

## To:

Jose Sierra  
Contracting Officer Representative  
IBWC

## Copies:

Padinare Unnikrishna (IBWC)  
Armando Flores (Arcadis)

Arcadis U.S., Inc.  
10352 Plaza Americana Drive  
Baton Rouge  
Louisiana 70816  
Tel 225 292 1004  
Fax 225 218 9677

## From:

Kirk Lowery, P.E.

## Date:

September 26, 2016

## Arcadis Project No.:

LA003315.0000

## Subject:

September 2016 Summary Report of Inclinometer Readings  
Remediation Design of Levee Floodplain Failure within the  
Upper Brownsville Levee Reach Lower Rio Grande Flood  
Control Project – IBM15D0001 – IBM15T0015

## 1. Introduction

Arcadis U.S., Inc. (Arcadis), is pleased to submit this summary technical memorandum including data charts of the slope inclinometer readings at the IBWC site. The baseline readings for the new inclinometers, Arc-1, Arc-2, Arc-3 and Arc-4, were taken in June 2016 and the third set of readings were measured on September 22, 2016. These inclinometers will be measured every month until June of 2017.

Readings for the existing inclinometers, I-32, I-33 and I-34, were not made when Arcadis visited the site on September 22, 2016. During the June readings, the inclinometer probe had difficulty passing certain depths and when Arcadis passed those depths retrieving the inclinometer probe was problematic. Arcadis plans to periodically read these inclinometers, but not to attempt to pass the probe through the constricted area of the pipe and possibly lose/abandon the probe. Since the readings could not be measured for the existing inclinometers, in September 2016, Arcadis measured the depth range in which the inclinometer probe could not pass through the constricted area of the pipe and are as follows:

I-32 (Top of the Levee): Depth Range: 32 feet to 33 feet

I-33 (Toe of the Levee): Depth Range: 38 feet to 39 feet

I-34 (Below Toe of Levee): Depth Range: 30 feet to 31 feet

The readings for ARC-1 through ARC-4 are reflected in the graphical displays provided in Attachment A. Attachment A includes both incremental and cumulative displacement plots. Attachment B shows the inclinometer locations on a Google Map.

The incremental displacement plot compares the mean deviation data to the baseline survey file. This plot reveals the exact depth where displacements are actually occurring. The cumulative displacement is the sum of the displacements from the base of the borehole. This plot shows the change in the position of the casing from the first set of readings.

The A-axis charts in the displacement plots show displacements in the plane perpendicular to the levee while the B-axis charts show displacements in the plane parallel with the levee. A positive reading in the A-axis chart indicates displacement to the west heading toward the Rio Grande River, and a positive reading in the B-axis chart indicates displacement to the north heading toward the Gateway Bridge.

## 2. Digitilt AT Inclinometer

Digitilt AT system was used to survey the inclinometers. The system components include an inclinometer probe, control cable, a Bluetooth reel and the Digitilt Reader app for certified Android-based tablet computer. The equipment is shown in Figure 1.

Figure 1: Digitilt AT System Components.



## 3. September 2016 Inclinometers Assessment

The depth of the casing restriction for the USACE installed inclinometers, I-32, I-33 and I-34 appears at about the same depth as the previous readings.

Data collected on September 22, 2016 followed the same trend as the baseline reading measured in June 2016. The displacement plots recorded on July 25, 2016 through September 22, 2016 are presented in Attachment A. Data comparisons for each inclinometer are described below:

## MEMO

Inclinometer Arc-1: The base readings for inclinometer Arc-1 were collected on June 22, 2016. The Arc-1 cumulative and incremental displacement does not show any sign of movement on the plane perpendicular to the levee nor on the plane parallel to the levee.

Inclinometer Arc-2: The base readings for inclinometer Arc-2 were collected on June 17, 2016. The Arc-2 cumulative and incremental displacement does not show any sign of movement on the plane perpendicular to the levee nor on the plane parallel to the levee.

Inclinometer Arc-3: The base readings for inclinometer Arc-3 were collected on June 17, 2016. The Arc-3 cumulative and incremental displacement does not show any sign of movement on the plane perpendicular to the levee nor on the plane parallel to the levee.

Inclinometer Arc-4: The base readings for inclinometer Arc-4 were collected on June 22, 2016. The Arc-4 cumulative and incremental displacement does not show any sign of movement on the plane perpendicular to the levee nor on the plane parallel to the levee.

