Portuguese Bend Land Movement Monitoring Survey

October 2023-January 2024-March 2024

Survey Report

for the

City of Rancho Palos Verdes

prepared by

McGee Surveying Consulting

October 30, 2023 Updated January 30, 2024; March 12, 2024

Portuguese Bend is typically monitored for land movement on a tri-annual basis with an initial survey of all current monitoring points at the beginning of the rainy season in the fall of each year followed by two subsequent partial winter and spring monitoring surveys. The survey report is published following the spring 2023 survey; however, at the City's request a special survey of all current points was conducted in early January 2024 and reported here as an Addendum. The partial winter and spring monitoring surveys are also reported here as addendums and included in the attached "PB MOVEMENT DATA POSTING…..xlsx". Movements are reported for the average date of the survey noted below and listed hereafter.

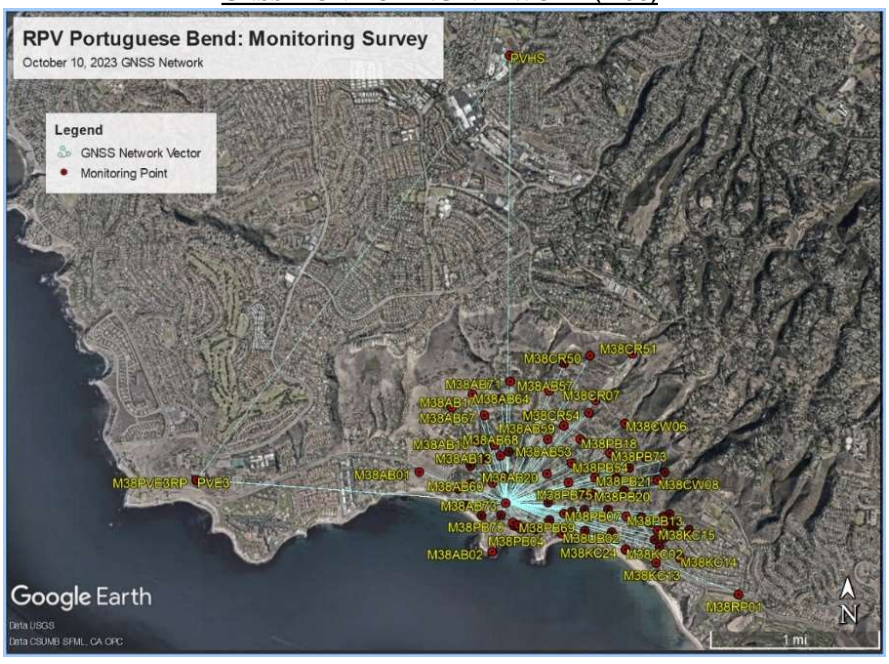
Initial Fall Full Survey No. M38 - October 10, 2023
Early Winter Full Survey No. M39 - January 13, 2024
Winter Partial Survey No. M40 – March 8, 2024
Spring Partial Survey No. M41 – April ?, 2024

SPREADSHEET ATTACHMENT: "PB MOVEMENT DATA POSTING (Revised 031224) 2007-March2024.xlsx"

<u>OVERVIEW</u>:

McGee Surveying Consulting (MSC) performed the 2023-2024 land movement monitoring surveys at Portuguese Bend. The surveys were planned, coordinated, and executed by Michael McGee, PLS3945 of MSC who is responsible for the field surveys, processing observations, network adjustments, analysis, and reports. For a general history, details and procedures utilized in this survey but not re-stated here, see the "Portuguese Bend Land Movement 2020-2021 Monitoring Survey" report dated October 5, 2021, Revised and published May 11, 2022. See also prior reports.

<u>GNSS MONITORING NETWORK (M38)</u>



This Initial October 10, 2023 Survey determined the precise positions of 79 monitoring and control points. PVE3RP and other CSRC CGPS stations were used to support and reference the survey network and verify the recovery of the reference frame. This survey included two new points set in July 2023 for the special request July 2023 M37 Monitoring Survey in Klondike Canyon (Seaview), and 10 new points set in September 2023. Point KC02 is expected to be destroyed in the spring and a new point "KC24" was set nearby during the October survey. Point AB20 was destroyed sometime after the October 10, 2023 survey and AB21, a nearby point, was recovered from the 2007 survey and substituted for AB20 which facilitated continuous monitoring at this location. The movements of

new points are reported, for the first time, in the January 13, 2024 monitoring survey and are included in this Report as an Addendums. All monitoring survey coordinates and movements to date are listed in the attached spreadsheet "PB MOVEMENT DATA POSTING (Revised 031224) 2007-March2024.xlsx" note above.

PROJECT DATUMS - REFERENCE FRAME

The horizontal and vertical positions of the monitoring points are based on the North American Datum of 1983 (NAD83) Epoch 2007.00 and the North American Vertical Datum of 1988 (NAVD 88) reference frames. Although more current epoch adjustments are available (e.g. NAD83 (2011) Epoch 2010.00), Epoch 2007.00 is retained to maintain consistently relative positions over time. Orthometric heights (NAVD88 Elevations) are based on measured ellipsoid heights combined with the NGS Geoid03 model and referenced to NGS Benchmarks. Although more current geoid models (e.g. Geoid18), are available, Geoid03 is retained to maintain consistently relative height movements over time as explained in said May 2022 Report. The latitudes and longitudes determined by GNSS measurements are projected onto NAD83 California State Plane Coordinates Zone 5 in US Survey Feet.

