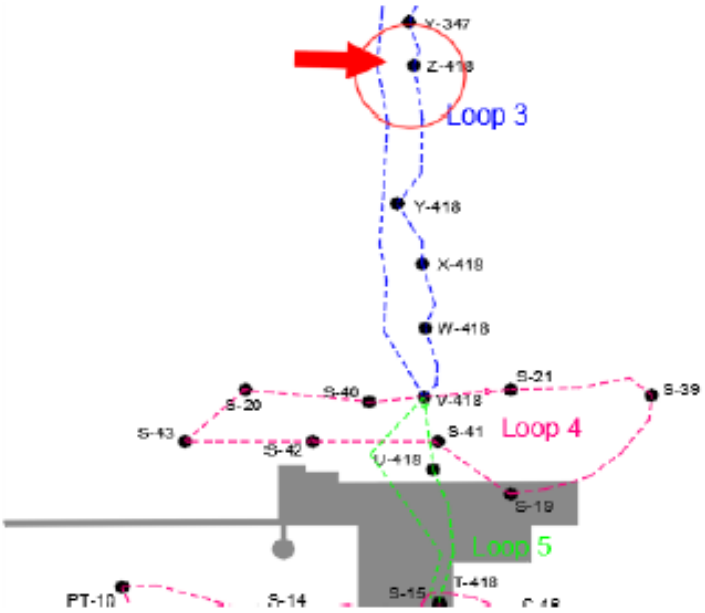


Figure 57. Monument Y-418 Elevation Data Graphs