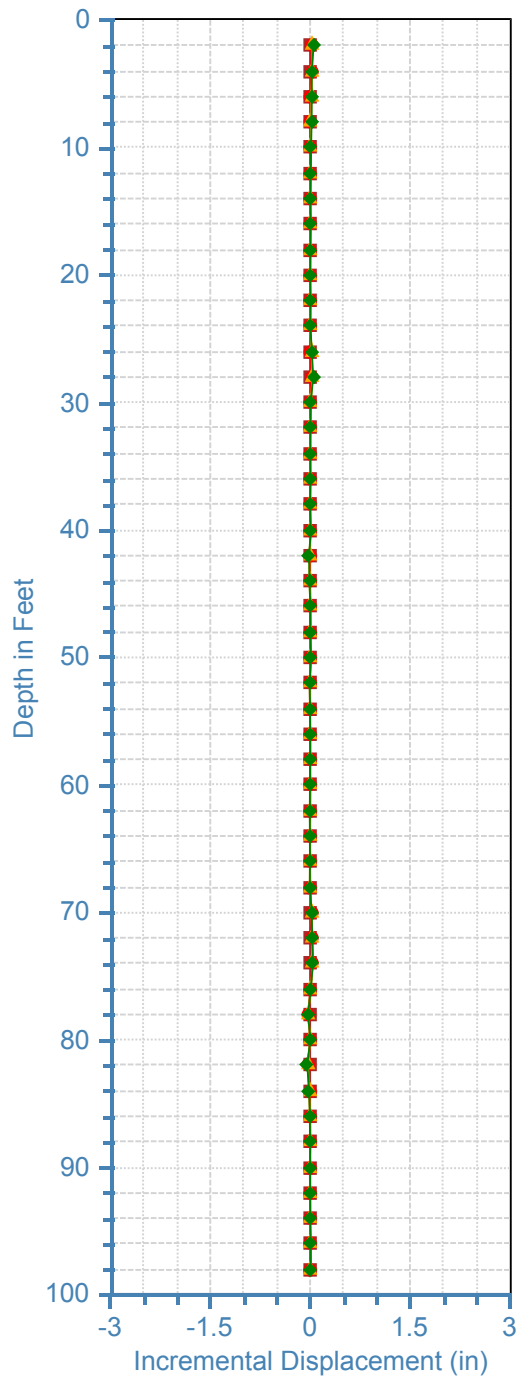
### **ATTACHMENTS:**

**A – Inclinometer Plots**

**B – Inclinometer Location Map**

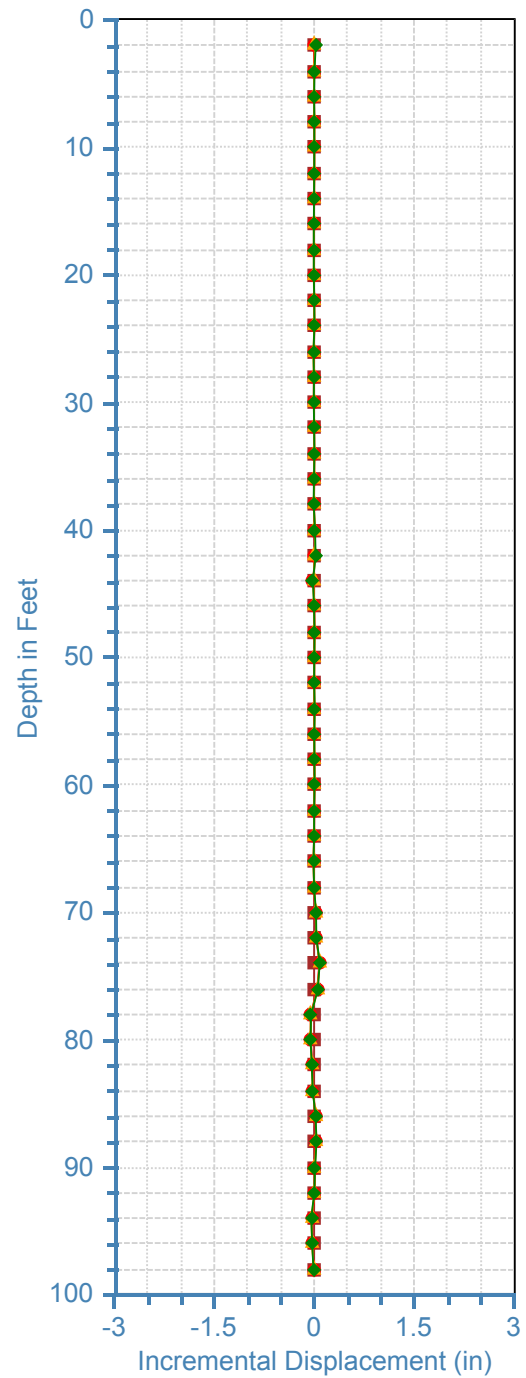
**ATTACHMENT A**  
**INCLINOMETER PLOTS**

