PEBBLE PROJECT
ENVIRONMENTAL BASELINE DOCUMENT
2004 through 2008

APPENDIX A.
ANALYTICAL QUALITY ASSURANCE/ QUALITY CONTROL REVIEW

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TABLE OF CONTENTS

LIST OF TABLES

FIGURE

LIST OF ATTACHMENTS

ACRONYMS AND ABBREVIATIONS

A2LA	American Association for Laboratory Accreditation
AAC	Alaska Administrative Code
ACZ	ACZ Laboratories Inc.
ADEC	Alaska Department of Environmental Conservation
Argon	Argon, LLC
AVS	acid volatile sulfide
BEESC	Bristol Environmental & Engineering Services Corporation
BTEX	benzene, toluene, ethylbenzene, and xylenes
°C	degrees Celsius
$CaCO_3$	calcium carbonate
CAS	Columbia Analytical Services
CN	cyanide
DQAR	data quality assessment report
DQO	data quality objective
DRO	diesel-range organics
EDF	electronic deliverable format
EPA	Environmental Protection Agency (U.S.)
ERA	Environmental Resource Associates
FSP	field sampling plan
GERG	Geochemical and Environmental Research Group (Texas A&M University laboratory)
GRO	gasoline-range organics
HDR	HDR Alaska, Inc.
Hg	mercury
ICP-MS	inductively coupled plasma/mass spectroscopy
ISO	International Organization for Standardization
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LD	laboratory duplicate
MDL	method detection limit
meq/L	milliequivalents per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
µg/L	micrograms per liter
µm	micron(s)

µmhos/cm	micromhos per centimeter
MRL	method reporting limit
MS	matrix spike
MSD	matrix spike duplicate
MUR	Method Update Rule
n	number of samples
NA	not applicable
NCA	North Creek Analytical, Inc.
ND	not detected
ng/L	nanogram per liter
n-pairs	number of primary and duplicate pairs
NQA	National Quality Assurance Limited
NRCC	National Research Council Canada
NS&T	National Status and Trends
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
%R	percent recovery
PE	performance evaluation
PSEP	Puget Sound Estuary Program
QA	quality assurance
QC	quality control
QAPP	quality assurance project plan
RPD	relative percent difference
RRO	residual-range organics
RSD	relative standard deviation
RTC	Resource Technology Corporation
SD	standard deviation
SEM	simultaneously extracted metals
SGS	SGS North America, Inc.
Shaw	Shaw Alaska, Inc.
SHC	saturated hydrocarbon
SLR	SLR Alaska
SM	Standard Method
SOW	statement of work
SRM	standard reference material
STL	Severn Trent Laboratories
SVOC	semivolatile organic compound
TA	TestAmerica, Inc.

TOC	total organic carbon
TQ	standard reference material for vegetation or aquatic animal tissue, as appropriate, with externally certified constituent concentrations
TSS	total suspended solids
T vs D	total versus dissolved
UCL	upper control limit
UCM	unresolved complex mixture
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VOA	volatile organics analysis
VOC	volatile organic compound
WAD	weak acid dissociable
WG	groundwater
WS	surface water
$\bar{x}$	average or mean

APPENDIX A. ANALYTICAL QUALITY ASSURANCE/ QUALITY CONTROL REVIEW

A.1 ANALYTICAL QA/QC PROGRAM OVERVIEW

For the Pebble Project, an analytical quality assurance (QA)/quality control (QC) program has been developed to govern the quality of chemistry data. This quality program was built in at the planning stages of the project in spring 2004. Shaw Alaska, Inc. (Shaw), is tasked with the development and maintenance of the QA/QC program.

The QA component of the program is a systematic process of verifying whether activities are meeting specified requirements. It strengthens the confidence in the data generated from various activities that help form the interpretations and conclusions made for baseline conditions. This strength is accomplished by establishing consistency and building in efficiencies that provide benefits throughout the project. The quality assurance project plan (QAPP), statements of work (SOWs), and work plans document the QA program and processes.

The QC component of the program is implemented through field and laboratory audits, peer review, data validation, and statistical analyses. These processes are based on a defined and documented set of criteria, which are accepted by industry and comply with relevant regulatory guidelines.

Tables A-1 and A-2a present summaries of the number of samples to be collected and the parameters to be analyzed for each sample type, respectively. The analytical QA/QC program is applied to environmental sample collection and analysis for the Pebble Project and includes the following:

- Development of data quality objectives (DQOs).
- Development of a QAPP.
- Development and management of laboratory services.
- Audit of field sampling and laboratory activities.
- Evaluation and development of analytical methods.
- Chemistry data management from sample collection to database.
- Compliance with analytical regulatory requirements.
- Management of multidisciplinary studies.
- Validation of analytical chemistry data.
- Chemistry consultation.

The analytical QA/QC program is critical to ensure that field procedures, laboratory analyses, and data deliverables meet technical and quality requirements stipulated by regulatory agencies and Pebble Partnership. The primary objectives of the program are to ensure that the quality of the analytical data is consistent among consultants collecting samples in the field and among laboratories and that the data meet specified DQOs. The program ensures that analytical QA/QC requirements are met for the water quality, trace elements, and marine chemistry data for the environmental baseline studies. This appendix includes a description of the analytical QA/QC program (Section A.1); an assessment of data collected from April 2004 through December 2008 for the water quality, trace elements, and marine studies (Section A.2); and a summary of and conclusions about the data quality (Section A.3).

A.1.1 SAMPLE COLLECTION OVERSIGHT

Oversight of sample collection included a review of field sampling plans (FSPs), sample management, and field audits. The following subsections further describe the sample collection oversight process.

A.1.1.1 Field Sampling Plan Review

FSPs are prepared by each consultant involved in the studies of water quality (Section A.2.2), trace elements (Section A.2.3), and the marine environment (Section A.2.4). These FSPs are reviewed before sample collection to ensure that sampling procedures are consistent among all consultants and sampling teams.

A.1.1.2 Field Sample Management and Quality Control

All samples collected in the field are received by Shaw personnel stationed in Iliamna. Samples are packaged and shipped to laboratories under chain-of-custody protocols within a day of sample collection. Sample volumes, containers, labels, and preservative are checked before packaging to ensure that all requirements have been met. Laboratories are notified of each shipment, and shipments are tracked to ensure samples arrive as scheduled.

Field QC samples are collected during the sampling to evaluate field sample handling, transportation, and analytical procedures, as well as total field and analytical variability. The field QC samples consist of field duplicate samples, trip blanks for low-level mercury (Hg) and volatile organics analyses (VOAs), equipment rinsate samples, and a blank sample of deionized water. Field duplicate samples are samples collected concurrently with project samples by using the same sampling equipment,methodology, and analyzed using the same or equivalent methods to indicate any contamination or imprecision introduced during the sampling process.

Low-level Hg and VOAs are constituents that, by their nature, can become airborne. Trip blanks are used to assess whether these airborne constituents are present, either from the natural environment surrounding the collection activities or emanating from collected samples, and possibly are cross-contaminating samples. Because the other constituents for which tests are conducted do not become airborne, trip blanks are not generated for them.

Trip blanks are samples of deionized water that accompany the laboratory-provided sample containers during shipment to and from the field and during sample collection and storage to indicate any contamination that may be introduced during transport and handling.

An equipment rinsate sample is an aliquot (portion) of deionized water that is exposed to the sampling equipment, such as pumps, tubing, and collection vessels, to detect possible contamination introduced by sampling equipment. A deionized water blank is used to indicate any artifacts that may have been present in the laboratory-provided water used for rinsing equipment.

A.1.1.3 Field Audits

Field audits are conducted as often as two times per year (winter and summer) for each field team involved in sample collection. Audits are based on field procedures presented in the FSPs and in the QAPP applicable for that year. The auditor travels to sampling sites with field teams, observes all field activities, and reviews field forms and logs for compliance with the FSP and the QAPP. A post-audit meeting is held in the field to address the results of the audit and any corrective actions.

Table A-3 summarizes the audits conducted for the project to date. One winter and one summer audit were conducted each year for studies of streams, seeps, and groundwater. Samples for Iliamna Lake stream sediment, terrestrial vegetation, soil, and fish from freshwater streams were collected in summer months. Therefore, no winter audits are shown for these field teams. Sampling protocols can be different and, in some cases, limited during winter months because of the challenges related to winter conditions in the field.

A.1.2 LABORATORY QUALITY PROGRAM

A large component of the quality program is management of laboratory services and laboratory data. Analytical requirements for laboratories are provided in a QAPP for each year of study. (Copies of the 2005, 2006, 2007, and 2008 QAPPs are provided in Appendix G of this environmental baseline document.) All field samples are analyzed by primary laboratories. Ten percent of the samples are collected in duplicate (field duplicate samples) or triplicate (field triplicate samples) for analysis by the primary and QA laboratories, respectively. Laboratory duplicate samples are identical to the field duplicate samples described in Section A.1.1.2, except their purpose is to assess reproducibility of field sampling protocols in combination with intra-laboratory precision. Field duplicate (QC) samples measure whether a laboratory is consistently performing within specifications outlined in the QA program. Field triplicate (QA) samples are submitted to a secondary independent laboratory as a relative measure of inter-laboratory precision. Field triplicate samples measure whether the QA program is effective and applicable. To be effective for quality control, field duplicate and triplicate samples are collected and analyzed in a manner identical to that for project samples.

Tables A-4a, A-4b, and A-4c list the primary and QA laboratories and their assigned media for the Pebble Project. The study dates are addressed as follows: Table A-4a, April 2004 through May 2007; Table A-4b, June 2007 through December 2007; and Table A-4c, January 2008 through December 2008. Primary and QA laboratory assignments changed in 2007 to accommodate available laboratory capacity, which was taxed by a larger than anticipated number of samples that year. Other assignment changes were based on laboratory specialties relative to sample collection for specific studies throughout the various years and the related testing needs.

QC samples consisting of laboratory control samples (LCSs), LCS duplicates (LCSDs), matrix spike (MS) samples, MS duplicate (MSD) samples, and laboratory duplicate (LD) samples (described above) have been incorporated into the analytical scheme to assess data quality. An LCS is a blank of laboratory water fortified with the constituents of interest. It is used to measure the efficiency of the analytical method used. MS samples of the sample matrix (soil, water, etc.) are fortified with the constituents of interest and are used to measure the effect of the matrix on the efficiency of the analytical method used.

In 2006, performance evaluation (PE) samples for water and soil were submitted to SGS North America, Inc. (SGS), and Columbia Analytical Services (CAS) as blind samples (Table A-5a). These samples were prepared by Environmental Resource Associates (ERA) specifically for the Pebble Project. ERA certifies the concentration of each parameter in the samples.

In 2007, PE samples for water and soil were submitted to SGS, CAS, ACZ Laboratories Inc. (ACZ), and North Creek Analytical, Inc. (NCA) of Portland, Oregon, as blind samples (Table A-5b). (NCA of Portland, Oregon, was later purchased by TestAmerica, Inc. [TA]. These samples were prepared by Resource Technology Corporation (RTC). RTC certifies the concentration of each parameter in the samples.

In 2008, PE samples for water were submitted to SGS and CAS (Table A-5c) and samples for ocean water were submitted to CAS and TA as blind samples (Table A-6). These samples were prepared by RTC. RTC certifies the concentration of each parameter in the samples.

