REPORT OF SURVEY
COASTAL CONNECTICUT

INTRODUCTION

Terrasurv was contracted by Earthdata International to perform a geodetic control survey in support of photogrammetric mapping of the coastline of the state of Connecticut. The imagery was obtained using an ADS-40 digital camera. The control survey was performed using the Global Positioning System (GPS). The map in figure 1 shows the location of these 16 new stations, as purple triangles. These stations were designated 04106A through 04106J. The locations of the four temporary base stations is indicated by blue circles. Finally, the location of the existing control is indicated by green stars.

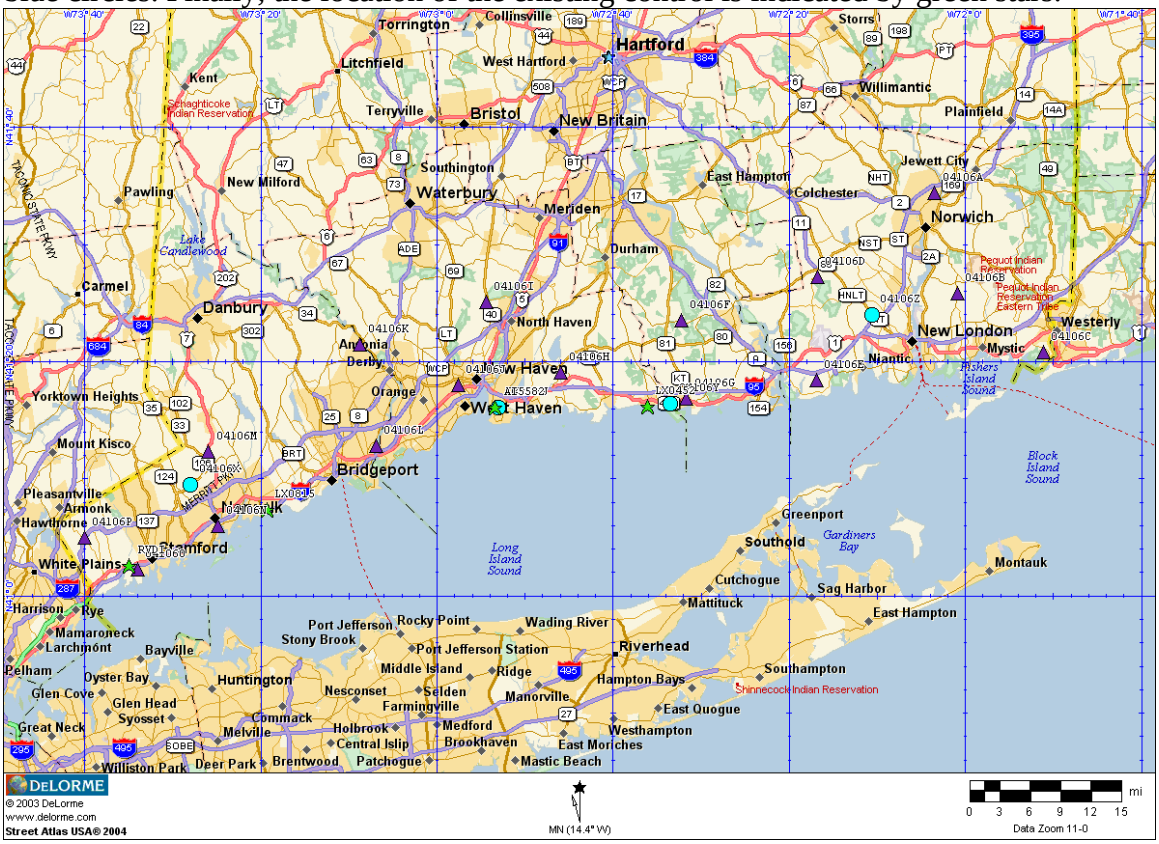


Figure 1 - new stations and control

CONTROL

Several stations of the National Spatial Reference System (NSRS) were used to provide control for this project. These stations are listed in the table below:

Station Name	PID	H Control	V Control	Comments
HVN D	AI5582	B	GPS	HARN at New Haven airport
P 36	LX0452	A	1	BM in seawall
F 33	LX0815		1	BM in abutment
RVDI ARP	DF9200	CORS		COOP CORS in Riverside

The horizontal datum was the North American Datum of 1983, 1996 adjustment (NAD 1983 1996). The vertical datum was the North American Vertical Datum of 1988 (NAVD 1988).

