

Survey Report

of the

Portuguese Bend Landslide Monitoring Surveys

Dated: Feb. 3, 2016, Revised & Appended March 11, 2016, Appended April 22, 2016, Revised Aug. 9, 2016
for the

City of Rancho Palos Verdes

prepared by

McGee Surveying Consulting

The Portuguese Bend Landslide is monitored on a tri-annual basis beginning and ending with the rainy season. The initial survey of about 70 monuments is conducted in the early fall and reported below in detail. Two subsequent partial monitoring surveys of about 30 monuments are conducted in mid-winter and early spring. The second and third surveys are reported as Addendums No. 1 and No. 2 to this Report. Therefore, this Report is issued three times with the third being the final for the particular rainy season. The average date of the surveys follows.

Initial Survey - Full Monitoring: October 8, 2015

Second Survey - Partial Monitoring: February 16, 2016

Third Survey - Partial Monitoring: April 19, 2016

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ATTACHMENT: "PB MOVEMENT DATA POSTING 2007-present.xlsx" (Overall & Periodic Movement)

Survey Report
of the
Portuguese Bend Landslide Monitoring Survey
October 8, 2015 Full Monitoring
for the
City of Rancho Palos Verdes
prepared by
McGee Surveying Consulting
February 3, 2016

PROJECT OVERVIEW:

McGee Surveying Consulting performed a landslide monitoring and control survey dated October 8, 2015 at Portuguese Bend on behalf of the City of Rancho Palos Verdes. This survey established positions on monitoring points to determine overall and periodic movements. The results of the survey are described in this Report and in the attached spreadsheet titled "PB MOVEMENT DATA POSTING 2007-2015.10.xlsx". Two partial monitoring surveys will be performed in the winter and spring and reported as addendums to this Report.

The field survey was planned, coordinated and executed by Michael McGee, PLS3945 of McGee Surveying Consulting who was also responsible for the final processing of the observations, network adjustments, analysis and reports. The monitoring points cover a 1½ mile square area and are measured to determine the rate and extent of ground movement. This monitoring program has occurred annually since 2007, semi-annually since 2012 and three times a year beginning with the September 2014 survey. The area has been monitored by the City of Rancho Palos Verdes since 1994 and prior by the County of Los Angeles. The Global Navigation Satellite System (GNSS formerly referred to as GPS) technology was used to measure positions based on the North American Datum of 1983 (NAD83) and the North American Vertical Datum of 1988 (NAVD 88). This survey is referenced to the California CGPS (Continuous GPS) Stations in the region which are permanently mounted GPS receivers used for monitoring seismic activity. The CGPS in California are similar to the national CORS (Continuously Operated Reference Stations).

Points that move a few inches or less per year are required to meet an accuracy standard of one centimeter (0.033 feet) at the 95% Level of Confidence. In the active slide area where the movements are greater than 0.25 feet per year (PB and UB points), the accuracy standard is two centimeters (0.066 feet) at the 95% Level of Confidence. Field procedures are designed to accomplish this purpose and Quality Control-Quality Assurance (QAQC) processes discussed hereafter are incorporated to verify these accuracies are attained.

Prior to September 2007, successive coordinate differences were used to compute movements which do not provide statistical information about the relative movement accuracies. Beginning with the initial 2007 survey, field and office procedures were designed to assure the accuracy and reliability of measurements and provide for queries between epochs that include statistical information about the relative precisions of the reported movements. Thereafter, measurements of temporal movements are based on a rigorous simultaneous least squares adjustment of multiple observations at two different epochs for each point.

HISTORY

This monitoring survey is a continuation of a program initiated by the County of Los Angeles and taken over by the City of Rancho Palos Verdes circa 1994. McGee Surveying Consulting has conducted the field surveys and reporting since September 2007. See the September 2007 Survey Report for a history of the previous survey process between 1994 and 2007. See the Survey Reports subsequent to 2007 for details of each monitoring campaign. Beginning with the 2012 rainy season (begins in September) full monitoring continued as usual and a

partial monitoring was initiated in the following winter-spring. Beginning in September 2014 a full monitoring was conducted and a partial monitoring surveys were conducted in the February and April.

PROJECT DATUMS, REFERENCE SYSTEM

Horizontal Datum: North American Datum of 1983 established by the National Geodetic Survey (NGS) referred to as NAD83 (2007) 2007.00 Epoch. The NAD83 (2007) 2007.00 Epoch adjustment is one of a series of national adjustments of NAD83 since its adoption in 1986 and is the realization used for these monitoring surveys since 2007. The latest realization of NAD83 is the 2011 adjustment referred to as NAD83 (2011) 2010.00 Epoch; however, the above referenced 2007 realization is retained to be consistent with prior reporting and the primary purpose of determining relative changes over time.

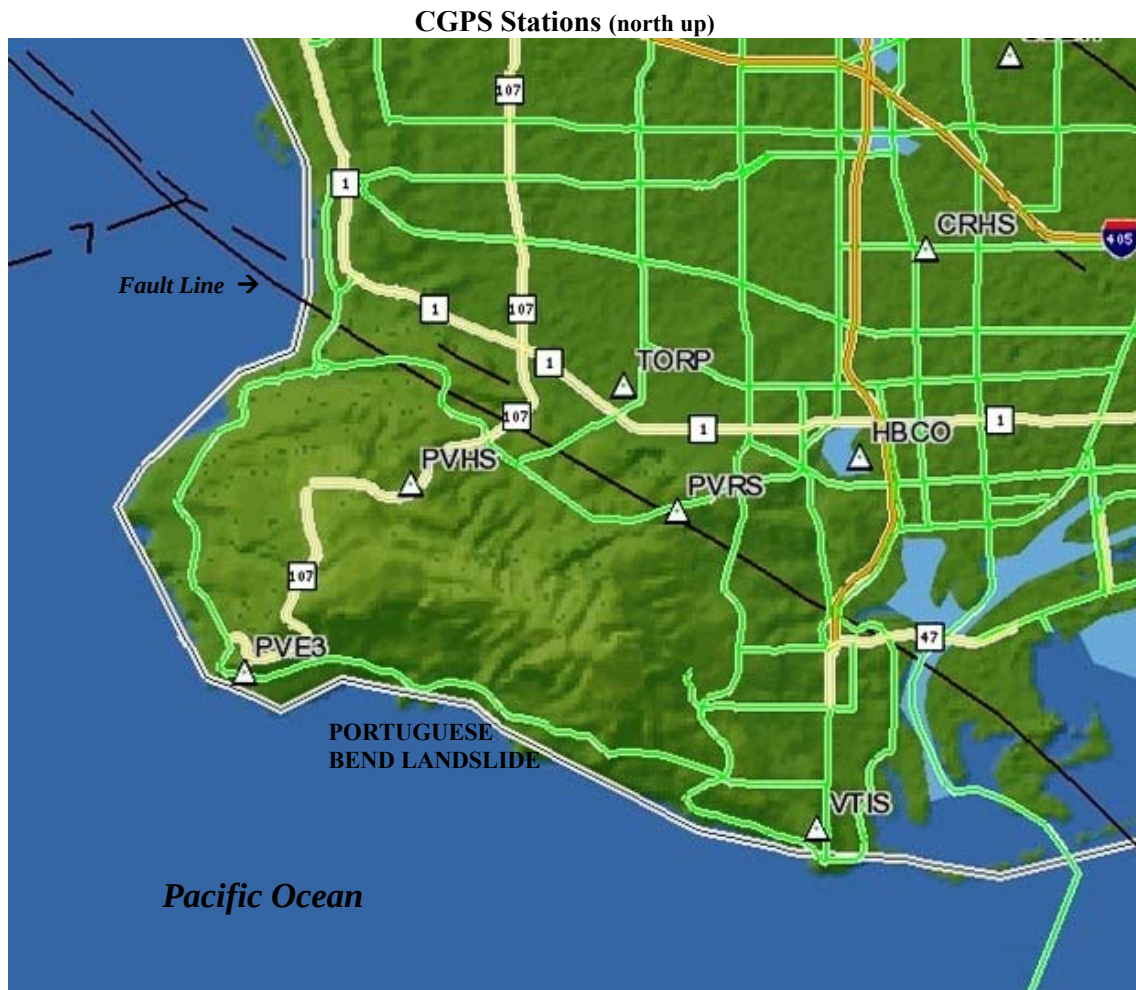
Reference Network: The survey is referenced to the CGPS Stations (continuously operating GNSS receivers). For more information see NGS Data Sheets for the PID's listed below (no data sheet exists for PVE3). The positions listed below were obtained in September 2007 from the California Spatial Reference Center (CSRC). The CSRC provides CA Public Resources Code sanctioned positions for the California CGPS Stations.