In all PE studies, samples were submitted to the laboratories as “double blind” samples in containers and with labels that mimicked field samples. This process of submitting double blind PE samples prevented the laboratories from knowing the samples were actually PE samples. Results of the analyses of the PE samples are discussed in Section A.2.

Analysis methods are defined by the Environmental Protection Agency (EPA) and are presented in the 2005, 2006, 2007, and 2008 QAPPs (provided in Appendix G). The target parameters, analytical methodology, and sample reporting limits for project samples are presented in the QAPPs. The data quality indicators of precision and accuracy in analysis were specified as DQOs in the QAPPs.

The number of parameters tested per sample and numbers of samples collected for the Pebble Project are extensive, and sample collection occurs at least 10 months of the year. A summary of the numbers of field samples collected and parameters analyzed during the last 4 years is presented in Table A-1. A summary of the parameters analyzed for each sample type is presented in Table A-2a.

A.1.3 DATA VERIFICATION

Data verification was performed to ensure the competency of the electronic data reported and archived. A complete cross-checking of laboratory identification numbers with field identification numbers was performed to ensure that analyses had been performed as specified by the chain-of-custody documentation. The laboratories supplied the analytical results in the electronic deliverable format (EDF), Version 1.2a, of the U.S. Army Corps of Engineers (USACE), North Pacific Division. Microsoft Access 2003 and Excel 2003 were used to extract data from the verified final EDF for generation of tabulated sampling results. The data verification process provides electronic data that meet the requirements for the chemistry database that has been developed for the Pebble Project.

A.1.4 DATA VALIDATION

For environmental studies, the purpose of data validation is to establish the completeness and usability of the data. Data validation is done by comparing data to project QA/QC criteria and DQOs before they are used in the intended decision-making processes. The Pebble Project QAPPs for 2005 through 2008 (Appendix G) present in detail the QA/QC criteria and DQOs for analytical data for each laboratory involved. The QAPP is the quality standard against which the data are judged.

Shaw performed data assessment for a systematic and independent verification to determine method compliance and assess data quality. Sources for data assessment were sample results and QC sample summaries provided by the laboratory and data validation worksheets prepared by DESIT from the verified EDF. Data are validated by sample event because field and laboratory QA/QC is specific to each sampling event. For example, water quality samples from streams in the mine study area are collected monthly nine times per year. Therefore, nine such events per year are validated as separate sampling events.

Beginning with the January 2009 events for water quality sampling, Argon, LLC (Argon) assumed responsibility for data validation on the Pebble Project. That change affected the approach to handling anomalies of total versus dissolved (T vs D) metals that were evaluated for the 2004 through 2008 period. Both Shaw and Argon participated in the investigation and corrective action activities that occurred in 2009 and 2010. The corrective action included re-validation of select metals data for water samples collected during 2004 through 2008. The re-validation was performed by Argon because of the timing of this shift in validation responsibility.

Data validation was performed following EPA guidance documents (EPA, 1999, 2001, 2002) and professional judgment consistent with industry standards, in cases for which specific guidance was not available.

The data quality indicator of precision was calculated from the results of field duplicate samples, LCS/LCSDs, LD samples, and MS/MSD samples and was compared to the laboratory-established control limits, method-established control limits, and precision goals in the 2005 through 2008 QAPPs (Appendix G).

The data quality indicator of accuracy was calculated from the results of the percent recovery of parameter-spiked LCS/LCSDs and MS/MSD samples and was compared to the laboratory-established control limits, method-established control limits, and accuracy goals in the 2005 through 2008 QAPPs (Appendix G).

As a result of the data validation, data qualifier codes (flags) may be appended to the result database as described below:

- U The parameter was analyzed for, but was not detected above the level of the reported sample quantitation limit. Detections below this limit are attributed to associated blank contamination.
- UJ The parameter was analyzed, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the parameter in the sample.
J+	The result is an estimated quantity, but may be biased high.
J-	The result is an estimated quantity, but may be biased low.
R	The data are unusable. The sample results were rejected because of serious deficiencies in meeting QC criteria. The parameter may or may not be present in the sample.

Data quality assessment reports (DQARs) have been prepared for each sampling event and are available upon request. DQARs present the finding of the data validation and the usability of the data for the purposes of the Pebble Project.

A.1.5 DATA MANAGEMENT

Data management includes report tracking; receipt, archiving, and distribution of reports; verification of EDF reports; compilation of data from individual EDF reports into a single file for each sampling event; and transfer of validated data files to the Pebble Project database. Validated data are uploaded into a secure database and made accessible to Pebble Partnership and its consultants through an Internet-based application that permits viewing and downloading of the chemistry data. The data are managed by electronic means from sample collection through laboratory reporting and database uploads; no chemistry data are manually entered into the Shaw systems or the final database. This approach greatly reduces the potential for error in the final product. The data management design and process are crucial for protecting and maintaining the data for current and long-term use. Figure A-1 depicts the flow of data for the Pebble Project.

Data are managed and validated by event, as described in Section A.1.4 above. Section A.2 discusses data assessment by matrix (surface water, soil, sediment, etc.) and includes all sample events from April 2004 through December 2008.

A.2 DATA ASSESSMENT

The usability of the chemistry data was assessed by data validation, which occurred before data were electronically loaded into the Pebble Project database. Key indicators used to assess the data against expected DQOs defined in the project QAPPs (2005 through 2008, in Appendix G) are precision, accuracy, representativeness, comparability, completeness, and sensitivity. Total and dissolved trace elements and cation/anion balance also have specific DQOs for water quality.

A.2.1 DEFINITIONS OF INDICATORS

A.2.1.1 Precision

Precision is a qualitative measure of reproducibility among independent measurements under a given set of conditions. This characteristic is expressed as relative percent difference (RPD) and relates to laboratory duplicates, field duplicates, and field triplicate samples. RPDs are used during the analytical and data validation processes to determine the effectiveness of the methods implemented by the laboratories on a batch (i.e., real time) basis. RPDs are calculated as follows:

$$RPD = [(C_1 - C_2) * 100 \div [(C_{1\,+}\, C_2) / 2]$$

Where:

RPD = relative percent difference

C_1 = larger of the two observed values

C_2 = smaller of the two observed values

Precision trends were evaluated by calculating a relative standard deviation (RSD) of RPDs generated from the results of LCS, LD, and field duplicate samples. RPDs involving sample results reported at values less than the method reporting limit (MRL) were included in the statistical calculations of the mean ($\bar{x}$) and subsequent RSD of measurements. The RSD is used to assess trends that may occur between samples as a result of subtle process changes that may not manifest themselves in day-to-day QC assessments. Such unnoticed changes may indicate a trend toward a situation in which compliance with the QC specifications may become difficult.

RSD is calculated as follows:

$$RSD = (SD/\bar{x}) \text{ x } 100$$

Where:

RSD = relative standard deviation

SD = standard deviation

$\bar{x}$ = mean of replicate analysis

Field duplicate samples were included in the analytical scheme to assess overall sampling and analytical variability. This variability includes that resulting from sample matrix differences or matrix heterogeneity, sample handling procedures, and the analytical measurement system. Field precision was calculated as the RPD between results for primary and field duplicate samples. The RPD is calculated as the difference between results, divided by their average, and multiplied by 100 to express the final result as a percentage. A percent RSD of the RPDs was calculated to assess the precision of these values.

A.2.1.2 Accuracy

Accuracy measures the degree that a measured value agrees with a known or true value. This indicator is typically expressed as percent recovery (%R) and is applied to laboratory QC and PE sample results. Percent recovery is calculated as follows:

$$\%R = \frac{\text{measured concentration}}{\text{true concentration}} * 100$$

Triplicate field (QA) samples were collected from the identical sample points designated for field duplicate samples and were submitted to the assigned QA laboratories. The intent of the triplicate sampling is to assess the accuracy of the primary laboratory. This comparison is accomplished by a quantitative comparison of data from the primary and QA laboratories through calculation of an RPD for the trace element and inorganic parameter values. The RPD of primary and field triplicate sample results was compared by standard control chart plotting of the RPD for those results. The chart parameters were established by calculating an upper control limit (UCL) established from the average RPD of primary and field duplicate results plus three times their SDs. The RPDs of primary and field triplicate sample results were plotted on the control chart to evaluate and ascertain whether the QA laboratory analysis was within the control limits established from the primary laboratory precision.

The control charts are provided in Attachment 1. The chart contents are as follows:

- Control Charts A-1 through A-44, April 2004-December 2008 Surface Water (Except Seeps).
- Control Charts A-45 through A-79, May 2004-November 2008 Surface Water (Seeps).
- Control Charts A-80 through A-118, September 2004-October 2008 Groundwater.
- Control Charts A-119 through A-149, 2004-2007 Sediment.
- Control Charts A-150 through A-179, 2004-2007 Vegetation.
- Control Charts A-180 through A-214, 2004-2007 Soil
- Control Charts A-215 through A-219, 2004-2005 Fish and Mussel Tissue.
- Control Charts A-220 through A-253, 2004-2008 Marine Sediment.
- Control Charts A-254 through A-260, 2008 Marine Vegetation.
- Control Charts A-261 through A-274, 2004-2008 Marine Water.

A.2.1.3 Representativeness

Representativeness is a measure of how closely the measured results reflect the actual concentration or distribution of the chemical parameters in the environment. This measurement is accomplished by incorporating double-blind PE and field triplicate samples into the analytical process.

A.2.1.4 Comparability

Comparability is the level of confidence with which one data set can be compared with another. This objective is met by selecting field sampling methods and laboratory analytical methods that are comparable throughout the baseline environmental studies. Changing sampling techniques or laboratory methods within a laboratory or between laboratories during the study may compromise comparability. The field sampling methods employed by multiple sampling teams collecting samples of similar media also must be consistent. Maintaining comparability is a continual process, evaluated as conditions, methods, or techniques change or new people are introduced into the laboratory program.

A.2.1.5 Completeness

Completeness is a measure of the amount of data determined to be valid compared to the total amount of data acquired. The actual completeness can vary with the intrinsic nature of the samples or random events that preclude successful measurements. This indicator is expressed as percent completeness, which is assessed after data review and validation (Table A-2b).

A.2.1.6 Sensitivity

Sensitivity is a comparison of the laboratory method detection limits (MDLs) and MRLs relative to the MRL goals tabulated in the project QAPPs (2005 through 2008, in Appendix G). The MRL goals are established with consideration given to the technology capabilities available to commercial laboratories as applicable to the required EPA-approved methodologies and benchmark criteria based on state and federal guidelines. Sample results reported greater than or equal to the MDL, but less than the MRL were flagged with a “J” during the validation process and are considered estimated values. This qualification informs the reviewer of a loss in accuracy and precision below the MRL and does not represent a laboratory data quality issue. Results reported with an “ND” (not detected) did not yield an analytical concentration greater than or equal to the MDL.

A.2.1.7 Total versus Dissolved Trace Elements

Total versus dissolved trace elements is a comparison of total metals—recovered from the water matrix in their collected forms and includes both non dissolved and dissolved metals—and dissolved metals. The dissolved form of the sample is created by filtering an unpreserved portion of the sample through a 0.45 micron (μm) filter in the field shortly after sample collection. The T vs D fractions are compared primarily to monitor for consistency and representativeness in the sample-collection techniques. The total metal concentration should be greater than the dissolved for a given analyte as total represents both dissolved and non dissolved (i.e. total) portions. This evaluation also serves as a secondary check on laboratory sample-handling protocols (e.g., indication of bottle mix-up) and related potential effects on data quality. The criteria are as follows:

- If both results are more than five times the MRL, the RPD between the two values must be less than or equal to 20 percent.
- If one of the results is less than five times the MRL, the difference between the two values must be less than or equal to the MRL. If one of the results is less than the MDL, the MDL is used for the difference calculation.
- If both results are below the MRL, the difference is accepted.

