



**Huddleston-Berry**  
Engineering & Testing, LLC

2789 Riverside Parkway  
Grand Junction, Colorado 81501  
Phone: 970-255-8005  
Info@huddlestonberry.com

January 11, 2023  
Project#01349-0001

Bowie Resources, LLC  
43659 Bowie Road  
Paonia, Colorado 81428

Attention: Mr. Basil Bear

Subject: Summary of Instrumentation Monitoring  
4<sup>th</sup> Quarter 2022  
Bowie Coal Waste Disposal Area No. 2  
Paonia, Colorado

Reference: *Summary of Instrumentation Monitoring, 3<sup>rd</sup> Quarter 2022, Bowie Coal Waste Disposal Area No. 2, Paonia, Colorado* by Huddleston-Berry Engineering & Testing, LLC for Bowie Resources, LLC, October 14, 2022.

*Stability Evaluation, Technical Revision #85, Gob Pile #2 Drying Area, Bowie No. 2 Mine* by Huddleston-Berry Engineering & Testing, LLC for Bowie Resources, LLC, June 3, 2014.

Dear Mr. Bear,

At the request of the Colorado Division of Reclamation, Mining and Safety (DRMS), Huddleston-Berry Engineering & Testing, LLC (HBET) prepared this letter regarding quarterly monitoring of vibrating wire piezometers and inclinometers at Coal Waste Disposal Area No. 2 (CWDA No. 2) at the Bowie mine near Paonia, Colorado. The intent of the monitoring was to detect significant changes in the pore water pressures or significant displacements within the coal waste which may impact the stability of the waste pile.

### **Inclinometers**

In 2005, three inclinometers, designated BG05-04, BG05-05, and BG05-07, were installed at CWDA No. 2 through the coal refuse and into the native foundation soils. The inclinometers have been monitored quarterly since August 2005. The 4<sup>th</sup> Quarter 2022 monitoring was completed by Buckhorn Engineering (Buckhorn) on December 23<sup>rd</sup>, 2022. The monitoring report prepared by Buckhorn includes a site plan showing the locations of the inclinometers and cumulative displacement curves relative to the baseline readings in 2005. Axis "A" reflects deformation with depth in the direction of anticipated movement perpendicular to the face of the gob. Axis "B" reflects deformation with depth parallel to the face of the gob.

### **Discussion of Inclinometer Monitoring**

The latest inclinometer readings indicate no major movements since the last quarterly reading. In general, the 4<sup>th</sup> Quarter 2022 monitoring data does not provide any indication of instability in CWDA No. 2.

### **Vibrating Wire Piezometers**

Between 2005 and 2012, a total of ten vibrating wire piezometers were installed in CWDA No. 2. However, several of the piezometers have been damaged or have otherwise ceased to function. Currently, five of the piezometers are functional.

Monitoring of the functioning piezometers was completed by Buckhorn on December 23<sup>rd</sup>, 2022. The attached monitoring report prepared by Buckhorn includes the piezometer monitoring data and the data is summarized in the following table.

| VWP ID | Initial Pore Pressure (psi) | 09/29/22 Pore Pressure (psi) | 12/23/22 Pore Pressure (psi) | Difference Since Installation (psi) | Difference Since Last Reading (psi) |
|--------|-----------------------------|------------------------------|------------------------------|-------------------------------------|-------------------------------------|
| VWP-05 | 6.8                         | 0.8                          | 1.0                          | -5.8                                | +0.2                                |
| VWP-06 | 11.3                        | 10.9                         | 10.8                         | -0.5                                | -0.1                                |
| VWP-08 | 8.2                         | 8.1                          | 8.1                          | -0.1                                | 0.0                                 |
| VWP-09 | 2.8                         | 3.0                          | 3.0                          | +0.2                                | 0.0                                 |
| VWP-10 | -1.9                        | -1.6                         | -1.6                         | +0.3                                | 0.0                                 |

### **Discussion of Vibrating Wire Piezometers**

#### **VWP-05**

VWP-05 was installed on August 3, 2005 near the toe of CWDA No. 2 adjacent to the access road/bench. The pore pressures recorded at VWP-05 have shown some seasonal fluctuations; however, the range of pore pressure changes is fairly small. In general, HBET does not believe that the pore pressures in VWP-05 are cause for concern regarding stability of the gob pile.

#### **VWP-06**

VWP-06 was installed on June 5, 2009 near the existing top of CWDA No. 2. The pore pressures recorded at VWP-06 have fluctuated since installation. In general, the fluctuations have been seasonal and reflect the level of coal mine waste placement activity on top of CWDA No. 2. In general, HBET does not believe that the measured pore pressures are an indication of any instability in CWDA No. 2.

#### **VWP-08**

VWP-08 was installed on June 5, 2009 at a slightly lower elevation than VWP-06. The pore pressures recorded at VWP-08 have fluctuated since installation. However, the measured values have dropped slightly over the past year. This is consistent with limited activity at CWDA No. 2, and the pore pressures are anticipated to remain steady or drop over time.