Units: Feet

CGPS	Latitude(dms)	Longitude(dms)	EH(feet)	NGS PID	NAME
PVE3	33 44 35.853290	-118 24 15.269036	235.42	none	PALOS VERDES CORS
PVHS*	33 46 46.020150	-118 22 19.741258	853.99	AJ1915	PENINSULA HIGH SCH
PVRS**	33 46 25.891904	-118 19 14.067218	198.63	AJ1916	PALOS VERDES RES
VTIS	33 42 45.489584	-118 17 37.712290	197.52	AJ1936	MARINE EXCHANGE

* Not Operational During Survey

** Falls in the proximity of a Fault Line as shown below but appears unaffected to date



Vertical Datum: North American Vertical Datum of 1988 (NAVD88) established by the NGS.

Reference Network: CGPS Station VTIS is also a Second Order leveled benchmark and the original basis for the heights by this survey.

CGPS	NAVD88 Ht (feet)	
PVE3	none	
PVHS	972.1	Based on a Refined Geoid Model
PVRS	316.37	Based on Second Order Leveling by CSRC
VTIS	315.26	Based on Second Order Leveling by CSRC and original basis for this survey

Geoid Model: Geoid 03; note Geoid09 became available from the NGS in 2009 and Geoid12A in 2012; however, Geoid03 is retained to be consistent with prior reported heights and the primary purpose of determining relative changes over time.

Projection: NAD83 California State Plane Coordinates Zone 5 in US Feet: The State Plane Coordinate Parameters follow: The average Scale Factor is 1.00007543, the Height Reduction Factor based on the average ellipsoid heights is 0.99999092, and the average Combined Grid Factor is 1.00006635. Distances in this survey are grid. To obtain ground distances divide grid distances by the Combined Grid Factor. Grid bearings resulting from this survey must be rotated by a Convergence Angle to obtain geodetic (true) bearings. The average convergence angle is -0-12-30± (rotate left 0-12-30).

Datum Stability: Rancho Palos Verdes sits on the Pacific Plate which is moving west-northwesterly relative to the North American Plate about 4 centimeters (0.14 feet) per year. The area southwesterly of the Fault Line shown on the above map includes the City and is moving at a constant rate as exhibited by the International Terrestrial Reference Frame (ITRF) north, east and up velocities of the CGPS Stations listed below. Note, there was no change.

ANNUAL VELOCITIES IN METERS					
SITE	N	E	U	START_DATE	END_DATE
PVE3	0.019	-0.039	-0.000	2000.7327	2016.0397
PVRS	0.019	-0.039	0.000	1999.0948	2016.0397
VTIS	0.019	-0.039	-0.001	1998.9407	2016.0397

These CGPS Stations provide a rigid reference frame for the Portuguese Landslide Monitoring Program that is validated during each monitoring campaign. See the Adjustments results below and the September 2007 Monitoring Survey Report by McGee Surveying Consulting for additional information.

FIELD SURVEYS, DATA COLLECTION, EQUIPMENT & PROCESSING

Three Leica geodetic GNSS receivers/antennas listed below were mounted on two meter fixed height poles or tripod/tribrach to collect satellite signal data. The GS15 receivers track Navstar GPS and GLONASS satellites. Prior to initiating the field observations a calibration of the poles and tribrach were conducted to verify their heights and plumb. The top of the poles were found to be plumb within 0.003 feet of the bottom consistent with prior years. There were no equipment failures.

Sixty-nine monitoring points were occupied and reported in this survey. Site photographs and recovery sheets detailing the location, character of the monuments and obstructions were maintained and updated. See the Appendix for "Monitoring Point Status". Monument AB61, established in September 2007 on Portuguese Point, is used as the primary base station in each survey because it sits above a stable basalt formation. AB20 serves as a secondary base during the surveys.

The field survey commenced each day by setting a Leica GS15 GNSS receiver on a fixed height pole at AB61 and on a tribrach/tripod at AB20 while a third GS15 GNSS receiver roamed freely collecting observations on a fixed height pole at the other 68 points. Points with annual movements less than 0.25' were measured with two or more independent occupations resulting in a minimum of four vectors to each point from AB61 and AB20. Independent occupations means the points were occupied under a different constellation of satellites usually on a different day. If the two measurements were within 0.03 feet (1 cm) horizontally, they were accepted,

otherwise a third measurement was required. On each day over a six day period, vectors based on 8 hours of observations connected AB61, AB20 to the CGPS stations. Twenty points, in the active areas, with annual movements greater than 0.25' were single occupied. A comparison with the linear movements from prior years was made to verify their accuracy.

Many of the points are over-shadowed by mature trees and shrubberies which interfere with signals received from satellites and affect the quality of measurements. To obtain the best possible accuracies, the satellite constellation is compared with obstruction diagrams to estimate the best time for observing un-obstructed satellites. To improve the accuracy of the measurements, satellites obstructed by foliage and trees are either turned off during the observation or noted for removal in post-processing. If six or more un-obstructed satellites with a GDOP of less than three (measure of the geometry or strength of figure of the constellation) are available, then the measurement commenced for a minimum of 15 minutes of data collection. If the geometry and number of satellites are insufficient then the receiver was moved to another point and returned later when satellite availability improved.

Date of Survey: 10/04/15 to 10/13/15 (mean date 10/08/2015) between 0600-1800 PDST (+7 hrs for UTC).

GNSS Survey Parameters:

Constellation: 30 US NAVSTAR GPS satellites and 24 Russian GLONASS satellites.

Observables: GPS L1 & L2 and GLONASS L1 & L2 Carrier Waves

Epoch Rate - Occupation Times: 15 seconds epoch rate - 15 minute occupations at monitoring points and six 8 hour occupations at base stations.

Satellites: 11-17; GDOP ≤ 2 ; Elevation Mask for Data Collection at 15° and Processing at 15°

Ephemeris: Rapid for Static Post-Processing of CGPS connections and Broadcast for onsite.

Weather: A mixture of clear and cloudy skies, temperature 68°-85° F, no significant weather.

Space Weather: Boulder K Index was 2-3 except 5-7 on 10/07/15, 3-5 on 10/12/15 and 4 on 10/13/15 (gauges ionospheric activity on a scale of 0-9; prefer less than 5 to avoid noisy data).

