

## **APPENDIX B**

### **Gamma Surveys**

B-1: Gamma Walkover Surveys

B-2: Gamma Surveys (Downhole & Spectral)

***DuPont Chambers Works FUSRAP – RI/FS Operable Unit 1******Gamma Walkover Survey******Area of Concern 2 – F Parking Corral Area*****1.0 INTRODUCTION**

The DuPont Chambers Works site is an approximately 700-acre active chemical plant located in Pennsville and Carneys Point Townships on the southeastern shore of the Delaware River, north of the I-295 Delaware Memorial Bridge, and adjacent to the residential community of Deepwater, NJ. The plant is owned and operated by E.I. DuPont de Nemours & Company (DuPont). DuPont has maintained chemical manufacturing operations on this site and the adjoining Carneys Point site since 1892.

Operations involving uranium were conducted at the Chambers Works site between 1942 and 1947 in support of the Manhattan Engineer District. Buildings involved in uranium processing were surveyed and decontaminated and turned back over to DuPont in 1949 under criteria current at the time. These areas are currently being evaluated under the Formerly Utilized Sites Remedial Action Program (FUSRAP) to determine whether current standards have been met.

The first two Areas of Concern (AOCs 1 and 2) identified under the FUSRAP have been designated Operable Unit (OU) 1 and are currently undergoing Remedial Investigation. The gamma walkover survey (GWS) summarized in this memorandum was conducted in support of RI activities at OU 1, and focused specifically on AOC 2, the F Parking Corral Area. This memorandum completes gamma survey reporting for OU1 (results for AOC 1 were issued in May 2002).

**2.0 SCOPE OF WORK**

Cabrera Services, Inc. (CABRERA), under contract to Weston Solutions (formerly Roy F. Weston; WESTON), was tasked to perform a GWS of the subject area, identify areas of elevated gamma readings, and prepare a summary report (i.e., this technical memorandum). The results of the GWS will be used to focus subsurface sample location efforts during the intrusive phase of RI data collection activities.

**3.0 ONSITE CHARACTERIZATION****3.1 Historical Site Assessment**

Area of Concern (AOC) 2 is the site of the F Parking Corral, which is located in the northwest quadrant of the manufacturing complex, directly west of Former Building 845 (AOC 1). The F Parking Corral (Attachment I) includes the location of former Building 708, which was used

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for the production of uranium metal. This area is now covered with asphalt, and had been used until recently for open storage and temporary office setup.

### **3.2 Gamma Walkover Survey**

The GWS of the F Parking Corral was carried out on June 18, 19, and 20, 2002 to provide an indication of the areal extent of elevated radiological contaminants of potential concern, specifically Ra-226, U-234, U-235, and U-238. The survey was performed over 100% of reasonably accessible areas within the boundaries (Attachment I). The survey unit was roughly 5.4 acres (233,327 square feet). The GWS was extended slightly beyond the AOC boundaries, due to elevated readings detected along the roadway entering the rail yard, along the southern boundary of the AOC.

#### *3.2.1 Instrumentation*

The GWS was performed using two Bicron G5 Field Instrument for the Detection of Low Energy Radiation (FIDLER) detectors coupled to Ludlum Model 2221 ratemeters with lower level discriminators set just above electronic noise (i.e., open window). FIDLERs are large-area sodium iodide (NaI) detectors sensitive to higher energy gamma radiation but optimized for low-energy gamma radiation detection. These detectors are most reliable in detecting gamma emitters close to the ground surface.

The Model 2221 ratemeters were connected to the TSC-1 data logger components of Trimble Pro XRS Global Positioning System (GPS) receivers and configured such that correlated gamma count rate and geospatial location data were downloaded once per second. The GPS units were operated such that positional accuracy to one meter or less was maintained throughout the survey.

#### *3.2.2 Quality Control Measures*

Quality Control measurements for field instrumentation include response to a radioactive source and operability checks. All instruments are calibrated within the last twelve months by the instrument vendor, a certified calibration laboratory. The calibration of these instruments is via sources with activity traceable to the National Institute of Standards and Technology (NIST). The calibration certificates are contained in Appendix I. Prior to commencing the GWS, the FIDLERs collected ten (10) readings from two different radiation sources, Cadmium 109 (Cd-109) and Cobalt 57 (Co-57) to establish a control for each unit to determine on a daily basis if the instruments were working within tolerance (i.e., within  $\pm 20\%$  of the average). Instruments are response checked daily at the beginning and end of each shift with an acceptance range of  $\pm 20\%$ . Both FIDLERs were within tolerance each day of the GWS. These data are included in Attachment II.

