

# CITY OF SAUSALITO HIGH PRECISION NETWORK

CITY OF SAUSALITO 2016 HIGH PRECISION NETWORK  
PREPARED BY LINDA A. CARRUTHERS, PLS  
OCTOBER 12, 2017

## OVERVIEW

This report was prepared to summarize the methods and procedures used for the City of Sausalito 2016 High Precision Network (CS-2016 HPN). In February and March of 2017, Nine High Precision Network (HPN) monuments were established in the City. A Record of Survey will be filed that incorporates the content of this report and will contain a detailed description of each monument. This network provides the framework for establishing a densification network to support general survey activities and was the basis for establishing precise ground control for an Ortho-photography and LIDAR survey in the City. The field survey was planned and conducted by Linda A. Carruthers and Associates, Land Surveyors, with the processing of the observations and network adjustments by Dan Eisengart, PLS 8961 from Oberkamper and Associates and peer review by Michael McGee, PLS3945. The Global Navigation Satellite System (GNSS) was used to determine positions of the HPN monuments based on the North American Datum of 1983 (NAD83.) The HPN survey shown on the Record of Survey entitled "City and County of San Francisco 2013 High Precision Network" (CCSF-2013 HPN) Record of Survey #8080, provided the basis for the CS-2016 HPN. This report follows the format of the Survey Report entitled "Survey Report for the City and County of San Francisco 2013 High Precision Network Surveys" prepared by McGee Surveying Consulting and F3 & Associates, Inc. dated February 28, 2014, Revised Dec. 18, 2015. (See Appendix for Record of Survey #8080 and abbreviations.)

The City of Sausalito is located at the North end of the Golden Gate Bridge which separates the City of Sausalito in Marin County from the City and County of San Francisco. The City of Sausalito is a long northwest, southeast City bounded by Richardson's Bay on the East and Golden Gate National Recreation Area on the West rising from Sea Level to over 1000.

The City of Sausalito High Precision Network monuments were established based upon the terrain and an unobstructed view of the sky. Station HPN-6 station was set on the roof of the City's Police Station as a potential site for a community base station.

As stated above, CCSF-2013 HPN, Record of Survey #8080 provided the basis for the City of Sausalito 2016 High Precision Network. Due to the accuracies and the close proximity of the CCSF-2013 HPN survey to the City of Sausalito, the CCSF-2013 HPN was accepted as the control for this project. NAD83 (2011) Epoch 2010.00 High Precision Monuments now exist across the Golden Gate Bridge into Marin County by this adjustment of the CS-2016 HPN.

- SHEET 1 OVERVIEW
- SHEET 2 REGIONAL NETWORK
- SHEET 3 HIGH PRECISION NETWORK
- SHEET 4 ADJUSTMENTS AND ANALYSIS
- SHEET 5 DATA COLLECTION, PROCESSING AND EQUIPMENT
- ACCURACY: LOCAL NETWORK
- SHEET 6 STATION DESCRIPTIONS AND FINAL COORDINATES

## PROJECT DATUMS AND REFERENCE SYSTEMS

Geometric Datums: North American Datum of 1983 - NAD83 (2011) Epoch 2010.00/Epoch 2017.20 (March 1, 2017 average date of field survey)

Reference Network: The survey is referenced to one NGS CORS stations and two continuous GPS (CGPS) stations according to the NGS data sheet and said Record of Survey #8080.

Vertical Datum and Reference Network: NAVD 88. The Orthometric heights of the bench marks that were utilized in this survey are based on the 1991 adjustment of the 1st order Class II differential leveling survey conducted by the NGS. (NGS data sheets in appendix)

Projections: The plane coordinates published in the survey are in units of feet and meters and provided in California State Plane Coordinate System (SPCS) Zone III unless otherwise noted.

## GEOMETRIC COORDINATES OF THE CONTROLLING CORS & CGPS STATIONS

The following positions were established in four Network Adjustments to develop the Geodetic and Plane coordinates in NAD 38 (2011) Epoch 2017.20 for this project. T3RP NAD83 (2007) Epoch 2017.20 results below are calculated from the Sector Utility.

NAD83 (2011) Epoch 2010.00 record positions per NGS Data Sheets and or Record of Survey #8080

ID	Latitude (dms)	W.Longitude (dms)	EH (mtrs)	NAME
TIBB	37-53-27.13938	122-26-51.3174	-20.565	AI4507 TIBURON PENINSUL ARP
P181	37-54-52.34985	122-22-36.26789	72.724	DI1085 MILLERKNOXCM2005 ARP
MHDL	37-50-32.34805	122-29-39.54740	66.402	CGPS ADJUSTED ROS #8080
UCSF	37-45-46.67199	122-27-29.28890	155.128	CGPS ADJUSTED ROS #8080

NAD 83 (2011) Epoch 2017.20 results of a minimally constrained Adjustment to CORS station TIBB (Adjustment 1)

ID	Latitude (dms)	W.Longitude (dms)	EH (mtrs)	Velocities (mm)
TIBB	37-53-27.14592	122-26-51.32263	-20.574	N 28.0 E-17.7 Up -1.3*
P181	37-54-52.35585	122-22-36.27288	72.710	N 25.7 E-17.6 Up -1.9*
MHDL	37-50-32.35508	122-29-39.55300	66.392	N 30.1 E-19.0 Up -1.4*
UCSF	37-45-46.67918	122-27-29.29476	155.118	N 30.8 E-19.9 Up -1.4
T3RP	37-55-40.39426	122-35-17.67344	732.875	Results from Sector Utility