A valid recovery of the reference frame is essential to accurately measure and assess the actual movements of individual points relative to the greater peninsula. The method for recovering the monitoring survey reference frame was modified in 2019 to improve the efficiency and simplify the processing and analysis of the monitoring surveys. Since 2007, Point AB02 (at the south end of Portuguese Point) has proven to be stable relative to PVE3 which is a California Spatial Reference Center (CSRC) Continuously Operated GPS Station (CGPS) at City Hall. The present procedure fixes PVE3RP (a PK Nail set on the concrete base of PVE3 as a reference mark to PVE3) and checking to point AB02. The proven positions relative to PVE3 are listed below.

Pt#	Latitude	Longitude	NAVD88 Ht	Source)
AB02	33-44-13.84878	118-22-26.19243	116.47 ft	2007 - October 2018 position
PVE3RP	33-44-35.74239	118-24-15.27451	346.88 ft	Average of 5 years referencing to PVE3

Comparing the positions of AB02 on Portuguese Point with PVE3RP at City Hall and other CSRC CGPS Stations provides a redundant verification that the reference frame is stable and successfully recovered for each monitoring survey. An additional check point "RP01" was established near the entrance to the Trump Golf Course for incorporation in future surveys.

The rate of movement (velocities) of the land masses have increased over the past five years compared to the previous 12-year average. See "Assessment of Movements & Accelerations" addressed on Page 11. Notwithstanding the 2019 monitoring process noted in the above paragraph, the processing of observations was necessarily modified for this fall survey because of the higher velocities as follows.

The October 2023 observations were processed as follows. The Base Station AB73 was occupied over a six-day period and was found to have moved about 0.016 feet per day similar to other monitoring points in the area. To determine accurate positions and therefore precision movements it was necessary to determine a daily position of AB73. This was accomplished by processing the static data collected each day at AB73 with static data downloaded from the CSRC for CGPS stations PVE3 and PVHS. PVE3 is and has always been the basic constraint for the monitoring survey's reference frame. PVHS was used to verify the stability of PVE3. Subsequently positions of AB73 were computed for each day referenced to PVE3. The identity for processing the daily observations of AB73 and related RTK measurements was to assign to AB73 the identity of AB731, AB732, AB733, AB734 & AB735 for days 1 through 5 occurring on October 8, 9, 10, 11 & 13.

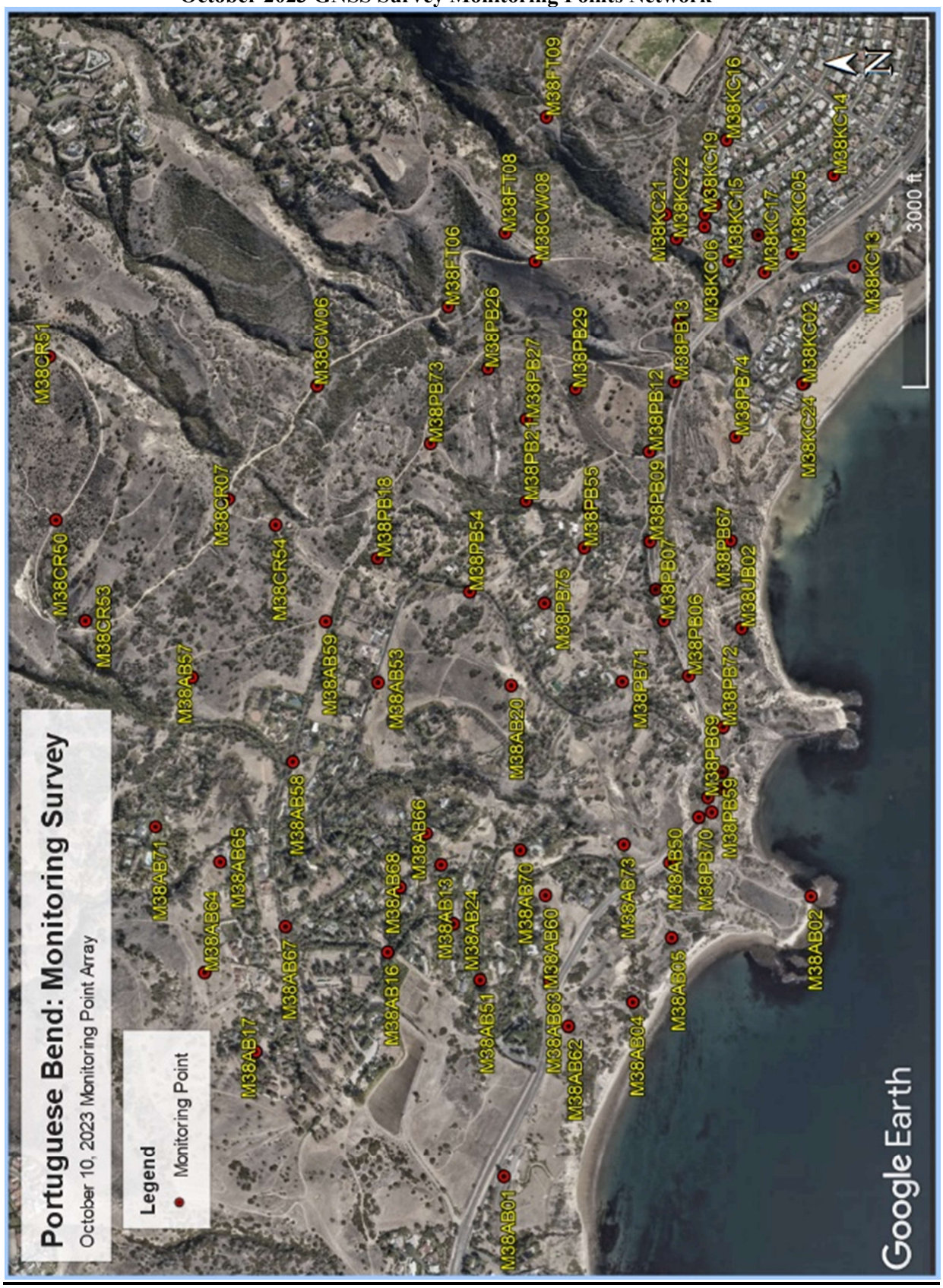
AB61 and AB20 have previously served as suitable GNSS Base Stations for referencing measured positions of the monitoring points. AB61 is no longer accessed due to its environmental sensitivity and lack of security. AB73, located on the US Pony Club property was utilized as the Base Station up to the October 2023 survey. Access was obtained unilaterally by MSC from the Pony Club manager for exclusive permission to enter the property confirmed prior to each survey entry with the understanding that strict driving protocols are observed. Point AB73 was not a planned monitoring point but given the increased rates of movement, it fills in a gap between AB20 and AB50 and moves consistent with AB20. AB50 and AB73 are on the south and north sides of