The GPS system used the North American Datum 1983 (NAD83), New Jersey East 2900 for the horizontal coordinate system in feet. The GPS systems were also referenced to a set location (a baseline reading) and compared to this location on each day of the GWS. Ten

separate readings were collected at this location and control charts generated for each GPS unit (#1 and #2). On each day of the survey, each GPS unit collected a location reading from this established position prior to and after the GWS. These location readings were compared to the baseline location reading and an offset calculated. If the offset was one meter or greater, the GPS unit would have been removed from use. Calculated offsets for both units were less than one meter each day of the GWS. The control charts are included in Attachment II.

### 3.2.3 *Survey Methodology*

The CABRERA personnel, Al Craig and Tom Rountree, walked side-by-side in successive, parallel, one-meter wide paths (i.e., grid columns) to complete the GWS of the survey unit. To accomplish this and achieve 100% coverage, surveyors adhered to the following protocol:

- Each two-meter wide grid column was delineated by use of traffic cones, which were moved at the completion of each grid column.
- Each surveyor completed a linear pass along each survey path, while moving the detector in a serpentine manner perpendicular to the travel path. The detector was maintained as close to the land surface as practically achievable. In most cases, this kept the detector within approximately four inches of the ground surface.
- While walking the survey paths, the surveyors visually observed the GPS signal reception status. In the event of GPS signal loss, the surveyors paused until signal was regained.
- Travel velocity was maintained at approximately 0.5 meters per second.

The only areas within the AOC 2 boundary not completely covered by the GWS were under the raised steam lines in the central portion of the site, where satellite reception was not possible, and isolated areas within the F Corral were inaccessible due to equipment stored on the ground. These areas show as white patches on the data plot in Attachment I.

### 3.2.4 *Data Processing*

Upon fieldwork completion, collated data were imported into a three-dimensional contouring software package (Surfer, Version 8.0). Project data included spatial coordinates (plotted on the X and Y-axes) and gamma readings (plotted on the Z-axis). The software generated a spatially interpolated contour map depicting the gamma count rate Z-scores. The Z-score is the count from each instrument minus the mean of the count population divided by the standard deviation of the population. Z-scores were determined for each instrument and then combined to create the plot seen in Attachment 1, Gamma Z-Score Contour Plot.

Prior to posting gamma data to the contour maps, the data were qualitatively reviewed for positional accuracy. No position points failed verification for this GWS, therefore all data

were used to develop contours. Posted data indicating sharp variation from surrounding data points (i.e., sharp, non-gradient color change) was examined to determine the cause of the variability. It should be noted that, while performing the GWS, variations in count rate occur in relatively small steps. Even upon encountering a small localized area of very elevated activity, the data trends up in incremental steps. As such, data spikes due to instrument errors are easily discerned during data analysis, since they have no surrounding data supporting the expected trending pattern. No such anomalous spikes were noted in this data set.

#### 4.0 RESULTS

As indicated in the Z-score plot (Attachment I), the majority of AOC 2 is within two Z-scores. This suggests that there is little variability of radiological constituents over the surface of the survey unit. Detector # 176941 collected 27,829 data points, which showed an average of 4,855 cpm and a standard deviation of 2,391.25. Detector #176947 collected 25,404 data points, which showed an average of 4,919 cpm and a standard deviation of 1,797.83. The Z scores ranged from -1.6 to 27.

Of primary interest are the areas exhibiting greater than three Z-scores and are shown in orange and red. A number of such areas were identified during this survey. They are located at:

Point	Easting	Northing	Description
1	209,430.34	315,115.03	NE Corner of survey area, by drainage ditch, in gravel
2	209,427.63	315,126.00	Immediately North of above point, in gravel
3	209,352.45	315,101.48	Approximate location of former Building 708
4	209,415.31	315,085.08	South of points 1 & 2, at the edge of gravel and asphalt
5	209,340.12	314,990.79	South west of point 4, at edge of gravel and asphalt
6	209,169.42	314,743.43	South east portion of survey, in gravel
7	209,125.66	314,683.28	South portion of survey, asphalt, leading to RR crossing
8	209,122.95	314,668.24	Immediately south of point 7
9	209,116.05	314,645.07	On top of RR crossing outside fenced area

Points 1, 2, 4 & 5 are located in the gravel area at the northeastern section of the survey area bordering the Building 845 area. Point 4 & 5 are at the edge of the gravel and asphalt. Point 3 is located in the asphalt area in the approximate location of former Building 708. Point 6 is in the southern portion of the survey area, in the gravel at the edge of the steam lines. Points 7 and 8 are on the asphalt leading up to the fence and the railroad crossing. Point 9 is outside of the fence at the top of the RR crossing.

