COASTAL WETLANDS PLANNING, PROTECTION AND RESTORATION ACT (CWPPRA) DEMONSTRATION: LA-06 SHORELINE PROTECTION FOUNDATION IMPROVEMENTS VERMILION PARISH, LA

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COASTAL WETLANDS PLANNING, PROTECTION AND RESTORATION ACT (CWPPRA) DEMONSTRATION: LA-06 SHORELINE PROTECTION FOUNDATION IMPROVEMENTS VERMILION PARISH, LA

Objective:

White Lake is located 55 miles southeast of Lake Charles, Louisiana in Vermilion Parish. The south shoreline of White Lake is retreating at an estimated average rate of 15 feet-per-year. As the shoreline erodes, the potential increases for low marsh management levees to breach and subject interior marsh to increased wave erosion. Poor soil conditions limit the effectiveness of shoreline protection dikes because of high rates of subsidence which require frequent and expensive project maintenance, lowering overall project cost effectiveness. The objective is to improve the cost effectiveness of shoreline protection projects by applying a sand foundation beneath rock dikes to achieving bearing capacity and consolidation settlement design tolerances to reduce 20-year project life cycle costs, as compared to traditional approaches.

Design and Instrumentation:

The demonstration project proposed a rigorous test design that included two replicates of two foundation improvement treatments with a separate control to meet engineering and statistical data and analysis requirements. The test design located with design soil reach #6 included six 900-linear foot sample sections with 50 foot intervals between sections. For engineering data control, all improved sample sections were adjacent to one control sample section. To determine the effects of the foundation improvements, each sample section was instrumented with four sets each of crown, front and rear settlement plates, inclinometers, and extensometers, at approximately 180-foot intervals. See Figure 1 for the dimensions of the demonstration sections and Figure 2 for the location of each demonstration section.

Demonstration Section A: This design included two 900-foot improved sample sections (A1 and A2) consisting of a sand foundation that displaced soft near-surface material. During construction, 2.5 feet of sand fill was placed on the existing ground to elevation +1.0 to induce initial settlement. Rock armor was then placed to an elevation of +3.5.

Demonstration Section B: This design included two 900-foot improved sample sections (B1 and B2) with soft near-surface material removed via dredging and backfilled with sand to match the existing ground surface. Rock armor was then placed to an elevation on +3.5.

Demonstration Section C: This design included two 900-foot unimproved control sections (C1 and C2) consisting of rock armor placed to an elevation on +3.5 without sand.

Instrumentation Results:
Settlement and deflection data was collected over a five-year period from 2006 to 2011 for each of the 6 demonstration reaches. Settlement data collected in 2009 and 2010 was not used for determining a preferred construction procedure since there appears to be some error in the surveys. The data points during this timeframe show results much lower than the previous data points from 2008 and showed an increase in the rate of settlement. This is not expected since no extra load was added so the 2009 and 2010 settlement data was removed. From the compiled data, average settlement and deflection was determined for each of the designs.

Deflection: The lateral deflection is determined by inclinometers at the P/S toe and F/S toe.

Demonstration Section A

Reach	Avg. Deflection (in.) Direction A	Avg. Deflection (in.) Direction B
A1	0.93	1.01
A2	0.78	0.84
Total Avg. Deflection (in.)	0.86	0.93

Demonstration Section B

Reach	Avg. Deflection (in.) Direction A	Avg. Deflection (in.) Direction B
B1	1.63	1.17
B2	1.03	1.48
Total Avg. Deflection (in.)	1.33	1.33

Demonstration Section C

Reach	Avg. Deflection (in.) Direction A	Avg. Deflection (in.) Direction B
C1	0.68	1.03
C2	1.58	0.88
Total Avg. Deflection (in.)	1.13	0.95

*Note: Direction A = perpendicular to the dike centerline
Direction B = parallel to the dike centerline

The inclinometer data shows about an inch of lateral movement of the foundation soil for each of the sections. The expected result was Demonstration Section B would have had the least amount of lateral deflection because the foundation soils (expected to deflect laterally) were dredged and replaced by sand (expected to deflect laterally a small amount). With the minimal lateral movement of the foundation soils and the similarity in the values, all sections performed well and a more preferred section cannot be chosen.

Settlement: The settlement of the demonstration sections was determined by settlement gauges placed in the centerline of the demonstration section.

Demonstration Section A

Reach	Max. Settlement (ft)	Avg. Settlement (ft)
A1	0.30 (Reach A1-4C)	0.18
A2	0.31 (Reach A2-C3)	0.26
Total Avg. Settlement (ft)		**0.22**

Demonstration Section B

Reach	Max. Settlement (ft)	Avg. Settlement (ft)
B1	0.52 (Reach B1-C2)	0.44
B2	0.50 (Reach B2-1C)	0.38
Total Avg. Settlement (ft)		**0.41**

Demonstration Section C

Reach	Max. Settlement (ft)	Avg. Settlement (ft)
C1	0.16 (Reach C1-2C)	0.13
C2	0.24 (Reach C2-4C)	0.15
Total Avg. Settlement (ft)		**0.14**

The settlement data shows between 2 inches and 5 inches of foundation settlement for the sections tested. Demonstration Section B (excavate and replace design) appears to have performed marginally worse than Section A and Section C. However, with the similarity in the results and minimal foundation settlement, all sections performed well and a more preferred section cannot be chosen. Graphs of the centerline elevations vs. time and $\log_{10}$ trend-line of the elevations vs. time of the demonstration section are shown in Appendix A.