Equipment:

GNSS Base Receiver Unit No.: M5, Operator: M. McGee, PLS; Station Occupied: AB61 (Base1)

Make & Model: Leica GS15; Antenna Leica GS15; Mount: Fixed Height Pole #1; Antenna Height: 1.803m

GNSS Rover Receiver Unit No.: M6, Operator: M. McGee, PLS;

Make & Model: Leica GS15; Antenna Leica GS15; Mount: Fixed Height Pole #3; Antenna Height: 1.800m

GNSS Rover Receiver Unit No.: M7, Operator: M. McGee, PLS, Station Occupied: AB20 (Base2)

Make & Model: Leica GS15; Antenna Leica GS15; Mount: Tribrach on Tripod; Antenna Height: varies

Vectors were processed using Leica LGO v8.4 post processing software. Analysis of residuals led to the rejection of 5 out of 52 vectors connecting the CGPS Stations to AB61 and AB20, and 0 out of 226 vectors connecting monitoring points. Network adjustments and analysis were performed with "Starnet-PRO" version 8.1.2 software. Rinex files of the satellite measurements for the CGPS Stations were downloaded from the SOPAC website. The Rapid Ephemeris and Absolute Antenna Models were downloaded from the NGS website.

NETWORK

AB61, the primary Base Station, sits on Portuguese Point and is the focal point of the static network connecting the monitoring points and CGPS Stations. AB20, a second Base Station is centrally located sitting on top of a high bluff overlooking Portuguese Bend. Sixty-nine points and three CGPS Stations were connected with 278 vectors. See the following Network Maps and the Aerial View in the Appendix.

The monitoring plan utilizes the CGPS Stations to verify the stability of the reference frame. The primary CGPS Station used to control this survey is PVE3 located just south of City Hall and 1.8 miles west-northwest of Base Station AB61. CGPS Stations PVR3 (3.9 miles northeast) and VTIS (4.9 miles east-southeast) are used to validate the stability of the network. During this survey PVE3, PVR3 and VTIS were operating.

MONITORING POINT HISTORY and STATUS

This is the 13th Monitoring Survey. For data management purposes during the field survey and data processing, the point names are prefixed with the sequential number of the survey to distinguish between monitoring surveys. For example, on the 13th monitoring survey, AB61 was named M13AB61 where M13 indicates the sequence number of the survey since the initial September 2007 Monitoring Survey. The prefix is stripped in the COORDINATES LIST and FULL DATA POSTING.

Between 1994 and 2006, 149 monitoring points were established to monitor the Portuguese Bend Landslides, many of which were lost or destroyed. Sixty of the original points were recovered in 2007. Eight of the 60 points were deleted because they were in close proximity of other points better suited for GNSS satellite measurements leaving 52 points monitored and reported between September 2006 and September 2007. Three of the 52 points (AB09, KC11 & PB51) were monitored in September 2007 for the last time and replaced by new points, set nearby and better suited for satellite observations.

2007: Eighteen new points were set in 2007 and had their movements reported for the first time in the following December 2008 survey. In September, it was noted that KC01 was previously reported by others on 9/14/2006 to have moved N 29°E 1.24' from its 12/9/2005 position. In the September 2008 survey, a buried partially illegible brass cap in concrete stamped "COUNTY ENGINEER RE8869 1956 STA ??IELDS" was found S31°29'W 1.48 feet from the 1" IP used by this survey in the initial September 2007 and subsequent surveys. The original 1994 position of KC01 was re-referenced to the 1" IP, resulting in correct overall reported movements.

2008: In December 2008, 49 original and 18 new points were surveyed for a total of 67 monitoring points. In December, it was noted that AB05 had been disturbed by a mowing machine. AB05 was found chipped and leaning to southerly about 0.4'. The movement reporting resumed in 2009. Analysis of the movement and historic data made it possible to estimate the disturbance to within 0.05'. The original 1995 position of AB05 was re-referenced S14°02'E 0.29' to be consistent with the disturbed position, resulting in correct overall reported movements.

2009: PB64 was set east of the Archery Range to replace PB63 (set 2007) which had become unsafe to access and was lost in 2010. PB64 was reported for the first time in October 2010.

2010: Points AB03 and BB25 were discontinued. AB03 is on the edge of a cliff 192 feet west-southwest of AB61 making it redundant, and BB25 is on a freestanding rock susceptible to disturbance by wave action. In the summer of 2010, PB62 was destroyed by road construction and in October 2010, PB65 was set 24' south-southwest of PB62's location and reported for the first time in October 2011. The following points may have been disturbed prior to the October 2010 survey. AB05 appears to have been disturbed by mower machinery, AB15 (½" GIP in a meter box) is driven over by vehicles occasionally accessing an adjacent field, and KC02 (½" GIP in a meter box) is occasionally parked on by vehicles accessing the beach.

2011: In October, new points AB62 and AB63 (initially referred to as AB62R and AB63R) were set to replace AB06 and AB07 which were hazardous to occupy due to their location near the traveled way of Palos Verde Drive South.

2012: In September, prior to initiating the survey, eight new monuments AB64, AB65, AB66, AB67, AB68, CR53, KC17 and PB66 were constructed to replace AB54, AB18, AB52, AB55, AB15, CR52, KC04 and PB53 respectively. The monuments were replaced because of poor sky visibility except for KC04 which was difficult to access and AB55 which was destroyed by trenching in the past year. Monuments were set with the following design. Monuments set in soil are 1" x 5' GIP driven flush and encase in a 6" PVC pipe sitting on a concrete collar down about 18". Monuments set in asphalt are 1/2" x 2' rebar driven below the surface inside a free floating 2" concrete encased plastic collar.

2013: Points AB15, AB18, AB52, AB54, CR52, KC04 and PB53 were surveyed for the last time in 2012 and discontinued. BB52 is on a freestanding rock susceptible to disturbance by wave action and was monitored for the last time in October and discontinued.

2014: In April PB64 was monitored for the last time due to unsafe access conditions and PB67 (a 5' t-bar steel post driven 3' into the ground) was set NNW'ly about 250' as a replacement and reported for the first time in September 2014 after 4.5 months whereas all other points in the "PB Movement Data Posting" are reported for

11.5 months since October 2013. In September, AB69 about 260' NE of AB12 and AB70 about 140' SE of AB12 were set as potential replacements; however, AB69 was destroyed by lot improvements and AB70 proved to be too obstructed for accurate results.

2015: In April, new points PB68, PB69 and PB70 were set to monitor movements of "Palos Verdes Drive South" and reported in October. In October, Monitoring Point AB56 was found disturbed by construction and a magnetic nail in AC was set as a temporary replacement which was destroyed in the fall; therefore, no movement information is available. In October, the steel post for PB67 was not found and an inconspicuous ½" x 4' rebar was set in its place. Because of the rapid movement in this area a more permanent monument is not necessary.

See the "Monitoring Point Status" in the Appendix for the present status of monitoring points.

MINIMALLY CONSTRAINED ADJUSTMENTS & ANALYSIS

Adjustment 1: Adjustment to develop NAD83 (2007) 2007.00 Epoch Geodetic, Ellipsoid and State Plane Coordinates. CGPS Station PVE3 was fixed at its published NAD83 (2007) 2007.00 Epoch position in a Minimally Constrained Adjustment to determine positions and verify its stability relative to other CGPS stations. PVE3 is located 1.8 miles west of and outside the influence of the slide area. PVE3 has been fixed in all adjustments since 2007. The CSRC publishes a Time Series representing the horizontal and vertical stability of PVE3 which indicate the position has been stable prior to 2007. The primary base station AB61 and two other operating CGPS Stations were measured relative to PVE3 and used to assess stability of the survey reference frame. The positions are based on 8 hours of observations collected daily for six days and three hours on the seventh day. The coordinate differences from previous positions to the present are listed below in feet.