**Attachment I**  
**SITE MAP – AOC 2**  
**CALIBRATION CERTIFICATES**  
**GAMMA Z-SCORE CONTOUR PLOT**

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**CABRERA SERVICES, INC.**



**CALIBRATION CERTIFICATE**

**A Division of RSCS, Inc.**

Customer Name: Cabrera Services, Inc.  
809 Main Street  
East Hartford, CT 06108

Company Contact: Eric Barbour Phone: 860-289-1885

Instrument Make: Ludlum Model: 2221 Serial Number: 176941

Precision Check				
Test 1	Test 2	Test 3	Mean	Sat/Unsat
1.0 Kcpm	1.0 Kcpm	1.0 Kcpm	1.0 Kcpm	Sat

Accuracy Check			
Scale	Exposure Rate	As Found	As Left
X1000	400.00 Kcpm	400.30 Kcpm	400.30 Kcpm
	100.00 Kcpm	100.00 Kcpm	100.00 Kcpm
X100	40.00 Kcpm	40.01 Kcpm	40.01 Kcpm
	10.00 Kcpm	10.10 Kcpm	10.10 Kcpm
X10	4.00 Kcpm	4.00 Kcpm	4.00 Kcpm
	1.00 Kcpm	1.00 Kcpm	1.00 Kcpm
X1	400.00 cpm	400 cpm	400 cpm
	100.00 cpm	99 cpm	99 cpm

All readings within +/- 10% unless otherwise noted.

All Scales were calibrated using a model 500 pulser (S/N 134720 Cal Due 8/23/2002).

Calibrated with a G5 probe (S/N B653V)

Window Off, HV = 900, Threshold = 100

Efficiencies on contact for foam holders

I-129 = 0.1310 Counts/Decay

Efficiencies at 1cm:

I-129 = 0.2744 Counts/Decay

Calibrated By:

Date: 3/8/2002 Expires: 3/8/2003

This calibration was performed using a NIST Traceable radiation source in conformance to the following standards: MIL-STD 45662, ANSI N323A (1997), NCRP 112 (1991). RSCS New Hampshire Radioactive Material License Number: 381R; RSCS calibration services are performed in accordance with the RSCS Radiation Protection Program Manual and all applicable sections of 10 CFR 21

**Radiation Safety & Control Services, Inc.**

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**CALIBRATION CERTIFICATE**

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Customer Name: Cabrera Services, Inc.  
809 Main Street  
East Hartford, CT 06108

Company Contact: Eric Barbour Phone: 860-289-1885

Instrument Make: Ludlum Model: 2221 Serial Number: 176947

Precision Check				
Test 1	Test 2	Test 3	Mean	Sat/Unsat
1.0 Kcpm	1.0 Kcpm	1.0 Kcpm	1.0 Kcpm	Sat

Accuracy Check			
Scale	Exposure Rate	As Found	As Left
X1000	400.00 Kcpm	400.47 Kcpm	400.47 Kcpm
	100.00 Kcpm	100.07 Kcpm	100.07 Kcpm
X100	40.00 Kcpm	40.00 Kcpm	40.00 Kcpm
	10.00 Kcpm	10.03 Kcpm	10.03 Kcpm
X10	4.00 Kcpm	4.10 Kcpm	4.10 Kcpm
	1.00 Kcpm	1.00 Kcpm	1.00 Kcpm
X1	400.00 cpm	400 cpm	400 cpm
	100.00 cpm	100 cpm	100 cpm

All readings within +/- 10% unless otherwise noted.  
 All Scales were calibrated using a model 500 pulser (S/N 134720 Cal Due 8/23/2002)  
 Calibrated with a G5 probe (S/N B464V)  
 Window Off, HV = 845, Threshold = 100  
 Efficiencies on contact for foam holders I-129 = 0.1283 Counts/Decay  
 Efficiencies at 1cm: I-129 = 0.2603Counts/Decay