NAD83 (2011) Epoch 2017.20 results of the Constrained Adjustment to the CORS station TIBB and CGPS stations MHDL and UCSF positions listed above. (Adjustment 2)

ID	Latitude(dms)	W.Longitude(dms)	EH(mtrs)
HPN 1	37-52-27.42689	122-31-11.74064	83.270
HPN 2	37-50-06.25200	122-28-21.06974	3.214
HPN 6	37-51-28.36176	122-29-04.52421	-17.176

(See Adjustments and Analysis on Sheet 4)

## SURVEYOR'S STATEMENT

THIS MAP CORRECTLY REPRESENTS A SURVEY MADE BY ME OR UNDER MY DIRECTION IN CONFORMANCE WITH THE REQUIREMENTS OF THE PROFESSIONAL LAND SURVEYORS' ACT AT THE REQUEST OF CITY OF SAUSALITO IN NOVEMBER 2017

*Linda A. Carruthers* 6-23-20  
LINDA A. CARRUTHERS P.L.S. 7053  
LICENSE EXPIRES 12/31/20



## COUNTY SURVEYOR'S STATEMENT

THIS MAP HAS BEEN EXAMINED IN ACCORDANCE WITH SECTION 8766 OF THE PROFESSIONAL LAND SURVEYOR'S ACT, THIS 11<sup>th</sup> DAY OF JULY 2020

TRACY W. PARK, PLS 8176  
*David O. Knell*  
DAVID O. KNELL, PLS 5301  
BY DEPUTY COUNTY SURVEYOR



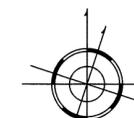
RECORD WITHOUT FEE PER GOVERNMENT  
CODE 6103

## RECORDER'S STATEMENT

FILED THIS 16<sup>TH</sup> DAY OF JULY 2020.  
AT 10:30 A.M. IN BOOK 2020 OF MAPS  
AT PAGE 192 AT THE REQUEST OF  
MARIN COUNTY DEPARTMENT OF PUBLIC WORKS  
SERIAL NO. 2020-0030732 FEE NO FEE