PVDS respectively. The separation between AB73 and AB50 is diminishing resulting in a steeper slope on the north side of PVDS which may be de-stabilizing.

Due to the continuously increasing velocities of land movement, the present on-site base stations (AB20 and AB73) are no longer stable for measuring relative movements. In the January 2024 survey the Smartnet RTN network utilizing remote base stations connected by the Internet was used to measure positions and vectors which are re-referenced to PVE3RP and PVE3 in a network least squares adjustment. See discussion hereafter.

For data management purposes the point names are prefixed with a sequential monitoring number to distinguish subsequent surveys. For example, on the 16th monitoring survey, AB02 was named M16AB02 where M16 indicates the sequence number since the first Monitoring Survey "M01" in September 2007. The prefix is stripped in these Reports.

October 2023 GNSS Survey Monitoring Points Network



GNSS October 2023 Survey Parameters, Metadata & Equipment

Date of Annual Initial Survey: M38 – October 10, 2023 (mean date) between 0800-1700 PDST (+7 hrs for UTC).
Constellations: GPS (31 Satellites), Russian GLONASS (23 Satellites), Galileo (23 Satellites) and Beidue (40 Satellites).
Observables (Carrier Waves): GPS (L1, L2, L5), GLONASS (L1, L2), Beidue (L1, L2); & Galileo (4 Carrier Waves)
Data Epoch Rate - 0.2 seconds (20HZ) at the GS18 Rover; 1 second at the GS18 Base
Satellites: 20-40; **GDOP:** < 2; **Elevation Mask:** 0° at the Rover and Base Station
Ephemeris: Broadcast for RTK vectors.
Weather: Mostly calm clear skies, temperature 65-75° F, no significant weather.
Space Weather: Boulder K Index 1-3 averaging 2 (gauges ionospheric activity on a scale of 0-9; less than 6 preferred)
Equipment: GNSS Base Receiver Unit No. M11, Operator: M. McGee, PLS; Occupied Base Station
Receiver Make & Model: Leica GS18 with integrated Antenna; Mount: Tripod & Tribrach
GNSS Rover Receiver Unit No. M10, Operator: M. McGee, PLS
Receiver Make & Model: Leica GS18T with integrated Antenna; Mount: Fixed Height Pole #4
Processing & Adjustments: Leica Infinity v4.0 and "Starnet-PRO" version 11.0.6 Software

Prior to 2019, geodetic grade GNSS receivers collected static satellite signal data for post processing. The instrumentation was upgraded in 2020 to a Leica GS18 Base with a GS18T RTK Rover operating in real-time with an FM radio system which utilizes the latest technology to deliver increased productivity and precision of point positions. The GS18 receiver incorporates an Inertial Measurement Unit and tracks four Global Navigation Satellite Systems (GNSS): GPS, GLONASS, Galileo and Beidue Satellites. The differences in two measured vectors are acceptable if they fall within 0.03 feet (1 cm) horizontally; otherwise, additional measurements are usually obtained with some exceptions. Experience has shown the independent measurements generally agree on average about 0.02 feet when referenced to a local base receiver.

ADJUSTMENTS & ANALYSIS

Network Adjustment: A minimally constrained adjustment is utilized to develop NAD83 (2007) 2007.00 Epoch Zone 5 State Plane Coordinates and NAVD88 Heights of the monitoring points. The NAVD88 orthometric heights (elevations) are determined by combining the measured ellipsoid heights with the Geoid 03 Model. Previously, Point AB02 was fixed, and the stability verified relative to PVE3RP which is 1.5 to 3 miles westerly and outside the influence of the land movements. AB02 is expected to be stable and unaffected by the land movement; however, due to the substantially increased rates of movement resulting in dynamically differential movements the process was modified as noted above to assure accurate positions. This was accomplished by computing daily positions on the Base Station AB73 (AB731, AB732, AB733, AB734, AB735) relative to the reference frame fixed at station PVE3 noted above. Listed here are the differences.