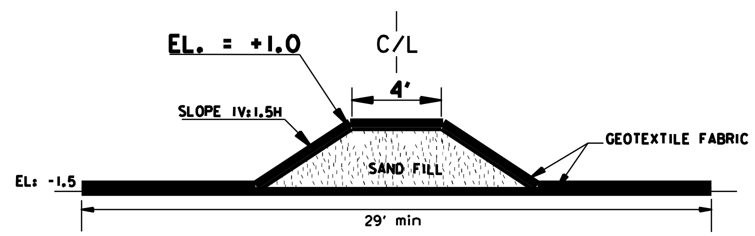
Conclusions:

Given the data, all three sections proved to be stable structures with minimal foundation settlement and lateral movement in the foundation. The purpose of the test was to find a suitable construction procedure to building rock dikes. At this site, all three sections would be suitable and a more preferred construction procedure cannot be recommended from the test data.

Lesson Learned:

For a more effective demonstration section, a site with more expected foundation settlement and lateral movement should have been chosen. This would provide a greater magnitude of values and most likely, a range of values from one section to the other. The site chosen predicted settlements too small to be compared because the survey error of 0.2 feet overlaps some of the data and small differences in values (settlement and lateral movement) between sections are too similar to provide a recommendation.

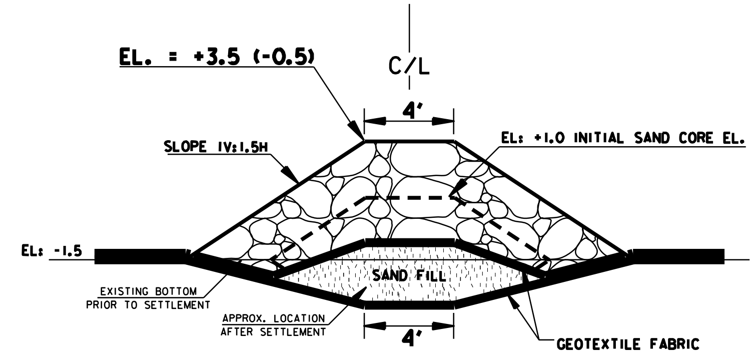
NOTES:
1) Non-excavated dike alignment, sand core placement prior to rock placement
2) Geotextile Fabric placed above and below (29' min) sand core
3) All instrumentation installed prior to placement of sand and geotextile fabric



SAND CORE, DEMONSTRATION SECTION "A"
Stations 139+00 - 148+00, 186+50 - 195+50

SCALE: N.T.S.

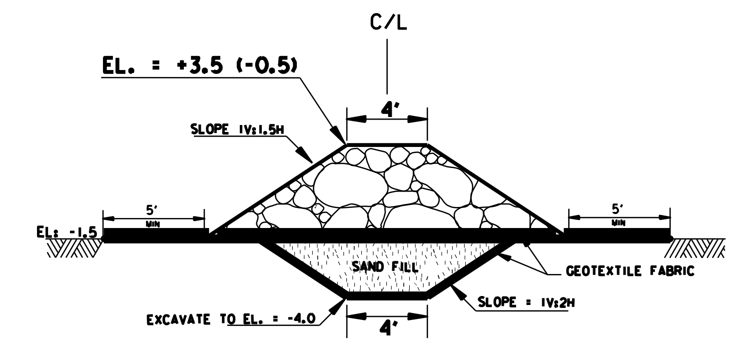
NOTES:
1) Non-excavated dike alignment, sand core placement prior to rock armor
2) Geotextile Fabric placed above and below (29' min) sand core
4) Riprap placement will proceed from toe to centerline in level "lifts"



TYPICAL DEMONSTRATION SECTION "A"
Stations 139+00 - 148+00, 186+50 - 195+50

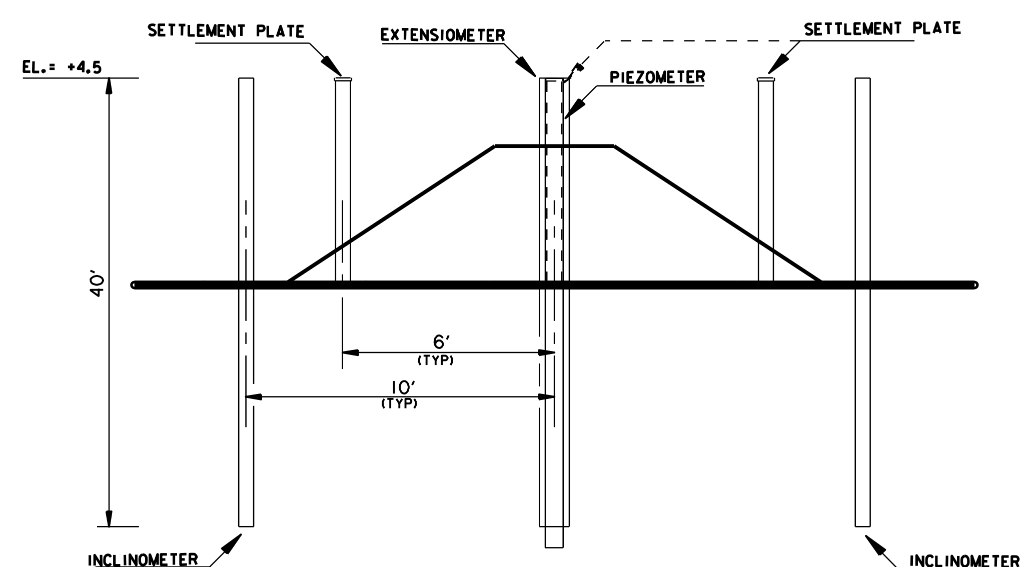
SCALE: N.T.S.