*Shelly Scott*  
COUNTY RECORDER  
BY DEPUTY

## RECORD OF SURVEY CITY OF SAUSALITO HIGH PRECISION NETWORK

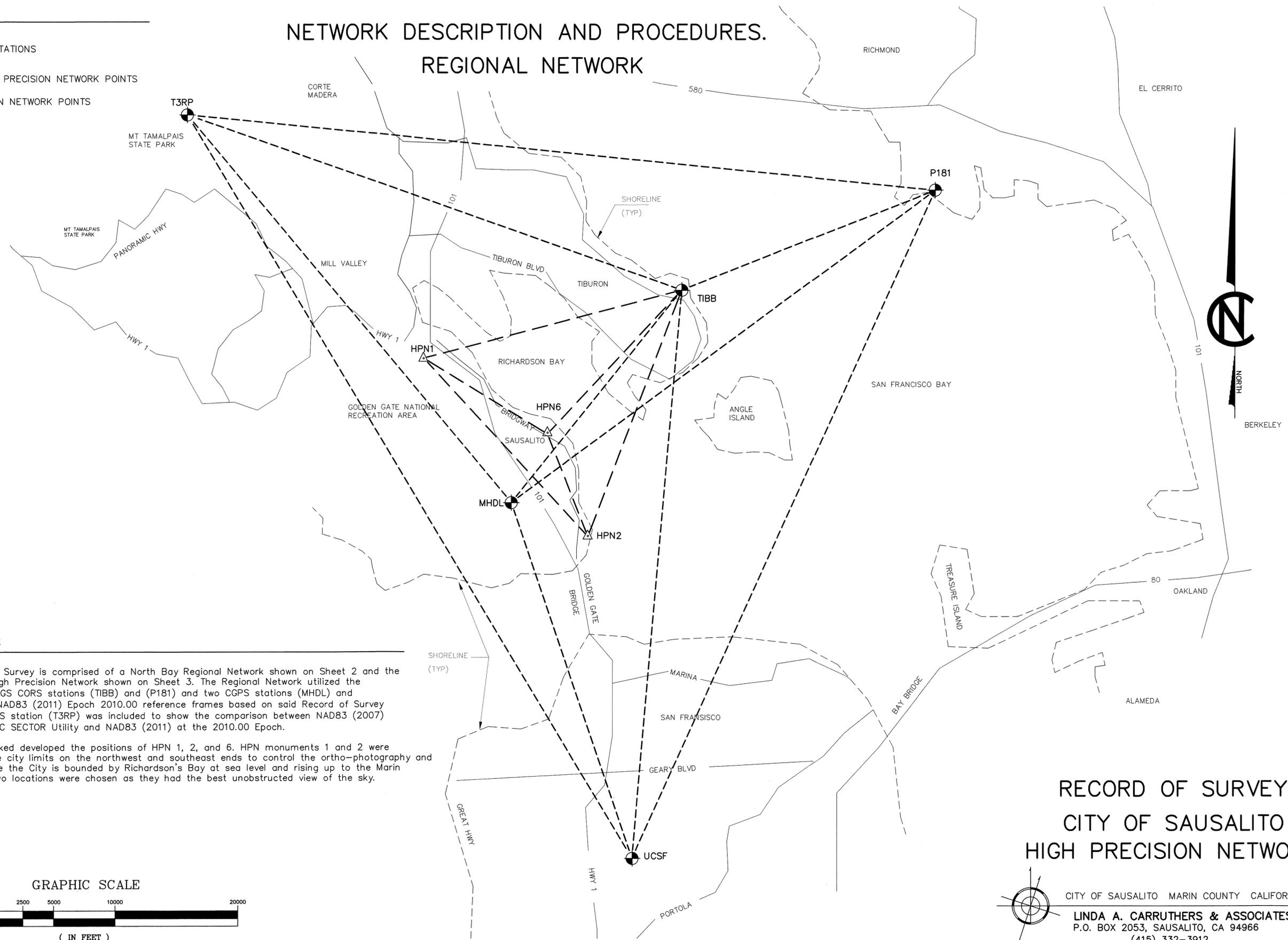


CITY OF SAUSALITO MARIN COUNTY CALIFORNIA  
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LEGEND

- CORS AND CGPS STATIONS
- △ SET PRIMARY HIGH PRECISION NETWORK POINTS
- SET HIGH PRECISION NETWORK POINTS

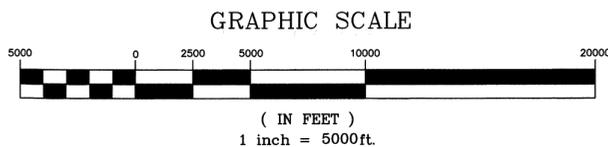
NETWORK DESCRIPTION AND PROCEDURES.  
REGIONAL NETWORK



Regional Network

The CS-2016 HPN Survey is comprised of a North Bay Regional Network shown on Sheet 2 and the City of Sausalito High Precision Network shown on Sheet 3. The Regional Network utilized the nearest operating NGS CORS stations (TIBB) and (P181) and two CGPS stations (MHDL) and (UCSF) to recover NAD83 (2011) Epoch 2010.00 reference frames based on said Record of Survey #8080. A third CGPS station (T3RP) was included to show the comparison between NAD83 (2007) based on the SOPAC SECTOR Utility and NAD83 (2011) at the 2010.00 Epoch.

The regional network developed the positions of HPN 1, 2, and 6. HPN monuments 1 and 2 were set just outside the city limits on the northwest and southeast ends to control the ortho-photography and LIDAR surveys. Since the City is bounded by Richardson's Bay at sea level and rising up to the Marin Headlands, these two locations were chosen as they had the best unobstructed view of the sky.



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SCALE: 1"=5000'  
DATE: NOV. 1, 2017 SHEET 2 OF 6 JOB NO. 16-977