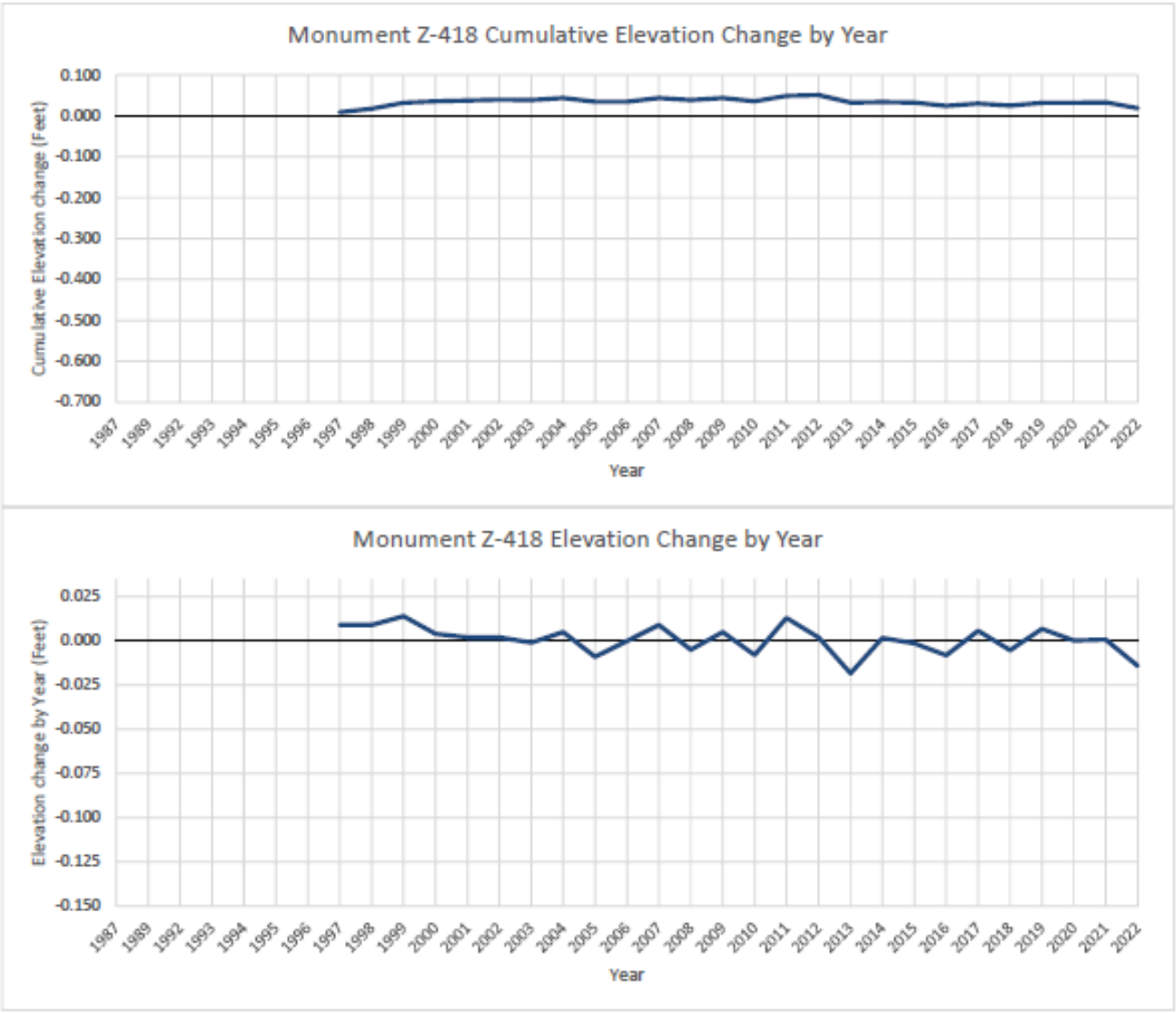


Figure 58. Monument Z-418 Elevation Data Graphs

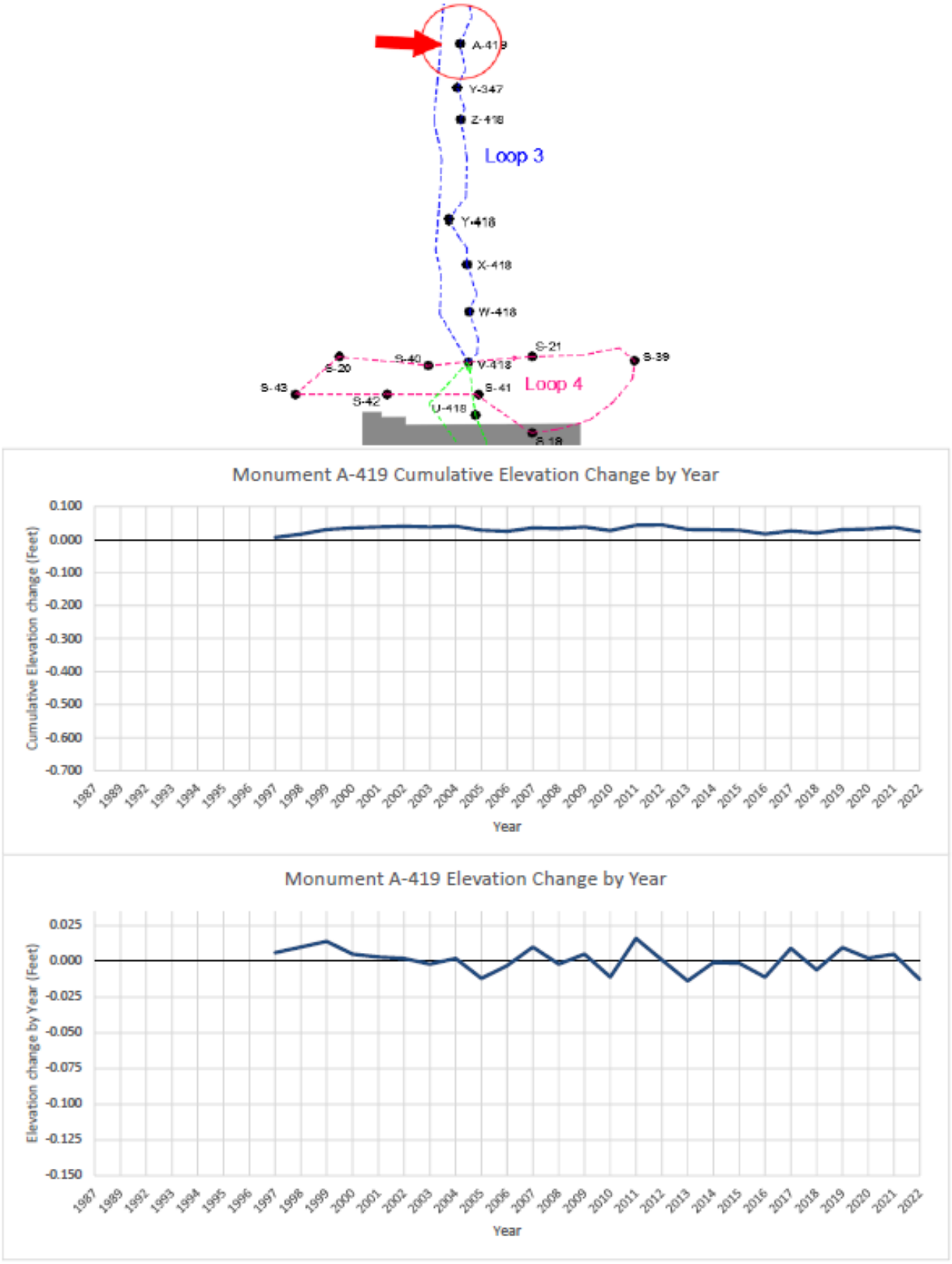


