



CITY OF CONROE
SURVEY CONTROL MONUMENTATION
PHASE I
SURVEY REPORT
November 13, 2019



Primary Control

Recovered existing NGS vertical control monuments shown on FIRM maps in the survey area. Constructed 4 new Primary Control Monuments in each quadrant of the project and 1 Primary Control Monument to cover west development. Coordinates and elevations were established for the 5 Primary Control Monuments and the recovered NGS monuments with GPS Static Surveys. Each monument in the Static Survey was occupied two sessions and collected data for 1 hour each session. The static survey data was processed and adjusted using Leica Infinity software. The raw survey data for the static survey was also sent to OPUS for processing and adjustment for comparison.

Our Static GPS survey was found to agree with OPUS by 0.19' average.

	North	East	Elev
PC FNW	10126739.94	3787708.54	222.65
PC SE	10107655.29	3841804.14	164.74
PC SW	10110855.63	3819743.29	166.42
N88	10109552.57	3834882.97	210.95
K1149	10106776.00	3835300.86	199.16
K88	10119400.28	3834571.51	231.50
PC NE	10125975.89	3839655.49	237.37
PC NW	10127413.33	3812942.98	274.48

Secondary Control

Survey crews were directed to recover the 90 monuments listed in the Clark 1999 report and the 5 additional monuments set by City of Conroe. New photos were taken of monuments found with field note sketches and distance ties updated. All monuments found were occupied at least twice with Leica GPS receivers using Leica SmartNet.

The following were not found:

SFNF CC03	SFNF CC09	SFNF CC21 AZ	SFNF CC24 AZ	SFNF CI03 AZ	SFNF N88 REF AZ
SFNF CC03 AZ	SFNF CC11	SFNF CC22 AZ	SFNF CI01	SFNF CI06	SFNF P88 REF AZ
SFNF CC05	SFNF CC11 AZ	SFNF CC23	SFNF CI01 AZ	SFNF CI07 AZ	SFNF RM1 AZ
SFNF CC05 AZ	SFNF CC12 AZ	SFNF CC23 AZ	SFNF CI02	SFNF K1149 AZ	SFNF U312
SFNF CC07 AZ	SFNF CC18 AZ	SFNF CC24	SFNF CI02 AZ	SFNF P88 REF	SFNF X1149
SFNF CC08	SFNF CC20				

The following existing monuments were found:

CC-01	10139768.81	3827594.10	308.66
CC-01_AZ	10138348.05	3827291.90	296.02
CC-02 DISTURB	10132799.53	3826832.44	277.49
CC-02_AZ	10134282.60	3826407.88	289.24
CC-04	10128368.15	3828409.48	283.63
CC-04_AZ	10128201.02	3829037.95	279.02
CC-06	10123408.89	3814503.74	246.14
CC-06_AZ	10123857.42	3814750.54	249.44
CC-07	10121062.61	3810568.85	156.39
CC-08_AZ	10111246.85	3815655.95	139.80
CC-09_AZ	10113441.67	3826607.54	237.11
CC-10	10117960.35	3826525.12	231.09
CC-10_AZ	10117464.09	3825031.76	201.16
CC-12	10124196.14	3841094.58	228.47
CC-13	10119647.01	3844225.55	243.64
CC-13AZ	10118608.11	3844872.60	234.17
CC-14	10110961.22	3851310.96	216.41
CC-14 AZ	10111957.02	3850075.05	216.38
CC-15	10112113.20	3838527.94	186.13
CC-15 AZ	10111927.08	3836964.24	202.95
CC-16	10107945.39	3837912.50	188.48
CC-16_AZ	10108250.29	3838980.84	188.38
CC-17	10107890.48	3842756.12	174.35
CC-17 AZ	10107502.86	3841357.68	165.88
CC-18	10104409.72	3849958.61	191.69
CC-19	10103419.61	3846847.50	162.50
CC-19AZ	10103933.58	3848148.56	181.42
CC-20_AZ	10100699.36	3840442.45	152.53
CC-21	10099084.94	3834639.36	158.68
CC-22	10107227.11	3826530.57	167.70
CC-26	10141628.12	3815075.32	363.50
CC26 AZ RESET	10140634.20	3815064.41	365.84
CC-27	10139188.92	3819804.05	339.16
CI-03	10117068.23	3818376.41	220.53
CI-04	10119275.75	3815482.21	221.24
CI-04_AZ	10120391.77	3813999.06	157.31
CI-05	10114017.48	3852555.20	206.02