HPN 1 MARIN CITY

# NETWORK DESCRIPTION AND PROCEDURES. HIGH PRECISION NETWORK

**LEGEND**

-  CORS AND CGPS STATIONS
-  SET PRIMARY HIGH PRECISION NETWORK POINTS
-  SET HIGH PRECISION NETWORK POINTS

**GLOSSARY**

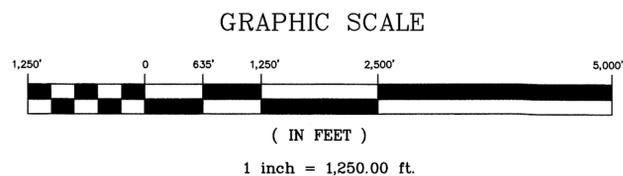
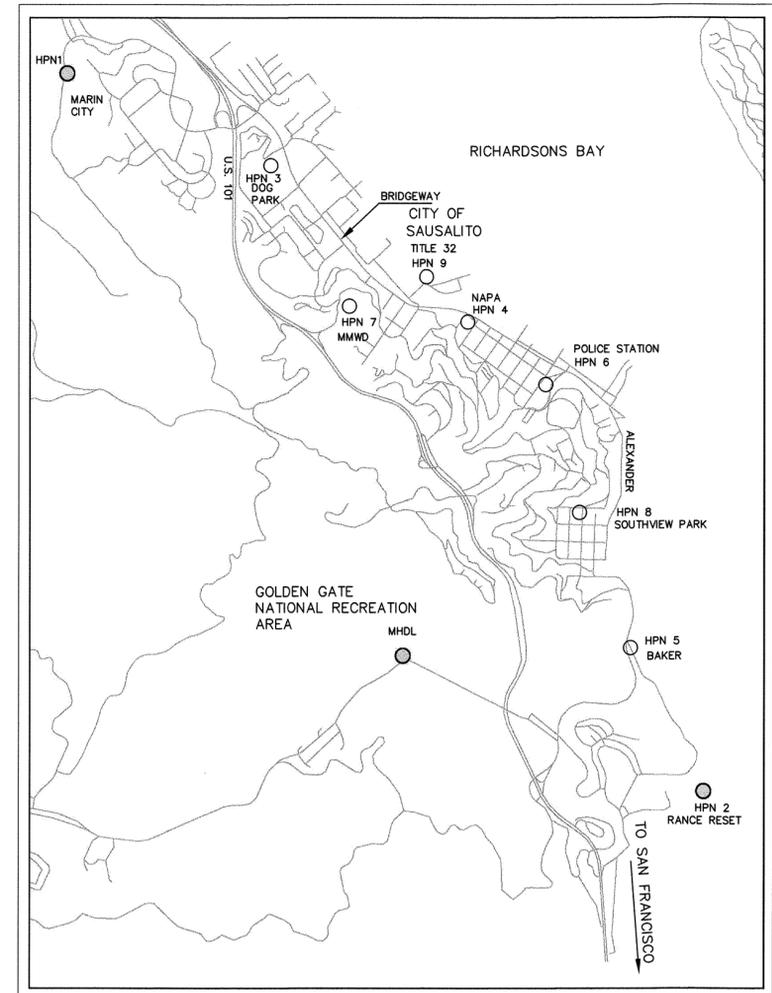
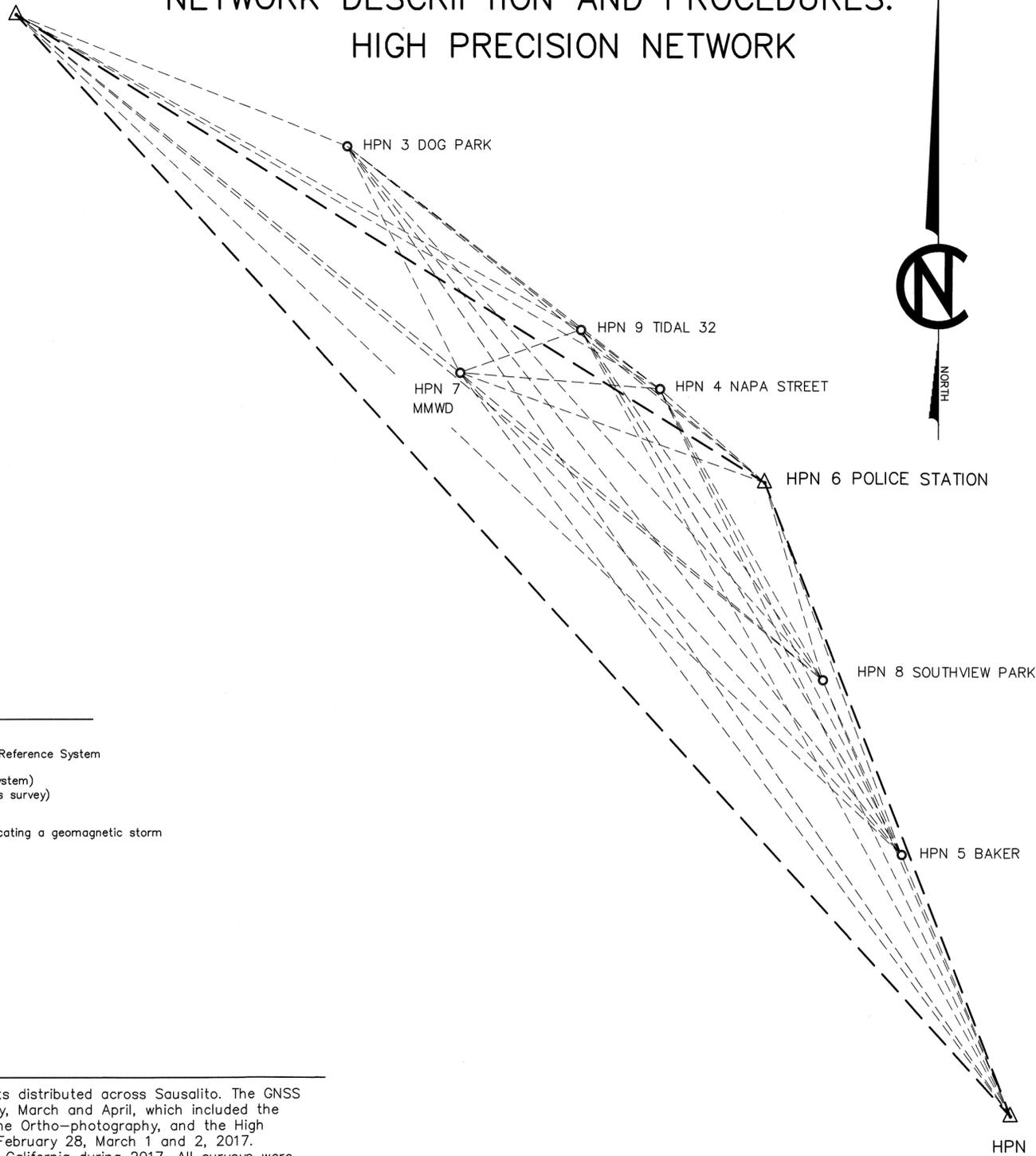
- CGPS Continuously GPS Stations in California
- CORS Continuously Operated Reference Stations in the National Spatial Reference System
- GIS Geographic Information System
- GLONASS Globalnaya Navigatsionnaya Sputnikovaya Sistema (Russian GPS system)
- GNSS Global Navigation Satellite System (GPS and GLONASS used in this survey)
- GPS Global Positioning System
- HPN High Precision Network
- K INDEX Space weather index ranging from 0-9, 1 being calm and 5 indicating a geomagnetic storm
- NAD83 North American Datum of 1983
- NAVD88 North American Vertical Datum of 1988
- NGS National Geodetic Survey
- SOPAC Scripps Orbit and Permanent Array Center
- HTDP Horizontal Time-Dependent Positioning Program
- PLS Professional Land Surveyor
- NOAA National Oceanic and Atmospheric Administration
- NAVD North American Vertical Datum
- NAD North American Datum

**High Precision Network**

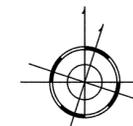
The CS-2016 HPN consists of nine primary HPN monuments distributed across Sausalito. The GNSS GPS field surveys took place during the months of February, March and April, which included the survey control for the LIDAR survey, 46 photo points for the Ortho-photography, and the High Precision Network. The HPN monuments were surveyed on February 28, March 1 and 2, 2017. Survey dates were chosen based on the unusual storms in California during 2017. All surveys were conducted during calm and clear weather.

The field crews operated Trimble R10 receivers mounted on tribrachs and tripods, except for the HPN 6 mounted on a stainless-steel bracket. The receivers and tribrachs were calibrated with calibration certificates issued by California Surveying and Drafting in Sacramento prior to the survey. A calibration of equipment and review of survey procedures took place prior to each field day.