	Differences in Feet			
ID	dN	dE	dZ	
PVE3	**0.000**	**0.000**		**Fixed Horizontal, CGPS Station at City Hall**
AB02	**-0.022**	**-0.008**	**0.000**	**Fixed Elevation & Horizontal Check**
PVE3RP	**-0.010**	**-0.003**	**-0.055**	**Closure Check from PVE3 to AB73 to PVE3RP at City Hall**
PVHS	**-0.035**	**0.003**		**Horizontal Check on CGPS Station 2 Miles North of PB**

Comments: Fixing the CGPS station PVE3 (fixed constraint since 2007) finds the differences at PVHS, PVE3RP and AB02 are insignificant measurement noise. Given that AB02, PVE3RP, PVE3 and PVHS are in good relative agreement, the survey reference frame is deemed stable and successfully recovered from which local land movements were determined.

ACCURACY STATEMENTS

Vector Residuals: In this Initial Survey, the two-dimensional vector residuals averaged 0.012 feet and the absolute value of the vertical residuals averaged 0.02 feet as listed below. The vector residuals are based on a network adjustment of independent point positions.

Vector Lengths(ft)		Two Dimensional Residuals			Absolute Vertical Residuals		
Vary	Average	Average	Std.Dev.	Maximum	Average	Std.Dev.	Range
131-16391	3792	0.012	0.006	0.029	0.02	0.02	-0.03 to +0.08

Movement Accuracy: A point is deemed to have moved if, at the 95% level of confidence the horizontal movement (signal) of a point between two epochs is greater than the 95% Error (noise). Based on multiple independent occupations, the horizontal (2D) movements reported between October 2022 (M34) and October 2023 (M38) statistically attained a relative average accuracy of 0.014 feet at the 95% Level of Confidence with a Standard Deviation of 0.004 feet and a Range of 0.01 to 0.03 feet. See the attached file "PB MOVEMENT DATA POSTING …..xlsx" for movements and coordinates.

Table of 2D & Vertical Movements for 12.0 Months October 10, 2022 (M34) & October 10, 2023 (M38)
Listed below are the movement Azimuths (directions clockwise from North) in degrees, the two-dimensional horizontal movements, and the vertical (elevation) changes during the period in US Survey Feet. See the attached spreadsheet "PB MOVEMENT DATA POSTING…..xlsx". Note: The horizontal measured movement confidence is estimated at +/-0.02' (1/4"); therefore, movements of less than 0.03' are statistically indeterminate. The estimated vertical measured movement confidence is +/-0.05'.
* = Control Point for Recovery of the Reference Frame.

Point ID	Azimuth°	Horizontal Movement	Vertical Movement		Point ID	Azimuth°	Horizontal Movement	Vertical Movement
AB01	244	0.06	0.0		KC02	196	1.99	0.1
AB02	201	0.02	0.0		KC05	219	0.88	-0.1
AB04	223	4.80	-0.6		KC06	253	1.34	-0.5
AB05	231	3.51	-0.6		KC07	256	0.02	0.0
AB13	198	2.48	-0.6		KC13	193	0.70	0.1
AB16	191	1.20	0.0		KC14	259	0.12	-0.1
AB17	187	0.06	0.0		KC15	233	1.36	-0.4
AB20	199	3.06	-0.1		KC16	251	0.03	0.0
AB24	198	2.68	0.0		KC17	222	1.24	-0.3
AB50	236	1.99	0.2		KC18	202	2.86	-0.3
AB51	202	2.05	-0.2		PB04	203	3.62	-0.3
AB53	192	2.75	-0.4		PB06	200	3.35	-0.3
AB57	169	2.37	-0.7		PB07	201	3.85	-0.1
AB58	183	2.22	-0.4		PB08	201	3.61	0.0
AB59	186	3.17	-0.8		PB09	198	3.49	-0.1
AB60	204	2.69	-0.3		PB12	200	4.67	-0.3
AB62	203	3.73	-0.4		PB13	201	3.83	0.1
AB63	207	3.58	-0.9		PB18	187	3.51	-0.5
AB64	155	0.35	-0.1		PB20	199	4.23	-0.4
AB65	167	1.49	-0.3		PB21	195	3.93	-0.6
AB66	196	2.29	-0.5		PB26	192	3.94	-0.4
AB67	180	1.12	-0.2		PB27	195	4.18	-0.8
AB68	193	2.03	-0.6		PB29	200	4.02	-1.0
AB70	203	2.97	-0.1		PB54	196	3.39	-0.2
AB71	158	1.76	-0.6		PB55	199	3.86	-0.8
AB73	203	3.00	-0.3		PB59	199	4.11	-0.6
CR07	171	1.87	-1.6		PB67	194	5.93	-0.8
CR50	225	0.11	-0.1		PB68	202	3.49	-0.1
CR51	223	0.08	0.0		PB69	202	3.91	-0.3
CR53	231	0.21	0.0		PB70	207	3.58	-0.8
FT06	192	3.66	-1.7		PB71	198	3.65	-0.4
FT08	257	0.06	0.0		UB02	189	4.17	0.3
FT09	271	0.08	-0.1		*PVE3RP	195	0.01	0.0

October 10, 2022 to October 10, 2023 Movement Distances (Feet) & Directions as Indicated

Note: Distances are exaggerated x 100 for viewing

Enlargement (PVDS)

Enlargement (Seaview)

MONITORING POINT MONUMENT NOTES & STATUS

See the May 2022 Survey Report for prior monument notes.
2023: 16 points added to the monitoring program as listed below. AB20 destroyed after October 2023 Survey and replaced by AB21.