IBWC Arc-1 A - Axis



■ 6/22/2016 11:22:30 AM    ● 7/25/2016 3:17:20 PM  
▲ 8/25/2016 1:34:40 PM    ◆ 9/22/2016 1:35:22 PM

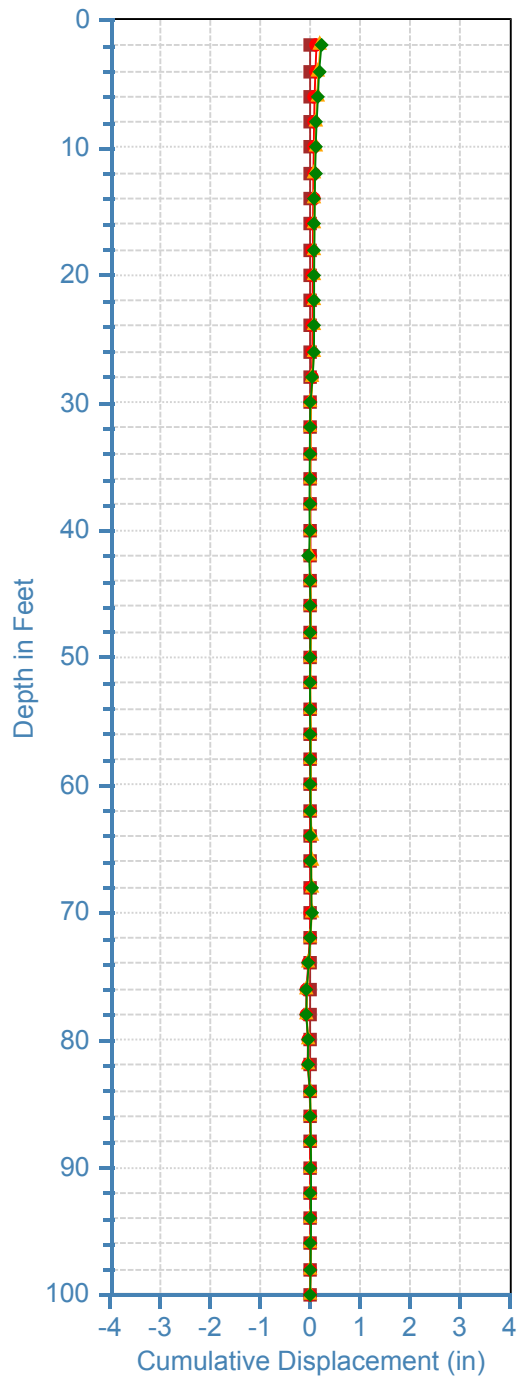
IBWC Arc-1 B - Axis



■ 6/22/2016 11:22:30 AM    ● 7/25/2016 3:17:20 PM  
▲ 8/25/2016 1:34:40 PM    ◆ 9/22/2016 1:35:22 PM

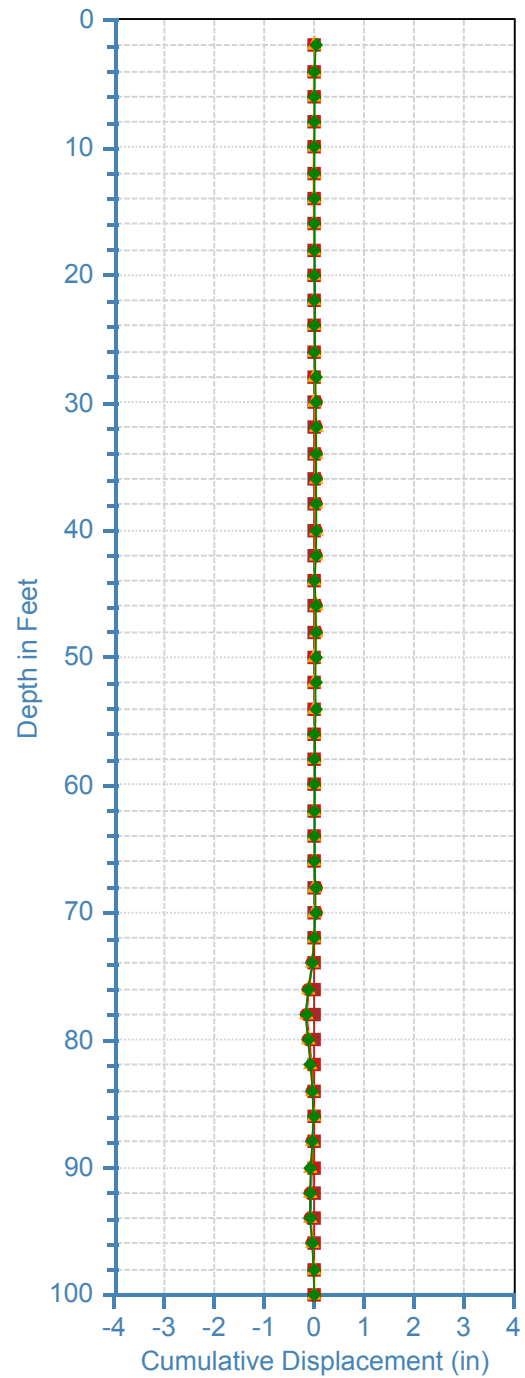
Base reading on 6/22/2016

IBWC Arc-1 A - Axis



■ 6/22/2016 11:22:30 AM    ● 7/25/2016 3:17:20 PM  