NOTES:
1) Excavate dike alignment to EL:-4.0, sand backfill level with adjacent waterbottoms
2) Geotextile Fabric placed above and below (29' width) sand backfill
4) Riprap placement will proceed from toe to centerline in level "lifts"



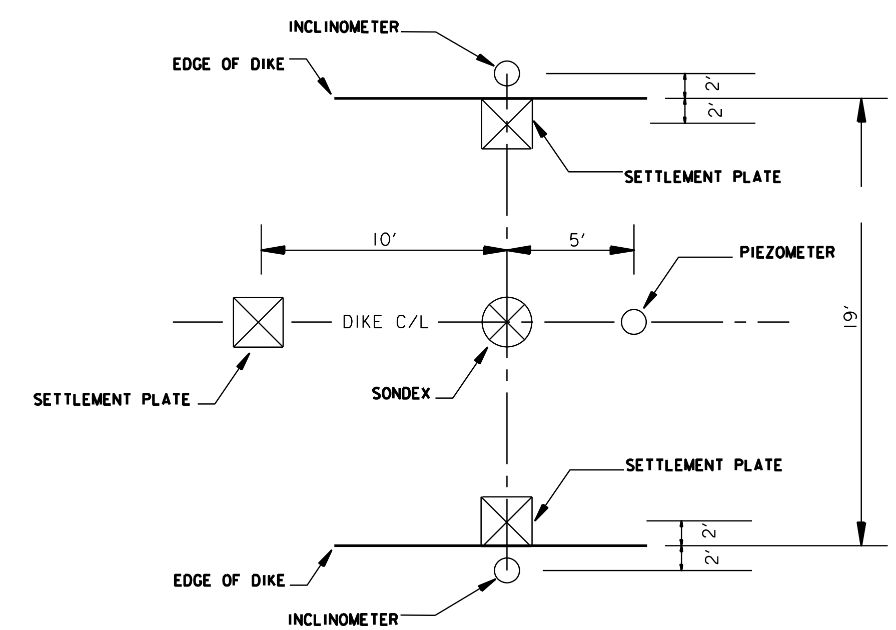
TYPICAL DEMONSTRATION SECTION "B"
Stations 158+00 - 167+00, 167+50 - 176+50

SCALE: N.T.S.

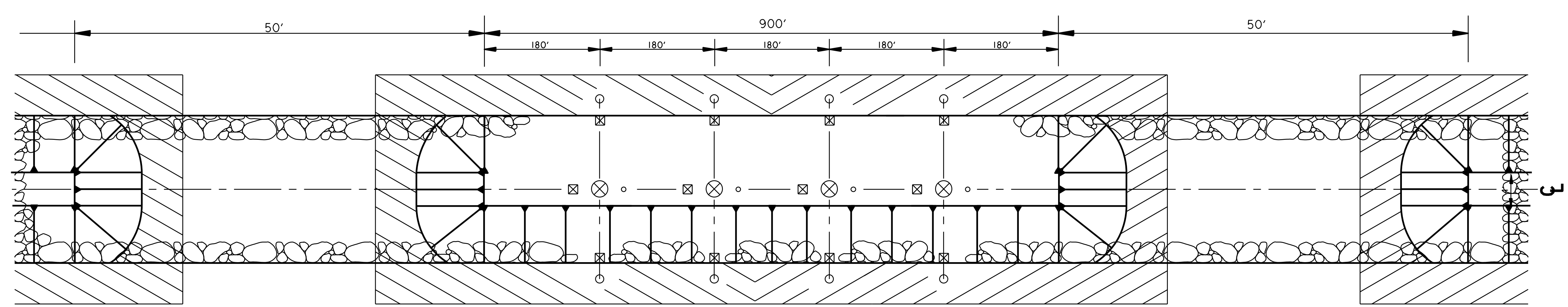


TYPICAL INSTRUMENTATION ELEVATION

SCALE: N.T.S.



INSTRUMENTATION SCHEMATIC (TYPICAL)



INSTRUMENTATION PLAN (TYPICAL)

SCALE: N.T.S.

Safety is a Part of Your Contract

U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

DESIGNED BY: MSF CHECKED BY: KJO DRAWN BY: MSF DATE: FEB 05	PLOT SCALE: 5:1	PLOT DATE: 07/29/04	DESIGN FILE NAME: 46056-14.DGN SUBMITTED BY: X DESIGN ENGINEER SOLICITATION NO. DACW29- X

COASTAL WETLAND PLANNING PROTECTION AND RESTORATION ACT
SOUTH WHITE LAKE
SHORELINE PROTECTION PROJECT
STA XX+XX - XX+XX
DEMONSTRATION SECTIONS
INSTRUMENTATION DETAILS
VERMILION PARISH, LA.

