
Surveyor's Report

Hydrology – Palm Beach County Wells

SFWMD Work Order Number: C-C1990P WO 09

NMI Project No. 1078.004

Report Date: August 31th, 2005

Submittal: Final

Prepared for:

**South Florida Water Management
District**



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OVERVIEW OF THE PROJECT

PURPOSE

The purpose of the Hydrology – Palm Beach County Wells Project is to establish vertical control marks near each monitoring well. The project tests the application of Federal Geodetic Control Subcommittee (FGCS) Second-Order, Class II leveling procedures with Third-Order equipment. The goal of this hybrid pairing of procedures and equipment is to produce leveling measurements that will be acceptable to the National Geodetic Survey (NGS) and used in future vertical adjustments throughout the District.

This project utilizes uncalibrated “off-the-shelf” fiberglass level rods. Such rods are not currently approved by NGS for precise leveling (Second-Order Class II and above) for three primary reasons:

1. The fiberglass material used to construct the rods is less dimensionally stable than rods constructed of Invar metal.
2. The fiberglass rods are not individually calibrated by the manufacturer to identify scale errors across the length of the rod.
3. The fiberglass rods are a three-section snap-together style that will, over time, wear at the connection points creating error in measurements on the top two sections.

While these limitations make the rods unsuitable for the extreme precision required in First-Order and Second-Order, Class I leveling, it is the hypothesis of this project that such rods can deliver Second-Order, Class II precisions. Fiberglass rods are commonly used by surveyors today. In contrast, Invar level rods are expensive and specialized equipment only used by surveyors working on the highest precision vertical control surveys. By demonstrating that fiberglass level rods such as those used in this project are suitable for Second-Order, Class II leveling the District will benefit from the increased number of consultants using these rods. As a result, more level lines run within the District should meet NGS’s requirements for inclusion in future vertical adjustments, further refining the elevation models used for water control.

LOCATION OF PROJECT

The project is located in Broward and Palm Beach County. Following is a map and legend.



- 2. PB-1643
- 3. PB-710
- 4. PB-596
- 5. PB-746
- 6. PB-789
- 7. PB-832
- 8. PB-1547
- 9. PB-717
- 10. PB-830
- 11. PB-715
- 12. PB-1534
- 13. PB-1583
- 14. PB-1152
- 15. PB-750 & PB-751
- 16. PB-1544
- 17. PB-1155
- 18. PB-935 & PB-1595
- 19. PB-1641
- 20. PB-1576 & PB-1577
- 21. PB-1097 & PB-1632
- 22. PB-1107 & PB-1631
- 23. PB-1620
- 24. G-2853
- 25. PB-1605 & PB-1622
- 26. PB-1647
- 27. PB-690
- 28. PB-1625
- 29. PB-1627 & PB-1628
- 30. PB-1633 & PB-1634
- 31. PB-1635 & PB-1636
- 32. PB-1638
- 33. PB-888 & PB-889
- 34. PB-693
- 35. PB-834B & PB-846
- 36. PB-847
- 37. PB-1645 & PB-1646
- 38. PB-733 & PB-767
- 39. PB-632 & PB-633
- 40. PB-620

ITEMS DELIVERED TO THE DISTRICT

The following items are delivered to the District with this report. Neither the report nor the items listed below are complete without the other.

1. Paper and electronic copy of field notes
2. Paper and electronic copy of all computation sheets
3. CORPSMET file for each site
4. Paper and electronic copy of site photographs
5. Paper copy of District Benchmark Description
6. Paper and electronic copy of NGS Blue Book submittal

VERTICAL DATUM FOR THE PROJECT

The vertical datum for the project is the North American Vertical Datum of 1988. For correlation with older data sets, the elevations of the benchmarks are also shown in the National Geodetic Vertical Datum (NGVD) of 1929. The NGVD 29 elevations were derived using data provided by the South Florida Water Management District in a file named “NGVD29.txt” when applicable, otherwise NGS superseded values were used. The linear unit for all elevations is the meter unless otherwise stated.