10/2013 Positions to 09/2014				9/2007 Positions to 09/2014			
ID	dN	dE	dZ	ID	dN	dE	dZ
PVE3	0.000	0.000	0.000	PVE3	0.000	0.000	0.000
PVRS	-0.011	-0.011	-0.003	PVRS	-0.005	0.009	-0.016
AB17	0.004	0.029	-0.078	AB17	-0.019	-0.005	-0.062
AB61	0.019	-0.005	-0.005	AB61	0.002	0.004	-0.054
CR51	0.001	-0.006	-0.047	CR51	-0.038	0.010	-0.129
KC16	0.004	-0.023	-0.038	KC16	-0.001	-0.013	-0.058

09/2014 Positions to 10/2015				9/2007 Positions to 10/2015			
ID	dN	dE	dZ	ID	dN	dE	dZ
PVE3	-0.000	-0.000	-0.000	PVE3	-0.000	-0.000	-0.000
PVRS	0.001	0.007	0.016	PVRS	-0.004	0.016	0.000
VTIS	0.003	0.005	0.049	VTIS	-0.000	0.017	-0.007
AB17	0.015	-0.017	0.042	AB17	-0.004	-0.022	-0.020
AB61	-0.007	0.003	-0.001	AB61	-0.005	0.007	-0.055
CR51	0.011	0.005	0.017	CR50	-0.038	-0.004	-0.026
KC16	0.014	0.008	0.010	KC16	0.013	-0.005	-0.048

Comments: The Base Station AB61 has no measureable horizontal difference since September 2014 and 2007 as referenced to PVE3. The differences at CGPS Station PVRS and VTIS demonstrate a possible consistent easterly shift and will be watched. PVRS and VTIS have no measureable vertical difference; however, the differences at several monitoring points are down and up over the last year and down from the 2007 survey. Notwithstanding the vertical is less precise than the horizontal positions, it would appear that there may be indications of subsidence which is left to the Geologists for an opinion. Given that PVE3 and AB61 are in agreement, the survey reference frame is deemed stable and successfully recovered. An adjustment constrained to the other CGPS Stations is not preferred or necessary because the purpose here is to track their movements over time to test the stability of the reference frame. See the "COORDINATE LIST" in the Appendix for a list of coordinates resulting from this adjustment. See prior Survey Reports for coordinates resulting from earlier surveys.

Adjustment 2: Adjustment to develop Orthometric Heights (Elevations) in NAVD88. The CGPS Station PVE3 was fixed horizontally and vertically at its NAVD88 orthometric height determined in the September 2007 survey. The 2007 height was based on the published 2nd Order NAVD88 Height of CGPS Station VTIS. This Adjustment combined the measured ellipsoid height differences with the NGS Geoid 03 (models the separation between the ellipsoid and geoid surfaces) to determine NAVD88 orthometric heights of the other CGPS Stations and the monitoring points. Vertical differences (dZ) for at key points in this survey are listed in the table in Adjustment #1 above.

ACCURACY

This survey conform to the intent of the California Spatial Reference Center & California Lands Surveyors Association's "GNSS Surveying Standards and Specifications, 1.1" (2014) and the Federal Geodetic Control Subcommittee (FGCS) "Specifications for GPS Relative Positioning" (1988).

Vector Residuals: The number of vectors, vector lengths, two dimensional residuals and the absolute value of the vertical residuals resulting from Adjustment #1 are listed below in feet. Thirty-three vectors to single occupied monitoring points are not included because they have no independent residuals and would optimistically skew the results. The statistics given below are applicable for all points.

Network	No.	Vector Lengths		Two Dimensional Residuals			Vertical Residuals (absolute)		
		Vary	Average	Average	Std.Dev.	Maximum	Average	Std.Dev.	Range
Monitoring Pt	193	479-7182	3333	0.009	0.005	0.037	0.011	0.011	-0.069 to +0.037
CGPS Sta's	47	1931-27757	18467	0.009	0.005	0.023	0.011	0.008	-0.024 to +0.023

Local Accuracy: The precisions and accuracy of vectors resulting from the minimally constrained adjustment at the 95% Level of Confidence are listed below in feet.

Network	Relative Distance Error		
	Average	Maximum	Av. Precision
Monitoring Pt	0.009	0.016	1: 278,300
CGPS Sta's	0.004	0.007	1:3,745,000

Coordinate Accuracy: The Standard Deviations (68% Level of Confidence) of the coordinates derived from Adjustment #1, relative to the CGPS Station PVE3 follow in feet.

	Monitoring Points			CGPS Stations		
	North	East	Up	North	East	Up
Average Standard Deviation	0.004	0.004	0.012	0.002	0.002	0.004
Maximum Standard Deviation	0.007	0.007	0.023	0.002	0.002	0.005

At the 95% confidence level, the average coordinate has a horizontal radius of circular error is 0.010 feet and a vertical of 0.024 feet with a max of 0.017 and 0.046 feet respectively.

Network Accuracy: The network accuracy (absolute accuracy relative to the reference frame) is expected to be less than 0.02 feet horizontal relative to the NAD83 Datum and Epoch based on the CGPS Stations.

NAVD88 Heights: The North American Vertical Datum of 1988 orthometric heights resulting from Adjustment #2 are derived from the difference in ellipsoid heights combined with the Geoid 03 model and constrained to the height of PVE3 determined in 2007. The average relative accuracy of the heights is 0.03 feet at the 95% level of confidence, but may be greater at obstructed sites. The absolute accuracy of the heights relative to the datum is dependent on the published orthometric height on the CGPS Station VTIS. Although relative elevation accuracies can be within 0.03 feet, up until October 2011 there were no requirements for vertical accuracies. In October 2011, a preference of 0.03 foot relative vertical accuracy was instigated for the following points: AB17, AB57, CR07, CR50 and CR51. In the September 2012 and subsequent surveys the criteria was extended to all points.

Movement Accuracy: For this period, 47 points are reported to have moved less than 0.30 feet with an average movement of 0.03 feet and a range of 0.00 to 0.15 feet. The relative error at the 95% Level of Confidence averaged 0.013 feet with a range of 0.005 to 0.019 feet. Overall, after removing outlier PB55 (severely obstructed site), the estimated 95% relative movement error averaged 0.014 feet with a range of 0.005 to 0.019 feet. No movement is considered detected unless the movement exceeds the 95% Error for individual points. See the attached “PB MOVEMENT DATA POSTING” for the estimated relative movement errors at the 95% Level of Confidence for individual points.

QUALITY CONTROL - QUALITY ASSURANCE (QAQC) ANALYSIS

To ensure the accuracy and validity of the measurement systems used in these GNSS monitoring surveys, an independent test was conducted in 2007 using conventional terrestrial based instruments as reported in the “QAQC ANALYSIS” section of the September 2007 Monitoring Survey Report. Comparing the results of the GNSS systems with conventional instrumentation found horizontal measurements agreed 0.01 feet on average. In November of 2011 the GNSS instruments and fixed height poles used in this survey were calibrated on the Santa Maria National Geodetic Survey Baseline and found to agree with published distances 0.003 to 0.006 feet.

