NPS Accurate Elevations

Support of Sea level Rise Science and Planning for Coastal National Parks

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Accurate Elevations

Two Facets to Park Elevations:

- Establishing survey monumentation to support current and future park planning and science.
- Establish precise elevations including local tidal heights on NPS assets.

Survey Monumentation

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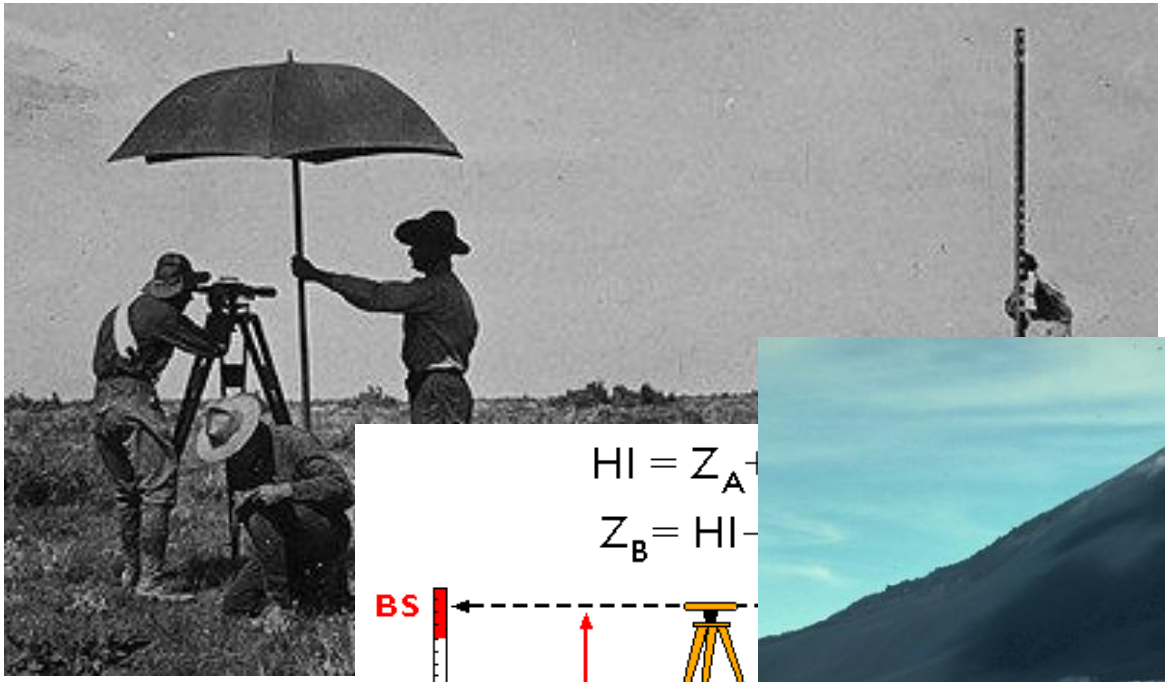

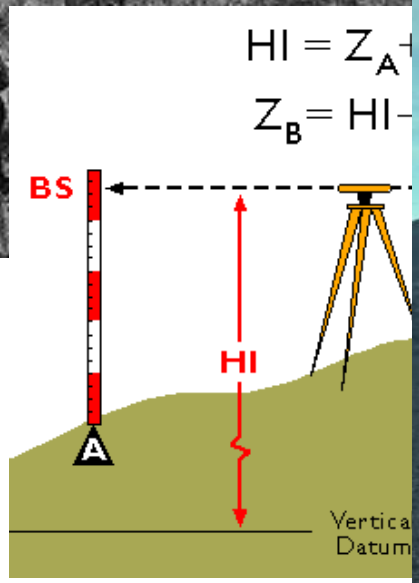

Survey Monumentation

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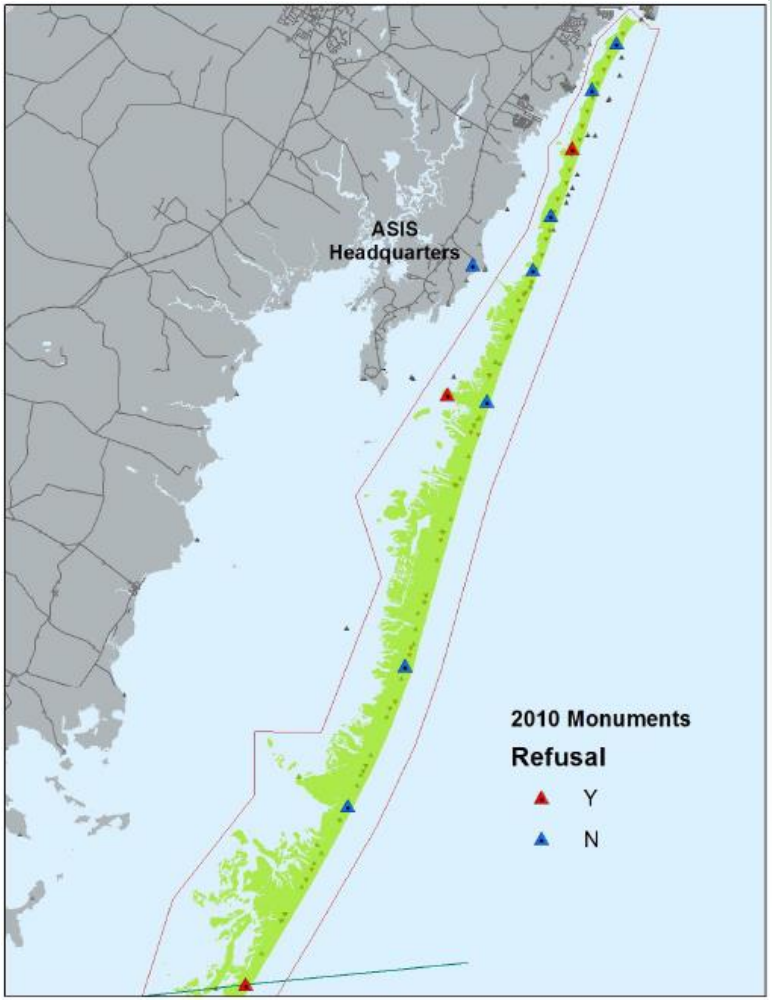
Survey Monumentation