Figure 59. Monument A-419 Elevation Data Graphs

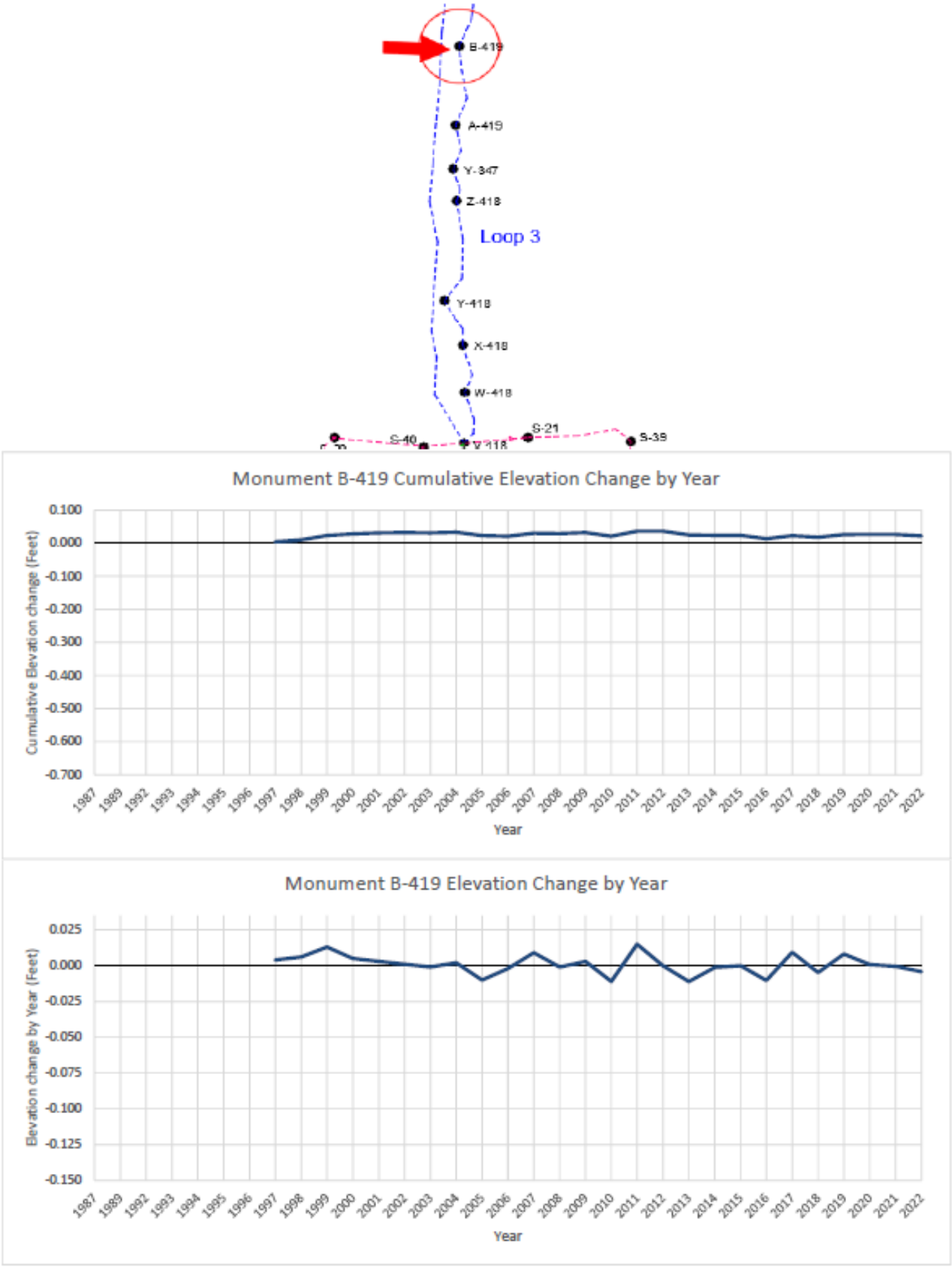