To validate the radial survey method used in these surveys to position points from base stations AB61 and AB20, independent GNSS cross connections were measured and compared with the stand alone computed inverse distances in the 2007, 2008 and 2009 surveys. The results found the two dimensional accuracy to agree 0.01 feet on average, indicating the radial method of measurements is reliable and the additional labor cost of measuring cross connection between points is not warranted. See the “QAQC ANALYSIS” section of the September 2007 and the December 2008 Monitoring Survey Reports for detailed analysis.

Deflection Analysis is a method established by this surveyor to assess the consistency of the direction of movements reported from period to period. Assuming that movements are generally linear for points moving less than a foot, the separation or the deflection between the direction of the previous and present periods taken over the moved distance implies the accuracy obtained with the equipment, methods and procedures. Analysis of individual deflections indicates that for points with multiple occupations the separations varied 0.01 to 0.02 feet.

SUMMARY

The relative movements reported between September 19, 2014 and October 8, 2015 (12.6 months) statistically attained an average accuracy of 0.014 feet at the 95% Level of Confidence for points occupied two or more times. The actual accuracy of measurements held to the “one-centimeter standard” are estimated to approach 0.01 feet as demonstrated by the vector residuals, repeatability of measurements at points considered stable, and the analysis of movement deflections over time. Refer to the sections titled ACCURACY and QAQC ANALYSIS in this Report for more information.

Between September 19, 2014 and October 8, 2015 (12.6 months) point movements are reported as follows: Portuguese Bend Landslide (PB##) moved 0.05 to 1.80 feet and 8.55 feet at PB67, Abalone Cove Landslide (AB##) moved 0.02 to 0.05 feet, and Klondike Canyon (KC##) moved 0.02 to 0.03 feet. See the graphic depiction of the Horizontal Movement in the Appendix.

Statistically, the probability at the 95% level of confidence is that movement (signal) has occurred at a point when the horizontal distance between two epochs is greater than the 95% Error (noise). See the “Movement Data Posting” for a listing of the 95% Error estimates (range 0.011 to 0.019 feet not including single occupied points). Applying this criteria, 11 points have not moved.

See the attached "PB MOVEMENT DATA POSTING" spreadsheet for overall and periodic movements of each point. The movements are given in north, east and up or down as well as a vector of distance and direction relative to north. The direction is given as an azimuth in degrees where 0° is north and increases clockwise (90° East, 180° South, 270° West). The overall movements are from the beginning position of each point which varies between 1994 and the date for newly established points.

The present status of monitored points is provided in the Appendix under "Monitoring Point Status". The historical status of all monitoring points is provided in the September 2007 Survey Report. The historical 1994-2006 positions of all points are listed in the Charles Abbott Associates Inc. file "ALL POINTS MOST RECENT OBSERVED POSITION AS OF SEPTEMBER 15, 2006.xls" attached as an electronic file to the 2007 Report.

RECOMMENDATION

An ongoing re-location program for monuments has long term benefits resulting in better accuracy and lower cost surveys due to improved sky visibility for tracking satellites. In this October 2015 survey, no monuments were re-located. Points AB16, AB17, AB24 and AB58 have limited sky visibility and are candidates for re-located or deletion. AB12 is in a horse corral and is difficult to access; however, there are no nearby alternatives.

Attachments: The following document is attached to this Report.
"PB MOVEMENT DATA POSTING" lists the coordinates of the initial positions, the overall and periodic movements of monitoring point since 2007.

SURVEYOR'S STATEMENT

This is a Report on the procedures, criteria and results of the City of Rancho Palos Verdes Portuguese Bend Landslide Monitoring Surveys. This Report includes the Initial Survey conducted in the fall, the Second Survey Addendum No.1 added in the winter and the Third Survey Addendum No.2 added in the spring. This survey was conducted and the report prepared by me at the request of Ron Dragoo, Principal Engineer of the City of Rancho Palos Verdes.

Initial Survey - Full Monitoring Signature


Michael R. McGee P.L.S. 3945 02/03/16
Date

Second Survey - Partial Monitoring Signature


Michael R. McGee P.L.S. 3945 03/11/16
Date

Third Survey - Partial Monitoring Signature


Michael R. McGee P.L.S. 3945 04/22/16
Date





Table of Movements: The Table below lists the movements and elevation changes in the last year. See the attached spreadsheet titled "PB MOVEMENT DATA POSTING 2007-(present)" for the overall and periodic movement history of each point.

PORTUGUESE BEND LANDSLIDE MONITORING					
Horizontal & Vertical Movements in Feet					
Full Monitoring: 12.6 months					
Sept. 19, 2014 to Oct. 8, 2015					
Point ID	Movement	Elevation	Point ID	Movement	Elevation
	Distance	Change		Distance	Change
AB01	0.03	0.03	KC01	0.04	0.01
AB02	0.02	0.00	KC02	0.01	0.03
AB04	0.06	0.00	KC05	0.01	0.00
AB05	0.05	-0.02	KC06	0.02	0.00
AB12	0.03	0.01	KC07	0.01	-0.01
AB13	0.02	0.02	KC13	0.03	0.01
AB16	0.01	0.03	KC14	0.01	0.00
AB17	0.02	0.04	KC15	0.02	0.00
AB20	0.05	0.00	KC16	0.02	0.01
AB24	0.04	-0.01	KC17	0.02	0.01
AB50	0.05	-0.02	PB04	0.79	-0.27
AB51	0.02	-0.01	PB06	0.75	-0.10
AB53	0.03	0.05	PB07	0.88	-0.05
AB57	0.02	-0.02	PB08	0.76	0.06
AB58	0.03	0.03	PB09	0.97	-0.14
AB59	0.04	0.01	PB12	1.80	-0.41
AB60	0.03	0.00	PB13	1.17	-0.09
AB61	0.01	0.00	PB18	0.05	-0.04
AB62	0.01	0.00	PB20	1.56	-0.30
AB63	0.00	-0.01	PB21	0.83	-0.08
AB64	0.02	0.00	PB25	0.05	0.00
AB65	0.04	-0.03	PB26	0.07	-0.01
AB66	0.04	0.02	PB27	1.61	-0.27
AB67	0.03	0.01	PB29	1.21	-0.34
AB68	0.02	-0.01	PB54	0.05	0.08
CR07	0.01	0.01	PB55	0.96	-0.07
CR50	0.01	0.04	PB59	1.31	-0.63
CR51	0.01	0.02	PB65	0.15	-0.02
CR53	0.02	0.01	PB67	8.55	-0.84
FT06	0.06	-0.02	*PB68	0.25	-0.05
FT07	0.04	-0.03	*PB69	0.24	-0.07
FT08	0.03	0.00	*PB70	0.22	-0.28
			UB02	2.61	0.00
* = Points set in April 2015, Period = 5.7 Months					
Note: Given the accuracies of the measurements, Movements & Elevation Changes at or greater than 0.02' (1/4") and 0.04' (1/2") respectively are deemed to have actually moved.					
See "PB MOVEMENT DATA POSTING 2007-(present)" for more details.					