The HARN point at Tweed-New Haven Airport was occupied by the flight crew during imagery acquisition.

STATIONS OCCUPIED

The following table lists the stations occupied as part of this survey:

Station Name	GPSID	USGS Quad	Description
1	04106A	NORWICH	ID=SE corner of drop inlet, south of I-395, in angle formed by Canterbury Pike and Old Canterbury Pike
10	04106J	NEW HAVEN	ID=NE corner of asphalt patch in concrete walk, S of Rt 34, near Yale University athletic fields
11	04106K	LONG HILL	ID=SE corner of crosswalk stripes on southerly berm of Rt 34
12	04106L	MILFORD	ID=westerly edge of concrete walk at angle point in walk, near dentist office parking on W side of Rt 110
13	04106M	NORWALK NORTH	ID=West end of line of logs for parking, south edge of gravel parking area, east side of entrance to parking
14	04106N	NORWALK SOUTH	ID=NW corner of concrete around drop inlet at east edge of parking lot for Norwalk Police Department
15	04106O	STAMFORD	ID=west edge of concrete sidewalk along east side of US 1, at north edge of concrete driveway apron
16	04106P	GLENVILLE	ID=NE corner of concrete pad at service station, also intersection of paint stripe with concrete pad
2	04106B	UNCASVILLE	ID=SW corner of concrete sidewalk, east side of parking lot for library. Note: asphalt surface is -0.15 m below concrete
3	04106C	WATCH HILL	ID=Center of west end of stop bar for Aimee Drive at Carnot Court
4	04106D	HAMBURG	ID=NE corner of stop bar for Darling Road at SR 82, just west of end of SR 11
5	04106E	OLD LYME	ID=SE corner of westerly bridge abutment on Flat Rock Hill Rd. over I-95, elevation at bridge deck level
6	04106F	HADDAM	ID=SW corner of asphalt parking pad on S side of Welsch Farms Rd.
7	04106G	CLINTON	ID=SW corner of painted crosswalk stripe in school parking lot, just E of Rt 81
8	04106H	BRANFORD	ID=SE corner of asphalt curb around parking island in strip mall parking lot, S of Rt 80
9	04106I	MOUNT CARMEL	ID=SW corner of asphalt parking lot for Wentworth Ice Cream, just E of Rt 40

Station Name	GPSID	USGS Quad	Description
BASE1	04106Z	MONTVILLE	
BASE2	04106Y	CLINTON	
BASE3	04106X	NORWALK NORTH	
BASE4	04106W	NEW HAVEN	
F 33	LX0815	SHERWOOD POINT	BM in bridge abutment
HVN D	AI5582	NEW HAVEN	HARN at Tweed-New Haven Airport
P 36	LX0452	CLINTON	BM/HARN in seawall
RVDI ARP	RVDI	STAMFORD	Co-op CORS

GPS OBSERVATIONS

Four Trimble dual frequency receivers were used to measure the interstation vectors. Each day, two base stations were established on random points. The other two receivers were then used to occupy each of the new stations and the existing NSRS control in turn. Station occupation times ranged from 12 minutes up to 58 minutes, depending on number of satellites available, obstructions present, and distance from the base receiver. The table below summarizes the occupations. Stations 040106W, 04106X, 04106Y, and 04106Z were the temporary base points used.