Figure 60. Monument B-419 Elevation Data Graphs

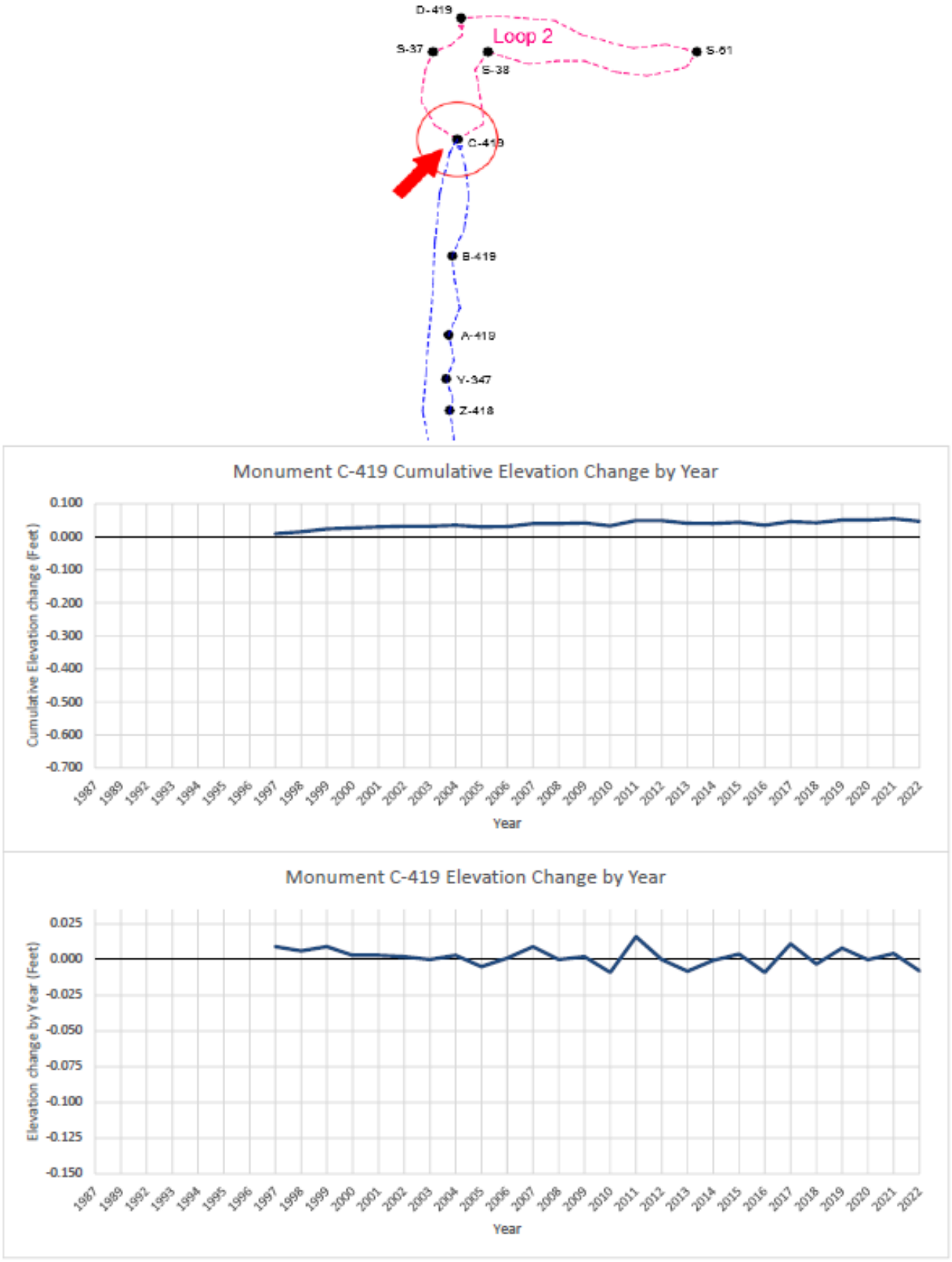


Figure 61. Monument