MCGEE SURVEYING CONSULTING							
RANCHO PALOS VERDES - PORTUGUESE LAND SLIDE MONITORING POINT STATUS for 2016 Prepared 01/26/2016							
Notes:	162+/- Monitoring Points established since 1994						
09/01/07	71 Points Surveyed 60 old points found with 52 monitored plus 19 new points						
12/01/08	67 Points Surveyed AB09, KC11, PB51 discontinued; BB53 destroyed; AB05 disturbed						
11/01/09	68 Points Surveyed Set PB64 to replace PB63 destroyed subsequently						
10/01/10	65 Points Surveyed Discontinued AB03, BB25; set PB65 to replace PB62 destroyed by paving						
10/03/11	69 Points Surveyed; Set AB62 & AB63 to replace AB06 & AB07						
09/14/12	72 Points Surveyed; Discontinued AB06, AB07; AB55 destroyed by trenching; Added 8 new points						
10/06/13	65 Points Surveyed; Discontinued AB15, AB18, AB52, AB54, CR52, KC04, PB53						
9/19/14	64 Points Surveyed; Discontinued BB52, PB67 set in April 2014; Added PVE3RP (reference to PVE3 antenna)						
10/08/15	69 Points Surveyed; AB56 Destroyed & Replaced by AB71; PB68, PB69, & PB70 Set in April 2015						
30+/- Points to Survey in Feb 2016 and April 2016							
Pt ID	Last Obs'd	Comments	GNSS	Pt ID	Last Obs'd	Comments	GNSS
AB01	10/08/2015	Base 1994-2006	G	KC01	10/08/2015	NE'ly/2 pipes 1.5' apart	G
AB02	“		G	KC02	“		G
AB04	“		G	KC05	“		G
AB05	“		G	KC06	“		G
AB12	“		G	KC07	“		G
AB13	“		F	KC13	“		G
AB16	“		P	KC14	“		G
AB17	“		F	KC15	“		F
AB20	“	NE'ly/ 2 monuments	G	KC16	“		G
AB24	“		F	KC17	“	Replaced KC04	G
AB50	“		G	PB04	“		G
AB51	“		G	PB06	“		G
AB53	10/08/2015		F	PB07	“		G
AB56	04/2015	Destroyed prior to Oct.	F	PB08	“		G
AB57	10/08/2015		G	PB09	“		G
AB58	“		P	PB12	“		G
AB59	“		G	PB13	“		G
AB60	“		G	PB18	“		G
AB61	“	BASE 2007-Present	G	PB20	“	S'ly/ 2 pipes 5.3' apart	G
AB62	“		G	PB21	“		F
AB63	“		G	PB25	“		G
AB64	“		G	PB26	“		F
AB65	“		G	PB27	“		G
AB66	“		G	PB29	“		G
AB67	“		G	PB54	“		F
AB68	“		G	PB55	“		F
AB71	10/08/2015	Replaced AB56	F	PB59	“		G
CR07	“		G	PB64	“		G
CR50	“		F	PB65	“		G
CR51	“		G	PB66	“	Discontinued	G
CR53	“		G	PB67	“		G
FT06	“		F	PB68	“		G
FT07	“		G	PB69	“		G
FT08	10/08/2015		G	PB70	“		G
			G	UB02	10/08/2015		G
GNSS column indicates site is Good, Fair or Poor for Satellite Visibility Conditions							

10/08/15 COORDINATE LIST

Portuguese Bend Landslide 10/08/2015 Monitoring Survey No. 13
Prepared by McGee Surveying Consulting: Document Date: 01/26/2016

Datum: Horizontal & EH NAD83 (2007) Epoch; California State Plane Zone 5; Vertical: NAVD88

Note, Fixed CGPS Station PVE3 at Record 3D Position & Orthometric Height per 09/2007 Survey; See 2007 and subsequent Survey Reports