Survey Monumentation at Assateague National Seashore

Backbone Monumentation
(Survive in perpetuity)

Sentinel Site Monumentation
(May survive but located at important management sites for the park)

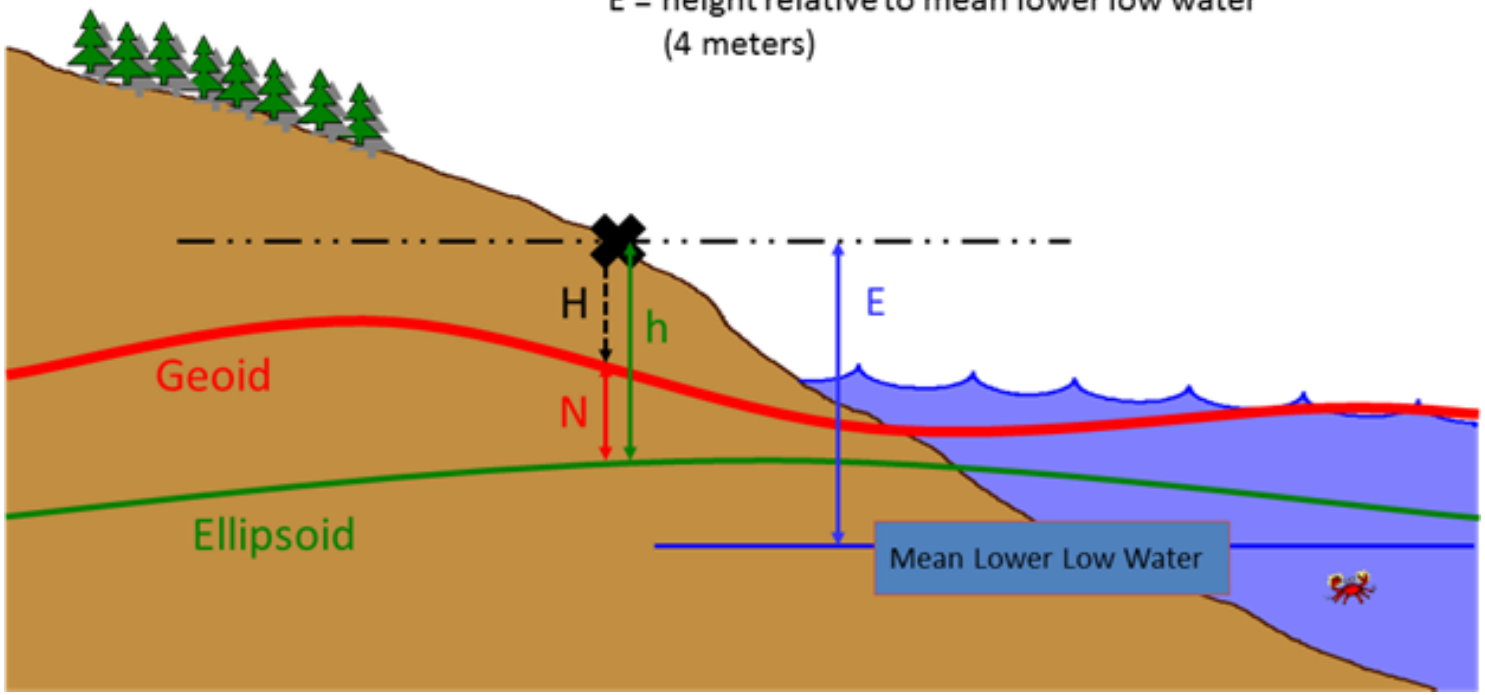


Accurate Elevations

H = h - N

H = orthometric height (2 meters)
N = geoid height (1.5 meters)
h = ellipsoid height (3.5 meters)

E = height relative to mean lower low water (4 meters)