CI-05AZ	10115502.69	3851860.67	208.15
CI-06_AZ	10109316.98	3852921.79	199.11
CI-07	10095989.35	3823779.22	133.34
CONROE_RM1	10111001.42	3834122.47	208.32
EK1	10098765.81	3842871.09	165.22
EK2	10101793.77	3841820.93	156.61
K1149	10106776.00	3835300.86	199.16
K88	10119400.28	3834571.51	231.50
K-88 AZ	10119810.45	3834001.38	240.60
L-1149	10102717.61	3835531.89	167.01
L-1149AZ	10101946.45	3835373.53	170.42
L-88	10112045.34	3835031.31	218.93
L-88_AZ	10111301.35	3835186.81	221.54
N-555_REF	10115508.36	3839566.93	200.16
N-555_REF_AZ	10116836.06	3840642.08	201.50
N88	10109552.57	3834882.97	210.95
Q-88	10093009.51	3835924.74	129.34
Q-88_AZ	10094039.59	3835936.32	130.63
R-555	10126089.91	3845273.13	243.61
R555_AZ	10125931.59	3843929.61	251.95
S-1203_REF	10120650.53	3834195.27	229.38
S-1203_REF_AZ	10120627.98	3834952.12	241.67
SJRA-1_AZ	10128015.64	3804298.79	210.92
SJRA-1	10128729.82	3805595.23	212.09
U312_AZ	10114265.39	3845976.05	208.28
X1149 REF AZ	10113390.33	3835111.33	207.37

Comments

The coordinates and elevations shown above were established using the Leica SmartNet system. The Leica SmartNet coordinates are based on the Texas Coordinate System, Central Zone, NAD 83 (2011), Epoch 2010, the vertical datum is NAVD 88 based on Geoid 18. The difference between Geoid 12B and Geoid 18 were found in this area to be only an average of 0.02'. We found the elevations measured for the NGS 1st Order Vertical Control Monuments shown on the FIRM maps to be an average of 0.76' higher than the Leica SmartNet elevations. When we compared the horizontal coordinates to Clark 1999 we found that the Leica SmartNet coordinates were southwest an average of 1.30 feet.



A handwritten signature in cursive script, appearing to read "George L. Totten".

George Totten, R.P.L.S.
Sr. Survey Manager

PHOTO ID AND MONUMENTATION

for

THE CITY OF CONROE

MONTGOMERY COUNTY, TEXAS

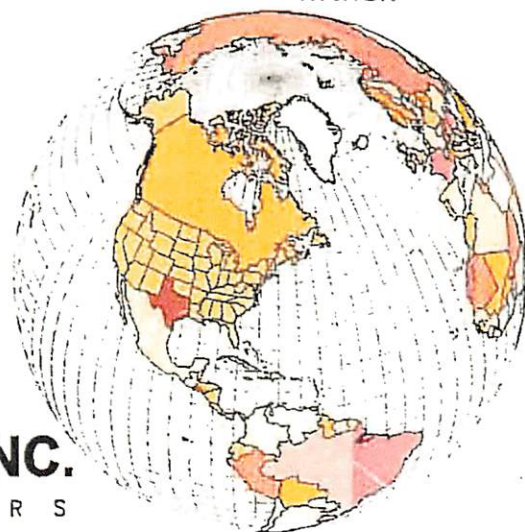
PHOTO ID
AND
MONUMENTATION

March - May, 1999

Prepared By:



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SURVEYOR'S REPORT

I. Paneling for Aerial Photography

The project was initiated with the placement of eleven (11) panels (targets) centered over iron rods driven into the ground at just below natural grade level at locations around the City of Conroe as selected by the client which were suitable for both GPS and aerial observations. A total of nineteen (19) existing National Geodetic Survey (NGS) benchmarks and horizontal and vertical control points were also paneled prior to the March 1, 1999 flight. During the flight, two of the existing horizontal and vertical control points (CI-3 and CI-5) were each occupied with an Ashtech Model Z-XII dual frequency GPS receiver gathering satellite data simultaneously with an identical Ashtech receiver in the aircraft. Following the flight, the resulting raw data was downloaded from the ground receivers and provided to the client for processing and adjustment.