Calibrated By: Date: 3/8/2002 Expires: 3/8/2003

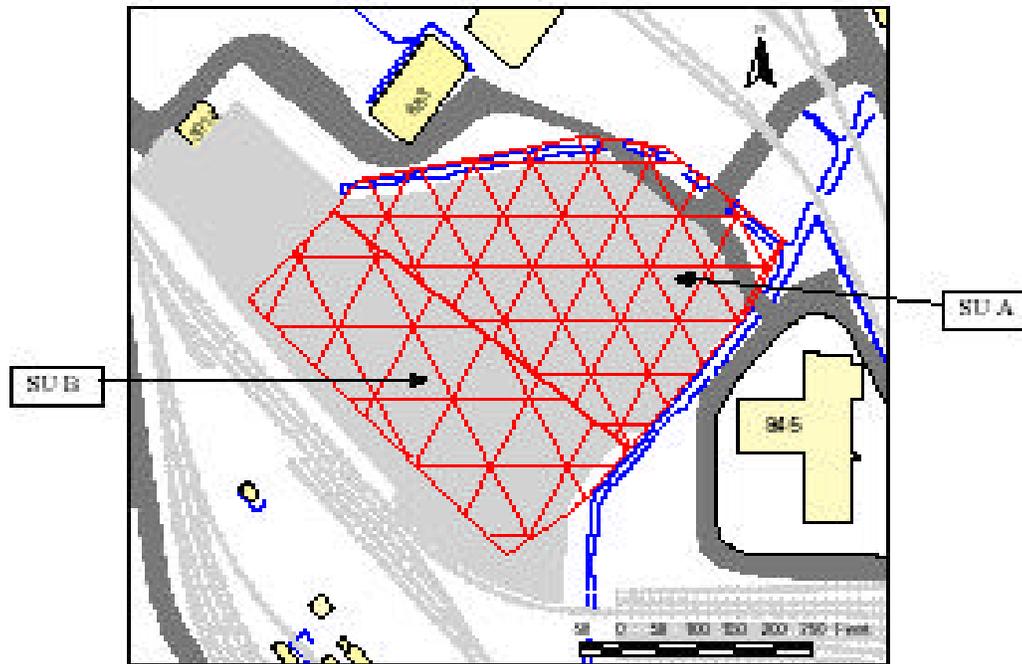
This calibration was performed using a NIST Traceable radiation source in conformance to the following standards: MIL-STD 45662, ANSI N323A (1997), NCRP 112 (1991). RSCS New Hampshire Radioactive Material License Number: 381R; RSCS calibration services are performed in accordance with the RSCS Radiation Protection Program Manual and all applicable sections of 10 CFR 21