As indicated in the referenced *Stability Evaluation* report, the stability of CWDA No. 2 is sensitive to increases in pore pressures in VWP-08. An increase in the pore pressure of 7 psi in VWP-08 would result in a reduction of the Factor of Safety to below 1.5.

The current pore pressure reflects a piezometric surface elevation of approximately 6095 feet which is much less than the critical elevation of 6113 feet. As a result, HBET does not believe that the measured pore pressures in VWP-08 are any indication of instability in CWDA No. 2.

#### VWP-09

VWP-09 was installed on May 18, 2012 near the toe of CWDA No. 2. The pore pressures recorded at VWP-09 have been fairly steady since installation. This suggests that dewatering of the gob in this area is likely nearly complete. It is anticipated that the pore pressures at VWP-09 will remain fairly steady over time.

#### VWP-10

VWP-10 was installed on May 18, 2014 near the toe of CWDA No. 2. The pore pressures recorded at VWP-10 have been fairly steady since installation. This suggests that dewatering of the gob in this area is likely nearly complete. It is anticipated that the pore pressures at VWP-10 will remain fairly steady over time.

#### General

In general, based upon the results of the recent VWP and inclinometer monitoring data, HBET does not believe that there is any reduction in the stability of CWDA No. 2. Due to the limited activity at the mine, HBET recommends that the monitoring frequency be reduced to semi-annually.

We are pleased to be of service to your project. Please contact us if you have any questions or comments regarding the contents of this report.

Respectfully Submitted:

**Huddlestone-Berry Engineering and Testing, LLC**



Michael A. Berry, P.E.  
Vice President of Engineering

**ATTACHMENTS**



December 28, 2022

Mr. Mike Berry, PE  
Huddleston-Berry Engineering and Testing, LLC  
2789 Riverside Parkway  
Grand Junction, CO 81501

**SUBJECT: Summary Report, 4<sup>th</sup> Quarter 2022, Inclinator and Active Vibrating Wire Piezometer Data October through December 2022, Bowie Mine #2 Coal Waste Disposal Area (CWDA) #2**

Greetings Mr. Berry:

Buckhorn Engineering, Inc. (BEI) conducted quarterly monitoring of inclinometers and vibrating wire piezometers (VWP) at Coal Waste Disposal Area #2 (CWDA #2), Bowie Resources, LLC Bowie Mine #2. This report covers the period from October through December 2022. Field VWP data and inclinometer data were recorded on December 23, 2022. Per Colorado Division of Reclamation, Mining & Safety (CDRMS) and your instructions, vibrating wire piezometer and inclinometer readings for all active instruments are currently recorded and reported quarterly.

**Vibrating Wire Piezometers**

The physical locations of the piezometers are shown on the attached Instrumentation Site Plan (Map 1). As seen on this map, five of the original piezometers were damaged, and some were replaced. Currently, there are five active VWP's, and three of them are adjacent to inclinometers. The graph of historical VWP data from May 16, 2005 through May 21, 2014 is presented in Figure 1. A graph of measured pore pressures of active piezometers is presented in the attached Figure 2 and is presented numerically in Table 1 below.

**Table 1. Summary of VWP Pore Pressure Readings**

| VWP ID # | Measured Pore Pressures (psi) |                                 |                                   |                               | Pore Pressure Difference (psi) |                         |                            |
|----------|-------------------------------|---------------------------------|-----------------------------------|-------------------------------|--------------------------------|-------------------------|----------------------------|
|          | Installation                  | Last Year (Qtr 4)<br>12/27/2021 | Last Quarter (Qtr 3)<br>9/29/2022 | Current (Qtr 4)<br>12/23/2022 | Since Installation             | Since Last Year (Qtr 4) | Since Last Quarter (Qtr 3) |
| VWP-05   | 6.8                           | 0.4                             | 0.8                               | 1.0                           | -5.8                           | 0.6                     | 0.2                        |
| VWP-06   | 11.3                          | 11.2                            | 10.9                              | 10.8                          | -0.5                           | -0.4                    | -0.1                       |
| VWP-08   | 8.2                           | 8.2                             | 8.1                               | 8.1                           | -0.1                           | -0.1                    | 0.0                        |
| VWP-09   | 2.8                           | 2.8                             | 3.0                               | 3.0                           | 0.2                            | 0.2                     | 0.0                        |
| VWP-10   | -1.9                          | -1.8                            | -1.6                              | -1.6                          | 0.3                            | 0.2                     | 0.0                        |