GPSID	UTC start	duration	HI	Filename
04106A	09/27/2004 17:09:00	30	2	37952710.dat
04106B	09/27/2004 18:12:00	17	2	37952711.dat
04106C	09/27/2004 19:07:15	15	2	37952712.dat
04106D	09/27/2004 20:18:30	15	2	37952713.dat
04106E	09/27/2004 17:37:00	38	2	36652711.dat
04106F	09/27/2004 18:57:30	33	2	36652712.dat
04106G	09/27/2004 16:47:30	18	2	36652710.dat
04106H	09/27/2004 19:58:30	32	2	36652713.dat
04106I	09/28/2004 12:49:00	31	2	36652724.dat
04106J	09/27/2004 21:02:45	58	2	36652714.dat
04106J	09/28/2004 11:58:00	19	2	36652723.dat
04106K	09/28/2004 13:58:30	47	2	36652725.dat
04106L	09/28/2004 15:19:45	36	2	36652726.dat
04106M	09/28/2004 14:04:00	15	2	37952720.dat
04106N	09/28/2004 16:30:00	24	2.25	37952723.dat
04106O	09/28/2004 15:41:15	29	2	37952722.dat
04106P	09/28/2004 14:50:45	19	2	37952721.dat
04106W	09/28/2004 11:29:00	456	0	99812720.DAT
04106X	09/28/2004 13:14:15	242	0	97572720.dat
04106Y	09/27/2004 16:28:30	345	1.402	99812710.dat
04106Z	09/27/2004 16:30:45	259	0	97572710.dat
AI5582	09/28/2004 18:44:00	12	2	36652728.dat
LX0452	09/27/2004 21:30:00	29	2	37952714.dat
LX0815	09/28/2004 16:40:30	31	2	36652727.dat
RVDI	09/28/2004 12:00:00	479	0	RVDI272.04O
RVDI	09/27/2004 16:00:00	419	0	RVDI271.04O

All of the stations were directly occupied.

GPS PROCESSING

The data was downloaded to a PC and processed using the WAVE processor, a part of the Trimble Geomatics Office software package. The single baseline method was used. The radial lines emanating from the temporary base locations were processed, as were the baselines from RVDI CORS to the base locations. In addition, the baselines between base locations were also processed. The following table summarizes the baseline processing:

From	To	UTC Start	Dur.	Length	Ratio	Var.	RMS
04106W	04106I	09/28/2004 12:49:00	31	17994	14.46	2.8	0.016
04106W	04106J	09/28/2004 11:58:00	19	8084	10.5	2.3	0.014
04106W	04106K	09/28/2004 13:58:30	47	24807	6.16	3.1	0.018
04106W	04106L	09/28/2004 15:19:45	36	20156	10.28	2.4	0.017
04106W	AI5582	09/28/2004 18:44:00	12	523	28.73	2.2	0.005
04106X	04106M	09/28/2004 14:04:00	15	6908	11.19	1.5	0.012
04106X	04106N	09/28/2004 16:30:00	24	6896	83.56	2.2	0.018
04106X	04106O	09/28/2004 15:41:15	29	14755	5.29	1.5	0.012
04106X	04106P	09/28/2004 14:50:45	19	18449	5.34	3.2	0.017
04106X	04106W	09/28/2004 13:14:15	242	50420	0	1.7	0.015
04106X	LX0815	09/28/2004 16:40:30	31	12848	5.77	2.3	0.018
04106Y	04106E	09/27/2004 17:37:00	38	23605	15.43	1.9	0.015
04106Y	04106F	09/27/2004 18:57:30	33	14388	10.9	3.6	0.019
04106Y	04106G	09/27/2004 16:47:30	18	3008	24.33	2.5	0.005
04106Y	04106H	09/27/2004 19:58:30	32	18458	10.02	1.6	0.013
04106Y	04106J	09/27/2004 21:02:45	58	33980	11.33	2.5	0.019
04106Y	04106Z	09/27/2004 16:31:00	258	34906	0	0.8	0.011
04106Y	LX0452	09/27/2004 21:30:00	29	3542	16.47	2.4	0.005
04106Z	04106A	09/27/2004 17:09:00	30	22713	9.9	1.7	0.014
04106Z	04106B	09/27/2004 18:12:00	17	14184	11.84	1.1	0.014
04106Z	04106C	09/27/2004 19:07:15	13	27445	18.13	1.8	0.014
04106Z	04106D	09/27/2004 20:18:30	15	11399	20.27	1.6	0.013
04106Z	04106E	09/27/2004 17:37:00	38	12725	11.29	1.7	0.015
RVDI	04106O	09/28/2004 15:41:15	29	1477	10.09	5.4	0.008
RVDI	04106P	09/28/2004 14:50:45	19	9188	13.82	3.4	0.018
RVDI	04106W	09/28/2004 12:00:00	425	63749	0	4.9	0.024
RVDI	04106X	09/28/2004 13:14:15	242	16087	0	2.3	0.018
RVDI	04106Y	09/27/2004 16:28:30	345	89691	0	4.6	0.025
RVDI	04106Z	09/27/2004 16:31:00	258	124390	0	1.8	0.017

No lines were rejected. All of the baselines had acceptable statistics.