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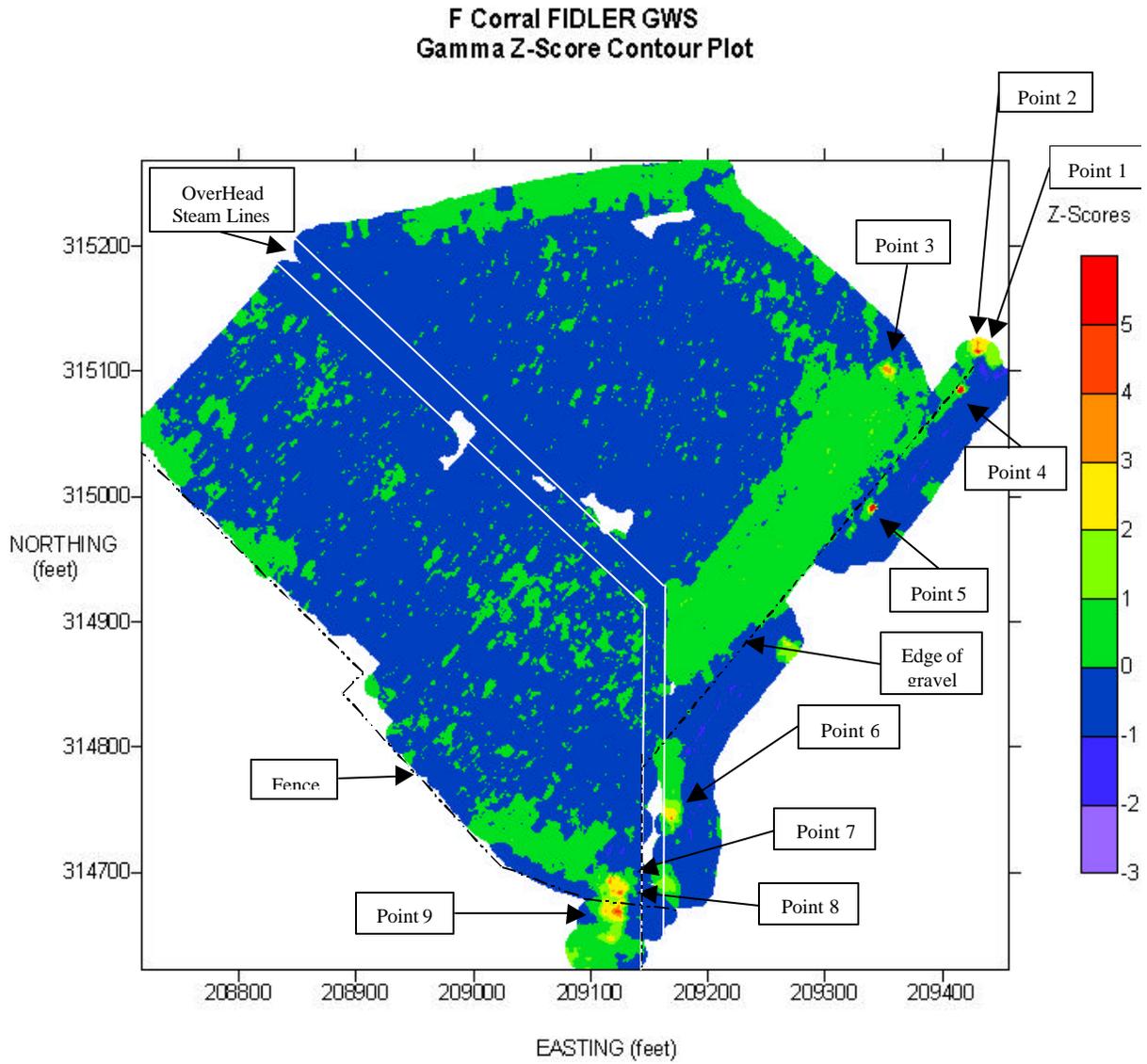


SITE MAP

F Corral AOC 2

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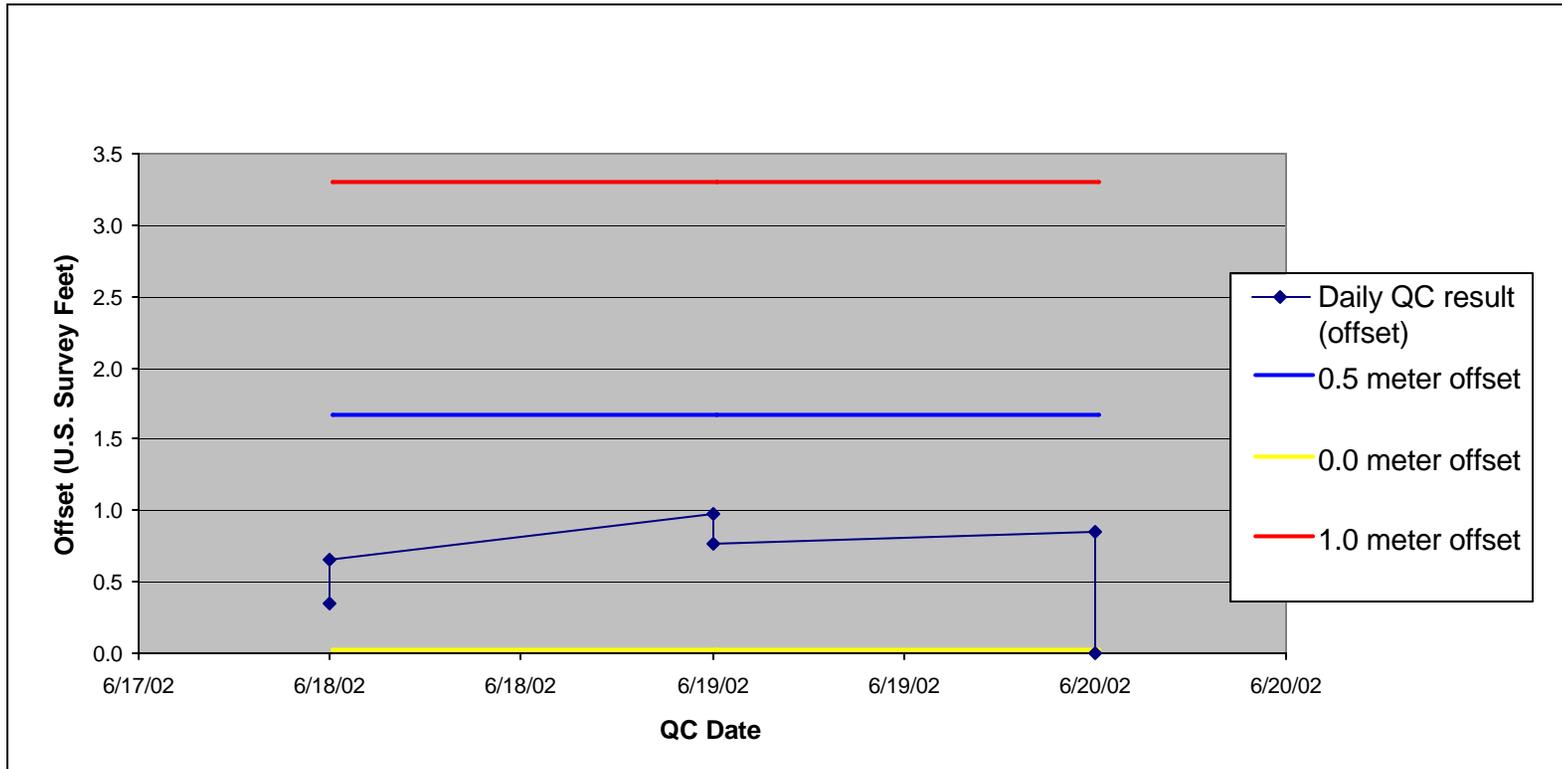
CABRERA SERVICES, INC.