Point	Latitude	Longitude	EH(ft)	North(ft)	East(ft)	OrthoHt(ft)	Description
AB01	33-44-38.30266	118-22-53.05152	60.05	1729427.57	6445709.59	178.53	Punched 1/2" GIP in meter box
AB02	33-44-13.84893	118-22-26.19236	-2.06	1726946.99	6447968.69	116.44	4" BC "SAN PEDRO 1936" on conc. block
AB04	33-44-28.09078	118-22-36.28776	-51.30	1728389.90	6447121.44	67.15	BC "CO ENG STA Q2.." on 2"GIP in mass of conc.
AB05	33-44-24.98972	118-22-30.09139	-38.02	1728074.45	6447643.59	80.43	BC "CO ENG STA Q3.." on 2"GIP in mass of conc.
AB12	33-44-38.27495	118-22-22.72108	164.82	1729415.15	6448271.03	283.16	BC "CO ENG STA 7A.." in mass of conc.
AB13	33-44-43.34502	118-22-23.16135	246.12	1729927.83	6448235.75	364.44	Punched 1/2" GIP in meter box
AB16	33-44-47.57965	118-22-31.51216	258.08	1730358.54	6447532.12	376.41	Punched 1/2" GIP in meter box
AB17	33-44-58.06080	118-22-41.08430	324.44	1731421.12	6446727.75	442.78	Punched 1/2" GIP in meter box
AB20	33-44-37.77443	118-22-05.96637	277.92	1729359.34	6449685.81	396.20	BC "CO ENG STA W. FIX 1956.." in mass of conc.
AB24	33-44-42.35371	118-22-28.79499	217.34	1729829.39	6447759.62	335.69	Cotton spindle in conc. In road
AB50	33-44-25.11110	118-22-22.94576	63.54	1728084.48	6448247.12	181.96	Nail & shiner in conc. collar of well
AB51	33-44-40.22966	118-22-34.15172	186.73	1729616.35	6447306.44	305.11	PK mag nail in plastic plug "LS6957" in 1"GIP
AB53	33-44-48.36782	118-22-05.78054	234.63	1730430.15	6449712.19	352.85	Chiseled + on s edge conc. Vault
AB57	33-45-03.17002	118-22-05.20548	446.53	1731926.37	6449759.47	564.68	6" mag nail & washer in conc. in 2"x 36" GIP
AB58	33-44-55.14402	118-22-13.27631	287.34	1731117.51	6449074.94	405.56	Punched RR spike on s side road
AB59	33-44-52.54025	118-21-59.79454	316.01	1730850.12	6450212.48	434.18	6" mag nail & washer in conc. in 2"x 36" GIP
AB60	33-44-35.04150	118-22-26.06536	60.93	1729089.33	6447987.39	179.31	6" mag nail & washer in conc. in 2"x 28" GIP
AB61	33-44-18.57314	118-22-25.95797	21.94	1727424.49	6447990.26	140.41	6" mag nail & washer in conc. in 2"x 24" GIP
AB62	33-44-33.23049	118-22-38.63210	24.52	1728910.22	6446925.41	142.96	6" mag nail & washer in conc. in 1"x 24" GIP
AB63	33-44-34.71810	118-22-34.12089	62.35	1729059.17	6447306.95	180.76	Punched 1/2 x 48" rebar
AB64	33-45-02.13646	118-22-33.46064	413.87	1731830.71	6447373.08	532.15	2" mag nail on NE side 2' conc. Collar/Well B12
AB65	33-45-00.93194	118-22-22.90391	340.20	1731705.63	6448264.09	458.44	2" mag nail & washer in conc. in 1"x 60" GIP
AB66	33-44-44.53517	118-22-20.15015	255.93	1730947.20	6448490.50	374.23	1/2" x 24" punched rebar 1" below AC conc. collar
AB67	33-44-55.71700	118-22-29.06603	287.00	1731180.38	6447741.76	405.29	1/2" x 24" punched rebar 1" below AC conc. collar
AB68	33-44-46.61240	118-22-25.31211	275.08	1730258.81	6448055.35	393.40	1/2" x 24" punched rebar 1" below AC conc. collar
AB71	33-45-06.10137	118-22-19.67329	453.72	1732227.20	6448538.84	571.93	2" mag nail on S side Vanderlip Dr. (AC road)
CR07	33-45-00.26894	118-21-48.09414	513.98	1731627.84	6451203.38	632.07	6" mag nail & washer in conc. in old 1" IP
CR50	33-45-13.97070	118-21-50.11935	754.58	1733017.58	6451037.37	872.63	Tack & shiner on lower rock wall
CR51	33-45-14.49690	118-21-34.43619	858.15	1733062.01	6452361.88	976.14	Tack & shiner on conc. pad
CR53	33-45-11.63371	118-21-59.73912	662.61	1732780.28	6450224.20	780.71	2" mag nail & washer in conc. in 1"x 60" GIP
FT06	33-44-42.78497	118-21-29.58586	370.52	1729854.75	6452760.02	488.61	6" mag nail & washer in conc. in 2"x 36" GIP
FT07	33-44-36.87027	118-21-13.65977	470.53	1729252.07	6454102.88	588.57	6" mag nail & washer in conc. in 2"x 36" GIP
FT08	33-44-38.19526	118-21-22.57431	540.33	1729388.67	6453350.51	658.41	6" mag nail & washer in conc. in 2"x 36" GIP
KC01	33-44-29.13340	118-21-33.10884	194.09	1728475.76	6452457.57	312.27	6" mag nail & washer in conc. in old 1" IP
KC02	33-44-14.54753	118-21-37.05748	-104.53	1727002.46	6452118.81	13.74	Punched 1/2" GIP in meter box
KC05	33-44-15.37054	118-21-24.50980	109.26	1727081.87	6453178.86	227.46	Punched 1/2" GIP in meter box
KC06	33-44-22.33195	118-21-21.96617	181.67	1727784.85	6453396.18	299.83	Punched 1/2" GIP in meter box
KC07	33-44-22.09036	118-21-18.55887	195.29	1727759.41	6453683.86	313.43	Punched 1/2" GIP in meter box
KC13	33-44-10.41193	118-21-25.78264	72.84	1726580.98	6453069.58	191.07	Cotton spindle in AC turnout
KC14	33-44-12.03480	118-21-17.07058	141.70	1726742.44	6453805.97	259.88	Punched spike in center road
KC15	33-44-20.39768	118-21-25.21732	168.83	1727590.29	6453120.91	287.01	Cotton spindle in cul-de-sac
KC16	33-44-20.55030	118-21-13.64611	208.73	1727602.26	6454098.23	326.86	Punched spike in intersection
KC17	33-44-17.54996	118-21-26.32424	97.01	1727302.74	6453026.40	215.21	2" mag nail & washer in conc. in 1"x 50" GIP
PB04	33-44-20.96730	118-22-15.81024	47.84	1727663.34	6448848.21	166.25	Nail & tag "RCE26120" in conc. in 3" pipe
PB06	33-44-23.66989	118-22-05.05130	58.60	1727933.21	6449757.87	176.94	Punched cap on 2" GIP
PB07	33-44-25.65185	118-21-59.68828	78.99	1728131.91	6450211.54	197.30	Brass tag "LA CO DPW" in conc. in 2" GIP
PB08	33-44-26.29486	118-21-56.72084	76.02	1728196.00	6450462.39	194.32	Punched cap on 2" GIP
PB09	33-44-26.75741	118-21-52.15117	70.04	1728241.36	6450848.49	188.31	Punched cap on 2" GIP in cable box
PB12	33-44-26.85905	118-21-43.46998	64.59	1728248.99	6451581.70	182.82	Punched cap on 2" GIP in cable box
PB13	33-44-24.79394	118-21-36.77901	88.11	1728038.19	6452146.04	206.32	Punched cap on 2" GIP in cable box
PB18	33-44-48.40985	118-21-53.76824	244.69	1730430.73	6450719.87	362.86	Punched 1/2" GIP in meter box
PB20	33-44-31.66253	118-21-48.92075	112.85	1728736.24	6451123.11	231.08	Punched cap on 2" GIP in cable box
PB21	33-44-36.63142	118-21-48.28117	153.61	1729238.35	6451178.94	271.81	Punched cap on 2" GIP in cable box
PB25	33-44-40.93065	118-21-38.74108	207.78	1729670.06	6451986.18	325.92	Punched cap on 2" GIP in cable box
PB26	33-44-39.63682	118-21-35.58707	164.75	1729538.31	6452252.08	282.88	Brass tag "LA CO DPW" in conc. in 2" GIP
PB27	33-44-36.64499	118-21-40.42451	152.13	1729237.33	6451842.46	270.30	Punched cap on 2" GIP in cable box
PB29	33-44-32.69288	118-21-37.46236	50.98	1728836.91	6452091.19	169.15	Brass tag "LA CO DPW" in conc. in 2" GIP
PB54	33-44-41.07858	118-21-56.95056	239.47	1729690.58	6450448.43	357.69	PK mag nail in plastic plug "LS6957" in 1"GIP
PB55	33-44-31.99923	118-21-52.73597	120.90	1728771.44	6450801.03	239.14	PK mag nail in plastic plug "LS6957" in 1"GIP
PB59	33-44-21.86964	118-22-18.05451	39.28	1727755.26	6448659.00	157.70	PK mag nail in plastic plug "LS?" in 1" GIP
PB65	33-44-28.81826	118-22-05.66844	169.26	1728453.86	6449707.66	287.59	2" alum. cap "MCGEE SURVEYING" on 5/8"x 24"rebar
PB67	33-44-20.66776	118-21-52.02882	-43.75	1727625.72	6450856.59	74.55	1/2" x 3' rebar
PB68	33-44-20.99054	118-22-14.21459	54.66	1727665.20	6448982.98	173.06	2" Alum Cap "PLS3945" in 1"x 30" GIP
PB69	33-44-22.14652	118-22-16.64080	46.20	1727782.81	6448778.50	164.60	2" Alum Cap "PLS3945" in 1"x 30" GIP
PB70	33-44-22.85189	118-22-18.52640	37.55	1727854.71	6448619.51	155.96	2" Alum Cap "PLS3945" in 1"x 30" GIP
UB02	33-44-19.52348	118-22-00.46842	-55.78	1727512.63	6450143.39	62.57	PK mag nail in plastic plug "?" in 1"GIP
PVE3	33-44-35.85329	118-24-15.26904	235.42	1729207.09	6438765.18	354.36	CGPS Pos. Fixed in 2007 and subsequent surveys
PVE3RP	33-44-35.74236	118-24-15.27474	227.96	1729195.88	6438764.66	346.90	Reference Pt: Mag Nail in Conc. Base 11' S/ PVE3
PVRS	33-46-25.89199	118-19-14.06716	198.60	1740239.30	6464237.89	316.30	CGPS Pos. Determined by this Survey
VTIS	33-42-45.48965	118-17-37.71213	197.51	1717933.68	6472307.24	315.25	CGPS Pos. Determined by this Survey

Addendum No.1
Second Survey Report
Portuguese Bend Landslide Monitoring
February 16, 2016 Partial Monitoring Survey
for the
City of Rancho Palos Verdes
by
McGee Surveying Consulting
March 11, 2016

Overview:

This Addendum No. 1 Report describes the February 2016 tri-annual Portuguese Bend Monitoring Survey. This partial survey included a sub-set of 30 points of the full monitoring set. Monitoring point AB56 was destroyed sometime after the April 2015 survey and AB71A was set in October as a replacement which was destroyed by paving sometime in the fall. Therefore, two new points AB71B and AB71C were set as temporary replacements until a permanent monument is set in the fall 2016 survey.