MONITORING POINT MONUMENT DESCRIPTIONS

All other Point Descriptions are listed in prior Reports.
California State Plane Coordinates Zone 5 in the NAD83 (2007) Epoch 2007.00 and NAVD88 Datums are listed in the attached spreadsheet file "PB MOVEMENT DATA POSTING….".

Point Description

Points added in July and October 2023

AB21	2" Punched GIP in "Cable Box", Replaced AB20 after Oct. 2023 survey
PB72	2" mag nail & washer in conc. in 2"x 24" GIP Collared in Concrete
PB73	2" mag nail & washer in conc. in 2"x 24" GIP Collared in Concrete
PB74	2" mag nail & washer in conc. in 2"x 24" GIP Collared in Concrete
PB75	2" mag nail & washer in conc. in 2"x 24" GIP Collared in Concrete
CR54	2" mag nail & washer in conc. in 2"x 24" GIP Collared in Concrete
CW05	Found ½" x 48" Punched Rebar in Concrete Collar set June 2022 for Calwater
CW06	Found ½" x 48" Punched Rebar in Concrete Collar set June 2022 for Calwater
CW07	Found ½" x 48" Punched Rebar in Concrete Collar set June 2022 for Calwater
CW08	Found 2" Mag nail in Concrete Base of 3' Bollard set June 2022 for Calwater
KC19	2" Mag Nail Drilled in a Concrete Curb on South side of Dauntless Dr.
KC20	2" Mag Nail Drilled in a Concrete Curb on West side of Excelsior Dr.
KC21	2" mag nail & washer in conc. in 2"x 24" GIP Collared in Concrete
KC22	2" mag nail & washer in conc. in 2"x 24" GIP Collared in Concrete
KC23	2" Mag Nail Drilled in a Concrete Curb on South side of Admirable Dr.
KC24	2" Mag Nail Drilled in the Southwest Corner of a Concrete Vault, KC02 planned replacement
RP01	Check Point at Trump Golf Course established in July 2023 for verifying the recovery of a stabile reference frame. Point is the top open part of the "B" on the south side of the rim of a manhole on the south side of PVDS at Conqueror Dr.

Addendum No. 1 Report

Portuguese Bend Land Movement Monitoring Survey

Early Winter Full Monitoring Survey No. M39 - January 13, 2024

A special Portuguese Bend Full Monitoring Surveys (M39) was requested by the City in January 2024. The average date of the survey is January 13, 2024, 3.1 months after the October 10, 2023 Initial Monitoring for 2023-2024 reported above. The M39 survey included 79 monitoring points representing the present full network. A central base station (usually occupying AB73) was not feasible due to the excessive rate of land movement and reliance was made on the remote Smartnet RTN Stations which resulted in a lesser accuracy. For this survey, this was not an issue since the signal (measured movement) was much greater than the noise of the measurements expected to be less than 0.05'. A typical minimally constrained adjustment, as described above for M38, was processed for M39 to develop NAD83 (2007) Epoch 2007.00 CA Zone 5 State Plane Coordinates and NAVD88 Heights.

The horizontal (2D) vector residuals averaged 0.03 feet with a Standard Deviation of 0.02 feet. The absolute value of the vertical residuals averaged 0.04 feet with a Standard Deviation of 0.04 feet. At the 95% Level of Confidence, estimated accuracy of the horizontal (2D) movements is 0.05 feet.

The adjustment fixed point PVE3RP (an indirect fix on PVE3) and checked to other points found to be stable. Differences from the known fixed positions to the measured positions in this survey are listed here with their north, east and vertical components in feet. The successful recovery of a stable reference frame (coordinate system) is confirmed.

	Differences in Feet			
ID	dN	dE	dZ	
PVE3RP	0.00	0.00	0.00	Fixed Reference at City Hall
AB02	0.01	0.01	-0.05	Check Point at Portuguese Point
RP01	-0.01	0.01	0.05	Check Point at Trump Golf Course

Table of 2D & Vertical Movements for 3.1 Months October 10, 2023 (M38) & January 13, 2024 (M39)