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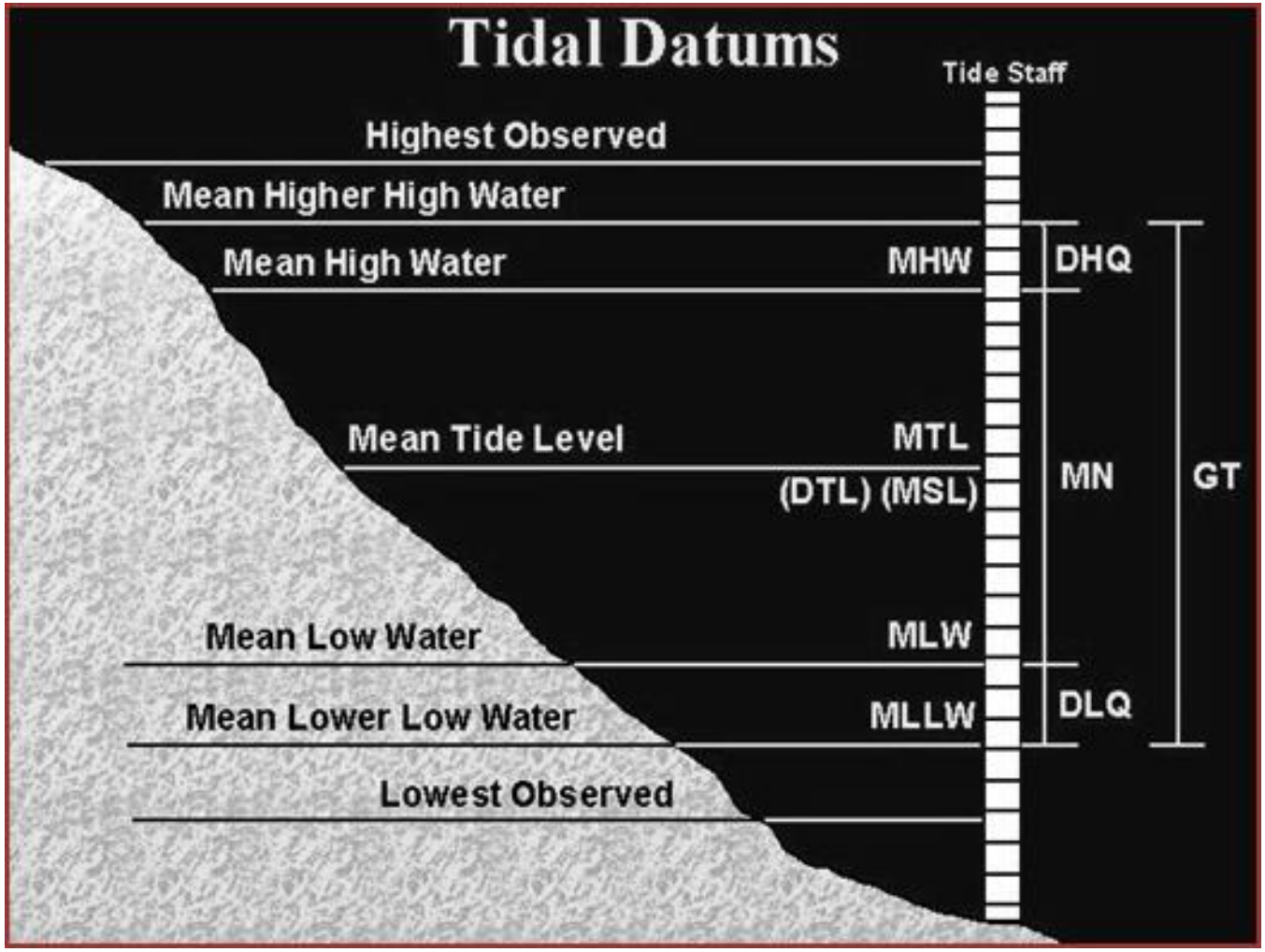

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NAVD88 - Father's Point, Ontario

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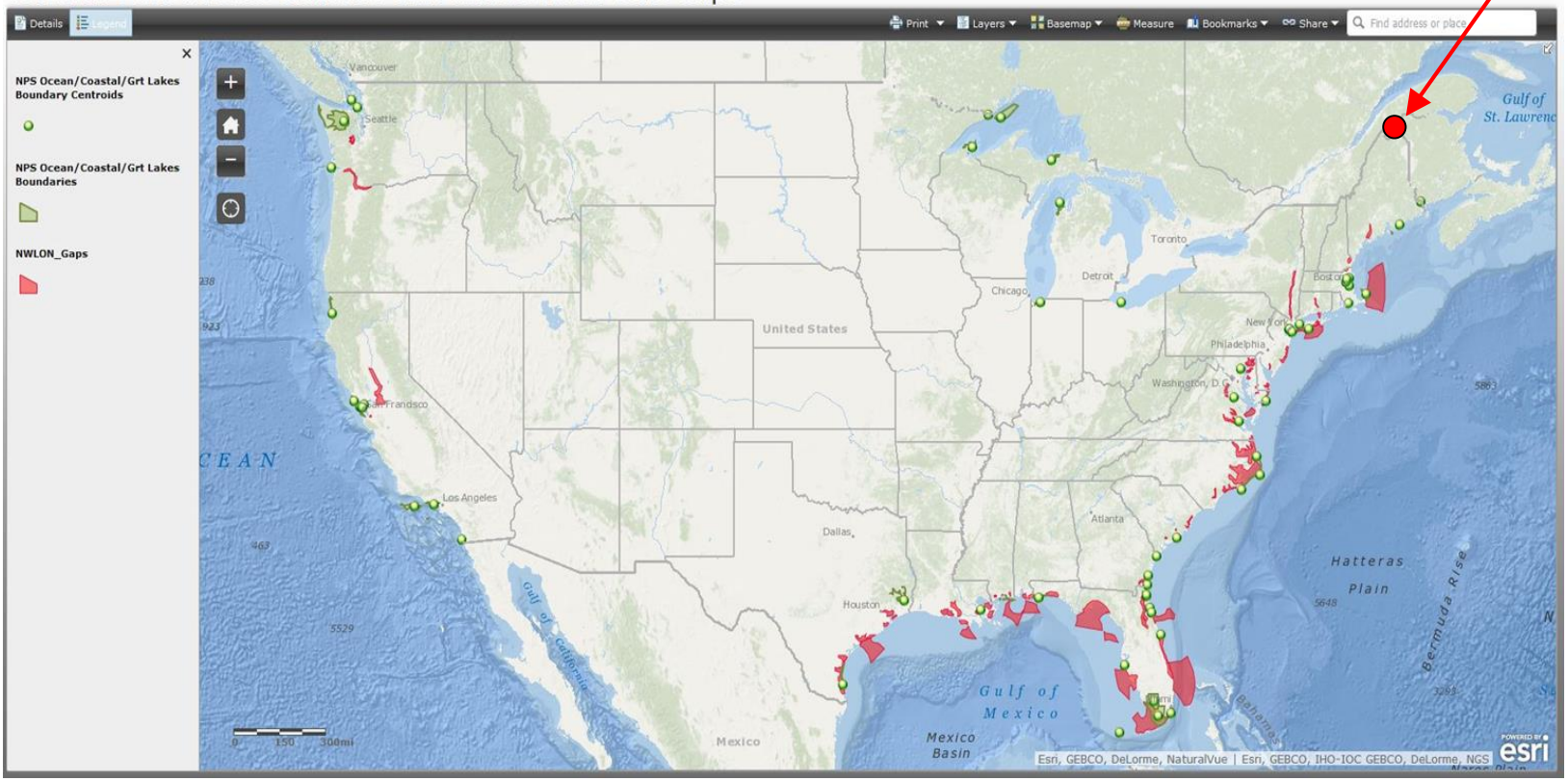
Father's Point