▲ 8/25/2016 1:34:40 PM    ◆ 9/22/2016 1:35:22 PM

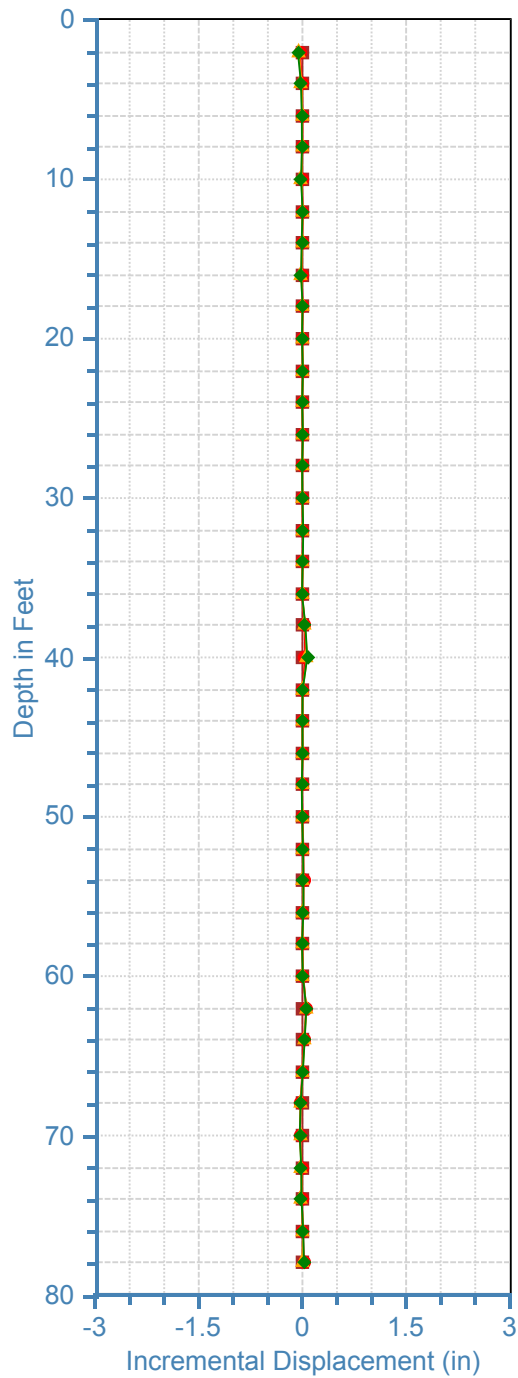
IBWC Arc-1 B - Axis



■ 6/22/2016 11:22:30 AM    ● 7/25/2016 3:17:20 PM  
▲ 8/25/2016 1:34:40 PM    ◆ 9/22/2016 1:35:22 PM

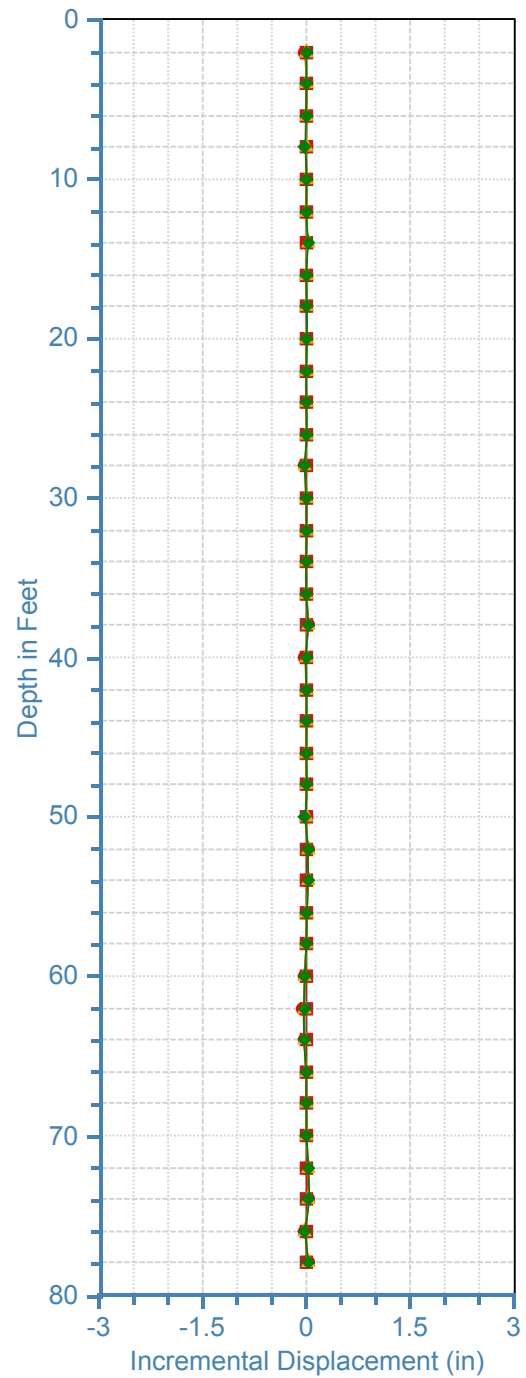
Base reading on 6/22/2016

IBWC Arc-2 A - Axis



■ 6/17/2016 6:27:13 PM    ● 7/25/2016 3:57:11 PM  
▲ 8/25/2016 2:02:22 PM    ◆ 9/22/2016 2:05:40 PM

IBWC Arc-2 B - Axis

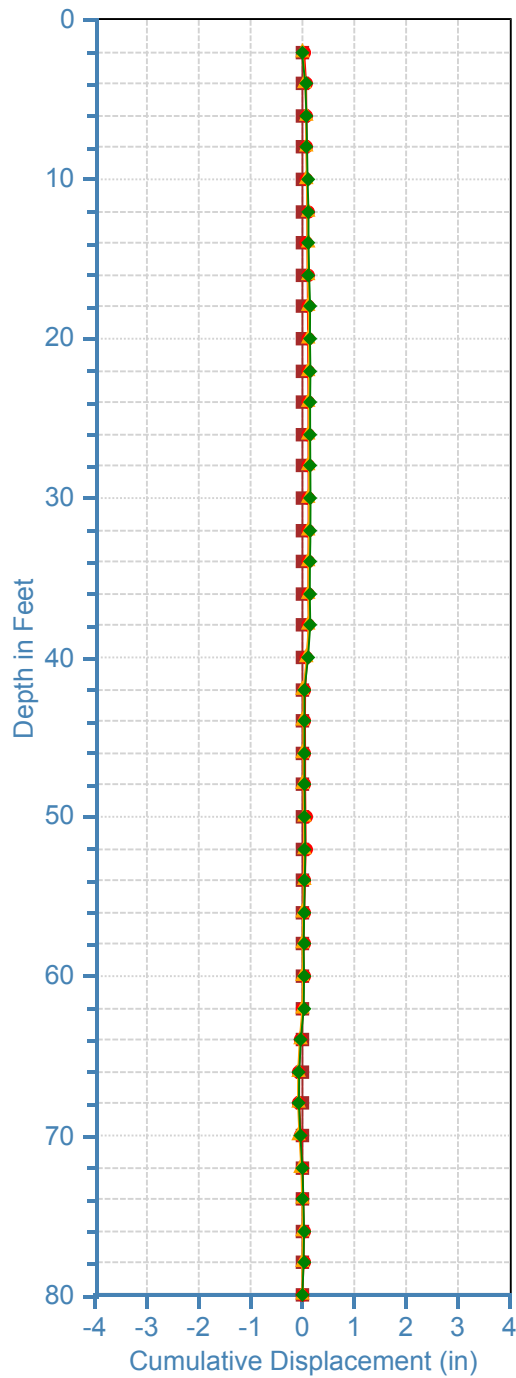