If more than 30 percent of the results for trace elements did not meet these criteria and sufficient sample volume was available, the total and dissolved fractions were re-analyzed.

A.2.1.8 Cation/Anion Balance

Cation/anion balance is a calculation of the total cation and the total anion content of a sample for filtered samples. (Cations are iron, aluminum, cadmium, calcium, magnesium, manganese, potassium, sodium, zinc, and acidity. Anions are bicarbonate alkalinity, chloride, fluoride, nitrate, and sulfate.) A comparison of the two values is performed under the criteria established in *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998), Standard Method (SM) 1030E. This evaluation was performed at the laboratory before the final deliverables were reported and by Shaw during data validation. Balance calculations falling outside acceptance limits (summarized below) can be an indication of a sample bottle mix-up or a loss of accuracy, precision, or both.

The cation and anion analyses describe a general condition of water quality. The water quality conditions are reported in milligrams per liter (mg/L) for anions and micrograms per liter (µg/L) for cations, and are expressed in milliequivalents per liter (meq/L) for conducting the balance calculations. Anions are negatively charged, and cations are positively charged. Because water is by definition electrically neutral, ideally the cation and anion sums will balance; in other words, they are expected to be equivalent for a given sample. Random variation in different analyses may affect this equivalency; therefore, criteria for an acceptable difference between the sums are established according to the following method:

Anion Sum (meq/L)	Acceptable Difference
0-3.0	±0.2 meq/L
3.0-10.0	±2%
10.0-800	±5%

If the acceptable difference criterion is not met, the individual analyses are evaluated to determine whether an error occurred in calculations and reporting or laboratory QC samples indicate the possibility of bias. Bottle labeling is also examined for accuracy. Re-analyses may occur depending on availability of sample volume and holding-time status. A holding time is a timeframe within which an analysis must be conducted in order to be considered valid, as stipulated by method, regulation, or both. A holding time is typically related to the date and time of sample collection.

Several troubleshooting approaches can be taken when an “acceptable difference” value is exceeded; for example, for alkalinity. Alkalinity can be a significant contributor to the anion sum. Some loss or gain of alkalinity will occur from the absorption or loss of carbon dioxide. Dissolved iron and manganese can be significant contributors to the cation sum and are potentially affected by exposure to oxygen. Consequently, filtering a portion of a sample for metals analysis is conducted as soon as possible after collection, as is cooling and the use of acid as a preservative.

The findings of the data assessment for each study are presented below.

A.2.2 WATER QUALITY

The development, operations, and waste disposal for mining operations can directly or indirectly expose surface water or groundwater to natural and man-made materials that could affect the characteristics of the water. The volume of available water may also be disrupted by its use in operations or by the nature of the disturbances and how they alter containments and pathways.

The natural range of water quality is being thoroughly characterized through environmental baseline studies as part of the permitting process. The baseline studies consider seasonal changes and geological features in the vicinity of the proposed mine.

The main objective of the surface water studies is to collect data on naturally occurring levels of water-quality parameters. Confidence in the data was assessed by evaluating the pool of data for the key quality indicators of precision, accuracy, representativeness, comparability, completeness, sensitivity, total and dissolved metals, and cation/anion balance.

A.2.2.1 Surface Water

The surface water studies for the Pebble Project study area include samples from streams, ponds, seeps, and lakes. Samples were collected by HDR Alaska, Inc. (HDR), in the mine study area and by Bristol Engineering & Environmental Services Corporation (BEESC) in the transportation corridor. Sample collection followed procedures outlined in FSPs developed each year.

Precision—Surface Water

Precision was calculated from the RSD in results of LCSs, LD samples, and field duplicate samples. Sample results reported at levels less than the MRL were included in the statistical calculations of the mean ($\overline{x}$) and the SD of the measurements.

LCS analysis provides information on analytical variability or laboratory precision without influence from a field sample matrix. The laboratory uses in-house purified water for the LCSs. Surface water and groundwater samples can be batched together under a single LCS. A single set of calculations of the mean and SD of LCS data points represents both matrices. Laboratory accuracy and precision are displayed in Table A-7.

LCS results for trace elements exhibit excellent accuracy for all parameters as indicated by mean percent recoveries that were within DQOs for accuracy.

The RSD for one polychlorinated biphenyl (PCB), six volatile organic compounds, and 19 semivolatile organic compounds exhibited a relatively higher variability, with RSD greater than 20 percent. The available data set is too limited to use this RSD information to form an accuracy statement for the organics analyses. Organic analyses were conducted on a limited basis to verify their absence from the environment. Because the organic parameters tabulated in the target lists in the 2005, 2006, and 2007 QAPPs (Appendix G) were not detected, sample concentration quantitations are not available as a basis for making accuracy statements.

Field duplicate samples were included in the analytical scheme to assess sampling and analytical variability. This variability includes that resulting from to sample matrix differences (heterogeneity), sample handling procedures, and the analytical measurement system at the primary laboratory (SGS). Field precision was calculated as the RPD between primary and field duplicate sample results. A percent RSD of the RPDs was calculated to assess the precision of these values.

For trace elements, total and dissolved, the Argon data validator evaluated a total of 394 primary-field duplicate sample pairs of surface water. For inorganic parameters, a total of 197 primary-field duplicate sample pairs of surface water were evaluated. Field teams collected 2,783 primary surface water samples for trace elements and 1,392 primary surface water samples for inorganic parameters, yielding a field duplicate frequency of 14 percent for this data set. Primary or field duplicate results that were reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating the mean and SD. Field-precision values for surface water are displayed in Table A-7, calculated as means of the duplicate results. Some parameters may have a higher count because of samples collected for testing of a subset of the full suite. The field-precision values for surface water are summarized as follows:

- **Trace Elements:** Trace elements in surface water exhibited an average RSD of 119 percent for their RPDs. Higher variability was observed for barium (152 percent), manganese (173 percent), silicon (176 percent), and sodium (155 percent).
- **Inorganic Parameters:** An average RSD of 148 percent was calculated for the RPDs of inorganic parameters. Alkalinity (215 percent), chloride (225 percent), and specific conductance (266 percent) demonstrated higher variability.
- **Organic Parameters:** Precision could not be calculated for the organic parameters because no target compounds were detected in the field duplicate pairs.

LD analyses were performed on the inorganic parameters, and MSD analyses were performed for the trace elements. The RPD values for the LDs generally exhibit lower variability than the RPD values for field duplicates. A percent RSD of the RPDs was calculated for each element and parameter to assess precision of the RPDs. Precision values for laboratory duplicates of surface water are shown in Table A-8 and are summarized below:

- **Trace Elements:** An average RSD of 165 percent was calculated for trace elements, with five elements contributing to the high overall RSD: manganese, nickel, silver, thallium, and tin.
- **Inorganic Parameters**: The inorganic parameters yielded an average RSD of 127 percent. This value is roughly equivalent to the precision for the field duplicates (147 percent). The thiocyanate RSD (171 percent) is largely due to the few detections found in the samples with values close to the MDL, for which small differences result in large RPDs. Data composing the sulfate RSD (149 percent), though not the largest of the inorganic parameters, demonstrate seasonal trends in concentrations that contributes to the variability. At times of lower sulfate concentrations, variability of apparently similar concentration values becomes more significant on a percentage basis.

Field triplicate samples from the identical sample points designated for field duplicates were collected and submitted to the QA laboratory (CAS). The intent of triplicate sampling is to assess the accuracy of the primary laboratory (SGS). This comparison is accomplished by a quantitative comparison of the data from the primary and QA laboratories through calculation of an RPD of the primary laboratory and QA laboratory sample results for the trace element and inorganic parameter values. These RPDs were plotted on control charts against an average ($\bar{x}$) of the RPD results of primary pairs of field duplicate samples and a UCL based on the RPDs of the field duplicate data [UCL = $\bar{x}$ + (3 * SD)] (Charts A-1 through A-44 in Attachment 1). The data points displayed in these charts reflect QA laboratory results with the RPD from the primary-field triplicate sample pair listed to the right of each point.

These RPD calculations and the related control charts provide another means to assess the precision of the test methods as they are being employed by the laboratories and also the precision of the field sampling procedures. Two variables, field sampling and laboratory techniques, are being evaluated in one effort. A primary-field duplicate sample pair is analyzed by the one primary laboratory. Consideration of the measurement of this pair as precise demonstrates that the field sampling methods used for sampling and the method used for testing can yield precise results and are therefore appropriate. Verification of the precision for a primary-field duplicate sample pair also indicates that the field team and the laboratory are able to obtain precise results by implementing their methods. The methods are more rigorously tested by the addition of a third entity—a second laboratory. Obtaining good precision in the comparison of results between the two laboratories further supports the capacity of the field teams and laboratories to achieve reproducible or precise results by implementing their methods.

Charts are not available for weak acid dissociable (WAD) cyanide (CN), tin, and organic analysis because of a lack of detections in the primary sample, the field triplicate sample, or both.

The control charts exhibit excellent precision, which is demonstrated by more than one-third of the data points being at or below the average RPD. These results, statistically replicated between two laboratories, attest to the accuracy of the methods used for surface water matrices (streams, ponds, and lakes) as employed at the primary laboratory.

Tables A-7 and A-9 provide the mean RPDs of primary-field duplicate and primary-field triplicate sample pairs, respectively. The inorganic parameter results for chloride, fluoride, and total phosphorus show the highest percentage of RPDs for primary-field triplicate sample pairs above the RPD UCLs for the primary-field duplicate sample pairs:

- Chloride exhibited variability—out of 214 primary-field triplicate sample pairs evaluated, RPDs for 11 of those pairs exceeded the UCL.
- Fluoride exhibited variability—out of 69 primary-field triplicate sample pairs evaluated, RPDs for 11of those pairs exceeded the UCL.
- Total phosphorus exhibited variability—out of 119 primary-field triplicate sample pairs evaluated, RPDs for 14 of those pairs exceeded the UCL.

The trace element results for bismuth, boron, cadmium, and vanadium show the highest percentage of RPDs for primary-field triplicate sample pairs above the RPD UCLs for the primary-field duplicate sample pairs. These parameters were seldom detected in the samples, and when detected, were at low concentrations. The combination of a small number of detections at low concentrations results in high statistical variability with little difference in absolute concentrations. Those trace element results are summarized below:

- Boron exhibited the highest variability—out of 59 primary-field triplicate sample pairs evaluated, RPDs for17 of those pairs exceeded the UCL.
- Bismuth exhibited variability—out of five primary-field triplicate sample pairs evaluated, RPDs for one of those pairs exceeded the UCL.
- Cadmium exhibited variability—out of 17 primary-field triplicate sample pairs evaluated, RPDs for two of those pairs exceeded the UCL.
- Vanadium exhibited variability—out of 135 primary-field triplicate sample pairs evaluated, RPDs for 22 of those pairs exceeded the UCL.
- For boron, bismuth, cadmium, and vanadium, the RPDs for more than 10 percent of primary-field triplicate sample pairs evaluated exceeded the UCLs.