As seen on Table 1 and Figure 2, the VWP readings and trends are consistent with recent and historic readings. Pore pressure readings changed by small amounts (-0.1 to -0.4 psi) for four of the five VWP's since the readings one year ago (Q4 2021), while VWP-05 changed by +0.6 psi. When compared with last quarter (Q3 2022), pore pressures also changed by relatively small amounts (0 to 0.2 psi) in all five VWP's. Although four of the five VWP's remain steady or have general declining trends in pore pressure over the life of the VWP's, one of the piezometers (VWP-05) has exhibited pronounced seasonal cyclical behavior for its lifespan. This piezometer generally (but not always) shows low pore pressures for Q1 and Q2 and higher pressures for Q3 and Q4, with a net loss of -5.8 psi over the lifetime of that VWP. The other four VWP's have experienced net changes of +/-0.5 psi or less since installation, meaning current readings are very similar to initial readings. For VWP-09 and VWP-10, pressures have been consistent throughout the lifetime of the piezometers; however, for VWP-06 and VWP-08, they experienced wild fluctuations in pore water pressure in the first half of their lifetimes, but have settled to pressures similar to the installation pressures in the past several years.

## **Inclinometers**

Three inclinometers (designated BG05-4, BG05-5, and BG05-7) were installed at CWDA #2 in August 2005. The inclinometers were installed through the coal refuse and approximately 20 feet into the native foundation soils. The locations of the inclinometers are shown on the attached Instrumentation Site Plan (Map 1). Baseline readings were taken on August 10, 2005 and subsequent readings have generally been taken quarterly since that time. Axis "A" reflects deformation with depth in the direction of anticipated movement (downslope), while Axis "B" is orthogonal to Axis A. Displacement curves for the three inclinometers for the initial, prior four readings, and the current readings are presented as attachments to this letter in Figure 3. As noted in the Q3 report, a field equipment/data logger error in inclinometer BG05-5 prevented accurate depiction of the 3<sup>rd</sup> quarter data, but an equipment repair has corrected the 4<sup>th</sup> quarter reading for this inclinometer.

As described in previous reports, historic displacements indicated on the plots for the approximate upper 12-14 feet of the inclinometers since installation in 2005 are due to placement of cover soil on the face of the waste pile during revegetation operations in late 2006 and early 2007. This man-caused displacement is documented in a report by Buckhorn Geotech dated December 22, 2008 to Bowie Resources called *Revised Stability Evaluations for Coal Mine Waste Disposal Area No. 2, Bowie No. 2 Mine*.

Based on the current inclinometer readings, there has not been evidence of significant downslope movement (Axis A) in any of the inclinometers since 2007 and they are generally consistent with previous readings. Some "noise" which is understood to be relatively common in orthogonal direction (Axis B) readings, was observed over the past few years for all three inclinometers. This can be due to various mechanical or installation causes that are unrelated to slope movement. For example, grout voids, poor grout coverage, or soil settlement around the instrument can all contribute to vibrations and pipe movement that impacts inclinometer readings. Software bias adjustments were applied which filtered this noise. All readings were

consistent with previous ones and the "displacement" error was within equipment tolerances and not deemed to be due to slope movement.

Standing water was measured at a depth of 7 feet below grade in the BG05-4 inclinometer pipe and at 10 feet in inclinometer BG05-7. Based on our observations there has usually been water in these pipes. Table 2 below, shows water levels in all three inclinometers for the past eight quarters. There was no water in the BG05-5 pipe and this inclinometer is typically dry. Worth noting is that in order for water to be in inclinometer pipes, the seal may be broken at the seams where the pipes snap together, the grout sleeve could have voids or has deteriorated so that it no longer forms a solid sleeve around the inclinometers, or there is a crack in the pipe, either due to slope movement or other pipe damage. Although it is not known for sure, we suspect the pipes cracked in 2006-2007 when the slope revegetation occurred and impacted the upper 12-14 feet of the inclinometers, thus allowing surface water to enter the pipes.

**Table 2. Summary of Groundwater Levels in Inclinometers**

| inclinometer | 2021-2022 Groundwater Levels per Quarter (feet) |      |      |      |      |     |     |      |
|--------------|---|------|------|------|------|-----|-----|------|
|              | 2021  |      |      |      | 2022 |     |     |      |
|              | Q1  | Q2   | Q3   | Q4   | Q1   | Q2  | Q3  | Q4   |
| BGI 05-04    | 6.0   | 5.0  | 3.0  | 4.0  | 6.0  | 7.0 | 6.0 | 7.0  |
| BGI 05-05    | dry   | dry  | dry  | dry  | dry  | dry | dry | dry  |
| BGI 05-07    | 8.5   | 10.5 | 10.0 | 12.0 | 10.0 | 8.0 | 8.0 | 10.0 |

If you have any questions regarding this letter or the instrumentation monitoring at CWDA #2, please contact me at (970) 497-8821 or LBrandt@buckhornengineering.com.