C-419 Elevation Data Graphs

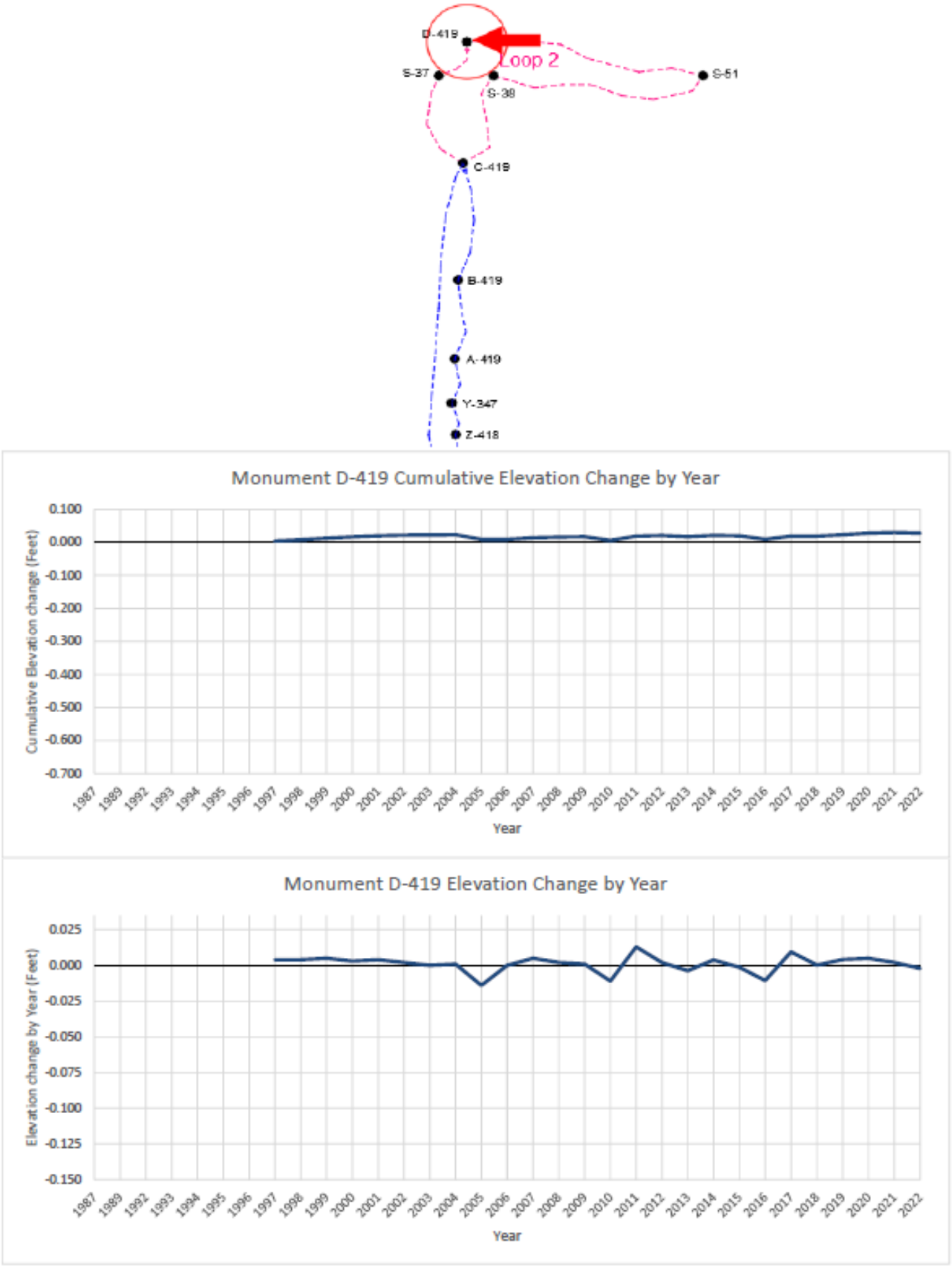


Figure 62. Monument D-419 Elevation