Fig. 1

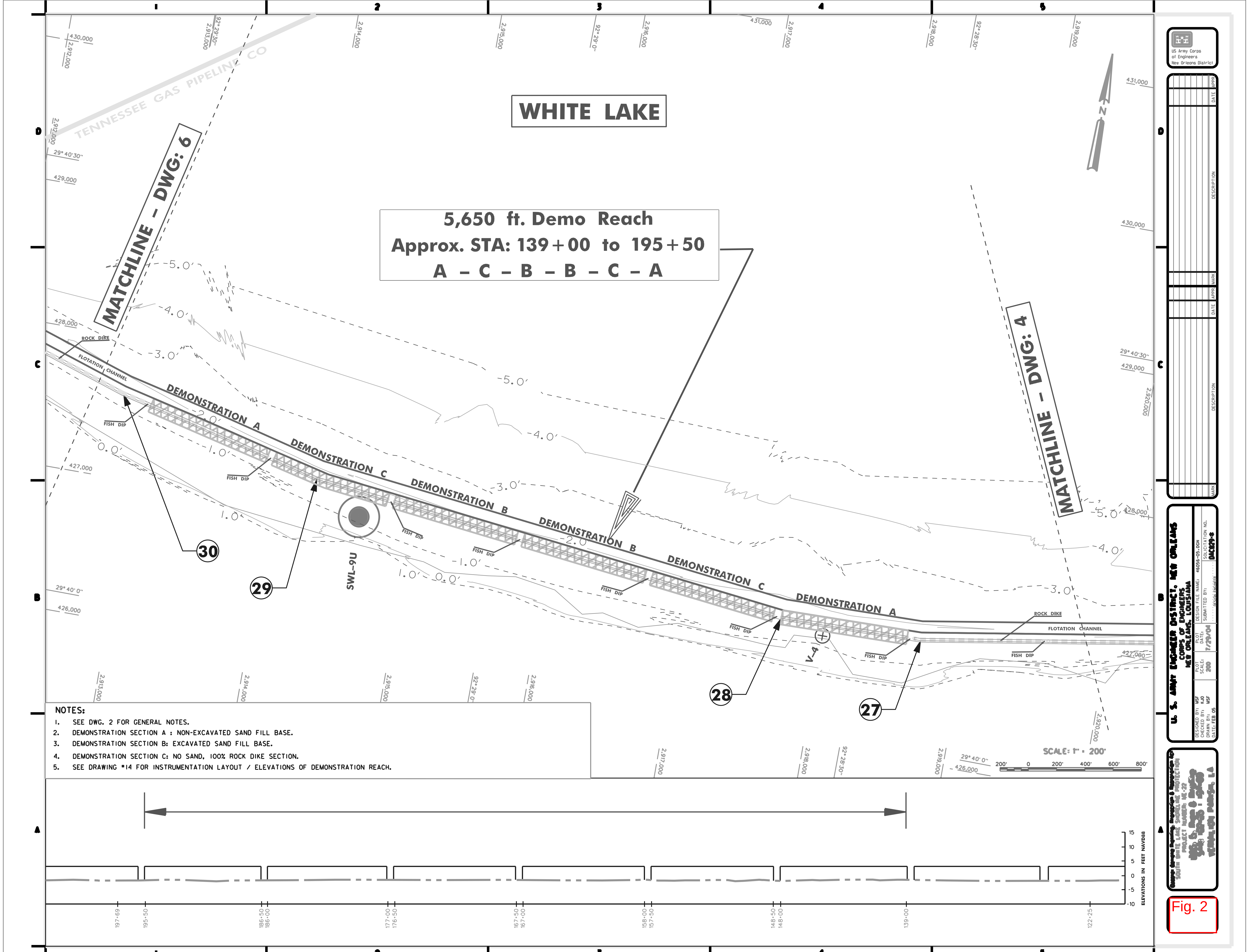
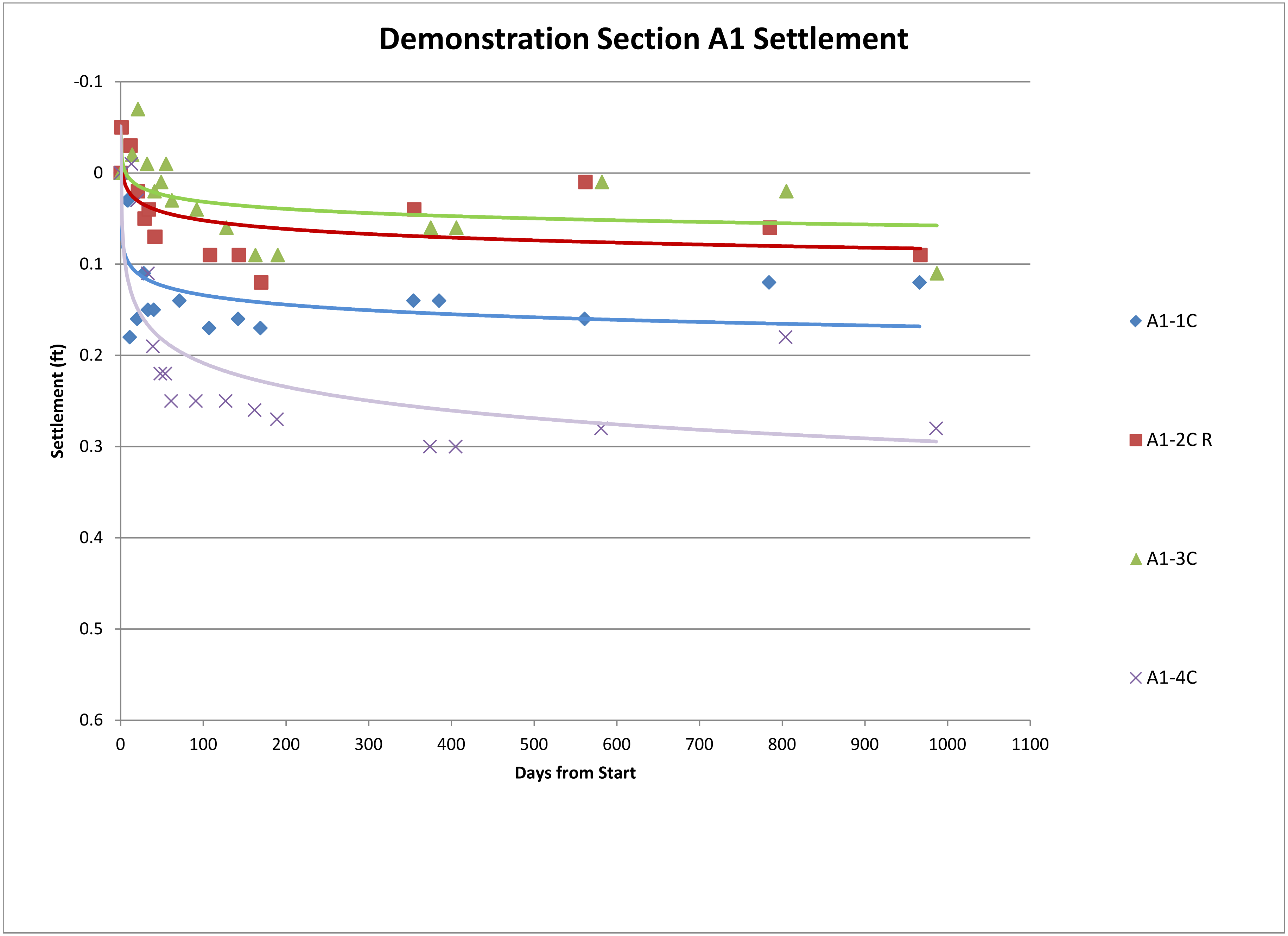
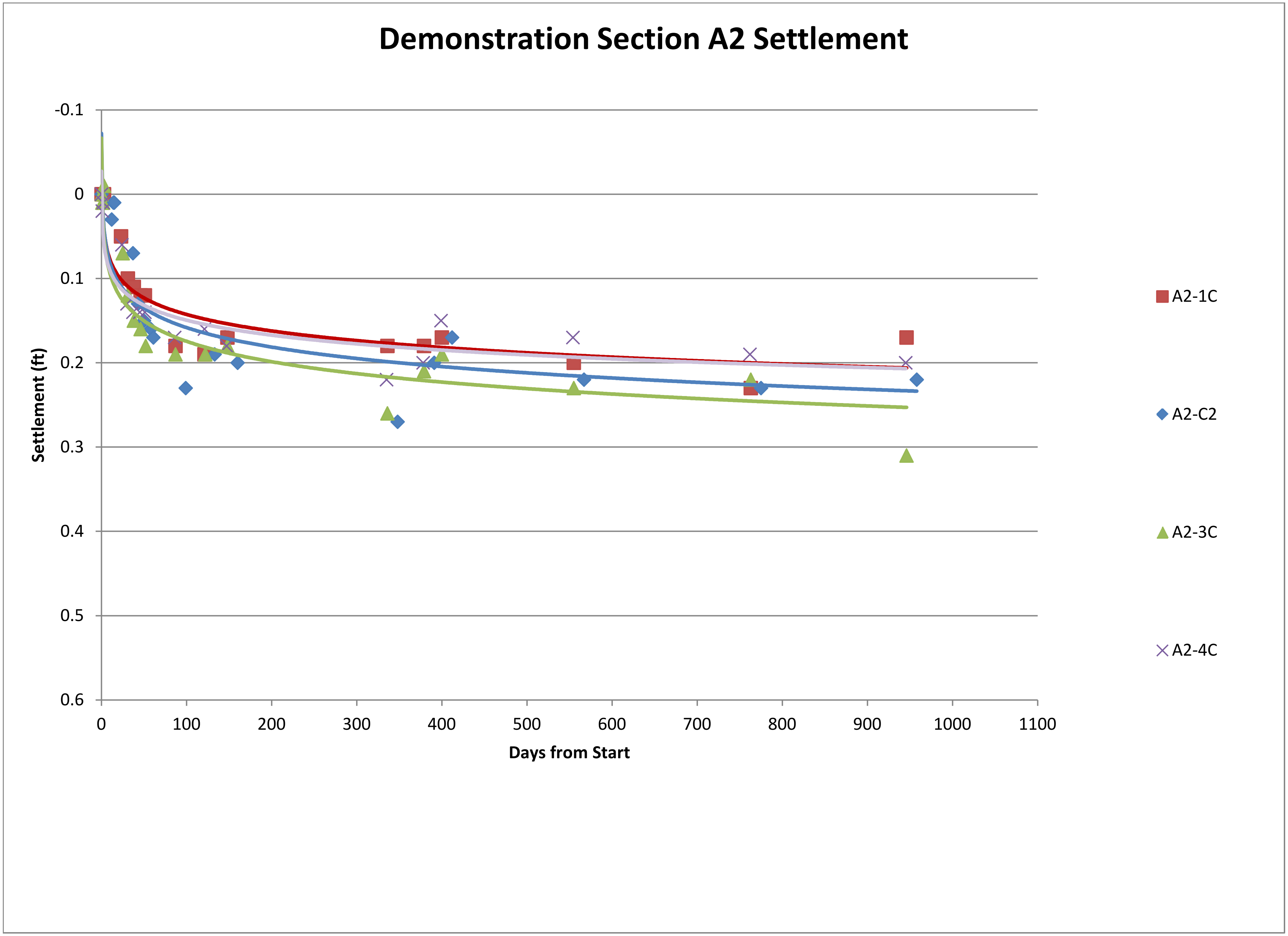