II. Monumentation of New Horizontal and Vertical Control Points and Azimuth Marks

A total of twenty-five (24) areas were selected by the City of Conroe as desired locations for the placement of new ground control monument pairs with each site containing a primary horizontal and vertical control point and an azimuth mark visible from the primary control point. Each of the desired areas was scouted and evaluated as to its suitability for GPS observations. A pair of brass disks were set in concrete approximately 1/4-mile apart (where possible) at each of the selected locations. All of the disks were stamped "CONROE 99" with a center punchhole and the monument designation. The primary control points were designated "CC-1" through "CC-24" and the corresponding azimuth marks as "CC-1 AZ" through "CC-24 AZ". In addition, a similar azimuth monument was set for each of the existing NGS benchmarks and horizontal and vertical control points mentioned above. Reference disks were placed in concrete for four (4) of the NGS benchmarks (N 555, P 88, S 1203 and X 1149) due to their unsuitability for GPS occupation and were stamped "N 555 REF", etc. The azimuth marks for these four points were set so as to be visible from the reference point and were stamped "N 555 REF AZ", etc. An iron rod was placed in the concrete beneath each of the new monuments to aid in its recovery with the aid of a conventional surveyor's metal detector. A recovery sketch was prepared for all of the new monuments with distance ties to identifiable ground features and digital photographs were taken of all new and existing monuments to aid in future recovery.

III. GPS Observations

All new and existing primary control points, NGS benchmarks or their applicable reference marks and the 11 aerial flight panel points were occupied using five (5) dual-frequency Ashtech GPS receivers operating simultaneously for a minimum two (2) hour static data gathering session. Due to the absence of existing control in the north and northeast portions of the project, two initial 3-hour static sessions were performed for the purpose of transferring primary control into these areas. A minimum of four (4) points were held fixed horizontally and vertically as the basis for these 3-hour sessions. Thereafter, the five receivers collected data in minimum 2-hour sessions in traverse mode. At least one control point with known (fixed) horizontal and vertical

III. GPS Observations (cont.)

coordinates was occupied with a GPS receiver for the first and last static session of each day thus providing a daily check of data integrity. The raw GPS data was downloaded to a PC following each days static sessions and processed to verify the quality of the data. Following the last days sessions and processing, the resulting post-processing output for all sessions was utilized to perform a simultaneous least squares adjustment of the entire network. This produces a consistent and homogenous data set and eliminates distortions created by "piece-meal" adjustments. Ashtech's least squares adjustment software package (Fillnet) was used to derive adjusted x, y and z values for each primary control point. The following control points were held fixed for the purpose of obtaining the adjusted least squares coordinates:

<u>Held in Northing, Easting and Elevation</u>	<u>Elevation Only</u>
CI-1, CI-2, CI-3, CI-4, CI-5, CI-6 and CI-7	S 1203 REF*
	P 88 REF*
	Q 88*
	X 1149 REF*
	L 1149*
	K 1149*
	K 88*
	R 555*
	N 88*
	CONROE RM 1*

* Indicates NGS Benchmark or reference mark

Initially, the City of Conroe provided coordinates and recovery information for seven (7) existing city control monuments (CI-1 through CI-7) to serve as primary control points with fixed horizontal and vertical values and a total of thirteen (13) NGS benchmarks to hold fixed in elevation to further augment and strengthen the vertical component of the network. However, in analyzing the initial accuracy reports provided by the Ashtech Fillnet package, it was apparent that the published values for three (3) of the NGS benchmarks were inconsistent with the remainder of the network. One of these, U 312, was listed by NGS as a second order mark rather than first order. The remaining two, L 88 and N 555, unlike the remaining ten benchmarks, were not a part of the June, 1991 NGS releveling. Therefore, in the final network adjustment, these 3 monuments were allowed to "float" rather than being held as fixed, and new elevations were derived which differ from the NGS published values. This provided excellent network results and eliminated undesirable distortions that would have been created by interjecting suspect elevations for these points.

IV. RTK (GPS) Observations for Azimuth Marks

Holding the static session GPS obtained coordinates for the primary control points fixed, two (2) Ashtech RTK (Real Time Kinematic) GPS systems were used to localize on a minimum of three

IV. RTK (GPS) Observations for Azimuth Marks (Cont.)

(3) known primary control points to obtain horizontal positions for the azimuth marks thus providing a grid azimuth between each primary control point and its corresponding azimuth mark.