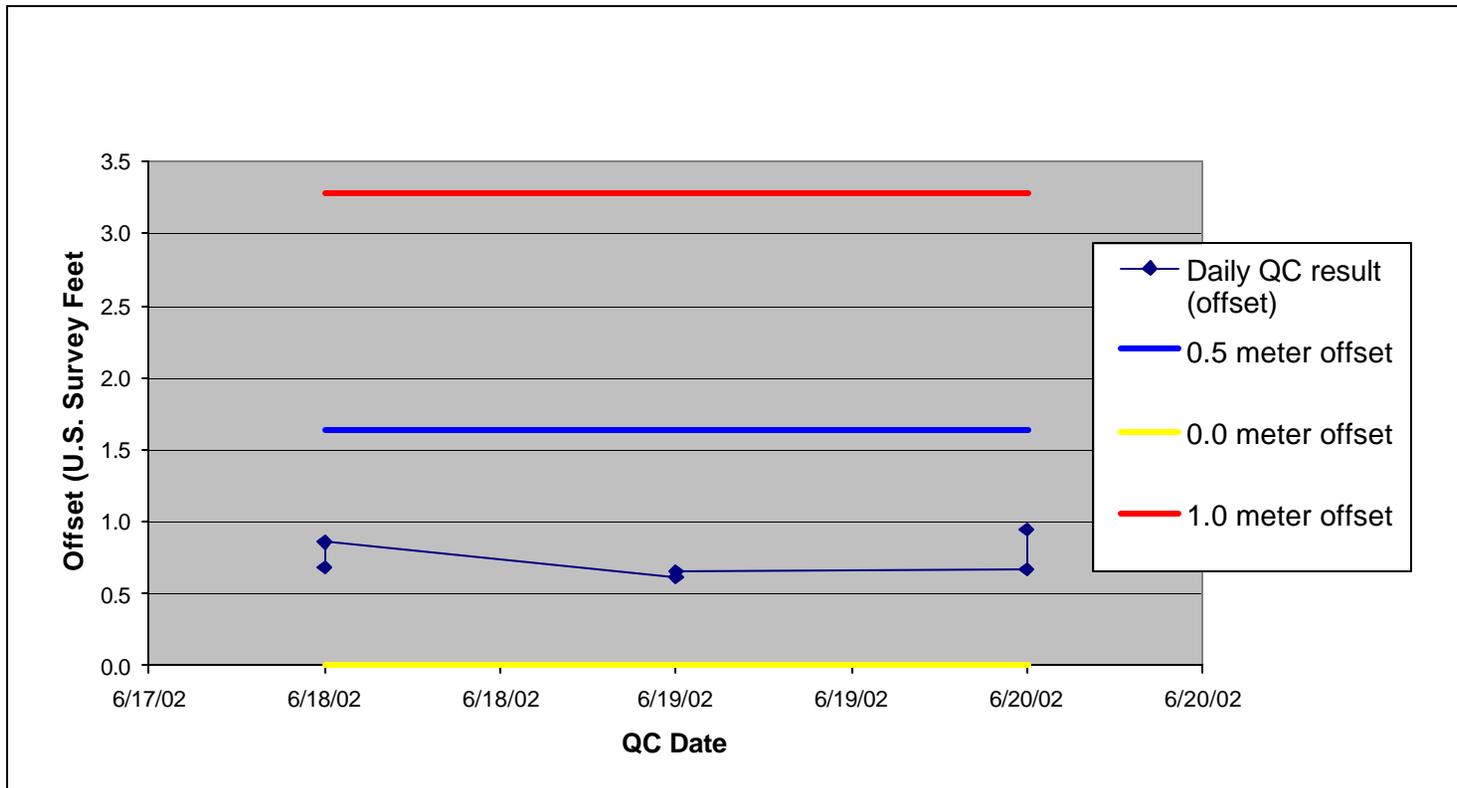
Coordinate System  
US State Plane 1983  
New Jersey 2900  
in feet