The HPN field survey began on February 28 (Day 1) with a base receiver occupying monument HPN 2 for the day while the field crew occupied all monuments for 45 minutes each developing a radial network. On Day 2 and 3, a second radial network was developed with a base receiver occupying monument HPN 1 for the two days, while the field crew occupied all monuments for 45 minutes completing a second independent occupation. At the end of the field survey, all HPN monuments were occupied two or more times on different days and under different constellations.



## RECORD OF SURVEY CITY OF SAUSALITO HIGH PRECISION NETWORK



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SCALE: 1"=20,000'  
DATE: NOV. 1, 2017 SHEET 3 OF 6 JOB NO. 16-977

# ADJUSTMENTS & ANALYSIS

## ADJUSTMENTS & ANALYSIS

Following are the adjustments used to analyze the GPS vectors and derive the final positions of the City of Sausalito High Precision Network Monuments. The adjustment results are listed in the appendix, under Final Geodetic and Plane Coordinates

As discussed previously the City and County of San Francisco (HPN) provided the basis for the CS-2016-HPN. To recover the NAD83 reference frame, CORS stations (TIBB) per NGS Data Sheet and two CGPS stations (MHDL & UCSF) as shown on said Record of Survey #8080 were processed under a fully constrained adjustment which developed the positions of HPN 1, 2, and 6. An additional CORS (P181) and CGPS (T3RP) station were included for a comparison, but not constrained.

Four adjustments were processed to develop the positions of the HPN monuments. A detail of the adjustments follows:

### NAD83(2011) Epoch 2017.20 Adjustments

#### Adjustment 1: 3D Minimally Constrained Adjustment

The NAD83 (2011) Epoch 2010.00 positions of CORS stations TIBB and P181 were moved with HTDP to Epoch 2017.20 (average date of field work). UCSF and MHDL were moved from the NAD83 (2011) epoch 2010.00 positions published on said Record of Survey #8080 in the same way. The SOPAC SECTOR utility was used to compute an NAD83 (2007) Epoch 2017.20 position on a third CGPS station (T3RP). This station was constrained in the adjustment.

CORS station TIBB was fixed in this Minimally Constrained Adjustment to determine preliminary latitude, longitude, ellipsoid heights at the other CORS and CGPS stations and compute closures. The table below is the coordinate differences (closures) in feet from the NAD83 (2011) Epoch 2017.20 described above to the computed positions in the minimally constrained adjustment.

#### Coordinate Differences: NAD83 (2011) Epoch 2017.20 to Computed

Station	dN(ft)	dE(ft)	dZ (ft)
MHDL	0.012	-0.004	0.016
P181	0.050	0.041	0.071
TIBB	0.000	-0.000	-0.000 Fixed
UCSF	0.020	0.029	0.034
T3RP	0.054	0.009	0.073 Difference from SOPAC SECTOR position to computed

The differences between the NAD83 (2011) Epoch 2017.20 position and the computed position ranges from 0.000' to 0.054' in north, -0.004 to 0.041 in the east and 0.000' to 0.073 in the up position with P181 having the largest closure potentially due to tectonic movement. For T3RP, the SOPAC SECTOR Utility was used to compute an Epoch 2017.20 position on NAD (2007)

#### Adjustment 2: 3D/Ellipsoid Heights- Constrained Adjustment

Adjustment 2 fixes the NAD83 (2011) Epoch 2017.20 HTDP positions of TIBB, UCSF and MHDL as fully constrained for latitude, longitude and ellipsoid heights to develop NAD83(2011) Epoch 2017.20 positions on Stations HPN 1, 2, & 6.

The results below demonstrate that both P181 and T3RP are compatible with the constrained adjustment. Because P181 was not published on Record of Survey #8080 it was not constrained. The position of T3RP shown below indicates the correlation between the two adjustments NAD 83 (2007) and NAD 83 (2011). T3RP was not constrained because it is remote from the Sausalito Network.

#### Coordinate Differences: NAD83 (2011) Epoch 2017.20 to Computed

Station	dN	dE	dZ
MHDL	-0.000	-0.000	-0.000 Fixed
P181	0.040	0.034	0.049
T3RP	0.044	0.001	0.051
TIBB	-0.000	-0.000	-0.000 Fixed
UCSF	-0.000	-0.000	-0.000 Fixed

## NAD83 (2011) Epoch 2010.00 Adjustments

### Adjustment 3: 3D Minimally Constrained Adjustment

The NAD 83 (2011) Epoch 2017.20 positions of HPN 1, 2, and 6 were moved back to NAD83 (2011) 2010.00 Epoch by applying the HTDP v3.2.5 modeled velocities to the Epoch 2017.20 resulting from Adjustment 2 above. HPN 6 is fixed in this Adjustment as minimally constrained to determine latitude, longitude, ellipsoid heights and compute closures at other stations. The following results are the coordinate differences between the NAD 83 (2011) Epoch 2010.00 positions from HTDP to their computed positions based on this adjustment

#### Coordinate Differences: NAD83 (2011) Epoch 2010.00 Epoch to Computed

Station	dN	dE	dZ
HPN 1	0.025	0.016	-0.022
HPN 2	0.014	0.008	-0.021
HPN 6	-0.000	-0.000	-0.000
T3RP	0.019	0.005	0.027

Being the most central to the City of Sausalito, the NAD83 (2011) Epoch 2010.00 minimally constrained position of HPN 6 was used to evaluate the closures at HPN stations 1 and 2. Similar to said Record of Survey #8080 for San Francisco, the closures at said stations HPN 1 and HPN 2 are within the expected precision of the HTDP model. And according to Record of Survey #8080 rather than degrade the network in a constrained adjustment the results of this adjustment were accepted to establish NAD83 (2011) 2010 for CS-2016 HPN.