Respectfully Submitted,  
**Buckhorn Engineering, Inc.**



Laurie J. Brandt, CPG  
Certified Professional Geologist



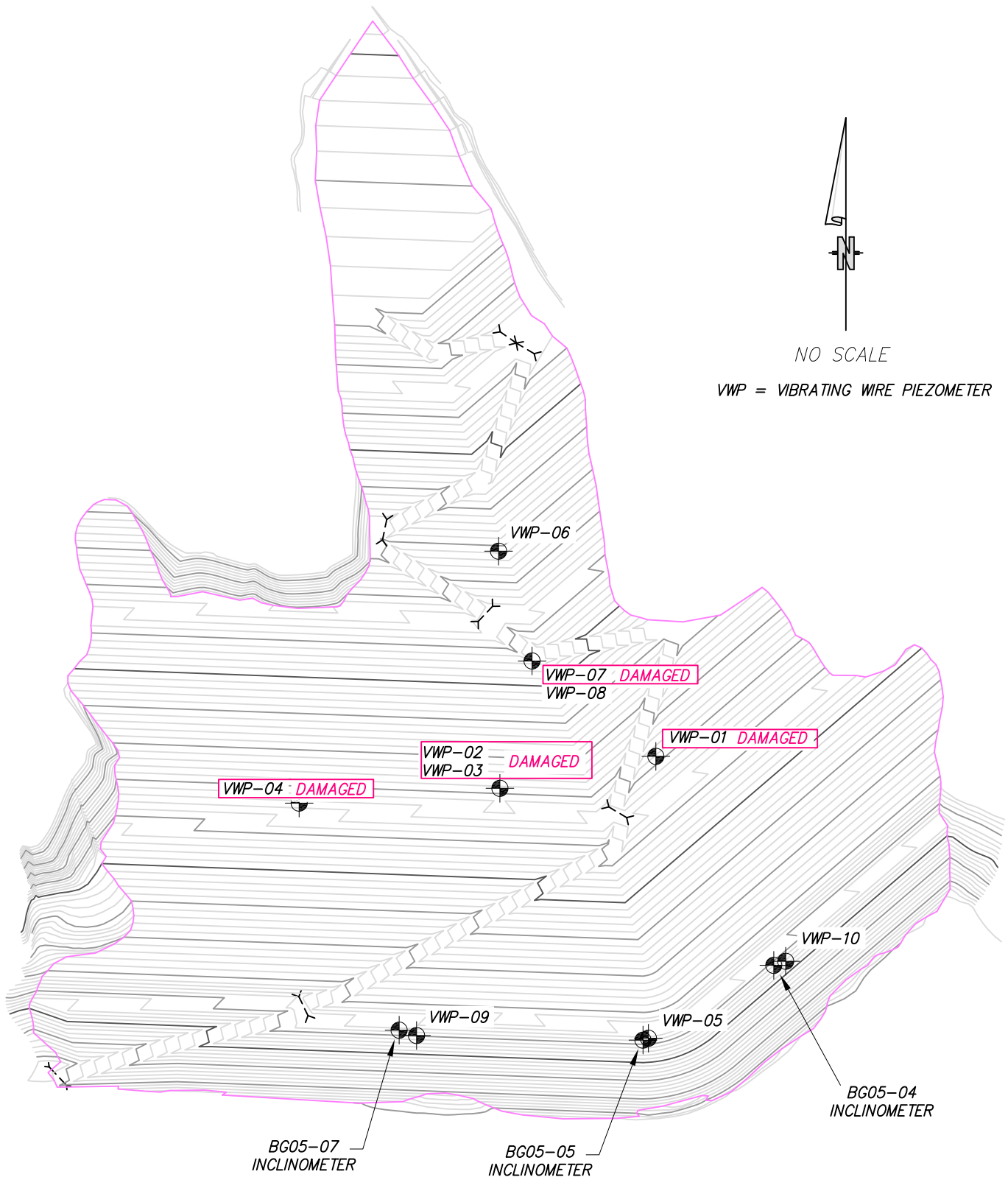
Daniel C. Quigley, P.E.  
Senior Civil Engineer/Professional Geologist



Attachments: Map 1 – Instrumentation Location Plan  
Figure 1 – Active and Damaged Piezometer Data Graph (2005-2014)  
Figure 2 – Active Vibrating Wire Piezometer Data Graph (installation to present)  
Figure 3 – Inclinometer Displacement Curves



# INSTRUMENTATION SITE PLAN



Map

1

OF 1

DATE

2021

JOB NO.