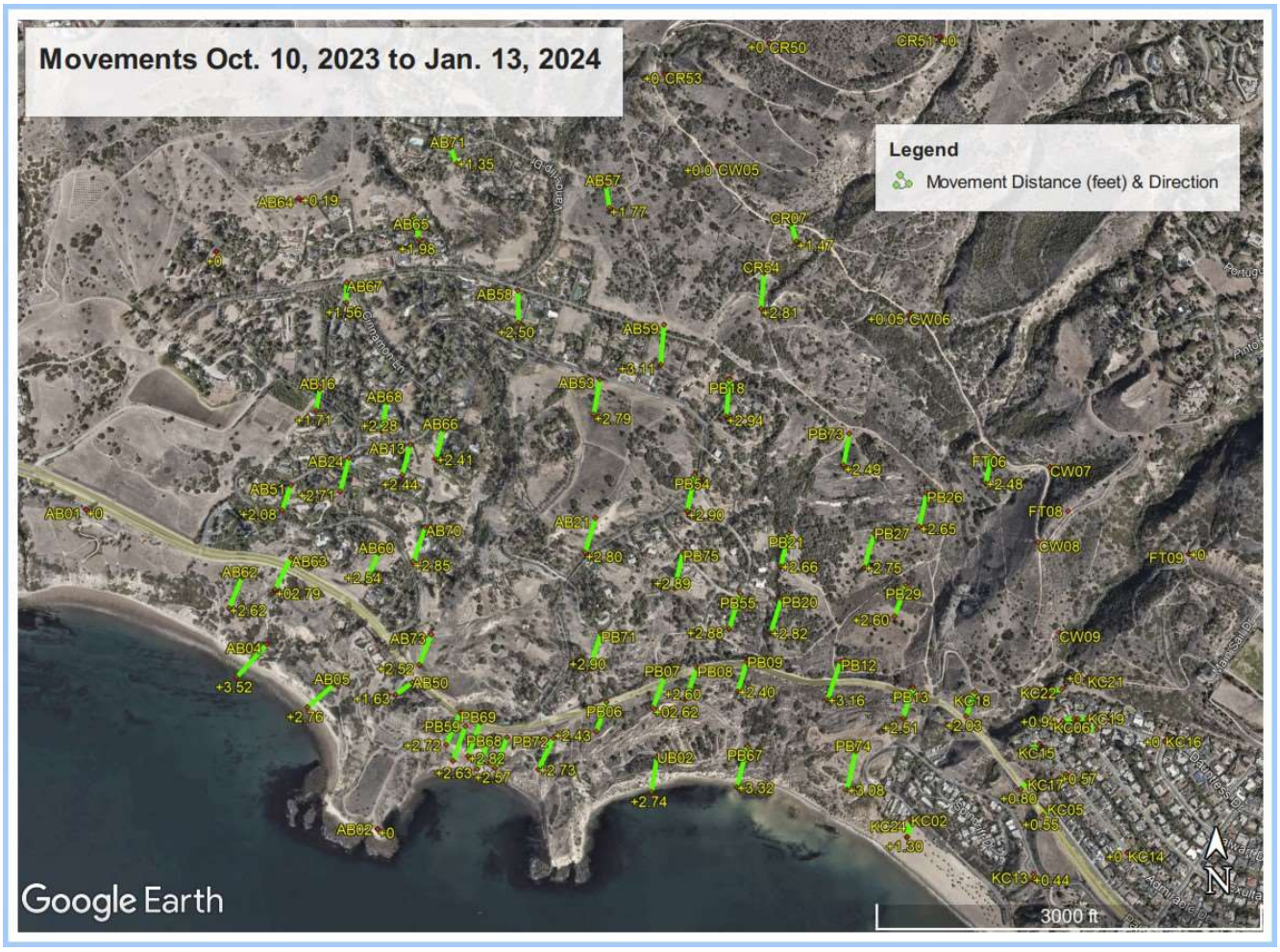
Listed below are the movement Azimuths (directions clockwise from North) in degrees, the two-dimensional horizontal movements, and the vertical (elevation) changes during the period in US Survey Feet. See the attached spreadsheet "PB MOVEMENT DATA POSTING (Revised 012224) 2007-Jan2024.xlsx". Note: The horizontal measured movement confidence is estimated at +/-0.04' (1/2"); therefore, indicated movements of less than 0.05' are statistically indeterminate. The estimated vertical measured movement confidence is +/-0.08'.
* = Control Point for Recovery of the Reference Frame.