■ 6/17/2016 6:27:13 PM    ● 7/25/2016 3:57:11 PM  
▲ 8/25/2016 2:02:22 PM    ◆ 9/22/2016 2:05:40 PM

Base reading on 6/17/2016

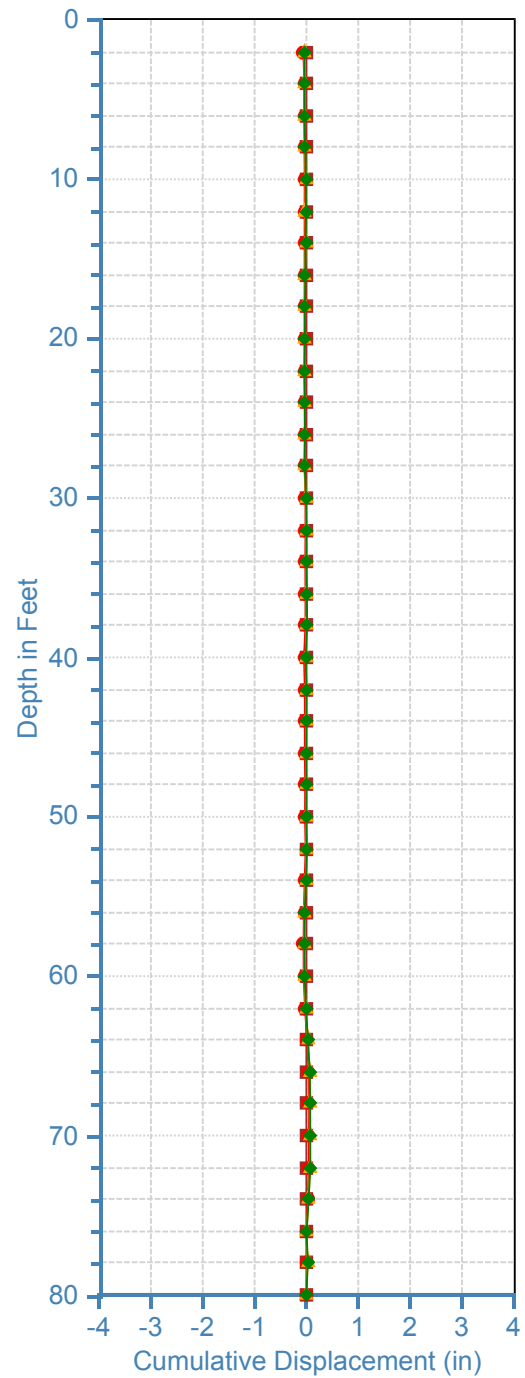


IBWC Arc-2 A - Axis



6/17/2016 6:27:13 PM    7/25/2016 3:57:11 PM  
 8/25/2016 2:02:22 PM    9/22/2016 2:05:40 PM

IBWC Arc-2 B - Axis



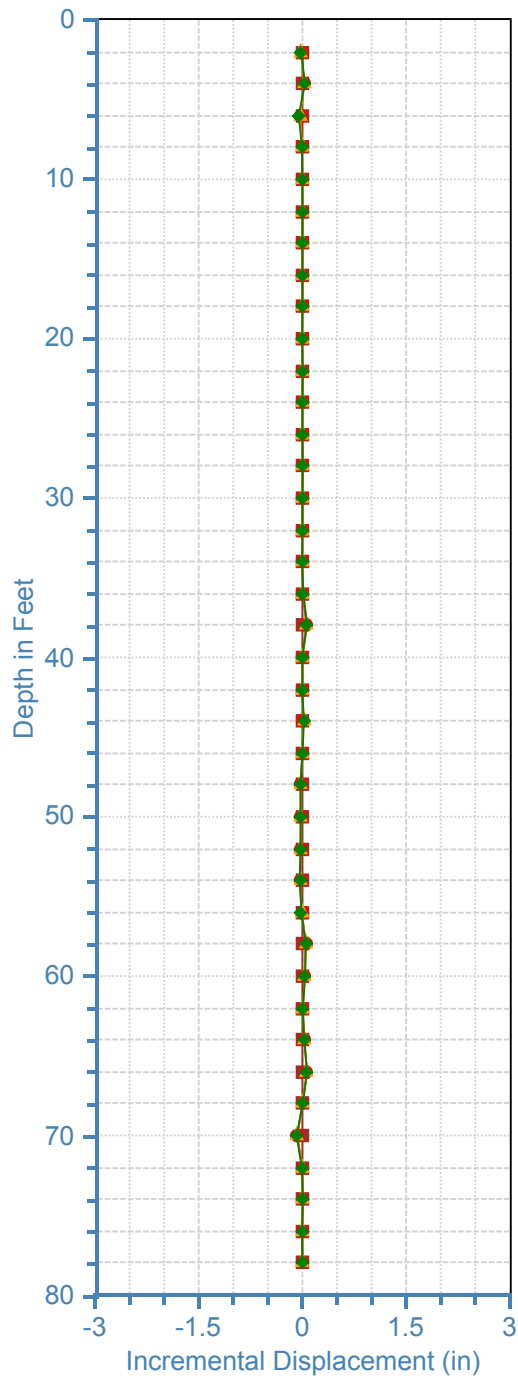
6/17/2016 6:27:13 PM    7/25/2016 3:57:11 PM  
 8/25/2016 2:02:22 PM    9/22/2016 2:05:40 PM