WHITE LAKE
5,650 ft. Demo Reach
Approx. STA: 139+00 to 195+50
A – C – B – B – C – A
MATCHLINE – DWG: 6
MATCHLINE – DWG: 4
TENNESSEE GAS PIPELINE CO
ROCK DIKE
FLOTATION CHANNEL
FISH DIP
DEMONSTRATION A
DEMONSTRATION C
DEMONSTRATION B
DEMONSTRATION B
DEMONSTRATION C
DEMONSTRATION A
SWL-9U
V-4
30
29
28
27
NOTES:
1. SEE DWG. 2 FOR GENERAL NOTES.
2. DEMONSTRATION SECTION A : NON-EXCAVATED SAND FILL BASE.
3. DEMONSTRATION SECTION B: EXCAVATED SAND FILL BASE.
4. DEMONSTRATION SECTION C: NO SAND, 100% ROCK DIKE SECTION.
5. SEE DRAWING #14 FOR INSTRUMENTATION LAYOUT / ELEVATIONS OF DEMONSTRATION REACH.
SCALE: 1" = 200'
ELEVATIONS IN FEET NAVD88
US Army Corps of Engineers New Orleans District
U. S. ARMY ENGINEER DISTRICT, NEW ORLEANS
CORPS OF ENGINEERS
NEW ORLEANS, LOUISIANA