Data Graphs

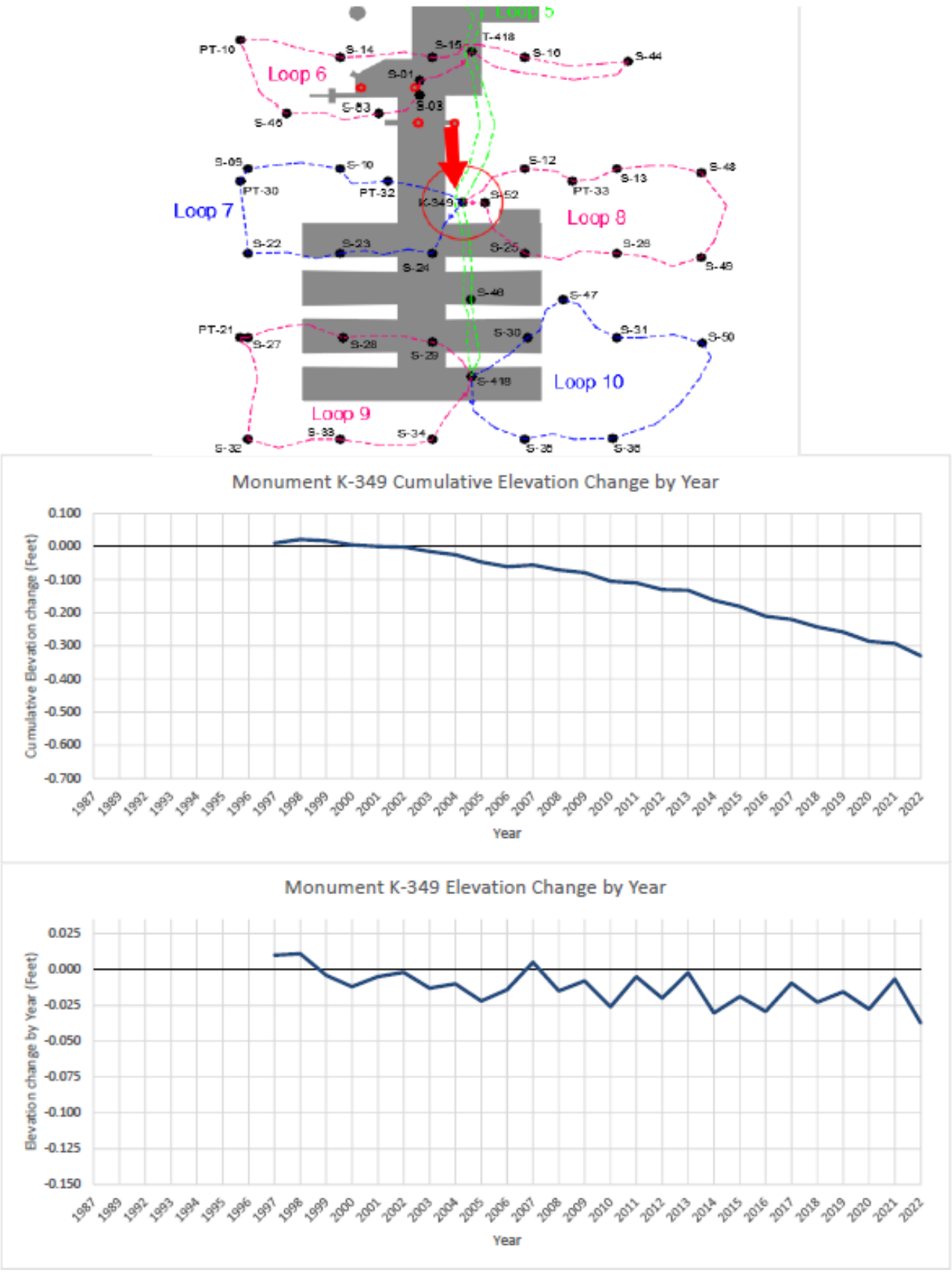


Figure 63. Monument K-349 Elevation Data Graphs