This survey followed the procedures described in the above October 8, 2015 Full Monitoring Report. For a detailed history of the program and surveys see "History" above and previous Monitoring Survey Reports back to 2007. The field survey took place February 15-18, 2016. The Field Surveys, Equipment, Data Collection and Network Design were as described in the above Report. The survey included 30 onsite points, two of which were base stations connecting each point with two to six vectors. Three continuously operating GPS stations (CGPS) were connected to this survey with 4-6 eight hours vectors each. It is to be noted that solar activity was high during the survey resulting in a minor increase in noise for the data collection.

The movements reported between October 8, 2016 and February 16, 2016 (4.3 months) statistically attained an average accuracy of 0.012 feet at the 95% Level of Confidence. The overall vectors residuals follow: the 2D averaged 0.005' with a maximum of 0.014' and the vertical averaged 0.012' with a maximum of 0.049'.

A Minimally Constrained Adjustment was processed to develop NAD83 (2007) 2007.00 Epoch Geodetic, Ellipsoid and State Plane Coordinates in feet. CGPS Station PVE3 was fixed and the differences are listed in feet from the October 08, 2016 to the February 16, 2016 positions for the CGPS stations and points considered to mostly stable.

10/2015 Positions to 02/2016				
Station	dN	dE	dZ	
AB17	-0.012	0.004	0.004	
AB50	-0.010	-0.009	0.024	
AB61	-0.001	0.001	0.009	Primary Base Station
CR50	-0.001	-0.004	0.045	
KC16	-0.024	0.014	0.001	
PVE3	0.000	0.000	0.000	Fixed CGPS Station
PVRS	-0.011	-0.002	-0.011	CGPS Station
VTIS	-0.007	-0.013	-0.007	CGPS Station

The adjustment, as a standard procedure, was constrained to the CGPS station PVE3 which finds no significant difference as expected in the horizontal position at the primary base station AB61. The difference at CGPS stations PVRS is 0.01 feet compared to the October 08, 2016 position. The survey reference frame was deemed stable and successfully recovered. The results are reported below.

Addendum No.2
Third Survey Report
Portuguese Bend Landslide Monitoring
April 19, 2016 Partial Monitoring Survey
for the
City of Rancho Palos Verdes
by
McGee Surveying Consulting
April 22, 2016

Overview:

This Addendum No. 2 Report describes the April 2016 Portuguese Bend Monitoring Survey. This partial survey included the same sub-set of 30 points reported in Addendum No.1.

This survey followed the procedures described in the above October 8, 2015 Full Monitoring Report. For a detailed history of the program and surveys see “History” above and previous Monitoring Survey Reports back to 2007. The field survey took place April 17-20, 2016. The Field Surveys, Equipment, Data Collection and Network Design were as described in the above Report. The survey included 30 onsite points, two of which were base stations connecting each point with two to four vectors. Two continuously operating GPS stations (CGPS) were connected to this survey with eight 3-7 hours vectors. It is to be noted that solar activity was low during the survey resulting in less noise for the field data collection.

The movements reported between February 16, 2016 and April 19, 2016 (2.0 months) statistically attained an average accuracy of 0.012 feet at the 95% Level of Confidence. The overall vectors residuals follow: the 2D averaged 0.005’ with a maximum of 0.016’ and the vertical averaged 0.008’ with a maximum of 0.037’.

A Minimally Constrained Adjustment was processed to develop NAD83 (2007) 2007.00 Epoch Geodetic, Ellipsoid and State Plane Coordinates in feet. CGPS Station PVE3 was fixed and the differences are listed in feet from the February 16, 2016 to the April 19, 2016 positions for the CGPS stations and points considered to mostly stable.

02/2016 Positions to 04/2016			
Station	dN	dE	dZ
AB17	-0.002	0.005	0.025
AB50	-0.011	-0.011	0.009
AB61	-0.002	-0.001	0.008
CR50	0.005	0.002	0.075
KC16	-0.007	-0.004	0.021
PVE3	0.000	0.000	0.000
PVRS	0.012	0.002	0.026
VTIS (Not Operating during survey)			

The adjustment, as a standard procedure, was constrained to the CGPS station PVE3 which finds no significant difference as expected in the horizontal position at the primary base station AB61. The difference at CGPS stations PVRS is 0.01 feet compared to the February 16, 2016 position and 0.00 feet compared to the October 8, 2015 position. The survey reference frame was deemed stable and successfully recovered. The results are reported below.

PORTUGUESE BEND LANDSLIDE MONITORING						
Horizontal & Vertical Movements in Feet						
	Oct. 08, 2015		Feb. 16, 2016		Oct. 08, 2015	
	to Feb. 16, 2016		to April 19, 2016		to April 19, 2016	
Point ID	Movement	Elevation	Movement	Elevation	Movement	Elevation
	Distance	Change	Distance	Change	Distance	Change
AB04	0.04	-0.01	0.01	0.02	0.05	0.01
AB12	0.03	0.02	0.02	-0.01	0.04	0.01
AB16	0.03	-0.01	0.00	0.02	0.04	0.01
AB17	0.01	0.00	0.01	0.02	0.02	0.03
AB20	0.01	0.03	0.01	0.02	0.02	0.05
AB50	0.01	0.02	0.02	0.01	0.03	0.03
AB59	0.01	0.02	0.01	0.01	0.02	0.04
AB60	0.02	0.01	0.01	0.01	0.03	0.01
AB61	0.00	0.01	0.00	0.01	0.00	0.02
AB65	0.03	0.07	0.01	0.03	0.04	0.11
CR07	0.02	0.02	0.01	0.02	0.02	0.04
CR50	0.00	0.05	0.01	0.08	0.00	0.12
FT06	0.02	0.02	0.01	0.03	0.03	0.05
FT07	0.03	0.05	0.01	0.01	0.03	0.06
KC06	0.01	0.03	0.01	0.01	0.02	0.04
KC07	0.02	0.03	0.01	0.03	0.01	0.06
KC13	0.01	0.01	0.01	0.02	0.02	0.03
KC16	0.03	0.00	0.01	0.02	0.03	0.02
KC17	0.02	0.02	0.02	0.00	0.03	0.02
PB04	0.34	-0.12	0.15	-0.04	0.49	-0.16
PB12	0.60	-0.12	0.33	-0.06	0.94	-0.18
PB13	0.40	-0.03	0.22	0.02	0.62	-0.01
PB18	0.02	0.00	0.01	0.04	0.03	0.04
PB26	0.04	0.02	0.02	0.03	0.06	0.05
PB55	0.26	-0.10	0.17	-0.05	0.43	-0.15
PB59	0.44	-0.21	0.27	-0.11	0.71	-0.32
PB67	3.03	-0.36	2.62	-0.31	5.65	-0.67
PB68	0.21	-0.15	0.14	-0.04	0.35	-0.19
PB69	0.27	-0.12	0.14	-0.05	0.41	-0.17
PB70	0.23	-0.30	0.12	-0.14	0.36	-0.44
Note: Given the accuracies of the measurements, Movements & Elevation Changes at or greater than 0.02' (1/4") and 0.04' (1/2") respectively are deemed to have actually moved.						
See "PB MOVEMENT DATA POSTING 2007-(present)" for more historical movements.						