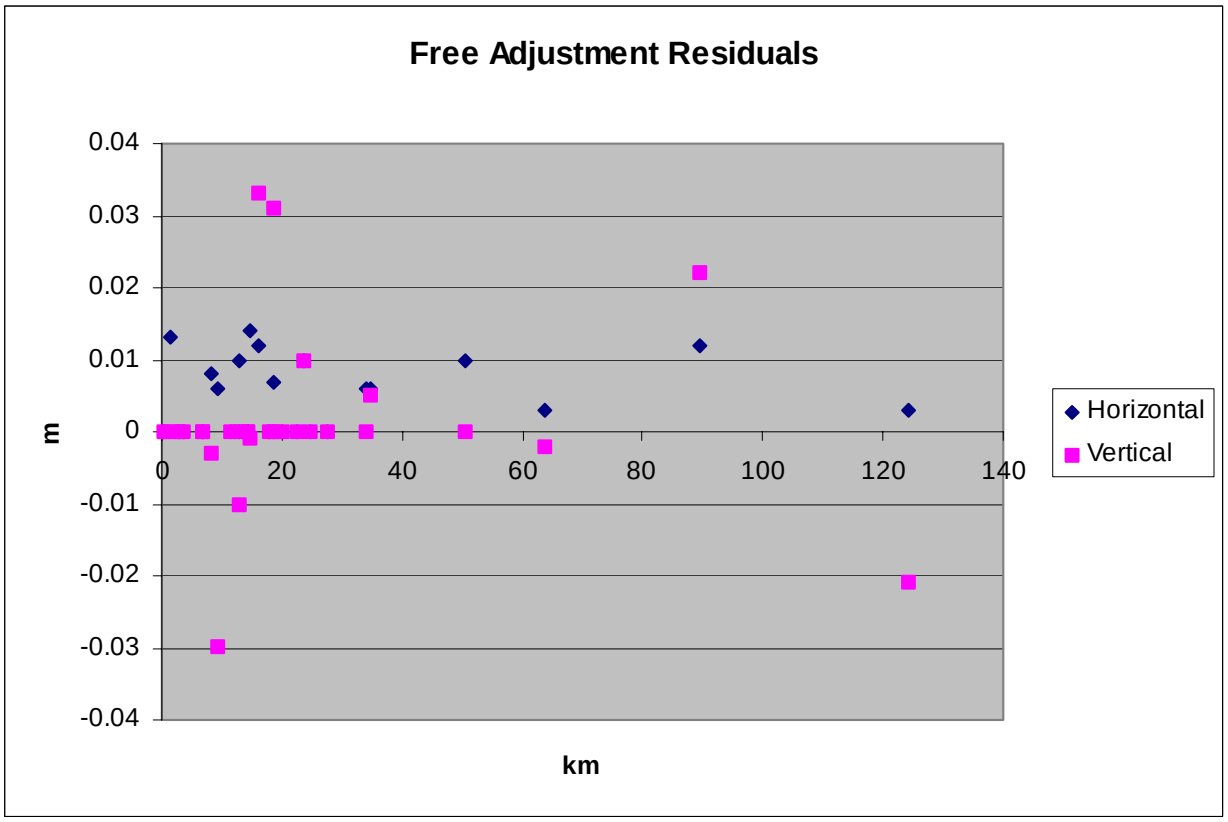
LEAST SQUARES ADJUSTMENTS

The processed baselines were parsed to form an input file for GeoLab, a least squares adjustment programs. No scaling of the apriori statistics was done. Station errors (HI and centering) of 0.005 m were input. Geoidal separations for each station were obtained using the GEOID03 model.

The first adjustment held the CORS **RVDI** (PID DF9200) fixed in all three dimensions (latitude, longitude, and ellipsoidal height. The estimated variance factor was 2.97. The misclosures at the other NSRS stations were as follows:

Station	Azimuth	Distance	Δ Ortho	Δ Ellip
HVN D	133°	0.002 m	+0.009 m	-0.004 m
F 33			-0.047 m	
P 36	97°	0.042 m	-0.004 m	-0.005 m

The graph below in figure 2 shows the horizontal and vertical residuals versus baseline length for this adjustment.