### NAVD 1988 DATUM RECOVERY

Differential Levels were run through the City of Sausalito during the time period of April 10 through May 11, 2017. Measurements were collected and recorded with a Leica DNA03 digital level with two GKNL47 fiberglass bar code rods with built in level. A calibration certificate was issued by Leica Geosystems Inc. in Costa Mesa, CA for the digital level and built in rod level prior to the survey. The instrument was further calibrated with a collimation or peg test three times during the survey and the rods levels were checked and calibrated at the same time.

This survey utilized six NGS first order Class II benchmarks based on NAVD88 Datum adjusted in 1991 by the NGS survey, along with one City of Sausalito Bench mark and with two private stations used for a check. This survey followed the procedure of backsite-foresite-foresite-backsite (BFFB) with three measurements taken and averaged for each sight and accepted if under .003m. A total of fifteen stations were leveled through in two main closed loops along Bridgeway and Alexander Avenue. Four separate closed loops were surveyed and connected to the two main loops to tie in the HPN monuments at higher elevations.

A minimal constrained adjustment was processed fixing Tidal 30. The results were analyzed and used to develop the final NAVD88 heights.

The table below shows the comparison between the (NGS) NAVD88 record vs measures heights.

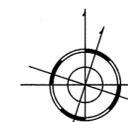
Point	BM	Record	Meas.	NGS(91) Diff.	Location
HT 3533	NGS BM	8.84	8.75	-0.09	North end of the City
Tidal 32	NGS BM	11.71	11.65	-0.07	Harbor Drive USACOE
3221A	NGS BM	12.08	12.06	-0.02	Napa/Bridgeway
Tidal 2	NGS BM	16.39	16.39	0.00	Vertical Bench Mark Pine
Tidal 30	NGS BM	16.02	16.02	0.00 FIXED	Down town square
BM Pier	CS BM	9.45	9.96	0.01	Fishing Pier
Tidal 25	NGS BM	110.74	110.75	-0.16	South end of City, Ft Baker

NOTE: NGS BM Tidal 25 has visual signs of disturbance and may still be moving. It is not recommended that this BM be used for future elevations.

### Adjustment 4: Orthometric heights and Geoid Analysis

The NAVD88 Orthometric heights of HPN 3, 4, 5, 7, 8, and 9, were determined in the field by differential leveling and tied to published NGS NAVD88 first order benchmark with published 1991 NAVD88 Orthometric heights based on the procedure described above. A minimally constrained adjustment was computed fixing the leveled Orthometric heights at stations HPN 3, 4, 5, 7, 8, & 9. The Geoid model 2012B was applied to the adjustment to establish Orthometric heights on those HPN stations not leveled through (HPN 1, 2 & 6).

## RECORD OF SURVEY CITY OF SAUSALITO HIGH PRECISION NETWORK



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# DATA COLLECTION, PROCESSING AND EQUIPMENT ACCURACY: LOCAL NETWORK

## ACCURACY: LOCAL AND NETWORK

Vector Residuals: 45 vectors were included in the network and averaged 7577 meters with a maximum of 21601 meters in length. The vector residuals resulting from the minimally constrained adjustment are listed below in meters.

Two Dimensional Residuals			Vertical Residuals (absolute values)		
Average	Std.Dev.	Maximum	Average	Std.Dev.	Range
0.003	0.001	0.007	0.003	0.003	-0.012 to +0.012

Local Accuracy: 36 local vectors connected the CS-2016 HPN and averaged 2177 meters with a maximum of 4965 meters in length. At the 95% Level of Confidence, the relative distance accuracy averages .007 meters with a maximum of 0.007 meters and relative vertical accuracy averages .005 meters with a maximum of 0.006 meters resulting from the minimally constrained adjustment

Network Accuracy: The Standard Deviations (68% Level of Confidence) of the latitude, longitude and ellipsoid heights and the 95% Level of Confidence of the Horizontal Positions and Ellipsoid Heights for the CS-2016 HPN are listed below in meters. The one-sigma accuracy estimates for the latitude, longitude, and ellipsoid heights for Stations TIBB (CORS), UCSF and MHDL were taken from the CCSF Record of Survey #8080 referred to herein. For Station TIBB, during the time of the survey the "Short Term Time Series" available at the NGS website differed 0.001 meters in the latitude and did not affect the statistical outcome. These one-sigma accuracy estimates were used for weighting the constrained adjustment to develop Network Accuracies listed in the table below and allow users to calculate the propagated error for future surveys based on the CS-2016 HPN positions.

NETWORK ACCURACY IN Meters					
Station	Coordinate Std. Deviations			Network Accy. 95% Confidence	
	Latitude	Longitude	Ellipsoid Ht	Horizontal	Ellipsoid Ht
1	0.001	0.001	0.003	0.003	0.005
2	0.001	0.001	0.003	0.003	0.005
3	0.002	0.002	0.003	0.006	0.006
4	0.002	0.002	0.003	0.006	0.006
5	0.002	0.002	0.003	0.006	0.006
6	0.002	0.002	0.003	0.005	0.006
7	0.002	0.002	0.003	0.006	0.006
8	0.002	0.002	0.003	0.006	0.006
9	0.002	0.002	0.003	0.006	0.006
MHDL	0.002	0.002	0.004	0.005	0.008
TIBB	0.001	0.001	0.004	0.002	0.008
UCSF	0.001	0.001	0.004	0.002	0.008

Accuracy Classification: At the 95-percent confidence level, these geodetic control data for the CS-2016 HPN meet the 1-Centimeter Local Accuracy Standard for the horizontal coordinate values, the 1-Centimeter Local Accuracy Standard for the vertical coordinate values (heights), the 1-centimeter Network Accuracy Standard for the horizontal coordinate values, and the 1-centimeter Network Accuracy Standard for the vertical coordinate values (heights) according to the reporting standard published by FGDC in "Geospatial Positioning Accuracy Standard, Part 2, Geodetic Control Networks", FGDC-Std-007, 2-1998. This survey conforms to the requirements of Public Resources Code Section 8801 through 8819 and 8850 through 8880.