For the surface water data set, the precision is acceptable overall. The results for sodium and chloride (Attachment 1, Charts A-41 and A-3, respectively) show high variability from the perspectives of laboratory testing and field sampling during the first 2 years of sample collection (April 2004 to May 2006). Variability also appears to be seasonal. These relationships indicate that both the field collection and laboratory procedures were introducing a measure of inconsistency. Concentrations reported for chloride should be considered estimates, with the maximum uncertainty equal to the RPD goal in the 2005 through 2008 QAPPs (20 percent; Appendix G).

Variability for nickel and selenium during the first 2 years of data collection (Attachment 1, Charts A-36 and A-38, respectively) is pronounced at the laboratory and is elevated for field precision, but not quite as high as that observed at the laboratory. An improvement in precision was observed for nickel in 2007 and 2008. Selenium pairs for 2007 and 2008 were not available for evaluation because of a lack of detections in either the primary or field duplicate samples or both.

Accuracy—Surface Water

Accuracy was calculated from the percent recoveries of LCS QC samples and PE sample analysis. Similar to the precision calculations, LCS results for surface water and groundwater are combined into one calculation scheme for determining the mean and the SD.

The mean LCS recoveries demonstrated excellent recoveries for all trace elements, inorganic parameters, and organic parameters relative to the DQOs given in the QAPPs (2005 through 2008, in Appendix G). Four semivolatile organic compounds each exhibited apparent low mean recoveries (Table A-7); however, with the exception of phenol, the values are within the DQOs, as shown below:

Compound	Mean Recovery (percent)	QAPP DQO (percent)
Benzoic acid	48.8	10-53
N-Nitrosodimethylamine	58.1	25-110
Hexachlorocyclopentadiene	46.3	22-111
Phenol	54.6	15-41

These compounds are historically known in the testing industry as “poor responders,” meaning the extraction efficiency for the approved sample-preparation procedure is low and the sensitivity to the method-prescribed instrumentation also is low.

Assessment of MS and MSD sample accuracy occurred during data validation to determine effects on accuracy from matrix interferences. Individual project-specific samples were flagged to indicate a bias in the analysis of the particular parent sample used to generate the MS/MSD set.

PE samples in an aqueous matrix (water) were included in the analytical scheme during the 2006, 2007, and 2008 data-collection activities. The samples were submitted to the laboratories (blind) by using bottles and chain-of-custody records typical for the project to mask the identity of the PE samples and make them appear to be field samples.

In 2006, ERA prepared PE samples double blind for testing trace elements and inorganic parameters. ERA maintains accreditations for the National Quality Assurance Limited (NQA) USA International Organization for Standardization (ISO) 9001 and the American Association for Laboratory Accreditation (A2LA) Proficiency Testing Providers. The PE samples were purchased as whole samples; therefore, even though they were synthetic samples, they were prepared with water and had the appearance of field samples. The samples were submitted to the primary laboratory (SGS) and the QA laboratory (CAS) by using bottles and chain-of-custody records typical for the project to perpetuate the contrived appearance of real field samples so that any special treatment was precluded.

The 2006 PE surface water results are presented in Table A-5a and summarized below:

- **Trace Elements:** The 2006 PE sample results (SGS) for two elements (cadmium and iron) were just below the certified acceptance limits for the study, and the CAS results contained two elements (beryllium and chromium) that had high results and one (lead) that was low. However, relative to ERA's certified value, all results yielded recoveries that were within the DQOs of 85 to 115 percent in the 2005, 2006, and 2007 QAPPs (Appendix G), with the exception of the iron result for SGS (83 percent).
- **Inorganic Parameters**: The 2006 PE results for several parameters were outside the certified acceptance limits; however, the reported values were close to the certified values, as demonstrated by the calculated percent of certified value, with the following exceptions:
  - SGS reported substantially high results for fluoride (361 percent), sulfate (556 percent), and total phosphorus (278 percent) and did not detect nitrate.
  - CAS reported two parameters with high results relative to the certified value: WAD CN (260 percent) and total phosphorus (290 percent) and did not detect alkalinity or acidity. It is suspected that an incorrect sample container was selected by the laboratory for the alkalinity and acidity testing as the PE samples were prepared to have alkalinity and acidity present.

Data assessment for accuracy demonstrates that the accuracy controls are stable within the laboratory because all LCS results are within the QAPP DQOs. The 2006 PE results for fluoride, sulfate, and total phosphorus exhibit a noticeably high bias. Considering that this apparent bias is from a single analysis, these particular outliers are not a significant cause for concern in terms of usability. Also, these parameters were acceptable in subsequent PE sample submittals, in both 2007 and 2008.

In 2007, RTC prepared and submitted PE samples double blind as follows: primary laboratory for surface water (SGS), primary laboratory for surface water seeps (ACZ), and QA laboratory for surface water and seeps (CAS). RTC maintains accreditations for A2LA Proficiency Testing Providers.

The 2007 PE surface water results are presented in Table A-5b and summarized below:

- **Trace Elements**: The 2007 PE sample results were acceptable at the primary laboratory (SGS) for surface water samples.
  - The 2007 PE sample result for barium submitted to the primary laboratory (ACZ) for surface water seep samples was reported above the acceptance limits for the study at 200 percent relative to RTC's certified value and exceeded the DQOs of 85 to 115 percent in the 2005, 2006, and 2007 QAPPs (Appendix G). Accuracy for surface water seep data is discussed in the subsection "Accuracy—Surface Water Seeps" in Section A.2.3.5.
  - The 2007 PE sample result for silver submitted to the QA laboratory (CAS) was reported below the acceptance limits for the study. However, relative to RTC's certified value, the

result yielded a recovery that was within the DQOs of 85 to 115 percent in the 2005, 2006, and 2007 QAPPs (Appendix G).

- **Inorganic Parameters**: The 2007 PE result for total alkalinity submitted to the primary laboratory (SGS) was reported above the acceptance limits at 348 percent relative to RTC's certified value.

In 2008, RTC prepared and submitted PE samples double blind to the primary laboratory for freshwater (SGS and CAS).

The 2008 PE results are presented in Table A-5c for freshwater and in Table A-6 for ocean water. The 2008 PE results for surface water are summarized below:

- **Water:** The 2008 PE water sample results were acceptable at the primary laboratory (SGS) and QA laboratory (CAS) for surface water samples.
- **Ocean Water:** The 2008 PE ocean water sample results were acceptable, except for one result at CAS. CAS reported total suspended solids (TSS) above the acceptance limit at 170 percent of the certified value.

Representativeness—Surface Water

Sampling techniques and sample-handling protocols (e.g., storage, preservation, and transportation) were developed, and documentation was established to demonstrate that protocols were consistently followed and that sample identification and integrity have been ensured. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. The results were considered during data validation.

QC measures to monitor for systematic background contamination in the field and laboratory environments were water blanks generated in the field by using laboratory water and method blanks generated at the laboratory with each batch of samples prepared and analyzed. Such contamination could have a significant effect on accuracy of the data.

The data are considered acceptable and usable for project purposes. The significance of anomalies noted during data validation, including their overall impact on project data (if any), is briefly summarized in the subsections on completeness, sensitivity, and total and dissolved metals.

Comparability—Surface Water

The comparability objective was met by selecting field sampling and laboratory analytical methods that are comparable throughout the baseline environmental studies. Differences in methods or technologies may preclude data comparisons or generation of viable trending information.

The field sampling methods were evaluated to ensure comparability among sampling teams collecting samples of similar media. The methods were implemented as written for each sampling event, with any deviations necessary to accommodate unexpected field conditions documented in field notes.

The laboratory analytical methods were evaluated to ensure comparability between the primary and QA laboratories. The methods selected were EPA-approved methods from the EPA water and wastewater manual (1983), *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al, 1998), and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996). The analytical methods used for parameters were as follows:

- Trace elements (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Na, Si, Ag, Tl, Sn, V, Zn) by EPA Method 200.8.
- Trace elements (mercury) by EPA Methods 245.1 (in 2004) and 1631 (in 2005, 2006, 2007, and 2008).
- Chloride, fluoride, and sulfate by EPA Method 300.0.
- Nitrate/nitrite by EPA Method 353.2 and SM20 4500NO3-F.
- Acidity by EPA Method 305.2 and SM20 2310B.
- Alkalinity by SM20 2320B.
- Ammonia by SM20 4500NH3-F and SM20 4500NH3-G.
- Cation/anion balance by SM20 1030E.
- Conductivity by SM20 2510B.
- Hardness by SM20 2340B.
- Total phosphorus by EPA Method 365.3 and SM20 4500P-B, E.
- Ortho-phosphorus (May 2006 through December 2006 and January 2007 through April 2007) by EPA Method 365.2.
- pH by EPA Method 150.1 and SM20 4500-H, B.
- Total dissolved solids by SM20 2540C.
- TSS by EPA Method 160.2 and SM20 2540D.
- Thiocyanate by SM20 4500-CN M.
- Total cyanide by SM20 4500-CN C, E and WAD CN by SM20 4500-CN I.
- Volatile organic compounds by SW846 Method 8260B.
- Semivolatile organic compounds by SW846 Method 8270C.
- Pesticides/PCBs by SW846 Methods 8081/8082.

The use of EPA-approved and -published methodologies allows for distinct comparisons of data collected during multiple sampling events. The methods also provide a basis for using a QA laboratory to check the accuracy of the primary laboratory at a set frequency. Multiple methods are listed for some parameters because an EPA Method Update Rule (MUR) issued on April 13, 2007, effectively removed some methods from the EPA-approved list and added others. The laboratory technologies used on each parameter are comparable, as evaluated by each laboratory upon issuance of the EPA MUR and implementation of alternative methods approved and supported by the EPA.

In consideration of the methods and technologies employed in the field and at the laboratories, the data set for the surface water studies is comparable.

Completeness—Surface Water

The completeness goal for surface water quality was 90 percent. For the April 2004 to December 2008 collection of surface water samples, the completeness level was met; completeness was calculated at 97.8 percent, which is based on 3,185 rejected results out of a total of 147,058 results for the surface water studies, not including seeps.

The nitrate/nitrite parameter constitutes 46 unusable results because of analyses occurring beyond the 48-hour holding time. This exceedence of holding times occurred because of a change in holding time pertaining to seep and stream water samples collected between April 2004 and September 2004. During the 2004 field season, the holding time for nitrate and nitrite analysis was set at 28 days. For the 2005 field season, this holding time was changed to 48 hours, and data from all of the previous seasons were reevaluated for the new criterion.

The parameter ortho-phosphorus also did not meet the individual completeness goal based on comparison of results to total phosphorus data. 101 of the 805 data points were rejected based on this evaluation during data validation.

The 2-chloroethyl vinyl ether parameter in 2007 Iliamna Lake surface water constitutes 16 of 72 unusable results. This parameter was mistakenly included in the target analyte list in the QAPP. The acid preservative in the sample container hydrolyzes this analyte, precluding the ability to measure the analyte in samples.

Barium, cobalt, copper, lead, nickel, and zinc constitute the majority of the rejected results at a count of 2,259. The rejected data are due to T vs D pairs that failed to meet validation criteria. This topic is discussed below in the subsection “Total and Dissolved Trace Elements—Surface Water.”

Sensitivity—Surface Water

The laboratory MDLs were compared to the MRL goals in the QAPPs (2005 through 2008, provided in Appendix G) as part of the validation process. Approximately 97 percent of the reported results for the trace elements and inorganic parameters have MDLs that meet the MRL goals for the surface water data set.