Point ID	Azimuth°	Horizontal Movement	Vertical Movement		Point ID	Azimuth°	Horizontal Movement	Vertical Movement
AB01	23	0.01	-0.1		KC13	188	0.44	0.0
AB02	27	0.01	0.0		KC14	262	0.03	0.0
AB04	223	3.52	-0.4		KC15	233	0.91	-0.3
AB05	230	2.76	-0.4		KC16	88	0.02	0.0
AB13	195	2.44	-0.4		KC17	218	0.80	-0.3
AB16	190	1.71	-0.1		KC18	200	2.03	-0.3
AB17	118	0.03	0.0		KC19	269	0.74	-0.2
AB21	197	2.80	0.1		KC20	277	0.67	-0.2
AB24	195	2.71	0.0		KC21	92	0.04	0.0
AB50	234	1.63	0.0		KC22	255	1.07	-0.5
AB51	200	2.08	0.0		KC23	237	0.57	-0.3
AB53	190	2.79	-0.3		KC24	199	1.22	-0.1
AB57	170	1.77	-0.5		PB04	202	2.63	0.0
AB58	179	2.50	-0.4		PB06	200	2.43	-0.2
AB59	185	3.11	-0.8		PB07	201	2.62	0.0
AB60	204	2.54	-0.2		PB08	201	2.60	0.0
AB62	203	2.62	-0.3		PB09	197	2.40	-0.1
AB63	207	2.79	-0.8		PB12	199	3.16	-0.3
AB64	128	0.19	0.0		PB13	199	2.51	0.0
AB65	167	1.98	-0.6		PB18	185	2.94	-0.5
AB66	193	2.41	-0.4		PB20	198	2.82	-0.3
AB67	181	1.56	-0.3		PB21	194	2.66	-0.5
AB68	191	2.28	-0.4		PB26	193	2.65	-0.2
AB70	200	2.85	-0.2		PB27	196	2.75	-0.5
AB71	158	1.35	-0.4		PB29	200	2.60	-0.7
AB73	202	2.52	-0.1		PB54	192	2.90	0.0
CR07	164	1.47	-1.2		PB55	198	2.88	-0.5
CR50	37	0.04	0.0		PB59	200	2.86	-0.3
CR51	107	0.04	0.2		PB67	195	3.32	-0.3
CR53	180	0.02	0.1		PB68	202	2.57	0.0
CR54	185	2.81	-0.9		PB69	201	2.82	-0.1
CW05	185	0.02	0.1		PB70	204	2.72	-0.3
CW06	59	0.05	0.1		PB71	197	2.90	0.0
FT06	191	2.48	-1.1		PB72	206	2.73	0.3
FT09	148	0.02	0.2		PB73	190	2.49	-0.4
KC02	193	1.30	0.0		PB74	193	3.08	-0.4
KC05	215	0.55	0.0		PB75	193	2.89	-0.1
KC06	256	0.94	-0.4		UB02	189	2.74	0.2
KC07	135	0.01	0.0		*PVE3RP	0	0	0.1

McGEE SURVEYING CONSULTING
5290 Overpass Road, Ste#107, Santa Barbara, CA 93111

October 10, 2023 to January 13, 2024 Movement Distances (Feet) & Directions as Indicated

Note: Distances are exaggerated x 100 for viewing



Enlargement (PVDS)

Enlargement (Seaview)

ASSESSMENT of MOVEMENT VELOCITIES & ACCELERATIONS 2014 to 2024

Others performed monitoring surveys of the Portuguese Bend land movement between 1994 and 2006. McGee Surveying Consulting assumed responsibility and defensibility for the Portuguese Bend Monitoring Program in 2007. The annual measured movements between 2007 and 2018 were fairly small and stable as shown below by the averages and maximums of a sampling of points for the 2014-2018 period. The fall 2019 monitoring survey found the annual rate of movements (velocities) increased (accelerated) about 4 to 6 times and remained stable for the next four years through 2022. A "year" here is defined as the 12-month period beginning with the rainy season on October 1st.

Annual Average Movements in Feet, Maximum Movements & Change in the Average of a Sample of Points

	2014-2018 (4 Yrs)		2018-2022 (4 Yrs)		Change in
ID	Average	Max.	Average	Max.	Average
AB20	0.09	0.20	0.48	0.54	+5X
AB53	0.07	0.18	0.43	0.49	+6X
AB68	0.05	0.11	0.31	0.32	+6X
CR07	0.06	0.13	0.30	0.32	+5X
KC06	0.04	0.09	0.16	0.22	+4X
PB55	0.89	1.31	0.89	1.23	+1X (No Change)

In the following twelve months between October 2022 and October 2023, the annual rate of movements were found to have again accelerated. The table below shows a sample of points within Abalone Cove (AB), Klondike Canyon (KC) and Portuguese Bend (PB). The left half of the table compares the annual movements and rate of movements per month for the October 2021 to October 2022 with the October 2022 to October 2023 period. The annual rate of movement for the sample averages in each slide increased about 6x for AB, 8x for KC and 5x for PB.

In the same 12-month period between October 2022 and October 2023, accelerations were noted in the first seven months over the previous year and again in the last five months over the previous seven months as shown in the right half of the table below. The average rate of movement in each slide for these samples in the first seven months October 2022 through April 2023 increased about 3x for AB, 4x for KC and 2x for PB over the previous 12-month period of October 2021 to October 2022. The average rate of movements in each slide for the samples in the last five months May 2023 to October 2023 increased 4x for AB, 4x for KC and 3x for PB over the previous seven months.

October 2021 to October 2023 Movements & Rates per Month (Feet)								
	M32 > M34 (12 Mo.)		M34 > M38 (12 Mo.)		M34 > M36 (7 Mo.)		M36 > M38 (5 Mo.)	
Point	Oct '21 > Oct '22		Oct '22 > Oct '23		Oct '22 > May '23		May '22 > Oct '23	
	Movement	Rate/Mo	Movement	Rate/Mo	Movement	Rate/Mo	Movement	Rate/Mo
AB20	0.51	0.042	3.06	0.255	0.84	0.119	2.22	0.444
AB53	0.49	0.041	2.75	0.229	0.74	0.105	2.01	0.403
AB58	0.41	0.034	2.22	0.185	0.60	0.085	1.62	0.325
AB60	0.45	0.038	2.69	0.224	0.80	0.114	1.90	0.379
AB67	0.18	0.015	1.12	0.094	0.32	0.046	0.80	0.160
AB68	0.32	0.027	2.03	0.169	0.54	0.077	1.49	0.299
AB70	0.48	0.040	2.97	0.248	0.84	0.120	2.14	0.427
CR07	0.31	0.026	1.87	0.156	0.44	0.062	1.43	0.287
Av Move	0.39	0.033	2.34	0.195	0.64	0.091	1.70	0.340
KC06	0.16	0.014	1.34	0.111	0.33	0.047	1.01	0.202
KC13	0.09	0.007	0.70	0.058	0.19	0.027	0.51	0.102
KC17	0.14	0.012	1.24	0.104	0.31	0.044	0.93	0.187
Av Move	0.13	0.011	1.09	0.091	0.27	0.039	0.82	0.163
PB55	0.80	0.067	3.86	0.321	1.06	0.151	2.80	0.560
PB70	0.72	0.060	3.58	0.299	1.14	0.163	2.44	0.488
Av Move	0.76	0.063	3.72	0.310	1.10	0.157	2.62	0.524