2021-008-GEO

Huddleston-Berry

BOWIE #2 GOB PILE

DELTA COUNTY, COLORADO

**BUCKHORN**  
**ENGINEERING**



**Figure 1 - Bowie Mine #2 - CWDA #2**  
**Active and Damaged Vibrating Wire Piezometer Data**

**Inception (5/16/05) through 5/21/14**

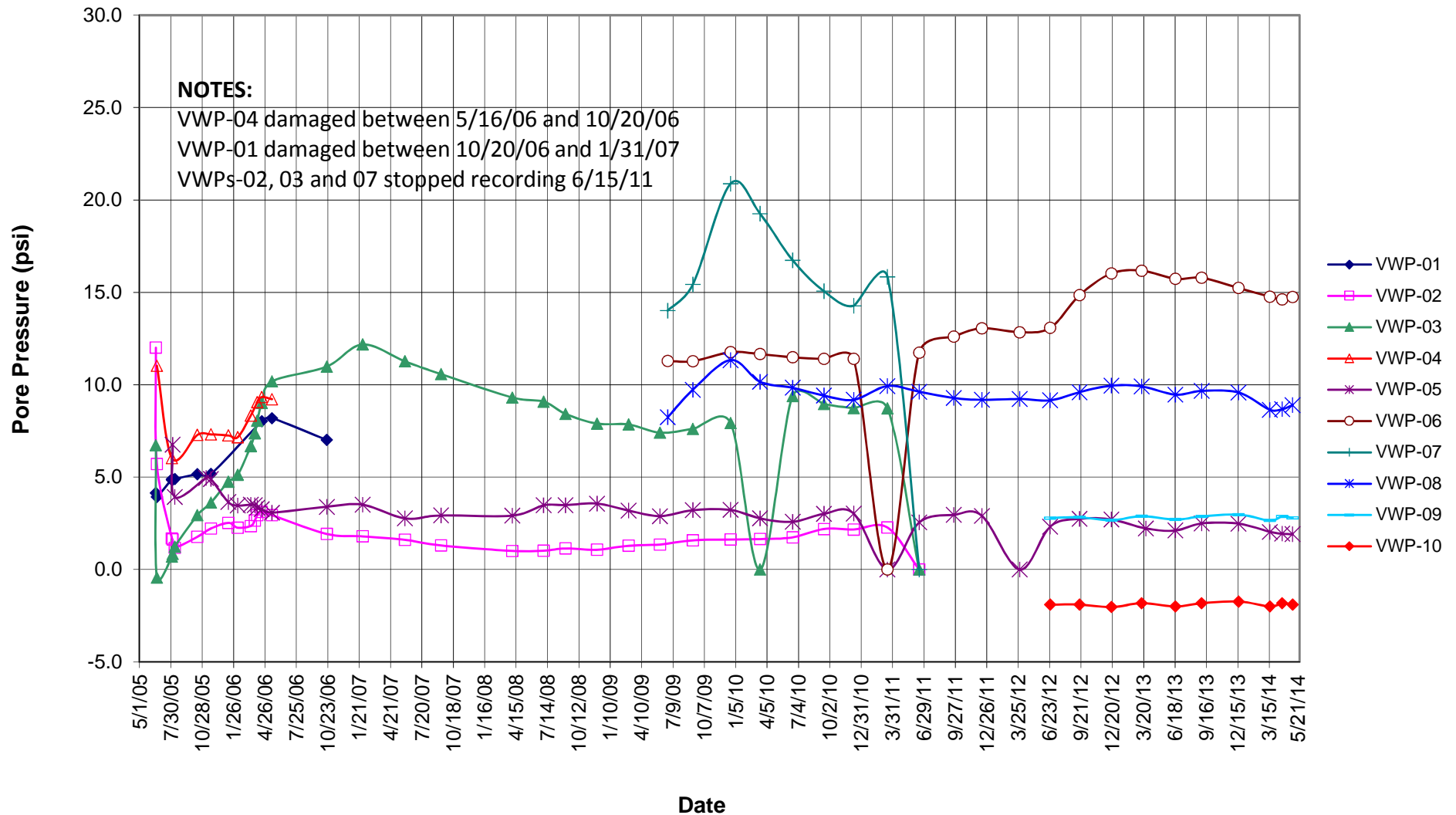


Figure 2 - Bowie Mine #2 - CWDA #2  