Three analytical methods are associated with the majority of the results in which MDLs were higher than the MRL goals:

- EPA Method 365.2 for total phosphorus as implemented by the primary laboratory (SGS) did not meet the MRL goal of 0.01 mg/L in 2004. The laboratory’s MDL was 0.031 mg/L; the MRL was 0.1 mg/L. A new instrument purchased by SGS and a related change to EPA Method 365.3 improved the sensitivity, and the MRL goal was met in 2005, 2006, 2007, and 2008.
- Pesticides were a targeted parameter for a limited number of samples to establish a baseline. The analyses conducted at SGS for select pesticides did not meet the MRL goals for the 2004 and

2005 sampling efforts. Pesticides were not detected in any samples. Table A-10 identifies the affected pesticides with the corresponding QAPP MRL goals.

- The exceedences of the MRL goals for trace elements were in some cases triggered by changes in the laboratory MRLs, as demonstrated by comparison of the MRL goals listed for each year in the surface water data summary table (Table A-10). SGS implemented some refinements in the overall protocol to improve sensitivity entering into the 2006 season. Boron sensitivity improved with a change in method that lowered the MRL, though it was still above the QAPP MRL goal. For beryllium, cadmium, lead, and vanadium, the MDL exceeded the MRL goal for several data points with ND results. The MDLs varied slightly with the method validation updates laboratories are required to perform at least annually. In each instance, they are close to the MRL goal (less than 1 µg/L difference). Overall, for approximately three-quarters of the data points for which MDLs for trace elements exceed the MRL, positive detections in the samples were reported for those trace elements. Hence, sensitivity goals were met for the majority of the data.

Total and Dissolved Trace Elements—Surface Water

The project laboratory made an initial comparison of sample results to ensure that in all instances values for dissolved metals were less than the related values for total metals. Then, situations for which results for dissolved metal were greater than results for total metals were evaluated against criteria presented in Section 4.2 of the 2005 through 2008 QAPPs (Appendix G) and Section A.2.1.7 of this document.

This evaluation was performed at the laboratory before the final deliverables were reported and by Shaw and Argon during data validation. Anomalous results that did not pass the QAPP criteria also were reviewed for the possibility of a systematic problem.

Early on in the project, data completeness calculations lower than the project goal of 90 percent for select metals triggered an investigation into anomalous T vs D metal pairs. The investigation included groundwater and surface water from streams, seeps, Iliamna Lake, and small lakes in the Pebble Project study area and identified contamination influences affecting the field-filtering procedures used to prepare dissolved metal samples. Corrective measures instituted in these procedures, involving a change in the brand of filter used and instituting a new filtering procedure derived from a U.S. Geological Survey (USGS) study, resulted in a reduction of T vs D metal anomalies. A filtering procedure resulted from the USGS study and is documented in the *National Field Manual for the Collection of Water-Quality Data* (USGS, 2004). However, more recent calculations for comprehensive data completeness revealed select metals that were continuing to trend below the project completeness goal, again largely because of failing T vs D metals results. The specific metals were barium, copper, nickel, and zinc.

A follow-up investigation was conducted in 2009, this time reviewing the process flow for reporting, validation, and interpretation, and again comprehensively covering groundwater and surface water from streams, seeps, Iliamna Lake, and small lakes in the Pebble Project study area. The validation criteria for T vs D metals pairs are largely based on the relationship between three values, the sample result, the MDL, and the MRL. MDLs are experimentally determined and represent the minimum concentration of a substance that can be measured and reported with 99 percent confidence that the analyte concentration is greater than zero. An MRL is considered the lowest concentration at which an analyte can be reported with 99 percent confidence in the accuracy of the result. In other words, it provides a concentration level at which quantitation is considered reliable and believed to not be significantly affected by background contamination during sampling or laboratory activities or random events. MRLs are calculated based on a factor, typically 3.18, applied to the MDL for all parameters. Two sources recommending the 3.18 factor are *Analytical Detection Limit Guidance& Laboratory Guide for Determining Method Detection Limits* (Wisconsin Department of Natural Resources, 1996) and “Definition and Procedure for the Determination of the Method Detection Limit,” Appendix B of Title 40, Part 136, of the *Code of Federal Regulations* (EPA, 1986).

Application of this factor to generate MRLs for all parameters assumes each parameter has similar levels of variabilities in its chemistry and background influences related to techniques, equipment, and the environment in which sample collection and testing procedures are conducted. An overall review of the QA/QC analytical program of the Pebble Project, including field quality control samples, specifically field equipment rinse blanks, T vs D metals results, and laboratory QC samples revealed a similarity in inherent analytical variability was not applicable for all metals. Specifically observed were detections just above the MRL in the field blanks and total and dissolved metal results that were within five times of the MRL, falling under T vs D metal Criterion 2 listed in Section A.2.1.7. These findings suggest that the MRLs for select metals are set too low to achieve reliable data—with 99 percent accuracy confidence—because of the variability introduced by background contamination, which was discretely observed (i.e., field blanks and T vs D results) during this comprehensive data investigation. Variability in the laboratory testing of these four metals (barium, copper, nickel, and zinc) at low concentrations is also a possibility, but definitive determination by experimentation of this aspect was not performed as part of the investigation.

Review of the data findings suggested that the MRLs for barium, copper, nickel, and zinc were established too low for achieving reliable data, given the sample collection and testing conditions. Exploration of published studies and documents was the next step in identifying industry-supported guidance that allowed for the possibility of dissimilar variabilities between parameters. The USACE document *Shell for Analytical Chemistry Requirements* (2001) specifies that the MRL “is established at a factor of five to ten times the MDL for the majority of target analytes, but no lower than three times the MDL for any target analyte.” The USACE document further states, “The appropriate factor applied to the MDL to establish the MQL [MRL] is based upon the acceptable amount of error the data user is willing to accept for the data generated.”

The resulting action item was to raise the MRLs for barium, copper, nickel, and zinc to levels 10 times their respective MDLs, as shown below:

Metal	Original MRL (µg/L)	Re-established MRL (µg/L)
Barium	0.05	0.25
Copper	0.1	0.5
Nickel	0.2	0.62
Zinc	1.0	3.1

The elevated MRLs were effective with the October 2009 sampling events for laboratory testing and reporting, data validation, and reporting to the project database.

The trace elements cobalt, copper, lead, nickel, and zinc were represented in more than 10 percent of surface water samples that did not meet the QAPP criteria.

Cobalt was identified as showing a systematic trend during the 2004 sampling season. Data were examined, and it was discovered that the majority of the anomalous cobalt results were in field-filtered sample volumes related to a particular brand of filter cartridge. A controlled experiment of the filter and tubing used in the field confirmed cobalt as a contaminant that was leaching from the filter. This brand of filter was removed from the process and replaced at the start of the 2005 sampling season by a brand of filter that did not exhibit contamination problems used by another sampling team. The change successfully terminated the trend of cobalt anomalies. Cobalt was not included in the MRL re-evaluation because the rejected data points, though large in number, are associated with an errant filter early on during field work.

Lead, nickel, and zinc exhibited repeated failures in the T vs D comparison during most of the 2005 sampling season and during the 2006 season up to May. Although the filters are believed to be the root of the problem, a protocol was devised and implemented in June 2006 to isolate the overall filtering procedure from other possible influences such as airborne contamination. The filtering process is conducted in a box constructed of polyvinyl chloride (PVC) and lined with plastic sheeting. All samples are filtered in this enclosure following a clean hands/dirty hands technique fashioned after USGS procedures for filtering. Another change was to replace the metal scissors dedicated for cutting tubing for the filtering process. Areas of pitting, scratches, and rust were noted on the scissors, and possibly were sources of contamination of the samples for these metals. These changes disrupted the trend of lead, nickel, and zinc anomalies for the remainder of the 2006, 2007, and 2008 data-collection activities.

Lead was also not included in the MRL re-evaluation because the rejected data points are sporadic. No consistent trend of rejected data has been observed for copper, nickel, and zinc. Barium was included in the re-evaluation because of a consistent trend of rejected data during 2007 and 2008. The cause of the barium contamination is uncertain, but is suspected to be related, in part, to the proximity of the original MRL to the MDL for this metal.

The corrective actions implemented for the subject metals were applied for all water studies involving total and dissolved metals testing.

Cation/Anion Balance—Surface Water

A comparison of the two cation and anion sums was performed according to the criteria established in *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998), SM 1030E (summarized in Section A.2.1.8). This evaluation was performed at the laboratory before final deliverables were reported and by Shaw during data validation. The cation/anion balances for more than 99 percent of the sample collection points met the criteria.

A.2.2.2 Groundwater

Groundwater samples in the mine study area were collected by CH2M Hill in 2004 and by SLR Alaska (SLR) in 2005, 2006, 2007, and 2008. Samples in the transportation corridor were collected by BEESC in 2004 and 2005. No groundwater samples were collected from the transportation corridor in 2006, 2007, and 2008.

Precision—Groundwater

LCS analysis provides information only on analytical variability or laboratory precision without influence from a field sample matrix. The laboratory uses in-house purified water for the LCS. Surface water and groundwater samples can be batched together under a single LCS. A single set of calculations of the mean and SD of LCS data points represents both matrices. Laboratory accuracy and precision are displayed in Table A-11. The subsection “Precision—Surface Water” in Section A.2.2.1 discusses laboratory precision covering both matrices.

One hundred forty pairs of primary-field duplicate pairs of groundwater samples were evaluated for trace elements out of a total of 782 primary groundwater samples. This sample evaluation yielded a frequency of 17.9 percent for field duplicates for trace elements in this data set. Seventy pairs of primary-field duplicate pairs of groundwater samples were evaluated for inorganic parameters, with a total of 396 primary groundwater samples. This sample evaluation yielded a frequency of 17.7 percent for field duplicates for inorganic parameters in this data set.

Primary results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating the mean and SD. Groundwater field precision is displayed in Table A-11 and results are summarized below:

- **Trace Elements**: barium (169 percent), boron (142 percent), manganese (150 percent), molybdenum (205 percent), nickel (142 percent), potassium (177 percent), and thallium (142 percent) exhibited increased variability, as indicated by their high RSD values; however, the average RSD for trace elements as a group was 118 percent.
- **Inorganic Parameters**: an average RSD of 144 percent was calculated for the inorganic parameters. The highest amounts of variability were observed for alkalinity (162 percent), chloride (193 percent), specific conductance (336 percent), and sulfate (213 percent).

Additionally, LD analyses were performed on the inorganic parameters, and MSD analyses were performed for the trace elements and organic parameters. The RPD values for the LDs generally exhibit lower variability relative to the RPD values for field duplicates. A percent RSD of the RPDs was calculated for each element and parameter to assess precision of the RPDs. Table A-12 summarizes groundwater precision from laboratory duplicates. Bismuth, cadmium, selenium, silver, and thallium were seldom detected in the samples, and when detected, were at low concentrations. The combination of a small number of detections at low concentrations resulted in high statistical variability with little difference in absolute concentrations. The results are summarized below:

- **Trace Elements**: An average RSD of 135 percent was calculated for trace elements, with the following elements contributing to the higher overall RSD: nickel (347 percent), silicon (243 percent), silver (252 percent), and thallium (232 percent).

- **Inorganic Parameters**: The inorganic parameters yielded an average RSD of 128 percent. For the laboratory duplicates, alkalinity (163 percent), chloride (168 percent), total phosphorus (161 percent), and total dissolved solids (192 percent) demonstrate a higher variability than the other parameters.