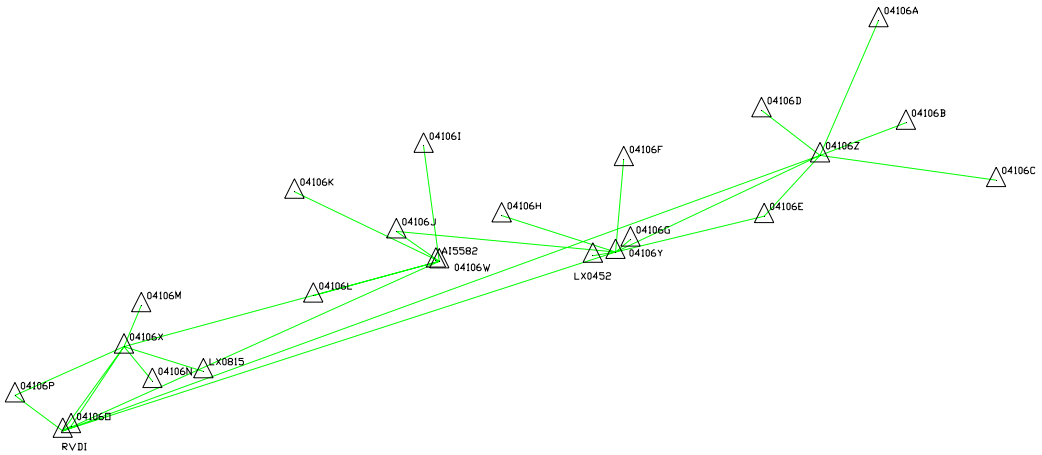
Note that many of the lines were radial (i.e. no check). All of the residuals were under ±0.035 m.

The final adjustment held **P 36** and **HVN D** fixed in all three dimensions (latitude, longitude, and orthometric height), and the **RVDI** CORS was constrained horizontally. The estimated variance factor was 3.31. The output from this adjustment is included in appendix A. The following table lists the 2-D and 1-D Station Confidence Regions (95.000 percent) in meters:

Station	Major-Semi Axis	Azimuth	Semi-Minor Axis	Vertical
04106A	0.042	131	0.040	0.041
04106B	0.041	98	0.040	0.040
04106C	0.042	92	0.041	0.047
04106D	0.042	120	0.040	0.044
04106E	0.030	112	0.029	0.031

Station	Major-Semi Axis	Azimuth	Semi-Minor Axis	Vertical
04106F	0.039	77	0.038	0.041
04106G	0.037	100	0.037	0.034
04106H	0.038	118	0.037	0.038
04106I	0.038	170	0.038	0.040
04106J	0.028	7	0.027	0.030
04106K	0.038	160	0.037	0.040
04106L	0.056	7	0.037	0.064
04106M	0.039	177	0.039	0.047
04106N	0.039	46	0.038	0.044
04106O	0.026	22	0.025	0.034
04106P	0.028	148	0.026	0.041
04106W	0.019	67	0.018	0.022
04106X	0.021	58	0.020	0.032
04106Y	0.020	101	0.018	0.022
04106Z	0.026	103	0.023	0.029
LX0815	0.039	36	0.038	0.043
RVDI				0.027

The output from this adjustment is included in appendix A. The map below in figure 3 shows the final network configuration:



SUMMARY

A geodetic control network was established in southern Connecticut, from the New York state line to the Rhode Island state line. The accuracy of the control established is ±0.05 m.

NAD 1983 1996/NAVD 1988 – meters

Station Name	Latitude	Longitude	Ortho H	Ellip H
1	41°35'01.30441" N	72°03'31.14142" W	66.746	36.55
10	41°18'35.63101" N	72°57'36.69169" W	12.267	-17.396
11	41°22'05.37095" N	73°08'47.13651" W	12.509	-16.943
12	41°13'23.83666" N	73°06'57.09378" W	15.356	-14.416
13	41°12'52.58526" N	73°25'57.94294" W	67.712	37.851
14	41°06'32.88539" N	73°24'53.30123" W	8.816	-21.245
15	41°02'54.00952" N	73°33'56.77521" W	19.398	-11.032
16	41°05'32.36138" N	73°40'04.67505" W	109.536	79.05
2	41°26'24.83528" N	72°00'52.40182" W	92.765	62.312
3	41°21'22.08845" N	71°51'06.97954" W	19.624	-10.979
4	41°27'50.61535" N	72°16'49.50826" W	70.103	39.909
5	41°19'01.51912" N	72°16'53.77471" W	48.35	17.869
6	41°24'07.35999" N	72°32'14.35297" W	147.651	117.685
7	41°17'24.37792" N	72°31'44.96634" W	10.152	-20.109
8	41°19'41.95566" N	72°45'55.52029" W	28.115	-1.734
9	41°25'40.25307" N	72°54'21.91427" W	32.303	2.873
BASE1	41°23'55.92600" N	72°10'30.28187" W	53.088	22.674
BASE2	41°16'24.19133" N	72°33'26.69299" W	5.966	-24.309
BASE3	41°09'27.67962" N	73°27'57.58416" W	74.713	44.706
BASE4	41°16'00.50546" N	72°52'56.64965" W	3.355	-26.557
F 33	41°07'16.39687" N	73°19'14.73600" W	14.558	-15.42
HVN D	41°16'04.79476" N	72°53'18.39305" W	1.328	-28.574
P 36	41°16'09.03408" N	72°35'57.56343" W	2.147	-28.091
RVDI ARP	41°02'31.14727" N	73°34'52.37875" W	30.916	0.448