## DATA COLLECTION, PROCESSING AND EQUIPMENT

Two Trimble R-10 GNSS and receivers/antennas listed below were mounted on Tribrachs and Tripods along with a fabricated stainless bracket mounted on the roof of the Sausalito Police Station, and used to store satellite signal data. The R10 receivers tracked Navstar GPS and GLONASS satellites. There were no equipment failures during the survey.

Date of Field Surveys: February 28 to March 2 2017 (Average Date 2017.20)  
GNSS Survey Parameters:

Observations: Static occupations collected GPS and GLONASS signal data at a 5 second epoch rate for 45 minutes at all points with 8 hours at the base station setups for the radial observations on all three days of the field survey. Observations at the CORS and CGPS stations were GPS only for 24 hours at a 15 second epoch rate and downloaded from the Internet.

Observables: GPS L1 & L2 Carrier wave, GLONASS L1 & L2.

Ephemeris: Precise GPS and GLONASS for static post processing.

Weather Conditions: Clear weather and mild temperatures.

Space Weather : The K Index was between 1-2 on February 28 K Index 4-5 on March 1, 2017 and K-Index of 3-4 on March 2, 2017.

### Equipment:

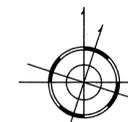
GNSS Base Receiver Unit No.: 9311, Operator: JM;  
Receiver Make & Model: TRIMBLE R10; Antenna Make & Model: R10  
Antenna Mount: Tribrach & Tripod; Antenna Heights varies  
GNSS Base Receiver Unit No.: 9123 Operator: LC, CC, JM  
Receiver Make & Model: TRIMBLE R10; Antenna Make & Model: R10  
Antenna Mount: Tribrach & Tripod; Antenna Height: Varies  
CORS & CGPS National Geodetic Survey Antennas

Note, absolute antenna models were used in the baseline processing and measurements were referenced to the monument not the antenna reference point (ARP).

Stat.	Antenna	Radome
CCSF	AX1202 GG	NONE
MHDL	ASH700936C_M	SNOW
TIBB	ASH701945B_M	SCIT
UCSF	ASH701945B_M	SCIT
P181	TRM59800.80	SCIT

Rinex Data, Antenna Models, Precise Ephemeris and Processing Software: Rinex files for the CORS and CGPS were imported from the NGS and SOPAC. Absolute antenna models were imported from the NGS and the Precise Ephemeris was imported from the NGS for the GPS and IGS for the GLONASS constellations. Baseline processing was performed in Trimble Business Center and the Network Adjustments were performed in STAR NET Version 8.2

## RECORD OF SURVEY CITY OF SAUSALITO HIGH PRECISION NETWORK



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# STATION DESCRIPTIONS AND FINAL COORDINATES

## NETWORK DESCRIPTIONS

### HPN 1 Marin City

Set a 3" Dome Top Brass Disk stamped " CITY OF SAUSALITO, CS HPN 01, PLS 7053, CS-HPN 2016 with 5/8" Rebar in 3" schedule 40 PVC pipe and concrete sleeve in a cast iron monument well set flush with the ground. At the end of Donahue Street in Marin City proceed southerly through the locked gate along the Alta Trail in Marin Headlands 0.06 miles to a fork to the right which leads to a MMWD water tank. Proceed westerly 0.04 miles along said fork to the southeast corner of a Catch Basin. The monument is southerly 60' from said SE corner of said Catch Basin.

### HPN 2 Range Reset

Found a 3" brass disk stamped Horizontal Control Mark , National Geodetic Survey "Range 1931 1973" epoxied in a drill hole on the top of the south corner of a concrete wall around an old abandoned Gun Emplacement. From the intersection of Alexander and East Street travel southeasterly along East Street toward Fort Baker for 0.6 miles to a dirt parking area on the left. Pass through the gate and go east and south on a graveled road 0.1 mile to a brick-lined tunnel. Enter the tunnel and walk southeast 130 feet to the station. This area is closed to the public, contact GGNRA for information and access.

### HPN 3 Dog Park

Set a 3" Dome Top Brass Disk stamped "CITY OF SAUSALITO, CS HPN 03, PLS 7053, CS-HPN 2016 in the top of a concrete picnic table pad at the Sausalito Dog Park. The station is located in the Dog Park, from the west entrance to the dog park adjacent to MLK School; travel easterly , 140 feet, to the most southeasterly picnic pad.

### HPN 4 Napa Street

Set a 3" Dome Top Brass Disk stamped "CITY OF SAUSALITO, CS HPN 04, PLS 7053, CS-HPN 2016 in Northeasterly side of the City Sidewalk at the southwest intersection of Bridgeway and Napa Street. Station is located northeasterly 19.3 feet from the northwesterly corner of the concrete foundation for the Bolinar statue.