Fig. 2

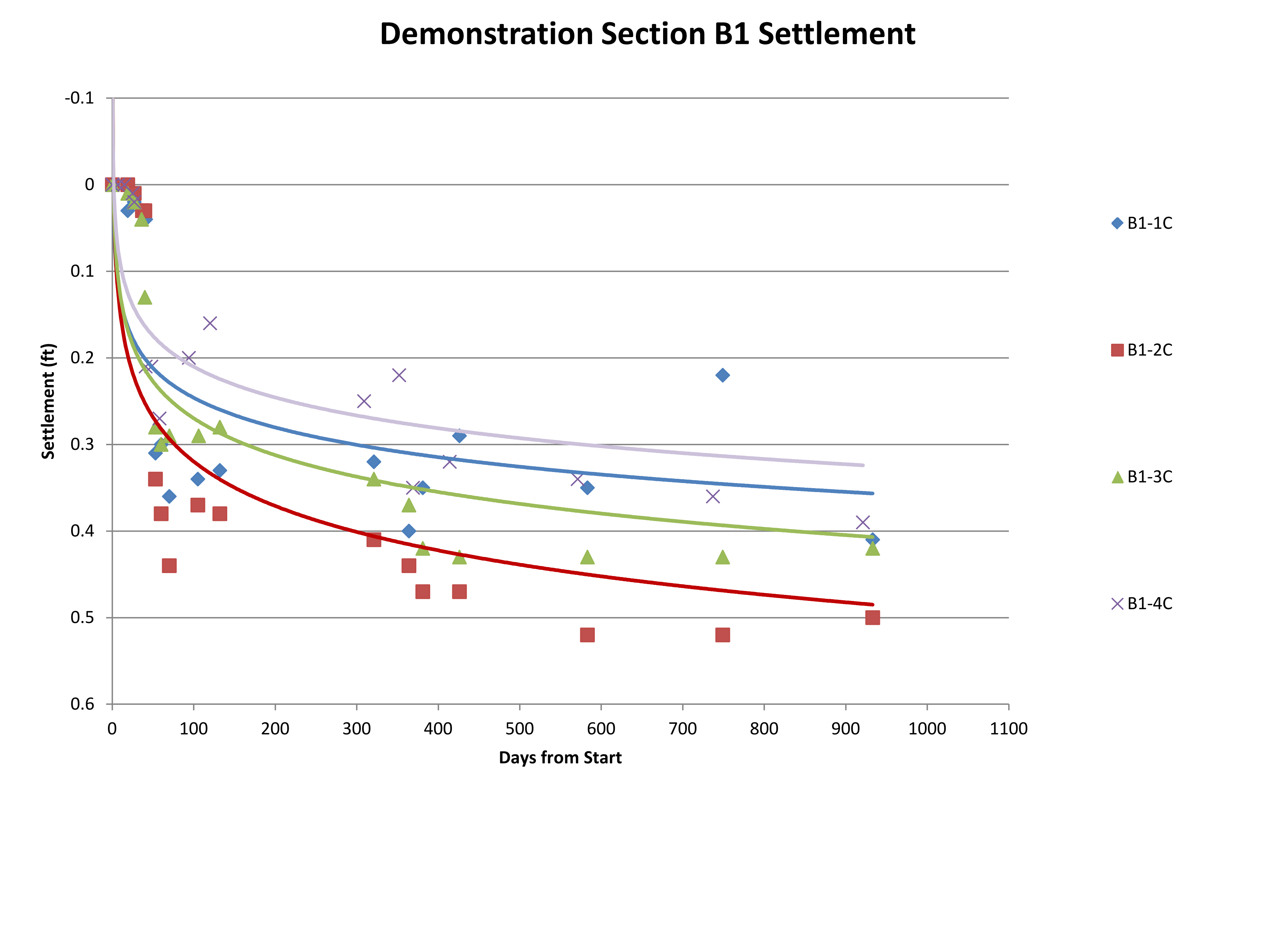
APPENDIX A

SETTLEMENT GRAPHS

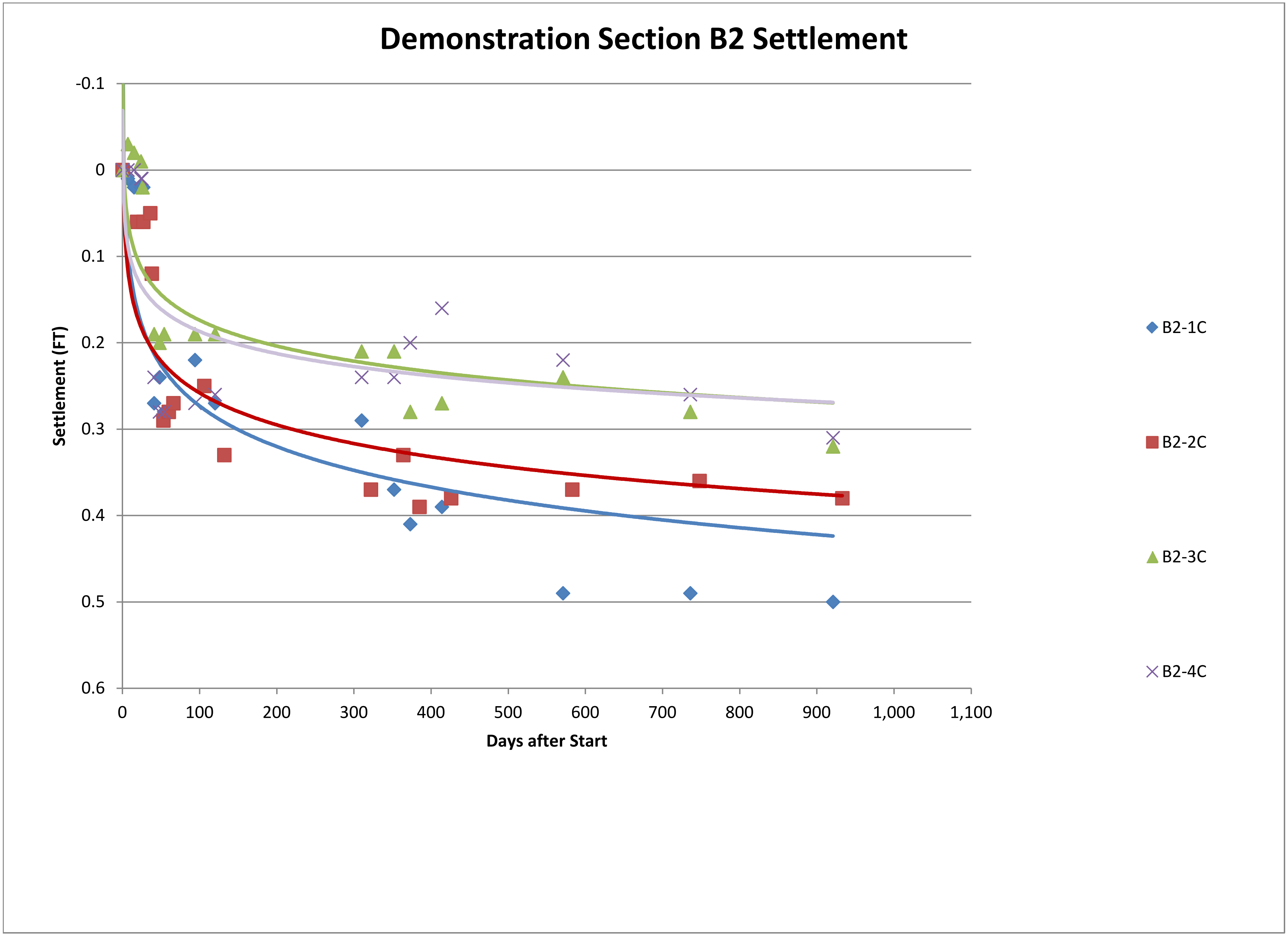

Demonstration Section A1 Settlement
Settlement (ft)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0
100
200
300
400
500
600
700
800
900
1000
1100