Field triplicate samples from the same sample points designated for field duplicates were collected and submitted to the QA laboratory (CAS). The intent of the triplicate sampling was to assess the accuracy of the primary laboratory (SGS). This comparison is accomplished by a quantitative comparison of the data from the primary and QA laboratories through calculation of an RPD of the primary laboratory and QA laboratory sample results for the values for trace elements and inorganic parameters. These RPDs were plotted on control charts against an average ($\bar{x}$) of the RPD results of primary-field duplicate sample pairs and a UCL based on the RPDs of the field duplicate data [UCL = $\bar{x}$ + (3 * SD)] (Charts A-80 through A-118 in Attachment 1). The data points displayed in these charts reflect QA laboratory results with the RPD from the primary-field triplicate sample pairs listed just to the right of each point.

These RPD calculations and the related control charts are another means, to assess the precision of the test methods as they are being employed by the laboratories and also the precision of the field sampling procedures. Two variables, field sampling and laboratory techniques, are being evaluated in one effort. A primary-field duplicate sample pair is analyzed by the one primary laboratory. Consideration of the measurement of this pair as precise demonstrates that the field sampling methods used for sampling and the method used for testing can yield precise results and are therefore appropriate. Verification of the precision for a primary-field duplicate sample pair also indicates that the field team and the laboratory are able to obtain precise results by implementing their methods. The methods are more rigorously tested by the addition of a third entity—a second laboratory. Obtaining good precision in the comparison of results between the two laboratories further supports the capacity of the field teams and laboratories to achieve reproducible or precise results by implementing their methods.

Charts are not available for three inorganic parameters—total cyanide, WAD CN, and nitrogen as ammonia—and for the trace elements bismuth and mercury because of a lack of detections in the primary sample, the triplicate sample, or both.

The control charts exhibit excellent precision, which is demonstrated by more than one-third of the data points being at or below the average RPD. These results, statistically replicated between two laboratories, attest to the accuracy of the methods used for groundwater matrices as employed at the primary laboratory.

The inorganic parameter results for total alkalinity, chloride, sulfate and thiocyanate show the highest percentage of RPDs for primary-field triplicate sample pairs above the RPD UCLs for the primary-field duplicate sample pairs. The control limits for total alkalinity, chloride, and sulfate are close to the project DQOs, and the exceedences are not significantly higher than the control limits. The variability exhibited by the high RPD for thiocyanate is largely due to the few detections found in the samples with values close to the MDL, for which small differences result in large RPDs. The results are summarized below:

- Total alkalinity exhibited variability—out of 68 primary-field triplicate sample pairs evaluated, RPDs for seven of those pairs exceeded the UCL.

- Chloride exhibited variability—out of 70 primary-field triplicate sample pairs evaluated, RPDs for seven of those pairs exceeded the UCL.
- Sulfate exhibited variability—out of 70 primary-field triplicate sample pairs evaluated, RPDs for nine of those pairs exceeded the UCL.
- Thiocyanate exhibited variability—out of four primary-field triplicate sample pairs evaluated, RPDs for two of those pairs exceeded the UCL.
- Thiocyanate exhibited the highest percentage (greater than 15 percent) of RPDs for primary-field triplicate sample pairs that exceeded the UCLs, largely because of the lack of detections in water samples at the site, resulting in a small data set for charting.

The trace element results for boron, iron, silver, and tin show the highest percentage of RPDs for primary-field triplicate sample pairs above the RPD UCLs for the primary-field duplicate sample pairs:

- Boron exhibited variability—out of 38 primary-field triplicate sample pairs evaluated, RPDs for nine of those pairs exceeded the UCL.
- Iron exhibited variability—out of 66 primary-field triplicate sample pairs evaluated, RPDs for 17 of those pairs exceeded the UCL.
- Silver exhibited variability—out of seven primary-field triplicate sample pairs evaluated, RPDs for two of those pairs exceeded the UCL.
- Tin exhibited variability—out of five primary-field triplicate sample pairs evaluated, two of those pairs exceeded the UCL.

Silver and tin exhibited the highest percentage of RPDs for primary-field triplicate sample pairs above the RPD UCLs because of the limited number of pairs available for evaluation. Also, values for the detections in the available pairs were close to the MRL, a concentration level at which slight changes can affect statistical calculations assessing variability. Another factor appears to be a higher reporting limit for the QA laboratory for boron, iron, and tin. The factor difference of reporting limits between the two laboratories is not large, however, given that the low concentrations for these parameters in most monitoring well samples resulted in significant differences in this statistical evaluation.

More than 80 percent of the primary-to-triplicate sample RPDs for beryllium, boron, cadmium, and silver are above the average for the primary-to-field duplicate RPDs. The distribution of the primary laboratory results that are less than or greater than field triplicate results is almost as varied as the RPDs. Also, the results from each laboratory are close to their respective MRLs. This fact along with the distribution observations suggests that the differences for these four parameters are related to the low-concentration sample detections and related random statistical variation.

Aluminum, selenium, and thallium results show notable variability based on field duplicate results, with RPDs above 150 percent. The precision of the field triplicates for these trace elements is much better with the exception of one thallium RPD (119 percent) from the May 2005 event. Although not as dramatic, this inconsistency is also apparent with beryllium, tin, and silver; however, the number of primary-field triplicate sample pairs for these three elements is limited; therefore, the amount of data may not be sufficient to indicate a trend.

The field triplicate data, which is derived from a third volume for a given location, and therefore having better precision, can be used to support a conclusion that some inconsistency in sampling may be occurring. However, because all other trace element RPDs for primary-field triplicate sample pairs show a good distribution around the average RPD of the RPDs for primary-field duplicate sample pairs, the data overall suggest consistency in sampling techniques.

Accuracy—Groundwater

Accuracy was calculated from the percent recovery for analysis of LCS QC samples and PE samples. Similar to the precision calculations, LCS results for surface water and groundwater are combined into one calculation scheme for determining the mean and SD. See the subsection “Accuracy—Surface Water” in Section A.2.2.1 for further discussions on accuracy and PE results covering both matrices. Table A-11 summarizes groundwater accuracy and precision.

Representativeness—Groundwater

Sampling techniques and sample-handling protocols (e.g., storage, preservation, and transportation) were developed, and documentation was established to demonstrate that protocols were consistently followed and that sample identification and integrity have been ensured. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. The results were considered during data validation.

QC measures to monitor for systematic background contamination in the field and laboratory environments were water blanks generated in the field using laboratory water and method blanks generated at the laboratory with each batch of samples prepared and analyzed. Such contamination could have a significant impact on accuracy of the data.

Data are considered representative. The significance of anomalies noted during data validation, including their overall impact on project data (if any), is summarized in the following subsections on completeness, sensitivity, and total and dissolved metals.

Comparability—Groundwater

This objective was met by selecting field sampling methods and laboratory analytical methods that are comparable throughout the baseline environmental studies. Differences in methods or technologies may preclude making data comparisons or generating viable trending information.

Field sampling methods were evaluated (Table A-13) to ensure comparability among sampling teams collecting samples of similar media. The methods were implemented as written for each sampling event, with any deviations necessary to accommodate unexpected field conditions documented in field notes.

The laboratory analytical methods were evaluated to ensure comparability between the primary and QA laboratories. The methods selected were EPA-approved methods from the EPA water and wastewater manual (1983), *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al, 1998), and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996). The analytical methods used for parameters were as follows:

- Trace elements (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Na, Si, Ag, Tl, Sn, V, Zn) by EPA Method 200.8.
- Trace elements (mercury) by EPA Methods 245.1 (in 2004) and 1631 (in 2005, 2006, 2007, and 2008).
- Chloride, fluoride, and sulfate by EPA Method 300.0.
- Nitrate/nitrite by EPA Method 353.2 and SM20 4500NO3-F.
- Acidity by EPA Method 305.2 and SM20 2310B.
- Alkalinity by SM20 2320B.
- Ammonia by SM20 4500NH3-F and SM20 4500NH3-G.
- Cation/anion balance SM20 1030E.
- Conductivity by SM20 2510B.
- Hardness by SM20 2340B.
- Total phosphorus by EPA Method 365.3 and SM20 4500P-B, E.
- Ortho-phosphorus (in May 2006 through December 2006 and January 2007 through April 2007) by EPA Method 365.2.
- pH by EPA Method 150.1 and SM20 4500-H, B.
- Total dissolved solids by SM20 2540C.
- TSS by EPA Method 160.2 and SM20 2540D.
- Thiocyanate by SM20 4500-CN M.
- Total cyanide by SM20 4500-CN C, E and WAD CN by SM20 4500-CN I.

The use of EPA-approved and -published methodologies allows for distinct comparisons of data collected during multiple sampling events. The methods also provide a basis for using a QA laboratory to check the accuracy of the primary laboratory at a set frequency. Multiple methods are listed for some parameters because an EPA MUR issued on April 13, 2007, effectively removed some methods from the EPA-approved list and added others. The laboratory technologies used on each parameter are comparable, as evaluated by each laboratory upon issuance of the EPA MUR.

In consideration of the methods and technologies employed in the field and at the laboratories, the data set for the groundwater study is comparable.

Completeness—Groundwater

The completeness goal for the groundwater study was 90 percent. The actual completeness level for sample collection from April 2004 to December 2008 was greater than 99.1 percent, calculated from 366 rejected data points out of a total of 40,801.

One result for one parameter (nitrate/nitrite) required an unusable qualification (R flag) because of a holding-time exceedence. The parameter ortho-phosphorus also did not meet the individual completeness goal based on comparison of results to total phosphorus data; 37 of the 1,000 data points were rejected.

Most other rejected data points are due to T vs D metals anomalies that did not pass data validation criteria, principally, lead, molybdenum, nickel, and zinc. The number of rejected points for the groundwater study is much smaller than for the surface water studies. However, these metals were included in an overall investigation of T vs D anomalies, which is discussed below in the subsection "Total and Dissolved Trace Elements—Groundwater."

Sensitivity—Groundwater

Laboratory MDLs were compared to the MRL goals set forth in the QAPPs (2005 through 2008, in Appendix G) as part of the validation process. Approximately 93 percent of the reported results have MDLs that are less than or equal to the MRL goals for the groundwater data set.

Two analytical methods are associated with the majority of the results for which MDLs are higher than the MRL goals. These results are discussed below:

- EPA Method 365.2 for total phosphorus as implemented by the primary laboratory (SGS) did not meet the MRL goal of 0.01 mg/L in 2004. The laboratory MDL was 0.031 mg/L; the MRL was 0.1 mg/L. A new instrument purchased by SGS and a related change to EPA Method 365.3 improved the sensitivity and subsequently the MRL goal was met for 2005, 2006, 2007, and 2008. Phosphorus results make up a minority of the MRL exceedences.
- The exceedences of the MRL goals identified for trace elements by EPA Method 200.8 were in some cases triggered by changes in the laboratory MRLs, as demonstrated by comparison of the MRL goals listed for each year in the groundwater data summary in Table A-14. SGS implemented some refinements in the overall protocol to improve sensitivity at the beginning of the 2006 season. The trace element results are summarized below:
    - Boron analysis in 2006 improved following a change in method that lowered the MRL, though it was still above the QAPP MRL goal. Boron analysis in 2007 and 2008 exhibited MDLs that were below the revised MRL goal of 0.005 mg/L set forth in the 2007 and 2008 QAPPs (Appendix G).
    - Beryllium, cadmium, lead, and vanadium in 2005 and 2006 each had several data points with ND results for which the MDL exceeded the MRL goal. The MDLs varied slightly with the method validation updates laboratories are required to perform at least annually. In each instance, the MDLs are close in value to the MRL goal (less than 1 μg/L difference). Beryllium, cadmium, lead, and vanadium analysis in 2007 and 2008 exhibited MDLs that were below the revised MRL goals set forth in the 2007 and 2008 QAPPs (Appendix G).