National Park Service Coastal Parks and NWLON Data Gaps



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Establish Local Tidal Datum Heights

Golden Gate and Marin Headlands National Parks

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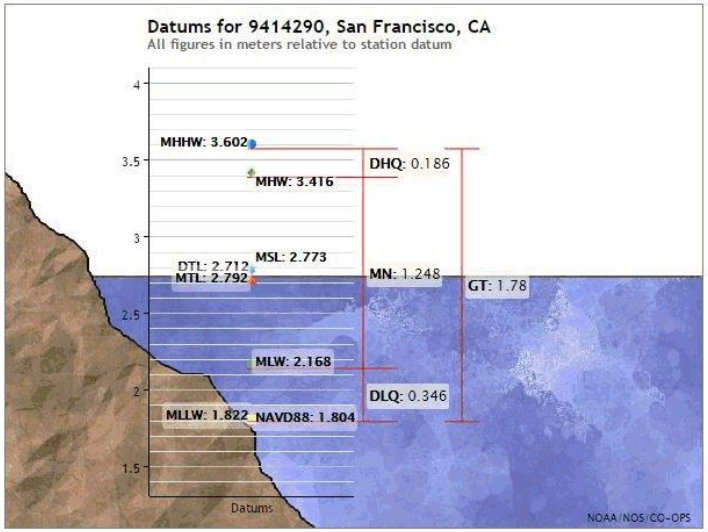
Datums for 9414290, San Francisco CA

Elevations on Station Datum

Station: 9414290, San Francisco, CA
Status: Accepted (Apr 17 2003)
Units: Meters
T.M.: 120
Epoch: 1983-2001
Datum: STND

Datum	Value	Description
MHHW	3.602	Mean Higher-High Water
MHW	3.416	Mean High Water
MTL	2.792	Mean Tide Level
MSL	2.773	Mean Sea Level
DTL	2.712	Mean Diurnal Tide Level
MLW	2.168	Mean Low Water
MLLW	1.822	Mean Lower-Low Water
NAVD88	1.804	North American Vertical Datum of 1988
STND	0.000	Station Datum
GT	1.780	Great Diurnal Range
MN	1.248	Mean Range of Tide
DHQ	0.186	Mean Diurnal High Water Inequality
DLQ	0.346	Mean Diurnal Low Water Inequality
HWI	7.530	Greenwich High Water Interval (in hours)
LWI	0.850	Greenwich Low Water Interval (in hours)
Maximum	4.462	Highest Observed Water Level
Max Date & Time	01/27/1983 09:30	Highest Observed Water Level Date and Time
Minimum	0.945	Lowest Observed Water Level
Min Date & Time	12/17/1933 18:00	Lowest Observed Water Level Date and Time
HAT	4.039	Highest Astronomical Tide
HAT Date & Time	12/31/1990 18:12	HAT Date and Time
LAT	1.186	Lowest Astronomical Tide
LAT Date & Time	05/25/1986 14:24	LAT Date and Time