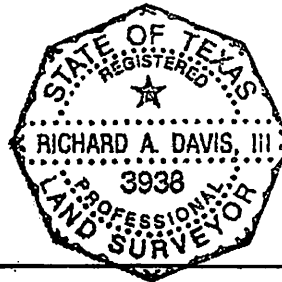
V. Datums

All horizontal coordinates were referenced to the North American Datum of 1983/86 (NAD83) and are provided in the Texas State Plane System, Central Zone. To convert the state plane grid coordinates to surface values compatible with surface coordinates utilized by the Texas Department of Transportation (TxDOT) in Montgomery County, multiply the grid value by a project scale factor of 1.00003 which is the factor used by TxDOT. Elevations are referenced to the North American Vertical Datum of 1988 (NAVD88) adjusted to the June, 1991 leveling performed by NGS.


I, Richard A. Davis, III, Registered Professional Land Surveyor No. 3938, do hereby certify that the information contained herein correctly represents the results of an on-the-ground GPS survey performed under my direct supervision.

Richard A. Davis, III
Richard A. Davis, III

5/12/99
Date



STATION NAME	GRID		ELEVATION	BEARING TO AZIMUTH MARK
	NORTHING	EASTING		
CI-01	10,100,863.790	3,825,661.030	146.95	S78°12'09"E
CI-01_AZ	10,100,572.69	3,827,054.78	141.2	
CI-02	10,100,209.360	3,828,804.080	141.42	S69°56'44"E
CI-02_AZ	10,099,554.50	3,830,597.99	150.9	
CI-03	10,117,069.140	3,818,377.130	221.19	S61°31'12"E
CI-03_AZ	10,116,385.74	3,819,636.85	195.3	
CI-04	10,119,276.660	3,815,482.820	221.89	N53°02'22"W
CI-04_AZ	10,120,392.71	3,813,999.65	158.1	
CI-05	10,114,018.840	3,852,555.720	206.66	N25°03'45"W
CI-05_AZ	10,115,504.05	3,851,861.18	208.8	
CI-06	10,110,567.970	3,853,312.020	202.42	S17°19'21"W
CI-06_AZ	10,109,318.48	3,852,922.31	200.0	
CI-07	10,095,990.510	3,823,779.890	134.13	N41°32'14"W
CI-07_AZ	10,096,396.09	3,823,420.60	134.4	
S-1203_REF	10,120,651.636	3,834,195.716	230.10	S88°17'37"E
S-1203_REF_AZ	10,120,629.09	3,834,952.54	242.3	
P-88_REF	10,097,808.720	3,835,619.779	141.89	S01°54'55"E
P-88_REF_AZ	10,096,481.82	3,835,664.15	132.0	
Q-88	10,093,010.792	3,835,925.543	130.16	N00°38'23"E
Q-88_AZ	10,094,040.78	3,835,937.04	131.5	
L-88	10,112,046.565	3,835,031.909	219.69	S11°47'32"E
L-88_AZ	10,111,302.39	3,835,187.27	222.7	
X-1149_REF	10,114,485.401	3,835,074.897	216.90	S01°55'59"E
X-1149_REF_AZ	10,113,391.56	3,835,111.82	208.3	
N-555_REF	10,115,509.517	3,839,567.470	200.98	N39°00'34"E
N-555_REF_AZ	10,116,837.03	3,840,642.83	202.8	
CONROE_RM1	10,111,002.607	3,834,123.044	209.22	S00°24'23"W
RM-1_AZ	10,109,487.53	3,834,112.30	211.6	
L-1149	10,102,718.887	3,835,532.591	167.80	S11°36'19"W
L-1149_AZ	10,101,947.69	3,835,374.21	171.1	
K-1149	10,106,777.048	3,835,301.678	200.13	S01°57'01"W
K-1149_AZ	10,105,515.42	3,835,258.71	186.3	
K-88	10,119,401.337	3,834,572.032	232.13	N54°15'59"W
K-88_AZ	10,119,811.54	3,834,001.88	241.1	
R-555	10,126,091.154	3,845,273.551	244.29	S83°16'46"W
R555_AZ	10,125,932.84	3,843,930.03	252.8	
U-312	10,114,094.203	3,844,739.942	198.80	N82°03'37"E
U-312_AZ	10,114,266.68	3,845,976.61	209.2	
N-88	10,109,553.771	3,834,883.525	211.78	N35°12'49"W
N-88_AZ	10,110,099.26	3,834,498.53	211.3	
CC-01	10,139,769.824	3,827,594.381	309.58	S12°00'17"W
CC-01_AZ	10,138,348.98	3,827,292.25	296.9	
CC-02	10,132,800.510	3,826,832.821	278.60	N15°58'35"W
CC-02_AZ	10,134,283.57	3,826,408.22	289.8	
CC-03	10,130,223.213	3,825,946.998	271.72	N74°00'25"W
CC-03_AZ	10,130,605.06	3,824,614.74	284.2	
CC-04	10,128,369.194	3,828,409.944	284.24	S75°06'15"E