Days from Start
A1-1C
A1-2C R
A1-3C
A1-4C



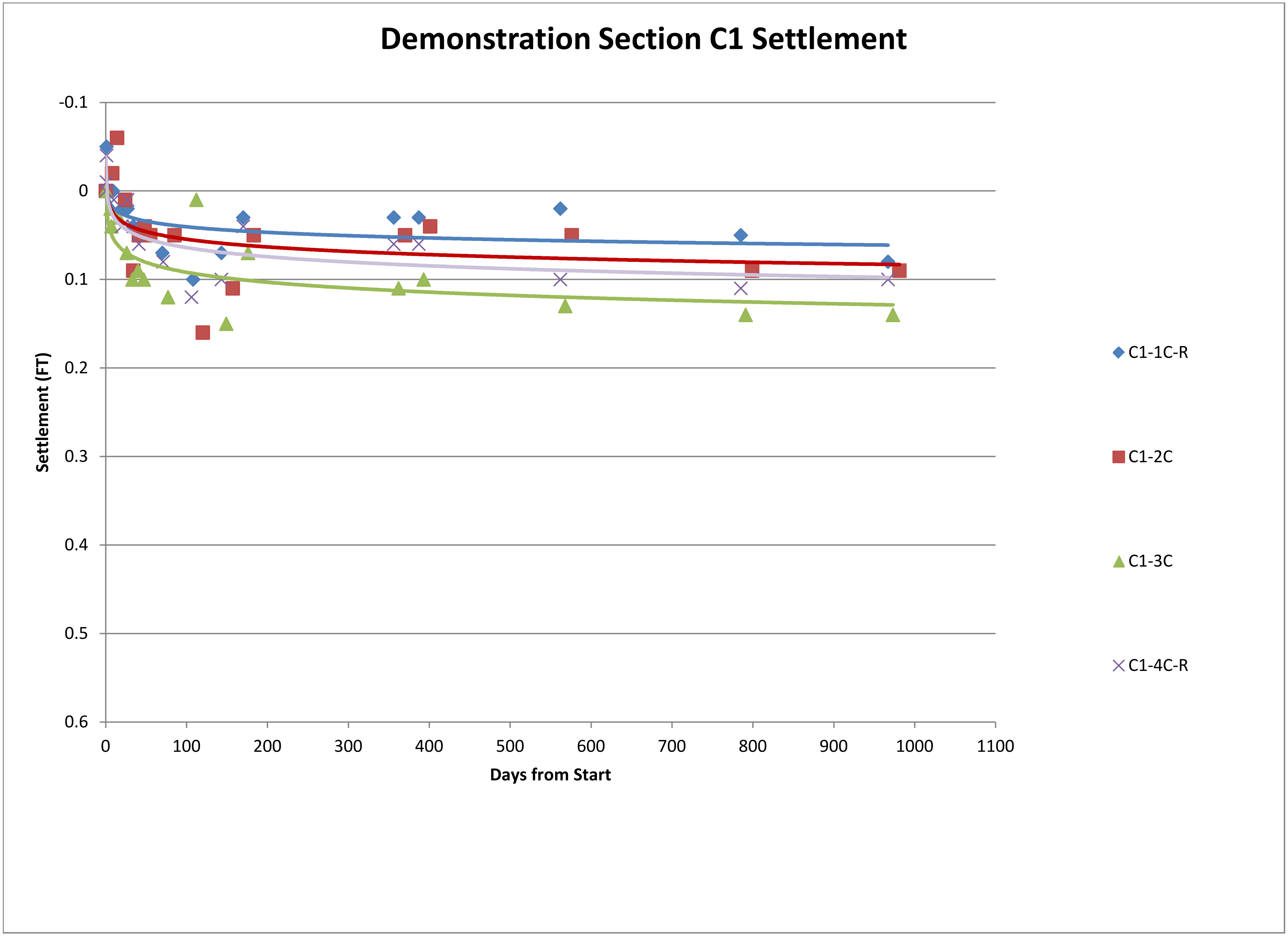
Demonstration Section A2 Settlement
Settlement (ft)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0
100
200
300
400
500
600
700
800
900
1000
1100
Days from Start
A2-1C
A2-C2
A2-3C
A2-4C