Showing datums for

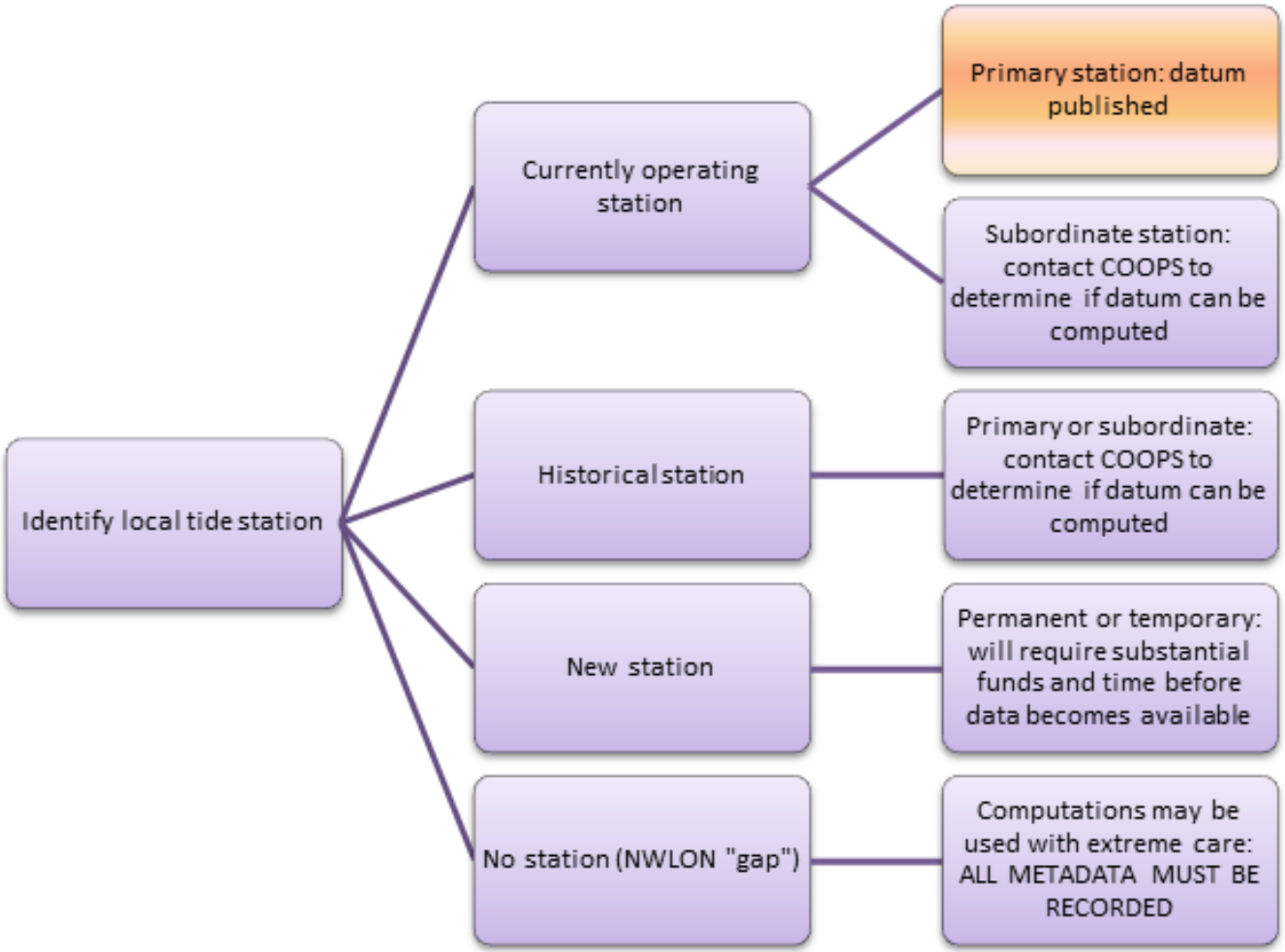
9414290 San Francisco, CA

Data Units ○ Feet ◉ Meters

Epoch ◉ Present (1983-2001) ○ Superseded (1960-1978)

Submit

Accurate Elevations



Accurate Elevations

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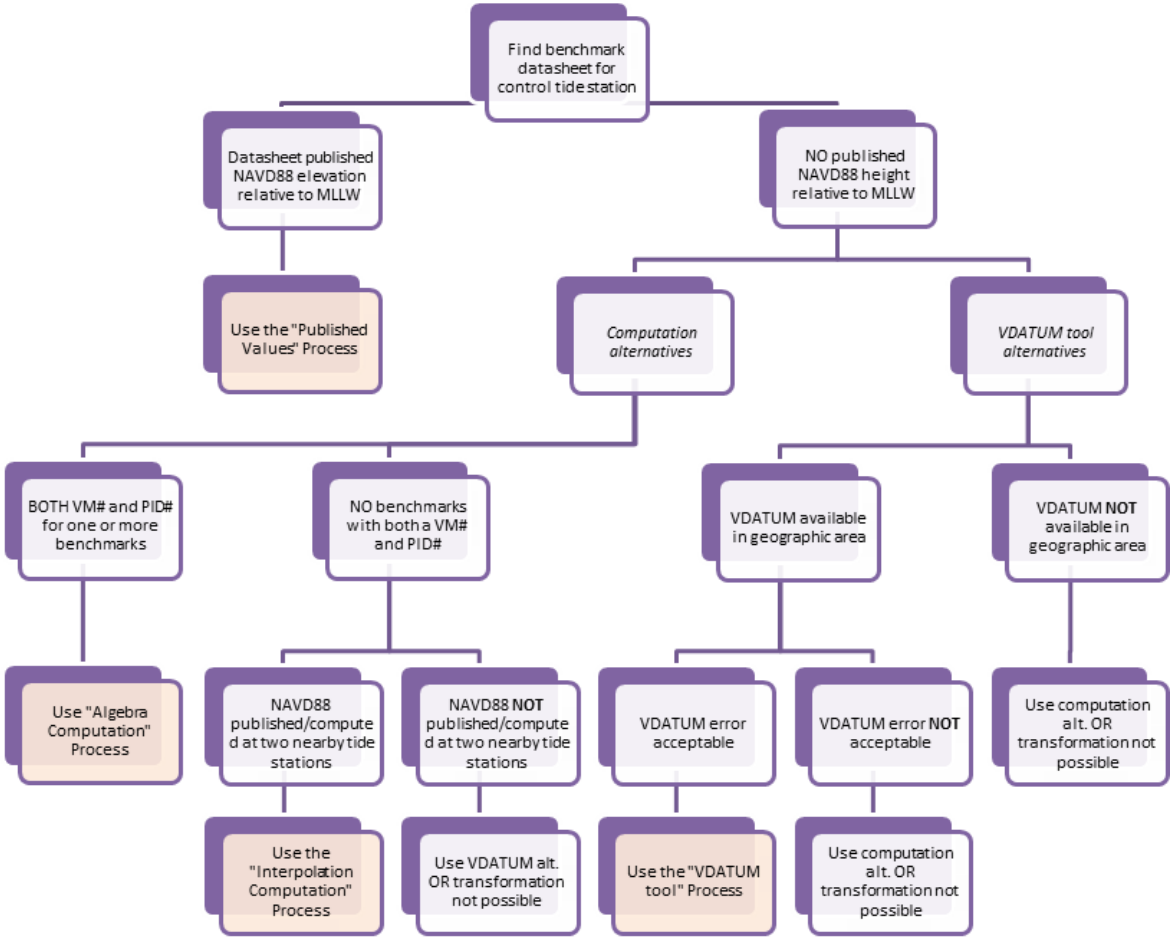