CC-04_AZ	10,128,202.03	3,829,038.40	279.7	
CC-05	10,124,751.345	3,825,469.389	276.16	S73°52'14"E
CC-05_AZ	10,124,407.51	3,826,658.33	276.2	
CC-06	10,123,409.762	3,814,504.291	246.80	N28°49'25"E
CC-06_AZ	10,123,858.04	3,814,750.98	250.2	
CC-07	10,121,063.380	3,810,569.433	157.09	S86°52'29"W
CC-07_AZ	10,120,968.53	3,808,832.35	156.1	
CC-08	10,111,212.711	3,817,414.363	138.01	N88°51'13"W
CC-08_AZ	10,111,247.89	3,815,656.65	140.6	
CC-09	10,113,916.050	3,825,303.434	237.09	S70°03'43"E
CC-09_AZ	10,113,442.73	3,826,608.26	237.7	
CC-10	10,117,961.462	3,826,525.706	231.66	S71°36'53"W
CC-10_AZ	10,117,465.13	3,825,032.40	201.7	
CC-11	10,124,797.491	3,832,099.395	240.38	S84°48'16"E
CC-11_AZ	10,124,646.05	3,833,764.86	228.2	
CC-12	10,124,197.008	3,841,095.053	229.42	S45°40'34"E
CC-12_AZ	10,122,794.67	3,842,530.89	226.1	
CC-13	10,119,648.297	3,844,226.078	244.55	S31°54'55"E
CC-13_AZ	10,118,609.40	3,844,873.12	235.2	
CC-14	10,110,962.594	3,851,311.502	217.15	N51°08'21"W
CC-14_AZ	10,111,958.45	3,850,075.59	217.1	
CC-15	10,112,114.436	3,838,528.530	186.91	S83°12'33"W
CC-15_AZ	10,111,928.22	3,836,964.75	203.7	
CC-16	10,107,946.699	3,837,913.065	189.43	N74°04'27"E
CC-16_AZ	10,108,251.54	3,838,981.40	189.3	
CC-17	10,107,891.822	3,842,756.697	175.19	S74°30'16"W
CC-17_AZ	10,107,504.15	3,841,358.36	166.8	
CC-18	10,104,410.854	3,849,959.392	192.12	N58°33'18"E
CC-18_AZ	10,105,192.01	3,851,236.87	195.8	
CC-19	10,103,421.016	3,846,848.128	163.74	N68°26'33"E
CC-19_AZ	10,103,935.01	3,848,149.15	182.4	
CC-20	10,100,975.868	3,839,104.265	172.02	S78°22'56"E
CC-20_AZ	10,100,700.60	3,840,443.14	153.2	
CC-21	10,099,086.215	3,834,640.048	159.47	S76°11'08"W
CC-21_AZ	10,098,812.75	3,833,527.91	160.0	
CC-22	10,107,228.330	3,826,531.126	168.81	N17°16'48"W
CC-22_AZ	10,108,549.71	3,826,120.07	176.3	
CC-23	10,107,059.386	3,818,319.561	141.60	S15°10'14"E
CC-23_AZ	10,105,615.79	3,818,710.98	138.7	
CC-24	10,112,770.668	3,829,997.354	181.10	N20°23'44"W
CC-24_AZ	10,114,424.08	3,829,382.60	191.0	
SJRA-1	10,128,730.641	3,805,595.742	212.83	S61°09'43"W
SJRA-1_AZ	10,128,016.73	3,804,299.17	211.9	

NOTES: 1. COORDINATES ARE SHOWN IN U.S. SURVEY FEET.