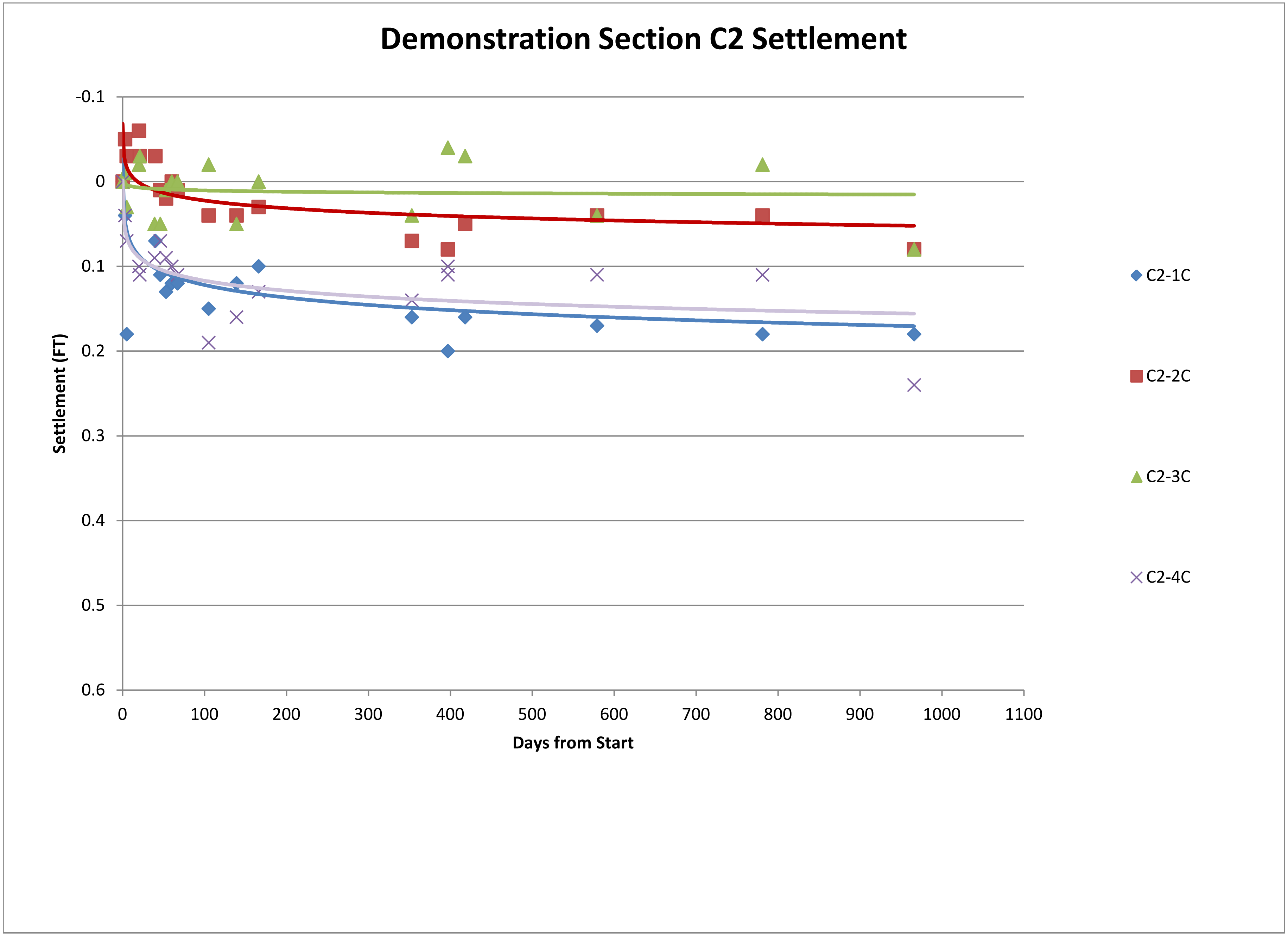


Demonstration Section B1 Settlement
Settlement (ft)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0
100
200
300
400
500
600
700
800
900
1000
1100
Days from Start
B1-1C
B1-2C
B1-3C
B1-4C



Demonstration Section B2 Settlement
Settlement (FT)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0
100
200
300
400
500
600
700
800
900
1,000
1,100
Days after Start
B2-1C
B2-2C
B2-3C
B2-4C


Demonstration Section C1 Settlement
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
Settlement (FT)
0
100
200
300
400
500
600
700
800
900
1000
1100
Days from Start
C1-1C-R
C1-2C
C1-3C
C1-4C-R



Demonstration Section C2 Settlement
Settlement (FT)
-0.1
0
0.1
0.2
0.3
0.4
0.5
0.6
0
100
200
300
400
500
600
700
800
900
1000
1100
Days from Start
C2-1C
C2-2C
C2-3C
C2-4C

APPENDIX B