Active Vibrating Wire Piezometer Data

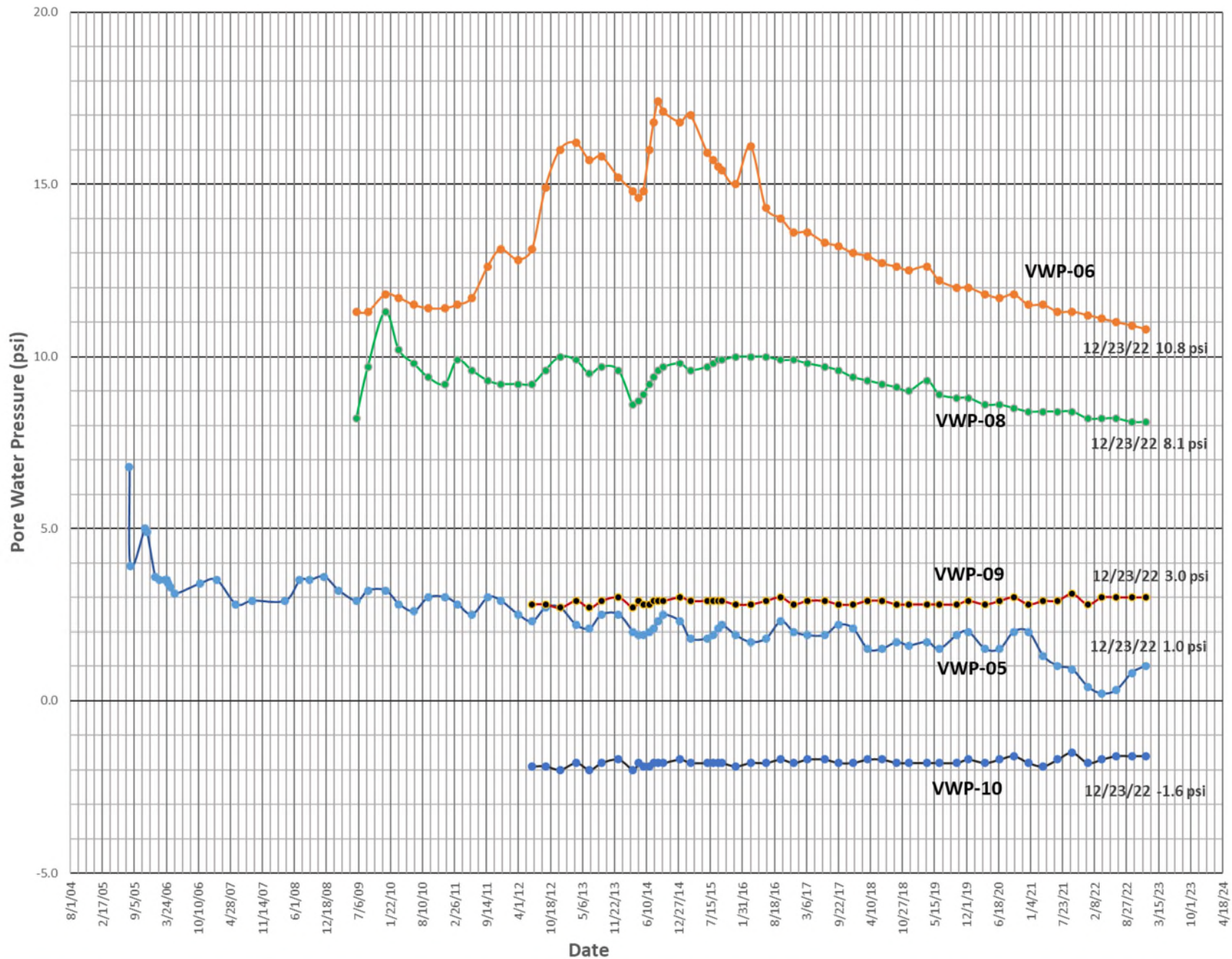
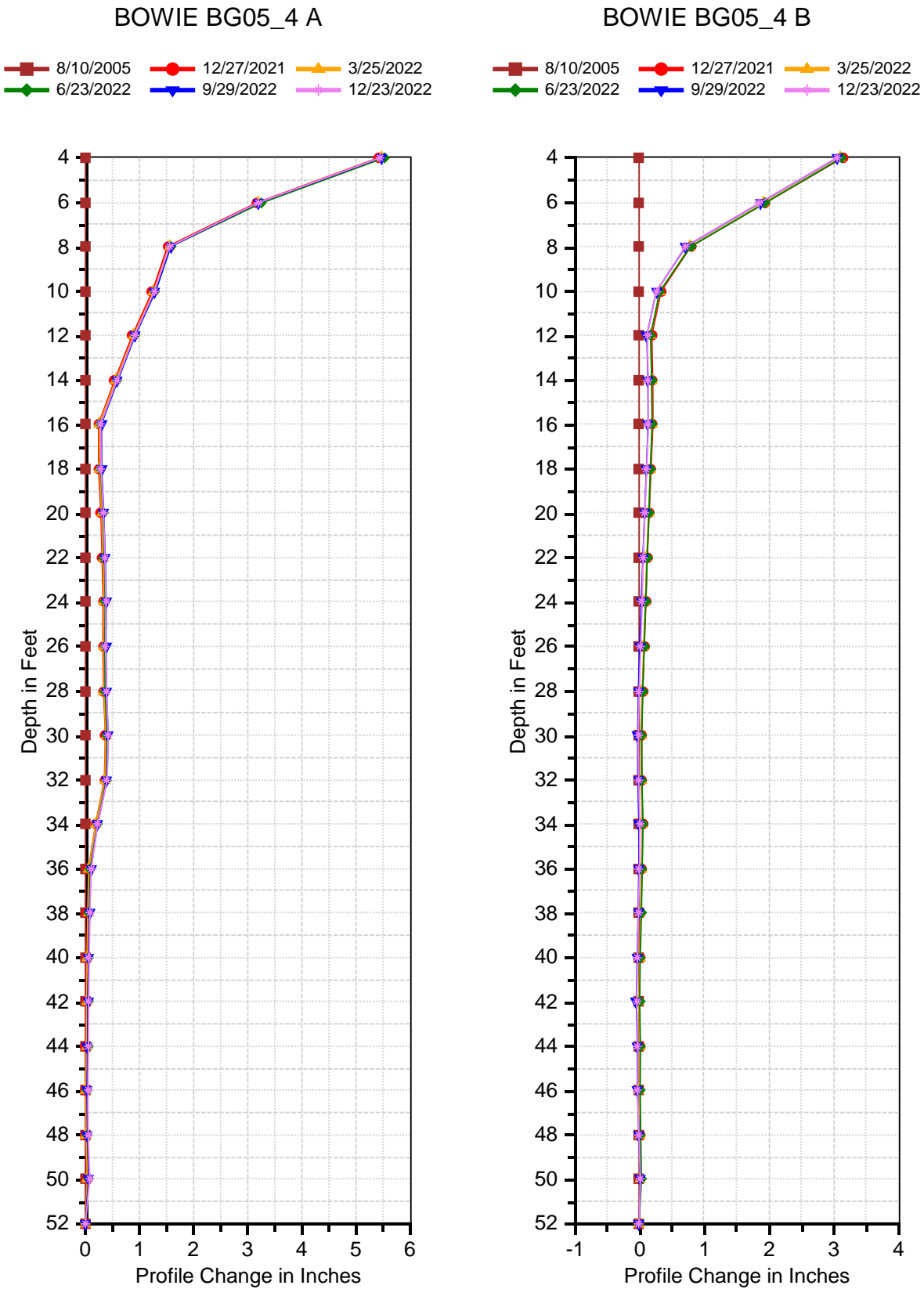
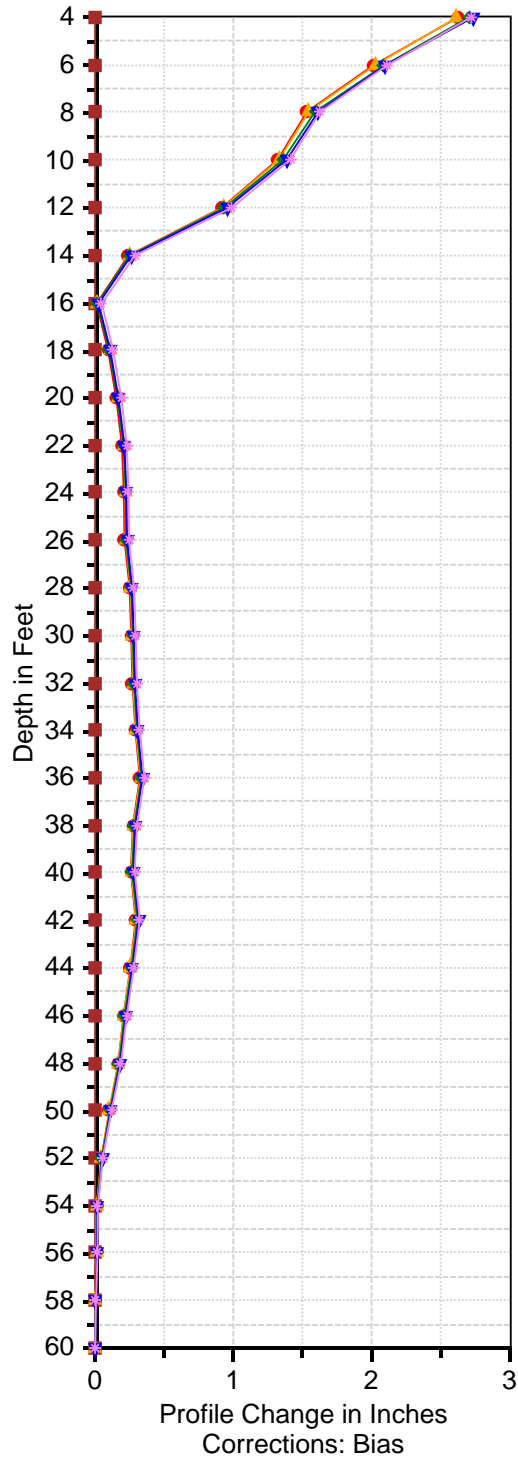