Overall, approximately three-quarters of the data points at which MDLs for trace elements exceed the MRL had positive detections in the samples for those trace elements. Consequently, the incidence of MRL exceedences does not translate into a substantial effect on sensitivity for the Pebble Project.

Total and Dissolved Trace Elements—Groundwater

An initial comparison of sample results for the Pebble Project was made at the project laboratory to ensure that the values for dissolved metals were less than the related values for total metals. Then situations for which results for dissolved metals were greater than results for total metals were evaluated against criteria presented in Section 4.2 of the project QAPPs (2004 through 2008, in Appendix G) and in Section A.2.1.7 of this appendix.

This evaluation was performed at the laboratory before the final deliverables were reported and by Shaw and Argon during data validation. Data points for the groundwater study are far fewer than those for the surface water studies; however, trace elements lead, molybdenum, nickel, and zinc account for the majority of the anomalous comparisons that do not meet QAPP criteria.

When associated laboratory method blank and field equipment rinsate contamination contributions were removed from an evaluation of results, the trace elements lead, molybdenum, and nickel exhibited the majority of results that did not meet the QAPP criteria.

The effect of the closed-system filtering process for groundwater study has resulted in far fewer numbers of rejected data for the groundwater study than for the surface water studies. The number of rejected points in the groundwater study does not in and of itself warrant corrective action; however, because of the frequency of rejected data observed in the surface water studies (see the subsection “Total and Dissolved Trace Elements—Surface Water”), action has been taken to address lead, nickel, and zinc. The corrective actions implemented for the subject metals were implemented for all water studies.

Molybdenum is not included in the aforementioned corrective action plan because the rejected data points have occurred sporadically, unlike the clear trends observed with lead, nickel, and zinc.

Cation/Anion Balance—Groundwater

The values for cations and anions were compared under the criteria established in *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998), SM 1030E, as summarized in Section A.2.1.8. This evaluation was performed at the laboratory before the final deliverables were reported and by Shaw during data validation. The cation/anion balances for greater than 99 percent of the sample collection points met the criteria.

A.2.3 TRACE ELEMENTS

Trace element studies included the collection and analysis of samples of sediment, vegetation, soil, fish tissues (muscle and liver), bivalve (mussel) tissues, and surface water seeps. These baseline data will provide defensible documentation of the natural levels and of spatial and temporal variability of trace elements and anions in the varying matrices.

The usability of the trace elements data was assessed by data validation, and data qualifier codes (flags) were appended to the data, as appropriate. Key data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity were assessed against DQOs defined in the project QAPP to evaluate the precision and accuracy for the trace element studies.

A.2.3.1 Sediment

Samples of stream, pond, and lake sediment were collected during 2004, 2005, 2006, and 2007 for the trace elements studies. Samples were collected by the following consultants in accordance with their respective FSPs:

- CH2M Hill during 2004 (July, August, September) in the mine study area.
- HDR during 2004 (June), 2005 (June, July, August, September, October), 2006 (June, July, August), and 2007 (June, August) in the mine study area and Iliamna Lake.
- BEESC during 2004 (July, August, September), 2005 (May, July, September), 2006 (August), and 2007 (September) in the transportation corridor.

Sediment samples were analyzed for trace elements and the following inorganic parameters: chloride, fluoride, sulfate, total cyanide, and nitrogen as ammonia. The organic parameters of gasoline-range organics (GRO), diesel-range organics (DRO), and residual-range organics (RRO) were analyzed in Iliamna Lake sediments during the 2005 data-collection activities.

SGS was designated the primary laboratory for sediment analysis in 2004, 2005 and 2006. ACZ was designated the primary laboratory for sediment analysis in 2007. This change in laboratory assignments was made to address a concern that a significant increase in sample load anticipated for 2007 may have exceeded the apparent available capacity at SGS. Available capacity at another laboratory was used to help ensure that regulatory sample holding times, the times within which analyses must occur relative to the sample collection times, were met for all testing.

Precision—Sediment

LCS analysis provides information on analytical variability or laboratory precision without effect from the sample matrix. SGS used a solid standard reference material (SRM) as the LCS matrix for both soil and sediment. Consequently, LCS results for sediment and soil samples were calculated together to ascertain the mean percent recovery and RSD for determining the analytical variability or precision. Sediment and soil sampling results, including individual RSD results for LCSs, are presented in Table A-15 and summarized below:

- **Trace Elements:** Sediment and soil LCSs exhibited good precision as indicated by RSDs of less than 15 percent, with the exceptions of antimony at 22 percent, bismuth at 44 percent, and silver at 18 percent.
- **Inorganic Parameters:** Sediment and soil LCSs exhibited excellent precision, as indicated by LCS RSDs of less than 15 percent.
- **Petroleum Hydrocarbon Compounds:** Sediment and soil samples exhibited excellent precision for GRO, DRO, and RRO, as indicated by RSDs of 6 percent, 9 percent, and 10 percent, respectively.

Forty-one primary-field duplicate sample pairs of sediment were evaluated. Three hundred twenty-one primary sediment samples were collected, giving a field duplicate frequency of 12 percent for this data set. Results that were reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating the mean and SD. Field precision values for sediment are displayed in Table A-15 and summarized below:

- **Trace Elements**: Results for trace elements in sediment exhibited an average RSD of 97 percent. A higher variability in measurement was observed for potassium (122 percent) and silver (136 percent).

- **Inorganic Parameters**: Results for inorganic parameters in sediment exhibited an average RSD of 92 percent. LD analysis also was performed on the inorganic parameters and is summarized in Table A-16.

Results for field triplicates were compared to results for primary samples and field duplicates. Field triplicate results that were reported as ND and flagged "U" during data validation (from associated blank contamination) were removed from the population when calculating an RPD between results for primary samples and field triplicate samples. Control charts for the sediment sample parameters for trace elements are presented in Charts A-119 through A-149 in Attachment 1.

These RPD calculations and the related control charts are another means, a more rigorous means, to assess the precision of the test methods as they are being employed by the laboratories and also the precision of the field sampling procedures. Two variables, field sampling and laboratory techniques, are being evaluated in one effort. A primary-field duplicate sample pair is analyzed by the one primary laboratory. Consideration of the measurement of this pair as precise demonstrates that the field sampling methods used for sampling and the method used for testing can yield precise results and are therefore appropriate. Verification of the precision for a primary-field duplicate sample pair also indicates that the field team and the laboratory are able to obtain precise results by implementing their methods. The methods are more rigorously tested by the addition of a third entity—a second laboratory. Obtaining good precision in the comparison of results between the two laboratories further supports the capacity of the field teams and laboratories to achieve reproducible or precise results by implementing their methods.

Parameters for which at least 20 percent of the RPDs for field triplicate samples exceeded the UCLs are summarized below. Boron and cadmium RPD control limits are high due to the combination of a small number of detections at low concentrations resulting in high statistical variability with little difference in absolute concentrations. Exceedences of the UCLs are described below:

- **Trace Elements:**
  - Boron in three of eight sediment samples evaluated exceeded the UCL established at 86 percent RPD.
  - Cadmium in seven of 22 sediment samples evaluated exceeded the UCL established at 87 percent RPD.
- **Inorganic Parameters:**
  - Chloride in six of 11 sediment samples evaluated exceeded the UCL established at 108 percent RPD.
  - Sulfate in 11 of 32 sediment samples evaluated exceeded the UCL established at 121 percent RPD.
  - Nitrogen as ammonia in 25 of 26 sediment samples evaluated exceeded the UCL established at 118 percent RPD.

For the sediment data set, the precision is largely within the acceptance criteria established in the 2005 through 2007 QAPPs (Appendix G). A relatively high variability in measurement was observed and noted for the trace elements manganese, molybdenum, potassium, and silver. The increased variability is not considered a data quality problem because it may be due to a random distribution of RPDs or to matrix heterogeneity.

Accuracy—Sediment

Accuracy was calculated from the percent recovery of laboratory-spiked parameters in analysis of LCSs and MS, MSD, and PE samples.

LCS results for sediment samples and soil samples were calculated together to ascertain the mean percent recovery. These data were combined because the laboratory uses a solid SRM as the LCS matrix for both soil and sediment samples. LCS results (Table A-15) exhibited excellent accuracy for trace elements, inorganics, and petroleum hydrocarbon compounds, as indicated by the mean percent recoveries that were within DQO accuracy goals for each parameter.

The accuracy of MS and MSD samples was assessed during data validation to ascertain any effects on accuracy from matrix interference. Individual project-specific sample results were flagged to indicate a bias in analysis, if applicable. MS results (2004, 2005, 2006, and 2007) for fluoride in sediment and soil samples exhibited low-biased recovery in analysis by EPA Method 300.0. Overall, the sediment and soil results of the primary laboratory (SGS) for fluoride are considered biased low.

PE samples in a solid matrix (soil) were included in the analytical scheme during the 2006 and 2007 data-collection activities. The applicability of PE sample results to a soil/sediment matrix are discussed in the subsection “Accuracy—Soil” in Section A.2.3.3.

Accuracy for sediment analysis is excellent and acceptable, as demonstrated by the matrix-specific LCS recoveries from SRM, blind PE sample recoveries within referenced control limits, and MS/MSD recoveries within the DQO accuracy goals established in the QAPP.

Representativeness—Sediment

Sampling techniques and sample-handling protocols (e.g., storage, preservation, and transportation) were developed, and documentation was established to demonstrate that protocols were followed and sample identification and integrity were ensured. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data as applicable.

Data are considered representative. Anomalies noted during data validation and issues related to sensitivity goals as noted in the subsection “Sensitivity—Sediment” in Section A.2.3.1 were insignificant in the overall effect on project data.

Comparability—Sediment

The DQO of comparability was met by selecting methods for field sampling and laboratory analysis that were comparable throughout the trace element studies. Field sampling methods were evaluated (Table A-17) throughout the trace element studies during QA field audits to ensure comparability among sampling teams collecting samples of similar media. The methods were implemented as written for each sampling event, with any deviations necessary to accommodate unexpected field conditions being documented in field notes.

The laboratory analytical methods were evaluated to ensure comparability between the primary (SGS and ACZ) and QA (CAS) laboratories. Analysis of sediment samples was conducted by using EPA-approved methods from the EPA water and wastewater manual (1983); *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al, 1998); *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods,* Publication SW846 (EPA, 1996); and petroleum hydrocarbon methods of the Alaska Department of Environmental Conservation (ADEC) from Title 18, Chapter 75, of the *Alaska Administrative Code* (AAC). The analytical methods used for parameters were as follows:

- Trace elements (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, K, Se, Ag, Na, Tl, Sn, V and Zn) by EPA Methods 6010B and 6020.
- Trace elements (mercury) by EPA Method 7471A.
- Cyanide (total) by SM 4500CN-E.
- Chloride, fluoride, and sulfate by EPA Method 300.0.
- Ammonia as nitrogen by SM 4500NH3.
- Total organic carbon by EPA Method 415.1.
- GRO by ADEC Method AK101.
- DRO by ADEC Method AK102.
- RRO by ADEC Method AK103.