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Tide Station

Supporting survey monumentation

Accurate Elevations

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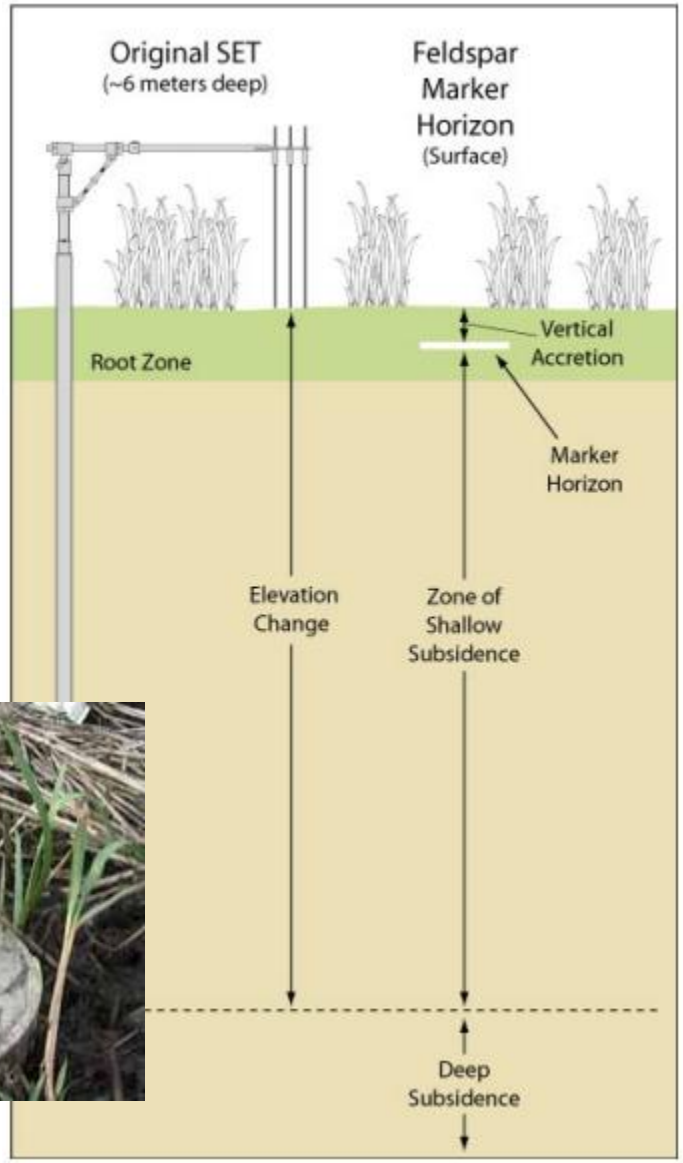
The NGS Data Sheet