Base reading on 6/17/2016



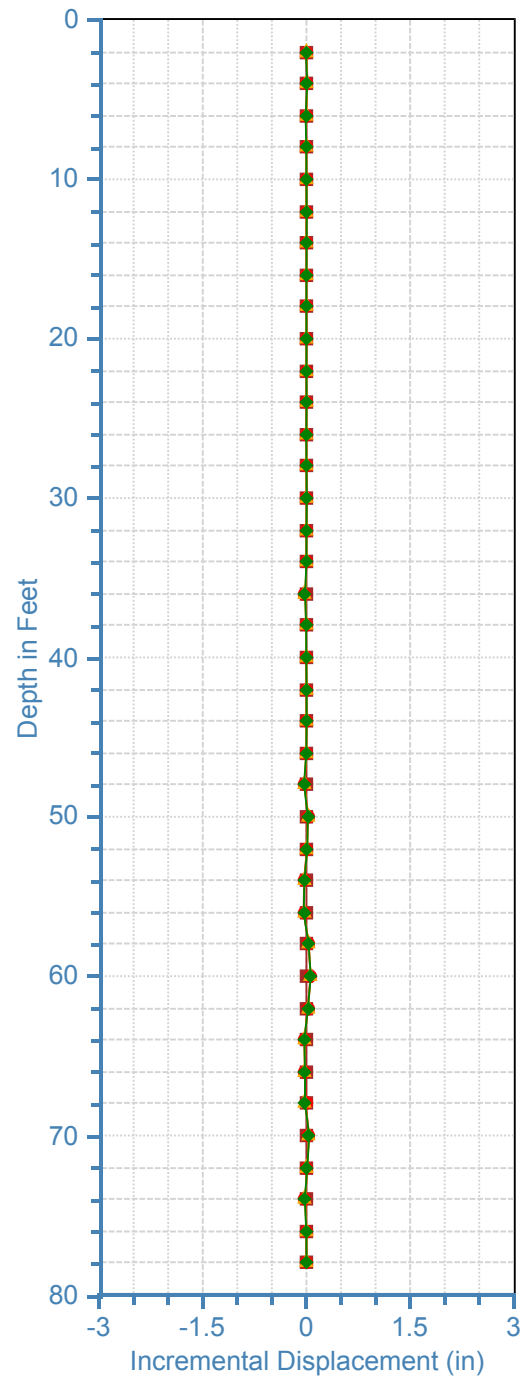


IBWC Arc-3 A - Axis



■ 6/17/2016 7:05:22 PM    ● 7/25/2016 4:28:56 PM  
▲ 8/25/2016 2:41:46 PM    ◆ 9/22/2016 2:36:13 PM

IBWC Arc-3 B - Axis

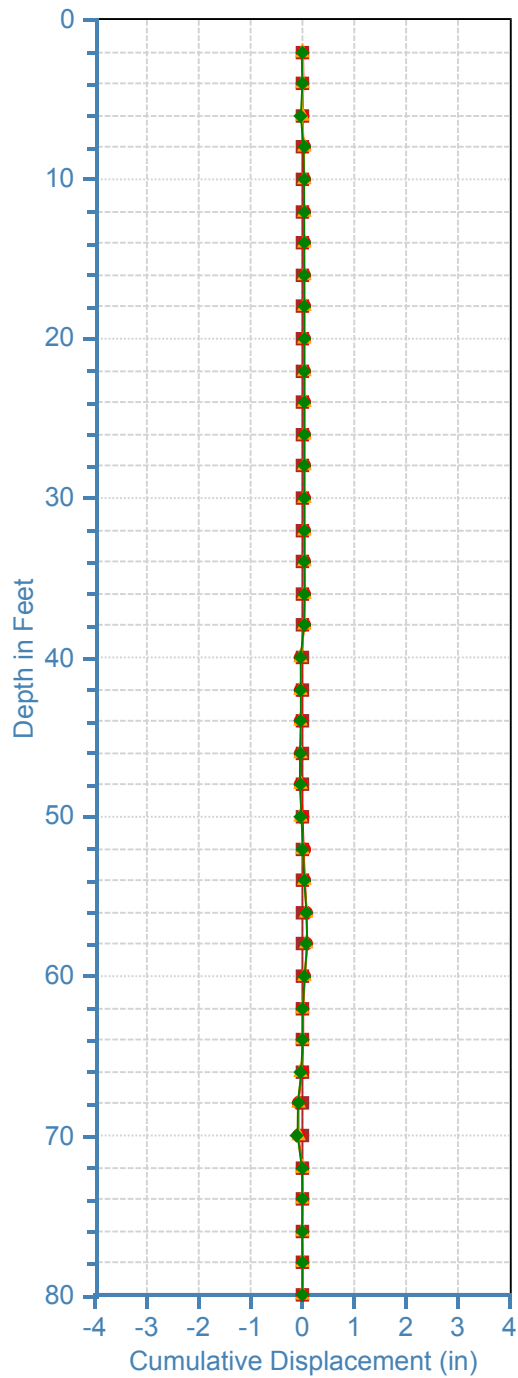


■ 6/17/2016 7:05:22 PM    ● 7/25/2016 4:28:56 PM  
▲ 8/25/2016 2:41:46 PM    ◆ 9/22/2016 2:36:13 PM

Base reading on 6/17/2016

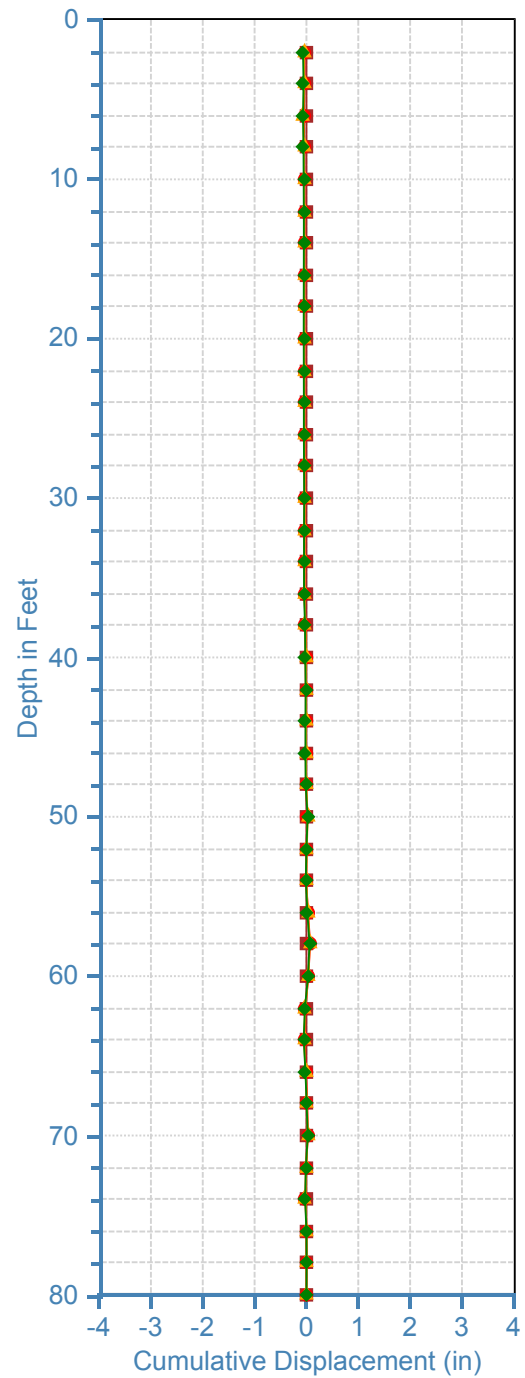


IBWC Arc-3 A - Axis



■ 6/17/2016 7:05:22 PM    ● 7/25/2016 4:28:56 PM  
▲ 8/25/2016 2:41:46 PM    ◆ 9/22/2016 2:36:13 PM

IBWC Arc-3 B - Axis