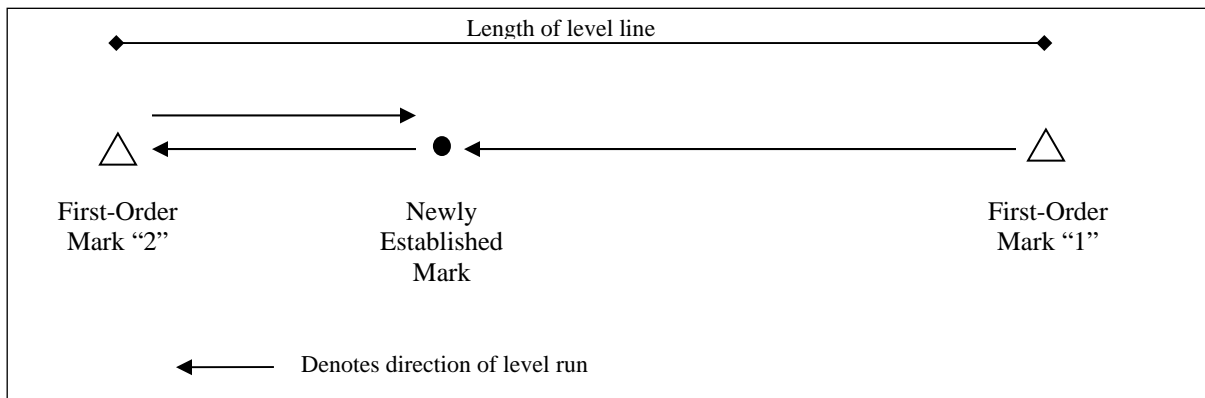
LEVELING METHODS

CONFIGURATION OF LEVEL RUNS

The leveling for the project was performed in accordance with the Federal Geodetic Control Subcommittee standard for Second-Order, Class II geodetic leveling. A brief description of the procedures used follows.

For each level line, two existing First or Second Order vertical marks were used. The run was started at one of the First or Second Order marks and continued through the newly established mark near the structure and closed on the second First or Second Order vertical mark. The run was then looped back from the second First or Second Order mark to the newly established mark (see Figure 1 below).

Figure 1 Typical Level Run Pattern



The FGCS maximum allowable misclosure for this type of run is eight millimeters multiplied by the square root of the length of the line in kilometers.

EQUIPMENT USED

All leveling during the project was performed with a Leica DNA03 digital level and Leica three-section, fiberglass bar-code level rods. Information and technical specification for the Leica DNA03 digital level are available at <http://www.leica-geosystems.com>.

GPS METHODS

INTRODUCTION

The vertical control marks listed below are located more than 6 miles from published survey control marks. Due to the large distances between established control and the new vertical survey marks, District staff and the Surveyor decided it was appropriate to perform a GPS survey for establishing the orthometric heights on these benchmarks.

- PB 830
- PB 1155
- PB 1544
- PB 1595
- PB 1633
- PB 1635
- PB 1641

The GPS observations for the project were performed in accordance with the Guidelines for Establishing GPS-Derived Ellipsoidal Heights (National Geodetic Survey Technical Memorandum NOS NGS-58). GPS observations were conducted over a three-day period, beginning Thursday, August 11, 2005 and ending Saturday, August 13, 2005.

The following instrumentation was used for the GPS observations:

- (2) Trimble 4700 receivers
- (2) Trimble Micro-centered L1/L2 antennas with ground plane
- (1) Trimble 4800 receiver/antenna
- (1) Trimble 5800 receiver/antenna
- (4) Trimble R8 receiver/antenna

Deviations from Planned Observations

Due to an equipment failure on the first day of observations, Control Station X 537 was not observed. To ensure that we obtained sufficient data, another session was planned for the last day of observations. No other deviations from the procedures and specifications occurred. No marks were eccentrically observed.

DATA PROCESSING

Data Acquisition

Data was downloaded from receivers to a desktop computer in our Palm Beach office through the software Trimble Geomatics Office, version 1.61 (TGO). The DAT files were transferred to our Tallahassee server through a Virtual Private Network.

Data Quality

Quality of the data was checked using the Timeline feature in the TGO software. Areas of the data that showed cycle slips were disabled.

Ephemeris

The Rapid ephemeris from IGS was used for processing the baselines.

Baseline Processing

Baselines were processed using TGO. For each session, (n-1) baselines were selected that produced fixed integer solutions with the lowest possible RMS values. Criteria for baseline selection also included ensuring that all unknown (newly set) marks had multiple vectors from multiple control stations.

Adjustment

The ADJUST software package from NGS was used for the network adjustment. The B-file and G-file were created through the TGO software. Initial positions and ellipsoidal heights of new marks were supplied in the creation of the B-file. Initial positions and ellipsoidal heights of control stations were obtained from the NGS datasheets. Both the B-file and G-file were checked using the file-checking utilities that are a part of the ADJUST software package. The B-file was edited to conform to the structure and data content necessary to remove any errors found in the file-checking utilities. This included using NAD83 as the horizontal datum, NAVD88 as the vertical datum, and GEOID03 for the geoid.

After all files were checked satisfactorily, a minimally-constrained adjustment was performed, with no weighting applied. The horizontal position and ellipsoidal height of control station ENR103 was held fixed. No apparent blunders were present in the adjustment.

Using the standard deviation of unit weight from the first minimally-constrained adjustment, standard errors were scaled using the MODGEE program. A second minimally-constrained adjustment was performed with satisfactory results.

For the constrained horizontal adjustment, the published horizontal position and ellipsoidal height for the control stations C402, CAN AZ MK, ENR103, L402, and X537 were fixed. The modified G-file, using the scaled standard errors, was used for this adjustment. The network adjustment was performed and no major shifts in position were found, and all statistics were found acceptable.


A minimally-constrained vertical adjustment was performed, with the horizontal position and orthometric height of control station ENR103 being fixed. Again, the scaled G-file was used for this vertical adjustment. No apparent blunders were present in the adjustment.

A fully-constrained vertical adjustment was performed, with the published horizontal position and ellipsoidal height for the control stations C402, CAN AZ MK, ENR103, L402, and X537 being fixed. The network adjustment was performed and no major shifts in height were found, and all statistics were found acceptable.