See file dsdata.txt for more information about the datasheet.

```
PROGRAM = datasheet95, VERSION = 8.8
1        National Geodetic Survey,   Retrieval Date = OCTOBER 13, 2015
 HT0698 ***********************************************************************
 HT0698  TIDAL BM     -  This is a Tidal Bench Mark.
 HT0698  DESIGNATION -  CLARK
 HT0698  PID          -  HT0698
 HT0698  STATE/COUNTY-  CA/SAN FRANCISCO
 HT0698  COUNTRY      -  US
 HT0698  USGS QUAD    -  SAN FRANCISCO NORTH (1995)
 HT0698
 HT0698                        *CURRENT SURVEY CONTROL
 HT0698  ______________________________________________________________________
 HT0698* NAD 83(1992) POSITION- 37 48 30.98554(N) 122 28 15.28359(W)   ADJUSTED
 HT0698* NAD 83(1992) EPOCH    -  1991.35
 HT0698* NAVD 88 ORTHO HEIGHT -     4.249 (meters)       13.94  (feet) ADJUSTED
 HT0698  ______________________________________________________________________
 HT0698  LAPLACE CORR     -          2.87  (seconds)                   DEFLEC12B
 HT0698  GEOID HEIGHT     -       -32.558 (meters)                     GEOID12B
 HT0698  DYNAMIC HEIGHT   -         4.247 (meters)       13.93  (feet) COMP
 HT0698  MODELED GRAVITY -    979,980.6   (mgal)                       NAVD 88
 HT0698
 HT0698  HORZ ORDER       -  SECOND
 HT0698  VERT ORDER       -  FIRST     CLASS I
 HT0698
 HT0698.The horizontal coordinates were established by classical geodetic methods
 HT0698.and adjusted by the National Geodetic Survey in March 1994.
 HT0698.
 HT0698.The orthometric height was determined by differential leveling and
 HT0698.adjusted by the NATIONAL GEODETIC SURVEY
 HT0698.in June 1991.
 HT0698
 HT0698.Significant digits in the geoid height do not necessarily reflect accuracy.
 HT0698.GEOID12B height accuracy estimate available here.
 HT0698
 HT0698.This Tidal Bench Mark is designated as VM 976
 HT0698.by the CENTER FOR OPERATIONAL OCEANOGRAPHIC PRODUCTS AND SERVICES.
 HT0698
 HT0698.Photographs are available for this station.
 HT0698
 HT0698.The Laplace correction was computed from DEFLEC12B derived deflections.
 HT0698
 HT0698.The dynamic height is computed by dividing the NAVD 88
 HT0698.geopotential number by the normal gravity value computed on the
 HT0698.Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45
 HT0698.degrees latitude (g = 980.6199 gals.).
 HT0698
 HT0698.The modeled gravity was interpolated from observed gravity values.
 HT0698
 HT0698. The following values were computed from the NAD 83(1992) position.
 HT0698
 HT0698;                    North         East     Units Scale Factor Converg.
 HT0698;SPC CA 3      -   647,057.980 1,826,466.036   MT  0.99992968   -1 12 24.0
 HT0698;SPC CA 3      - 2,122,889.39  5,992,330.65    sFT  0.99992968   -1 12 24.0
 HT0698;UTM  10       - 4,184,711.750   546,573.137   MT  0.99962672   +0 19 27.7
```

```
Elevations of tidal datums referred to Mean Lower Low Water (MLLW), in METERS:

     HIGHEST OBSERVED WATER LEVEL (01/27/1983)          =  2.640
     MEAN HIGHER HIGH WATER                  MHHW       =  1.780
     MEAN HIGH WATER                         MHW        =  1.595
     MEAN TIDE LEVEL                         MTL        =  0.970
     MEAN SEA LEVEL                          MSL        =  0.951
     MEAN LOW WATER                          MLW        =  0.346
     MEAN LOWER LOW WATER                    MLLW       =  0.000
     North American Vertical Datum           NAVD88     = -0.018
     LOWEST  OBSERVED WATER LEVEL (12/17/1933)          = -0.877

North American Vertical Datum (NAVD88)

Bench Mark Elevation Information                In METERS above:

     Stamping or Designation                    MLLW        MHW

     180 1936                                    3.972      2.378
     BM 174 1925                                 5.013      3.418
     BM 176 1925                                 4.814      3.219
     181 1945                                    3.987      2.392
     NO 2 1948                                   4.221      2.626
     CLARK 1948                                  4.233      2.639
     4290 K 1976                                 5.828      4.234
     4290 L 1976                                 6.620      5.025
     4290 M 1982                                 3.705      2.111
     BM 175 1925                                 4.160      2.566
     4290 N 1995                                 3.646      2.051
```

Accurate Elevations



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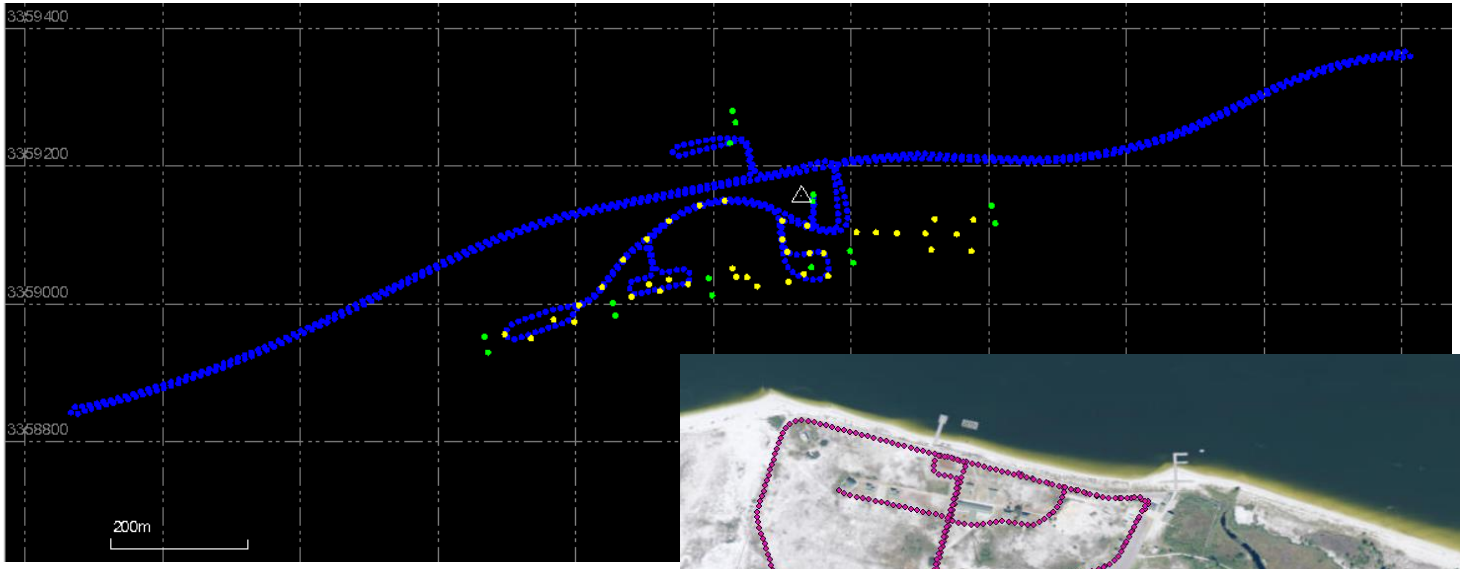