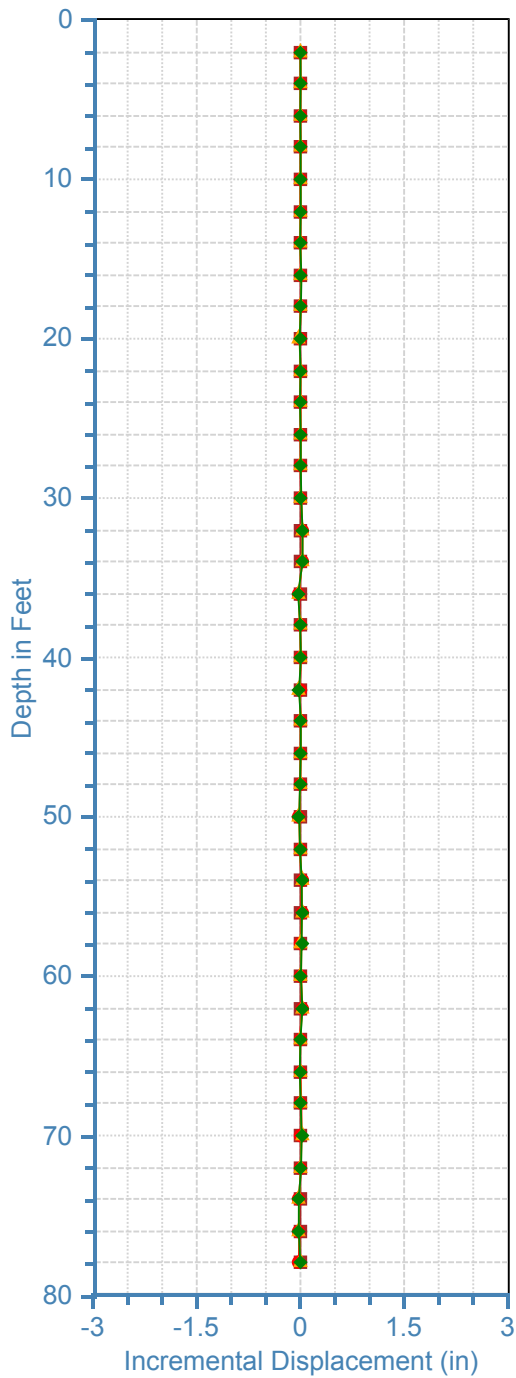


■ 6/17/2016 7:05:22 PM    ● 7/25/2016 4:28:56 PM  
▲ 8/25/2016 2:41:46 PM    ◆ 9/22/2016 2:36:13 PM

Base reading on 6/17/2016

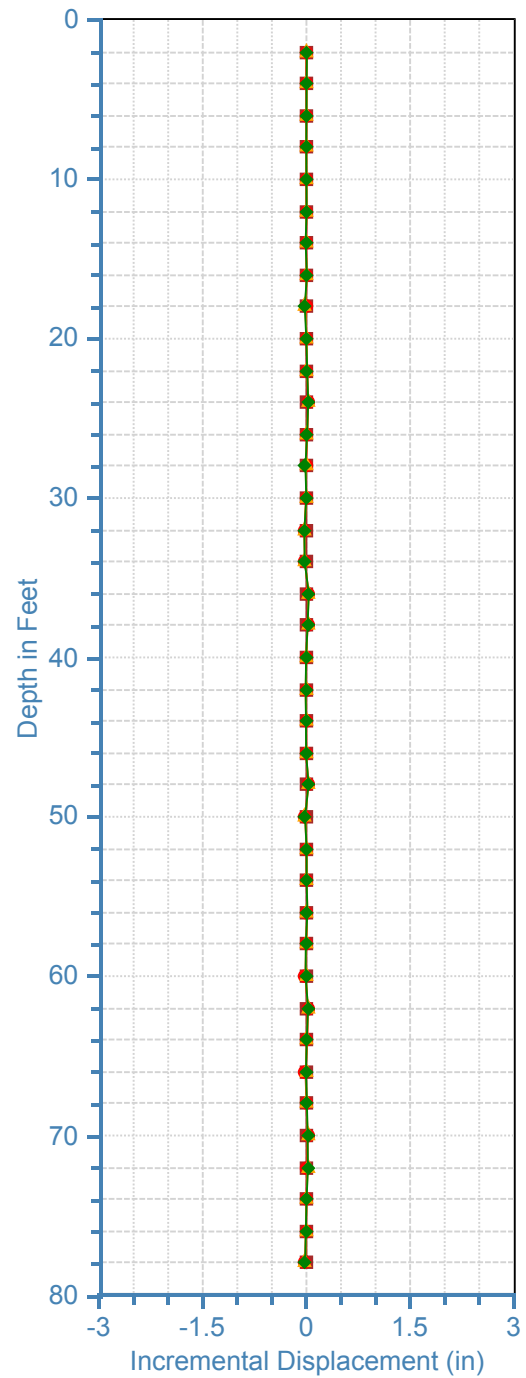


IBWC Arc-4 A - Axis



■ 6/22/2016 10:48:04 AM 
 ● 7/25/2016 5:08:42 PM  
▲ 8/25/2016 3:15:23 PM 
 ◆ 9/22/2016 3:09:20 PM

IBWC Arc-4 B - Axis

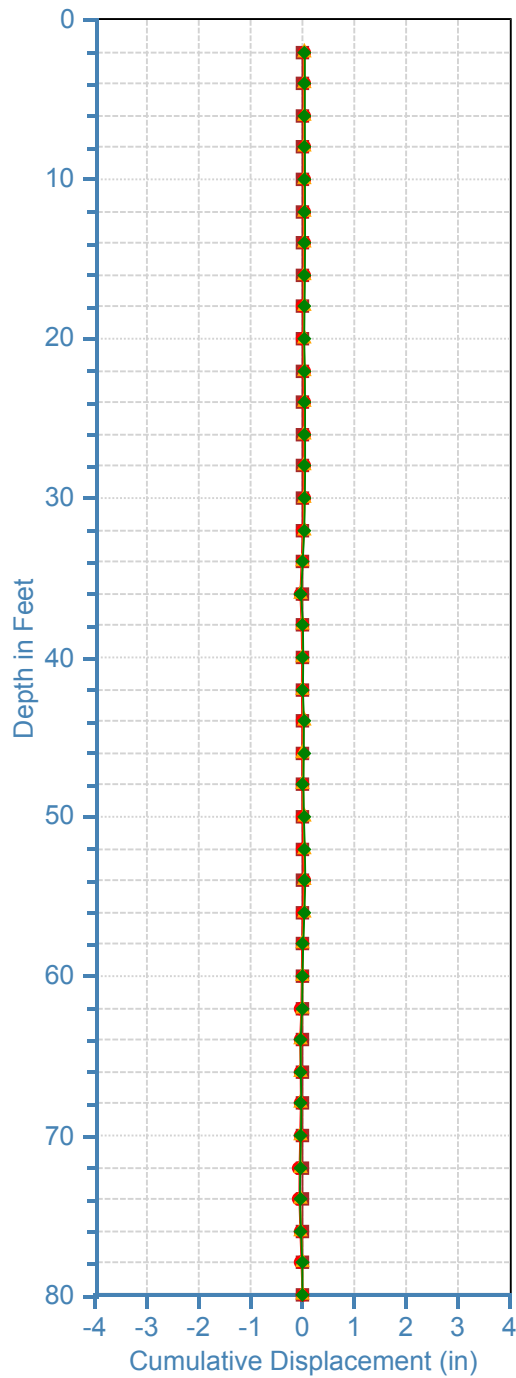


■ 6/22/2016 10:48:04 AM 
 ● 7/25/2016 5:08:42 PM  
▲ 8/25/2016 3:15:23 PM 
 ◆ 9/22/2016 3:09:20 PM

Base reading on 6/22/2016

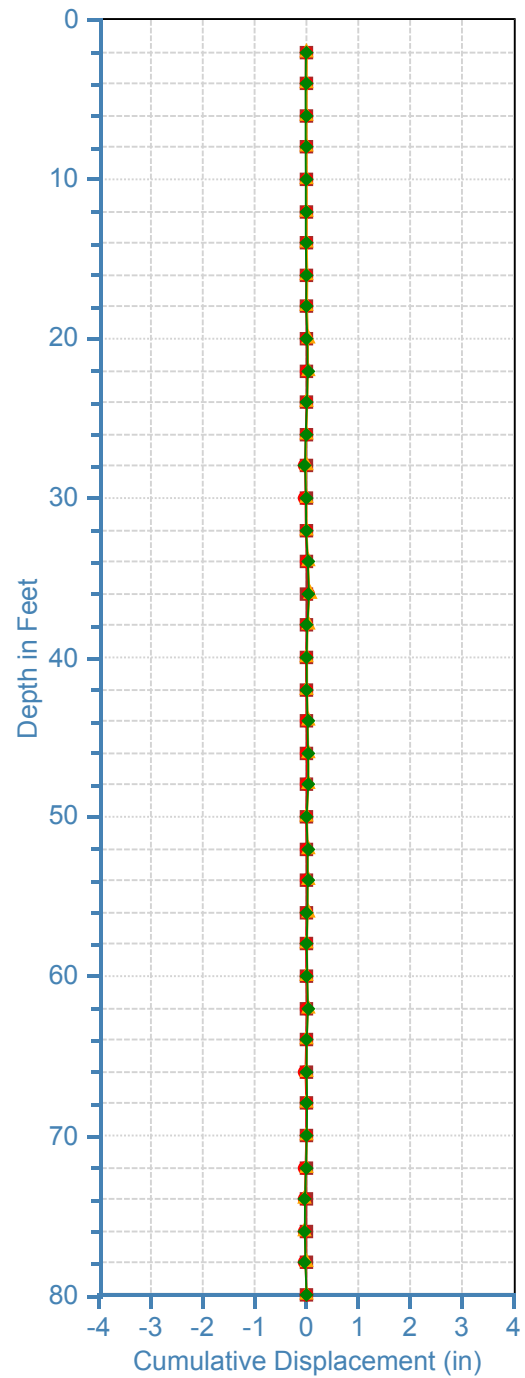


IBWC Arc-4 A - Axis