UTM Zone 18 – meters

Station Name	UTM N	UTM E	Ortho H
1	4607735.193	745189.849	66.746
10	4575166.450	670749.648	12.267
11	4581285.000	655021.177	12.509
12	4565256.150	657926.941	15.356
13	4563764.998	631380.863	67.712
14	4552082.939	633099.442	8.816
15	4545113.646	620534.459	19.398
16	4549860.639	611871.088	109.536
2	4591931.593	749416.567	92.765
3	4583075.461	763343.597	19.624
4	4593844.738	727119.871	70.103
5	4577522.983	727533.192	48.350
6	4586316.173	705859.555	147.651
7	4573907.034	706896.252	10.152
8	4577613.625	687001.906	28.115
9	4588369.950	674962.510	32.303
BASE1	4586888.312	736154.393	53.088
BASE2	4571983.816	704582.168	5.966
BASE3	4557396.332	628706.242	74.713
BASE4	4570538.365	677378.406	3.355
F 33	4553572.714	640970.358	14.558
HVN D	4570658.327	676869.238	1.328
P 36	4571418.422	701084.721	2.147
RVDI ARP	4544387.402	619247.834	30.916

Connecticut State Plane Coordinates
NAD 1983 1996/NAVD 1988 – US Survey Feet & Meters

Station Name	SPC N m	SPC E m	Ortho H	SPC N ft	SPC E ft	Ortho H ft
1	235965.139	362449.704	66.746	774162.294	1189137.071	218.983
10	205347.654	287199.326	12.267	673711.428	942253.122	40.246
11	211872.759	271633.984	12.509	695119.210	891185.829	41.040
12	195772.473	274123.239	15.356	642296.855	899352.660	50.380
13	194969.645	247543.715	67.712	639662.910	812149.672	222.152
14	183244.773	248959.373	8.816	601195.559	816794.210	28.924
15	176601.567	236215.471	19.398	579400.308	774983.591	63.642
16	181572.507	227675.775	109.536	595709.133	746966.272	359.369
2	220062.715	366262.089	92.765	721989.091	1201644.870	304.347
3	210851.926	379948.732	19.624	691770.027	1246548.465	64.383
4	222554.092	344029.671	70.103	730162.884	1128704.012	229.996
5	206231.181	344019.143	48.350	676610.133	1128669.472	158.628
6	215581.923	322585.014	147.651	707288.359	1058347.667	484.418
7	203151.753	323299.376	10.152	666507.043	1060691.369	33.307
8	207372.459	303509.525	28.115	680354.476	995764.167	92.241
9	218437.580	291753.668	32.303	716657.294	957195.159	105.981
BASE1	215367.236	352877.942	53.088	706584.007	1157733.715	174.173
BASE2	201289.363	320936.552	5.966	660396.852	1052939.338	19.573
BASE3	188671.213	244704.402	74.713	618998.805	802834.359	245.121
BASE4	200549.183	293705.999	3.355	657968.445	963600.432	11.007
F 33	184530.563	256867.622	14.558	605414.022	842739.857	47.762
HVN D	200682.299	293200.107	1.328	658405.176	961940.684	4.357
P 36	200814.795	317426.032	2.147	658839.873	1041421.907	7.044
RVDI ARP	175908.694	234910.167	30.916	577127.107	770701.106	101.430