Movement & Rate of Movement per Month

In the last 3-month period October 10, 2023 to January 13, 2024, accelerations were noted again relative to the previous 12-months. The average rate of movements in each slide for the last 3-months for these samples increased about 4x for AB, 3x for KC and 3x for PB over the previous 12-month period of October 2022 to October 2023.

Point	M38 > M39 (3.1 Mo.) Oct. 10, 2023 to Jan. 13, 2024	
	Movement	Rate/Mo
AB20	2.80	0.903
AB53	2.79	0.900
AB58	2.50	0.806
AB60	2.54	0.819
AB67	1.56	0.503
AB68	2.28	0.735
AB70	2.85	0.919
CR07	1.47	0.474
Average	2.35	0.758
KC06	0.94	0.303
KC13	0.44	0.142
KC17	0.80	0.258
Average	0.73	0.236
PB55	2.88	0.929
PB70	2.72	0.877
Average	2.80	0.903

RECOMMENDATION

Continuity in the methods, precision and reporting of the monitoring surveys are necessary to evaluating results relative to and consistent with prior 2007-2024 monitoring survey campaigns. Monitoring survey campaigns require the services of an independent GNSS/Geodetic expert to evaluate and validate results to assure program integrity and defensibility.

Maintaining a clearing of foliage in a 10' radius around monitoring points and trimming nearby trees and brush above eye height is necessary to assure a clear view of the sky for tracking satellites. Satellites, although unseen, can appear anywhere in the sky above the horizon and the radio signals passing through foliage degrade the required survey accuracy and productivity. Presently, Points AB04, AB13, AB17, AB24, AB51, AB58, AB66, PB18, PB54, CR51 and CR53 have foliage obstructions limiting sky (satellite) visibility and require clearing prior to the next survey.

SURVEYOR'S STATEMENT

This Fall October 2023 Full Survey and the early Winter January 2024 Full Survey and Report on the procedures, criteria, and results of the City of Rancho Palos Verdes Portuguese Bend Land Movement Monitoring Surveys was prepared by me on October 30, 2023 and updated January 30, 2024 at the request of Ramzi Awwad, City Engineer of the City of Rancho Palos Verdes.

Michael R. McGee, PLS3945

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Addendum No. 2 Report

Portuguese Bend Land Movement Monitoring Survey

Winter Partial Monitoring Survey No. M40 – March 8, 2024

This is the mid-winter Partial Monitoring Survey M40 Report. The average date of the survey is March 8, 2024, 1.8 months after the January 13, 2024 Full Monitoring Survey. The survey included 44 monitoring points and 3 reference control points. Occupying a central base station (usually AB73) was not feasible due to the excessive rate of land movement and reliance was made on the remote Smartnet RTN Stations which resulted in a lesser accuracy. For this survey, this was not an issue since the signal (measured movement) was much greater than the noise of the measurements expected to be about 0.05'. A typical minimally constrained adjustment, as described above for M38, was processed for M40 to develop NAD83 (2007) Epoch 2007.00 CA Zone 5 State Plane Coordinates and NAVD88 Heights.

The adjustment fixed point PVE3RP and checked to other points expected to be and found stable. Differences from the known fixed positions to the measured positions in this survey are listed here with their north, east and vertical components in feet.

	Differences in Feet			
ID	dN	dE	dZ	
PVE3RP	0.00	0.00	0.00	Fixed Reference at City Hall
AB02	0.02	0.01	-0.09	Check Point on Portuguese Point
RP01	0.00	0.02	-0.10	Check Point at Trump Golf Course

The successful recovery of a stable horizontal reference frame confirmed. The Z height variations are attribted to the noise in the Smartnet Network solution.

2D Horizontal & Vertical Movements for 1.8 Months January 13, 2024 (M39) to March 8, 2024 (M40)

The general rate of land movement increased significantly over the January 13, 2024 survey assessment. See the attached spreadsheet "PB MOVEMENT DATA POSTING…. .xlsx" for the movement Azimuths (directions clockwise from North) in degrees, the two-dimensional horizontal movements, and the vertical (elevation) changes during the period in US Survey Feet. See also the column for the rate of movement for each period annualized for an average month.

Accuracy Statements

The horizontal (2D) vector residuals averaged 0.04 feet with a Standard Deviation of 0.03 feet. The absolute value of the vertical residuals averaged 0.04 feet with a Standard Deviation of 0.03 feet.

At the 95% Level of Confidence, the accuracy of the horizontal (2D) movements is estimated to be less than 0.04'. Movements of less than 0.05' are statistically indeterminate. The estimated vertical measured movement confidence is 0.06' to 0.09'.