■ 6/22/2016 10:48:04 AM    ● 7/25/2016 5:08:42 PM  
▲ 8/25/2016 3:15:23 PM    ◆ 9/22/2016 3:09:20 PM

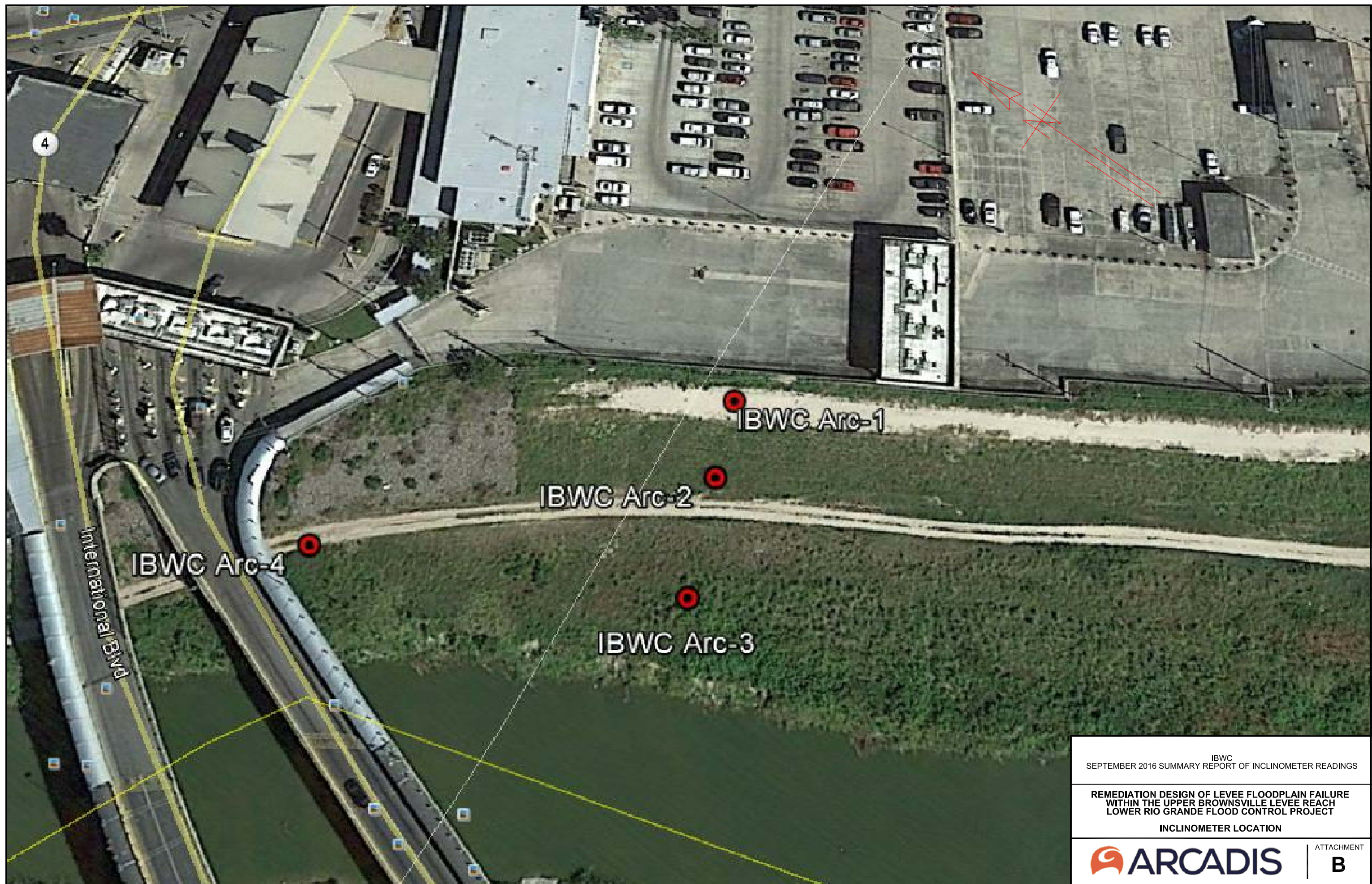
IBWC Arc-4 B - Axis



■ 6/22/2016 10:48:04 AM    ● 7/25/2016 5:08:42 PM  
▲ 8/25/2016 3:15:23 PM    ◆ 9/22/2016 3:09:20 PM

Base reading on 6/22/2016

**ATTACHMENT B**  
**INCLINOMETER LOCATION MAP**



IBWC  
SEPTEMBER 2016 SUMMARY REPORT OF INCLINOMETER READINGS

REMEDATION DESIGN OF LEVEE FLOODPLAIN FAILURE  
WITHIN THE UPPER BROWNSVILLE LEVEE REACH  
LOWER RIO GRANDE FLOOD CONTROL PROJECT

INCLINOMETER LOCATION

 **ARCADIS**

ATTACHMENT

**B**