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Accurate Elevations

Resulting Elevations:

	A	B	C	D	E	F	G	H	I	J	K	L
1	Point Name (F	Latitude	Longitude	Northing	Easting	HAE (m)	NAVD88 (m)	Local Tidal (MLLW)	Local Tidal (MLW)	Local Tidal (MSL)	Local Tidal (MHW)	Local Tidal (MHHW)
2	CALO1	35.06907827	-76.05791914	3881215.311	403542.450	-37.658	0.493	0.535	0.532	0.499	0.419	0.408
3	CALO 42922	35.06853091	-76.05769093	3881154.386	403562.614	-37.215	0.937	0.979	0.976	0.943	0.863	0.852
4	CALO 42927	35.06958518	-76.06129374	3881274.800	403235.351	-36.994	1.15	1.192	1.189	1.156	1.076	1.065
5	CALO 42941	35.07096569	-76.06166758	3881428.267	403202.895	-36.983	1.162	1.204	1.201	1.168	1.088	1.077
6	CALO 42952	35.06887131	-76.06057061	3881194.927	403300.444	-36.557	1.588	1.630	1.627	1.594	1.514	1.503
7	CALO 42957	35.06927567	-76.06035457	3881239.563	403320.619	-36.951	1.195	1.237	1.234	1.201	1.121	1.110
8	CALO 42960	35.06946458	-76.06077377	3881260.920	403282.620	-37.010	1.136	1.178	1.175	1.142	1.062	1.051
9	CALO 43000	35.06972853	-76.06083894	3881290.257	403276.989	-36.837	1.308	1.350	1.347	1.314	1.234	1.223
10	CALO 43051	35.06721234	-76.06392333	3881014.197	402992.778	-36.956	1.181	1.223	1.220	1.187	1.107	1.096
11	CALO 43063	35.06979299	-76.06385679	3881300.337	403001.899	-37.212	0.927	0.969	0.966	0.933	0.853	0.842
12	CALO 43065	35.07020271	-76.06419998	3881346.110	402971.092	-37.035	1.104	1.146	1.143	1.110	1.030	1.019
13	CALO 43069	35.07174182	-76.06295083	3881515.589	403086.808	-36.803	1.34	1.382	1.379	1.346	1.266	1.255
14	CALO 43070	35.07212029	-76.06289128	3881557.505	403092.685	-36.895	1.248	1.290	1.287	1.254	1.174	1.163
15	CALO 43071	35.07014567	-76.06570491	3881341.250	402833.807	-36.891	1.244	1.286	1.283	1.250	1.170	1.159
16	CALO 43072	35.06988353	-76.06815797	3881314.571	402609.827	-36.541	1.589	1.631	1.628	1.595	1.515	1.504
17	CALO 43324	35.07006903	-76.06023102	3881327.430	403332.820	-36.720	1.428	1.470	1.467	1.434	1.354	1.343
18	CALO 43325	35.06878391	-76.06166143	3881186.292	403200.879	-37.081	1.063	1.105	1.102	1.069	0.989	0.978
19	CALO 43326	35.06927124	-76.06295422	3881241.596	403083.578	-37.225	0.916	0.958	0.955	0.922	0.842	0.831
20	CALO 43327	35.07071486	-76.06252862	3881401.285	403124.091	-37.044	1.099	1.141	1.138	1.105	1.025	1.014
21	CALO 43328	35.07019652	-76.06348823	3881344.732	403035.981	-37.103	1.037	1.079	1.076	1.043	0.963	0.952
22	CALO 43330	35.06791725	-76.06355093	3881092.012	403027.569	-36.883	1.256	1.298	1.295	1.262	1.182	1.171
23	CALO 46568	35.06563695	-76.0565291	3880832.311	403665.150	-35.154	2.998	3.040	3.037	3.004	2.924	2.913
24	CALO 53250	35.06898087	-76.05808259	3881204.668	403527.432	-37.230	0.921	0.963	0.960	0.927	0.847	0.836
25	CALO 53392	35.06849562	-76.05781256	3881150.590	403551.482	-36.949	1.202	1.244	1.241	1.208	1.128	1.117
26	CALO 114217	35.06588061	-76.05616159	3880858.980	403698.948	-35.993	2.159	2.201	2.198	2.165	2.085	2.074
27												
28	Difference between Local Tidal (Cedar Island, Station# 8655151) and NAVD88 was calculated using difference at Tidal BM PID# AC7508											
29	NAD83 (CORS96); NAVD88 (Geoid09); Tide Control Station: 8656483 Beaufort, Duke Marine Lab (1983-2001 epoch)											

National Park Service

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Survey Monumentation