### HPN 5 Baker

Set a 3" Dome Top Brass Disk stamped "CITY OF SAUSALITO , CS HPN 05, PLS 7053, CS-HPN 2016 with 5/8" Rebar in a 3" schedule 40 PVC pipe and concrete sleeve in a cast iron monument well set flush with the ground. The station is located at the south end of Sausalito and at the intersection of Alexander Avenue and East Road. From said intersection and along the easterly side of the guard rail, head southerly 3.3 feet from the last 6"x8" guard rail post set on top of the AC Curb to the station.

### HPN 6 Police Station

Station is a fabricated stainless steel bracket set on the roof of the Sausalito Police Station inside a protection compound for the air conditioning unit. This station was used as a base station for Cities Aerial Photo and LIDAR project. This Police Station is at the Intersection of Johnson and Caledonia Street. Access to this station is by permission. Contact the City of Sausalito Engineering Department for questions .

### HPN 7 MMWD Tank Site

Set a 3" Dome Top Brass Disk stamped " CITY OF SAUSALITO, CS HPN 07, PLS 7053, CS-HPN 2016 in the top of the concrete rim for the MMWD water tank at the northeasterly side of the tank. To reach the station from the intersection of Rodeo Avenue, Nevada Street and the Utility access road to the MMWD Tank site, travel through the access gate easterly and southerly along the access road 0.8 miles to the Tank Site. The Station is northwesterly 5' from the end of the concrete block wall.

### HPN 8 Southview Park

Set a 3" Dome Top Brass Disk stamped "CITY OF SAUSALITO, CS HPN 08, PLS 7053, CS-HPN 2016 in the top of a 12" x 12" Concrete Pillar at Southview Park. The station is located at the Northeast corner of Southview Park at the intersection of 3RD and North Street and the entrance to the children' s Playground.

### HPN 9 Tidal 32

Found a 3" Brass Disk set in a concrete slab stamped U.S. Coast & Geodetic Survey Bench Mark "32" . To reach the station from intersection of Marinship and Liberty Ship Way, travel northeasterly along Liberty Ship Way 0.08 miles. The station is set in the top of the south corner of a 8x30 foot concrete slab 0.5 feet northwesterly of the south corner of the slab.

## FINAL GEODETIC AND PLANE COORDINATES

NAD83 (2011) Epoch 2010.00  
 GEODETIC COORDINATE LIST (US Survey Feet)

Station	Latitude	Longitude	Ellip Ht
HPN1	37-52-27.42011906	-122-31-11.73495550	273.235
HPN2	37-50-06.24520385	-122-28-21.06407428	10.557
HPN3	37-52-11.16594504	-122-30-15.79863789	-85.941
HPN4	37-51-40.35684821	-122-29-22.51780322	-92.843
HPN5	37-50-40.09207056	-122-28-40.28965170	9.826
HPN6	37-51-28.35487011	-122-29-04.51874000	-56.322
HPN7	37-51-41.87553258	-122-29-56.04967165	184.312
HPN8	37-51-02.73056315	-122-28-54.14914959	33.065
HPN9	37-51-47.84353677	-122-29-35.97943987	-94.808
MHDL	37-50-32.34823676	-122-29-39.54755928	217.856
TIBB	37-53-27.13895644	-122-26-51.31715860	-67.456
UCSF	37-45-46.67242520	-122-27-29.28909844	508.920

## CA STATE PLANE COORDINATE and ELEVATIONS LIST

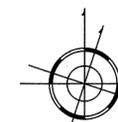
California State Plane Coordinates Zone 3: NAD83(2011) Epoch 2010.00  
 and NAVD88 Heights (US Survey Feet)

Station	State Plane Coord.		NAVD88
	North	East	Elevation
HPN1	2147100.136	5978690.233	379.68
HPN2	2132532.125	5992069.954	117.20
HPN3	2145360.039	5983138.761	20.54
HPN4	2142153.355	5987343.670	13.67
HPN5	2135987.384	5990600.392	116.39
HPN6	2140909.026	5988760.958	50.15
HPN7	2142364.225	5984658.622	290.80
HPN8	2138300.186	5989537.474	139.62
HPN9	2142933.404	5986280.547	11.65
MHDL	2135305.165	5985831.776	324.44
TIBB	2152696.649	5999690.606	38.70
UCSF	2106196.108	5995673.065	615.83

Convergence Angles (DMS) and Grid Factors at Stations  
 (Grid Azimuth = Geodetic Azimuth - Convergence)  
 (Elevation Factor Includes a Geoid Height Correction at Each Station)

Station	Convergence Angle	Factors		
		Scale	x Elevation	= Combined
HPN1	-1-14-11.99	0.99993148	0.99998693	0.99991842
HPN2	-1-12-27.50	0.99993025	0.99999950	0.99992974
HPN3	-1-13-37.74	0.99993132	1.00000411	0.99993543
HPN4	-1-13-05.12	0.99993102	1.00000444	0.99993546
HPN5	-1-12-39.27	0.99993050	0.99999953	0.99993003
HPN6	-1-12-54.10	0.99993091	1.00000269	0.99993360
HPN7	-1-13-25.65	0.99993103	0.99999118	0.99992222
HPN8	-1-12-47.75	0.99993069	0.99999842	0.99992911
HPN9	-1-13-13.36	0.99993109	1.00000453	0.99993562
MHDL	-1-13-15.55	0.99993044	0.99998958	0.99992002
TIBB	-1-11-32.55	0.99993214	1.00000323	0.99993537
UCSF	-1-11-55.80	0.99992920	0.99997566	0.99990486
Project Averages:	-1-12-54.67	0.99993123	0.99998810	0.99991933

# RECORD OF SURVEY CITY OF SAUSALITO HIGH PRECISION NETWORK



CITY OF SAUSALITO MARIN COUNTY CALIFORNIA

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