Lastly, a final minimally-constrained adjustment with accuracies was performed, per NGS specifications. Reported accuracies were found to be acceptable.

PROJECT RESULTS

The following tables list the elevations established for each new mark, the level run misclosure, “to-reach” description for each mark and a photo of the mark. All elevations are in US Survey Feet.

PB 596		Elevation:	11.75 ft	(NAVD 88)	13.26 ft	(NGVD 29)
Bench Mark 1:	J 305		15.90 ft	(NAVD 88)	17.42 ft	(NGVD 29)
Bench Mark 2:	H 305		20.89 ft	(NAVD 88)	22.41 ft	(NGVD 29)
Monitoring Well:	PB 596		11.81 ft	(NAVD 88)	13.32 ft	(NGVD 29)
Length of Run:	3.04 km		To Reach PB 596:			
Max Allowable Misclosure:	14 mm		FROM US HWY 1 & A1A/JUNO ISLES BLVD. JUNCTION GO NORTH ON A1A FOR 0.3 MILES TO CELESTIAL WAY. GO EAST ON CELESTIAL WAY FOR +/-250' TO KAGAN PARK PLAYGROUND ENTRANCE CONCRETE MONUMENT FOUND, IN SOUTHWEST CORNER OF PLAYGROUND. 98.5' NORTHEAST OF NW CORNER OF CHAIN LINK FENCE. 14.2' NORTH OF CHAIN LINK FENCE. 10.0' WEST OF MONITORING WELL PB 596. 4.5' SOUTH OF PALM TREE. MAGNET SET 1' NORTH OF CONCRETE MONUMENT.			
Actual Misclosure:	2 mm					
						



U . S D E P A R T M E N T O F C O M M E R C E

**NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
NATIONAL GEODETIC SURVEY**

Charles W. Challstrom
Director

PROJECT REPORT
Second Order Class II Leveling and Mark Setting

May 2005 to August 2005

Ronnie L. Taylor
National Geodetic Survey, NOAA
National Ocean Service Advisor, Florida

PROJECT TITLE

HYDROLOGY – PALM BEACH COUNTY WELLS

LINE TITLE FOR L26803

ESTABLISH BENCH MARKS NEAR WELLS IN PALM BEACH COUNTY

STARTING HEIGHT IS BASED ON NAVD 88 HEIGHTS.

NOTE: COLLIMATION STORED IN ELECTRONIC INSTRUMENT.

NOTE: LATITUDE AND LONGITUDE WAS OBTAINED FROM
SUB-METER GPS OBSERVATIONS.

JOB CODE AA



PROJECT REPORT

I. INTRODUCTION

A. Authority

Bench Mark Setting and Leveling along this level route was authorized by a contract between the Southwest Florida Water Management District and the Nick Miller Incorporated.

B. Purpose

The purpose of this leveling project was to establish precise NAVD 88 heights near existing Ground Water Monitoring Wells for use by the Water Management District and the citizens of the State of Florida.

II. PROJECT AREA

A. Locality

This project is located in Palm Beach and Broward, Florida.

B. Terrain

The terrain is flat to rolling.

C. Specifications

FGCS Specifications and Procedures to Incorporate Electronic Digital/Bar-Code Leveling Systems were followed.

D. Monumentation

All monuments are set in concrete with a South Florida Water Management survey disk marker. A Magnetic device was either placed in or near the monuments. Please see descriptions for magnetic placements.

E. Instrumentation

Two LEICA DNA03 Electronic Digital Level Instruments were used along with two sets of LEICA Digital/Bar-Code Leveling Rods:



III. COMMENTS

A. Reconnaissance

See the To-Reach Descriptions included, for a clear access to all L26803 Stations.

B. Specifications

There were no deviations from the FGCS Specifications and Procedures to Incorporate Electronic Digital/Bar-Code Leveling Systems.

C. Route

The leveling route varied for each leveling part.

STARTING ELEVATION BASED ON NAVD 88 HEIGHTS PUBLISHED HEIGHTS FROM THE NGS DATA BASE. NOTE: COLLIMATION STORED IN ELECTRONIC INSTRUMENT. NOTE: LATITUDE AND LONGITUDE WAS DERIVED FROM NGS DATA SHEETS AND GPS SUB METER OBSERVATIONS

These are all new second order class 2 level II runs by the Nick Miller, Inc.

D. Problems

No problems were encountered.



IV. Closures

Loop closures were computed and are included in the package for L26803.

A. Status

All records will be kept at the Nick Miller, Inc. For information on these records please contact Stephen M. Gordon at (561)627-5200.

For question concerning the collection or processing of this data please call Ronnie L. Taylor or Randy Wegner at (850)245-2606.

B. Attachments

The following are included in this package:

Hardcopy of the ABS & BOK files and Quad Maps

Disk containing the following data files is attached to the front of the folder containing the ABS, and BOK Files:

- DSC
- BLU
- HGZ
- ABS
- BOK
- LST RAW
- BACKUP.GSI
- BACKUP.RAW (RAW DATA UNTOUCHED)
- PHOTO'S
- LST