Figure 3 - Inclinometer Displacement Curves



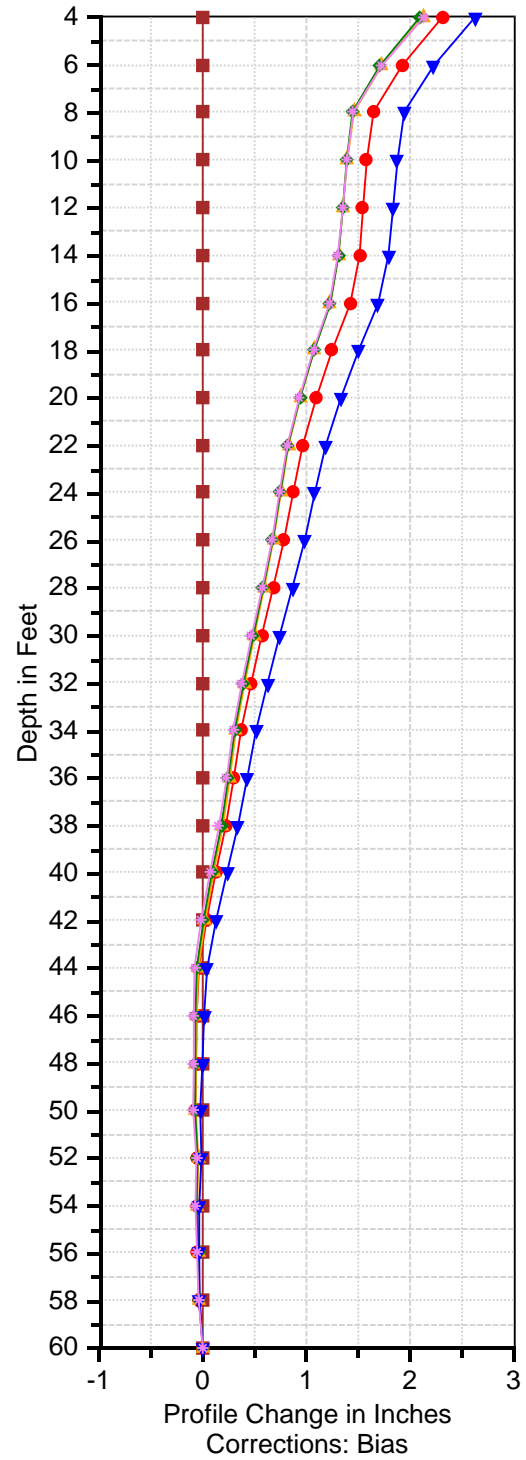
BOWIE BG05\_5 A

8/10/2005 9/21/2021 12/27/2021  
3/25/2022 6/23/2022 12/23/2022



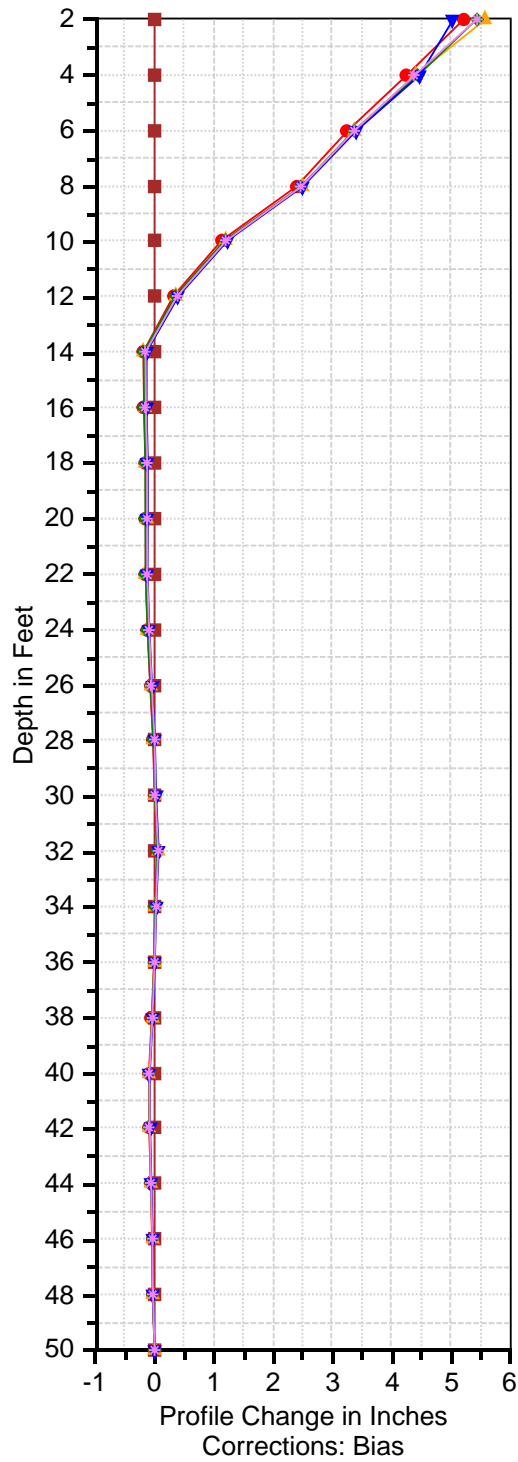
BOWIE BG05\_5 B

8/10/2005 9/21/2021 12/27/2021  
3/25/2022 6/23/2022 12/23/2022



BOWIE BG05\_7 A

8/10/2005 12/27/2021 3/25/2022  
6/23/2022 9/29/2022 12/23/2022



BOWIE BG05\_7 B

8/10/2005 12/27/2021 3/25/2022  
6/23/2022 9/29/2022 12/23/2022