**2. NORTHINGS AND EASTINGS ARE TEXAS STATE PLANE GRID,
CENTRAL ZONE, REFERENCE TO NAD83/86 DATUM.**

CLARK CALL COMPARISON TO FOUND
HORIZONTAL LOCATION

FAR NORTHWEST

SJRA-1	S32-07-47W	0.97
SJRA-1 AZ	S19-07-42W	1.16

NORTH

CC-01 AZ	S20-33-19W	0.99
CC-01	S15-42-32W	1.04
CC-02 AZ	S19-07-44W	1.03
CC-04	S24-03-29W	1.14
CC-04 AZ	S23-52-07W	1.11

CENTRAL

CC-09 AZ	S34-10-15W	1.28
X1149 REF AZ	S21-43-50W	1.32
CC-15 AZ	S23-50-16W	1.25
CONROE RM1	S26-05-00W	1.30

EAST

CI-05	S20-56-50W	1.46
CI-05 AZ	S20-39-49W	1.45
CI-06 AZ	S19-15-38W	1.59
CC-14	S21-44-01W	1.48

WEST

CI-03	S38-17-41W	1.16
CC-08 AZ	S33-38-31W	1.29
CI-07	S29-56-50W	1.34
CC-22	S24-24-24W	1.33

SOUTH

Q88	S32-00-48W	1.50
CC-21	S28-19-16W	1.44
CC-20	S29-08-10W	1.42
CC-19	S24-00-20W	1.53
CC-19 AZ	S22-20-19W	1.54

AVERAGE DIFFERENCE 1.30

City of Conroe Monumentation
Comparison of Differences
PD 49163-19

Geoid 18

09/23/19 First Network Tie

Diff Static
to OPUS

				NGS CALL	Diff	Leica Static	Diff	OPUS	Diff	Clark 1999	Diff	0.19		
1000	10126739.94	3787708.54	222.65	PC FNW		223.00	-0.35	222.81	-0.16			0.02		
1001	10107655.29	3841804.14	164.74	PC SE		164.89	-0.15	164.87	-0.13			0.24		
1002	10110855.63	3819743.29	166.42	PC SW		166.71	-0.29	166.47	-0.05			0.20		
1003	10109552.57	3834882.97	210.95	N88	211.78	-0.83	1st Order Vertical	211.19	-0.24	210.99	-0.04	211.78	-0.83	0.35
1004	10106776.00	3835300.86	199.16	K1149	200.13	-0.97	1st Order Vertical	199.44	-0.28	199.09	0.07	200.13	-0.97	0.15
1005	10119400.28	3834571.51	231.50	K88	232.13	-0.63	1st Order Vertical	231.67	-0.17	231.52	-0.02	232.13	-0.63	0.29
1006	10125975.89	3839655.49	237.37	PC NE		237.53	-0.16	237.24	0.13					0.31
1007	10127413.33	3812942.98	274.48	PC NW		274.78	-0.30	274.47	0.01					0.00

9/27/2019

NGS Call

1065	10102717.61	3835531.89	167.01	L-1149	167.50	-0.49	1st Order Vertical			167.80	-0.79			
1068	10111001.42	3834122.47	208.32	CONROE_RM1	209.22	-0.90	1st Order Vertical			209.22	-0.90			
1094	10126089.91	3845273.13	243.61	R-555	244.28	-0.67	1st Order Vertical			244.29	-0.68			
1130	10093009.51	3835924.74	129.34	Q-88	130.16	-0.82	1st Order Vertical			130.16	-0.82			
1131	10120636.30	3834177.16	228.70	S-1203	229.42	-0.72	1st Order Vertical							
1102	10120650.53	3834195.20	229.36	S-1203_REF						230.10	-0.74			

Average -0.76 -0.24 -0.02 -0.80 0.19
SmartNet is 0.76 higher then NGS Monuments

	North	East	Elev	
PC FNW	10126739.94	3787708.54	222.65	PC FNW
PC SE	10107655.29	3841804.14	164.74	PC SE
PC SW	10110855.63	3819743.29	166.42	PC SW
N88	10109552.57	3834882.97	210.95	N88
K1149	10106776.00	3835300.86	199.16	K1149
K88	10119400.28	3834571.51	231.50	K88
PC NE	10125975.89	3839655.49	237.37	PC NE
PC NW	10127413.33	3812942.98	274.48	PC NW

COMPARISON

CLARK HELD FIXED, COORDINATES & ELEVATION

	Clark 1999 Northing	Clark 1999 Easting	Clark 1999 Elev	SmartNet Horizontal	SmartNet Elev	Diff Elev
CI-01	Not Found					
CI-02	Not Found					
CI-03	10117069.14	3818377.12	221.19	S38-17-41W 1.16'	220.53	0.66
CI-04	10119276.66	3815482.82	221.89	S33-40-22W 1.10'	221.24	0.65
CI-05	10114018.84	3852555.72	206.66	S20-56-50W 1.46'	206.02	0.64
CI-06	Not Found					
CI-07	10095990.51	3823779.89	134.13	S29-56-50W 1.34'	133.29	0.84
					Average	0.70

new coc monuments

CC-26

CC-26 AZ

CC-27

EK1

EK2