**Attachment II**  
**CONTROL CHARTS**

### GPS # 1 CONTROL CHART



### GPS # 2 CONTROL CHART



**FIDLER RESPONSE CHECK DATA**

**FIDLER # 1 Serial # 176941**

**Response to Cd - 109**

2221/176941		2221/176941		2221/176941	
QC Daily Nal Background		QC Daily Nal Source		Initial Nal Readings	
Date	Result (cpm)	Result (cpm)	P/F	Date	Results (cpm)
6/18/2002	n/a	18673	Pass	3/18/2002	17992
6/19/2002	n/a	17994	Pass	3/18/2002	18037
6/20/2002	n/a	20102	Pass	3/18/2002	18133
				3/18/2002	17531
				3/18/2002	17770
				3/18/2002	18234
				3/18/2002	17907
				3/18/2002	18117
				3/18/2002	17791
				3/18/2002	17581
					Average
					17909

**Response to Co - 57**

2221/ #176941		2221/ #176941		2221/ #176941	
QC Daily Nal Background		QC Daily Nal Source		Initial Nal Readings	
Date	Result (cpm)	Result (cpm)	P/F	Date	Results (cpm)
6/18/2002	n/a	18001	Pass	3/18/2002	18010
6/19/2002	n/a	17418	Pass	3/18/2002	17938
6/20/2002	n/a	17763	Pass	3/18/2002	17876
				3/18/2002	17796
				3/18/2002	18112
				3/18/2002	17619
				3/18/2002	18208
				3/18/2002	18212
				3/18/2002	17895
				3/18/2002	18089
					Average
					17976

**FIDLER RESPONSE CHECK DATA****FIDLER # 2 Serial # 176947****Response to Cd - 109**

2221/176947	
QC Daily Nal Background	
Date	Result (cpm)
6/18/2002	n/a
6/19/2002	n/a
6/20/2002	n/a

2221/176947	
QC Daily Nal Source	
Result (cpm)	P/F
17668	Pass
17054	Pass
18246	Pass

2221/176947	
Initial Nal Readings	
Date	Results (cpm)
3/18/2002	18289
3/18/2002	18185
3/18/2002	17906
3/18/2002	18002
3/18/2002	18199
3/18/2002	18908
3/18/2002	17843
3/18/2002	18004
3/18/2002	18090
3/18/2002	18312
	Average
	18174

**Response to Co - 57**

2221/ #176941	
QC Daily Nal Background	
Date	Result (cpm)
6/18/2002	n/a
6/19/2002	n/a
6/20/2002	n/a

2221/ #176941	
QC Daily Nal Source	
Result (cpm)	P/F
20102	Pass
19639	Pass
19738	Pass

2221/ #176941	
Initial Nal Readings	
Date	Results (cpm)
3/18/2002	20075
3/18/2002	20230
3/18/2002	19990
3/18/2002	20365
3/18/2002	21206
3/18/2002	20154
3/18/2002	19843
3/18/2002	20318
3/18/2002	19089
3/18/2002	20484
	Average
	20175