The use of EPA-approved and -published methodologies allows for distinct comparisons of data collected during multiple sampling events. Laboratory methods have not changed during the study period (2004 through 2007). The use of consistent laboratory methods has resulted in comparable data between the primary and QA laboratories during the course of the study.

In consideration of the methods and technologies employed in the field and at the laboratories, the data set for the freshwater sediment study is comparable.

Completeness—Sediment

The completeness goal for sediment samples in the trace elements study was established in the 2005, 2006, and 2007 QAPPs (Appendix G) at 90 percent. Completeness was calculated from the amount of data determined to be valid after data validation in comparison to the total amount of data acquired. Rejected data were considered not valid.

Sediment samples collected during 2004 through 2005 met the completeness goal for all parameters analyzed. Completeness was 100 percent for all parameters, with the exception of fluoride and gasoline range organics (GRO). Two fluoride sediment samples (2004) in a total population of 306 fluoride sediment samples and one GRO in a total population of seven GRO sediment samples were rejected because of laboratory QC outliers that invalidated the usability of the results.

Sensitivity—Sediment

Sample results reported as ND to the MDL were compared to the DQO MRL goal specified in the QAPPs (2005, 2006, and 2007, in Appendix G). A summary of sensitivity for sediment is presented in Table A-18.

Antimony, bismuth, boron, cadmium, mercury, molybdenum, selenium, silver and thallium were reported as ND for at least 10 percent of the sediment data set. At least 50 percent of bismuth, cadmium, molybdenum, and silver samples reported as ND also reported an MDL value that was greater than the MRL DQO for sensitivity.

MRL DQOs for sensitivity in the QAPPs were established at values considerably lower than the benchmark criteria given in the National Oceanic and Atmospheric Administration (NOAA) and ADEC documents referenced in the QAPP table. There is no significant effect on data quality or usability from the referenced parameters not meeting the MRL DQO for sensitivity.

A.2.3.2 Vegetation

Vegetation samples for the trace elements studies were collected during 2004, 2005, 2006, and 2007. Samples were collected by consultants, in accordance with their respective FSPs, as follows:

- CH2M Hill during August and September 2004 in the mine study area.
- SLR during July and August 2005, July and August 2006, and July and August 2007 in the mine study area.
- BEESC during August and September 2004, August 2006, and September 2007 in the transportation corridor.

Vegetation samples were analyzed for trace elements and the inorganic parameter total cyanide. The inorganic parameters of chloride, fluoride, sulfate, and nitrogen as ammonia were also analyzed in 2004.

Precision—Vegetation

CAS was designated the primary laboratory for vegetation analysis. LCS analysis provides information on the analytical variability or laboratory precision without any effect from sample matrices. CAS used an SRM (peach or apple leaves) certified for use as a vegetation matrix for inorganic parameters and used laboratory grade water for trace elements.

Individual RSD results for LCSs are presented in Table A-19 and summarized below:

- **Trace Elements:** Vegetation LCSs exhibited excellent precision as indicated by RSD values of less than 12 percent.
- **Inorganic Parameters:** RSDs for vegetation LCSs were less than or equal to 10 percent, with the exception of chloride at 45 percent RSD for analysis associated with samples collected during 2004.

One hundred fifteen field duplicate sample pairs of vegetation were evaluated for trace elements and total cyanide. One thousand forty-eight primary vegetation samples were collected, giving a field duplicate frequency of 11 percent for this data set.

Twenty-three primary-field duplicate sample pairs of vegetation were evaluated for the inorganic parameters chloride, fluoride, sulfate, and nitrogen as ammonia. With a total of 250 primary vegetation samples collected for these inorganic parameters in 2004, the field duplicate frequency is 9.2 percent for this data set.

Results reported as ND and flagged "U" during data validation (from associated blank contamination) were removed from the population when calculating mean and SD. Field precision for vegetation is displayed in Table A-19 and summarized below:

- **Trace Elements:** Results for trace elements in vegetation exhibited an average RSD of 118 percent. Higher variability in measurement was observed for potassium (205 percent RSD).
- **Inorganic Parameters:** Results for inorganic parameters in vegetation exhibited an average RSD of 99 percent.

LD analysis also was performed for the inorganic parameters and trace elements. Results are summarized in Table A-20. Trace elements in LD vegetation samples exhibited an average RSD of 117 percent, which is the RSD obtained from primary-field duplicate sample pairs. Inorganic parameters in LD vegetation samples exhibited an average RSD of 109 percent and were comparable with the RSD obtained from primary-field duplicate sample pairs.

Results for field triplicate (QA) samples were compared to results for primary samples and field duplicates. Field triplicate sample results reported as ND and flagged "U" during data validation (from associated blank contamination) were removed from the population when calculating an RPD in the results for primary and field triplicate samples. Control charts for trace elements parameters for vegetation samples are presented in the Charts A-150 through A-179 in Attachment 1.

These RPD calculations and the related control charts are another means to assess the precision of the test methods as they are being employed by the laboratories and also the precision of the field sampling procedures. Two variables, field sampling and laboratory techniques, are being evaluated in one effort. A primary-field duplicate sample pair is analyzed by the one primary laboratory. Consideration of the measurement of this pair as precise demonstrates that the field sampling methods used for sampling and the method used for testing can yield precise results and are therefore appropriate. Verification of the precision for a primary-field duplicate sample pair also indicates that the field team and the laboratory are able to obtain precise results by implementing their methods. The methods are more rigorously tested by the addition of a third entity—a second laboratory. Obtaining good precision in the comparison of results between the two laboratories further supports the capacity of the field teams and laboratories to achieve reproducible or precise results by implementing their methods.

Parameters for which at least 20 percent of the field triplicate sample RPDs exceeded the UCL, as exhibited in their respective control charts, are summarized below:

- **Trace Elements:**

  - Antimony in two of two vegetation field triplicate samples evaluated exceeded the UCL established at 126 percent RPD.
  - Bismuth in one of one vegetation field triplicate sample evaluated exceeded the UCL established at 145 percent RPD.
  - Boron in one of three vegetation field triplicate samples evaluated exceeded the UCL established at 43 percent RPD.
  - Chromium in nine of 14 vegetation field triplicate samples evaluated exceeded the UCL established at 88 percent RPD.
  - Lead in nine of 37 vegetation field triplicate samples evaluated exceeded the UCL established at 109 percent RPD.
  - Mercury in four of 16 vegetation field triplicate samples evaluated exceeded the UCL established at 75 percent RPD.
  - Nickel in 17 of 64 vegetation field triplicate samples evaluated exceeded the UCL established at 129 percent RPD.
  - Silver in three of 12 vegetation field triplicate samples evaluated exceeded the UCL established at 120 percent RPD.
  - Sodium in 19 of 63 vegetation field triplicate samples evaluated exceeded the UCL established at 56 percent RPD.
  - Thallium in six of 22 vegetation field triplicate samples evaluated exceeded the UCL established at 89 percent RPD.
  - Tin in one of two vegetation field triplicate samples evaluated exceeded the UCL established at 67 percent RPD.
  - Vanadium in 13 of 41 vegetation field triplicate samples evaluated exceeded the UCL established at 97 percent RPD.

- **Inorganic Parameters:**
  - Fluoride in 22 of 23 vegetation field triplicate samples (2004) evaluated exceeded the UCL established at 150 percent RPD.
  - Nitrogen as ammonia in 14 of 21 vegetation field triplicate samples (2004) evaluated exceeded the UCL established at 102 percent RPD.

For the vegetation data set, the precision is considered acceptable. For antimony, bismuth, boron, chromium, mercury, silver, tin, and vanadium, variability demonstrated by the high control limits and varied distribution of the plotted points of the primary-QA laboratory RPD is largely due to very few detections in the samples and low concentrations when the parameters were detected. The combination of a small number of detections at low concentrations resulted in high statistical variability with little difference in absolute concentrations. The lead, nickel, sodium, and thallium charts exhibit similarly high variability, but also represent significantly more sample detections relative to other parameters.

Accuracy—Vegetation

Accuracy was calculated from the percent recoveries of laboratory-spiked parameters in analysis of LCSs and the MS and MSD samples. CAS used a vegetation SRM as the LCS matrix for inorganic parameters and used laboratory-grade water for the trace elements.

Accuracy for vegetation tissue LCSs is displayed in Table A-19. LCS results exhibit excellent accuracy for all parameters, as indicated by mean percent recoveries that were within DQOs for accuracy.

The accuracy from MS and MSD samples was assessed during data validation to ascertain any effects from sample-matrix interference. Individual project samples subsequently were flagged to indicate bias in analysis, as necessary. MS and MSD results did not indicate an overall bias in recovery for trace elements or inorganic parameters.

Accuracy for vegetation analysis is excellent and acceptable, as demonstrated by recoveries within the SRM control limits and by recoveries for MS and MSD samples within the DQOs for accuracy established in the QAPP.

Representativeness—Vegetation

Sampling techniques and sample-handling protocols (e.g., storage, preservation, and transportation) were developed, and documentation was established to demonstrate that protocols were consistently followed and that sample identification and integrity were ensured. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data as applicable.

Data are considered representative. Anomalies noted during data validation and issues related to comparability, as noted in the following subsection ("Comparability—Vegetation") were insignificant in the overall effect on project data, as were issues related to sensitivity goals, as noted below in the subsection "Sensitivity—Vegetation."

Comparability—Vegetation

The DQO for comparability was met by selecting methods for field sampling and for laboratory analysis that were comparable throughout the trace elements studies. Field sampling methods were evaluated (Table A-21) throughout the trace elements studies during QA field audits to ensure comparability among sampling teams collecting samples of similar media. The methods were implemented as written for each sampling event, with any deviations necessary to accommodate unexpected field conditions being documented in field notes.

The analytical methods of individual laboratories were evaluated to ensure comparability between the primary laboratory (CAS) and the QA laboratory (TA). Analysis of vegetation samples was conducted by using EPA-approved methods from the water and wastewater manual (1983) and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996). The analytical methods used for parameters were as follows:

- Trace elements (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, K, Se, Ag, Na, Tl, Sn, V and Zn) by EPA Methods 6010B and 6020.
- Trace elements (mercury) by EPA Method 7471A.
- Cyanide (total) by EPA Methods 335.2 and 9012A (CAS 2005, 2006, 2007).

Vegetation samples also were analyzed for the following inorganic parameters in the 2004 studies:

- Chloride and sulfate by EPA Method 300.0.
- Fluoride by EPA Method 340.2 (CAS) and Method 300.0 (NCA).
- Ammonia as nitrogen by EPA Method 350.1.

The use of EPA-approved and published methodologies allows for distinct comparisons of data collected during multiple sampling events. The methods also provide a basis for using a QA laboratory to check the accuracy of the primary laboratory at a set frequency.

Preparation of vegetation samples differed between laboratories for the 2004 and 2005 data-collection activities. The individual preparatory methods are briefly discussed below:

- CAS: Vegetation tissue samples were prepared by the primary laboratory. The entire sample was homogenized (i.e., cut into approximately 1/4-inch pieces) at the laboratory before any subsampling for metals, mercury, and cyanide. A portion of the laboratory-homogenized sample (wet) was analyzed for mercury and cyanide. A separate portion was dried at 60 degrees Celsius (°C) and ground for the analysis of trace elements. Ten percent of the homogenized vegetation sample (wet) was split into primary, field duplicate (QC), and field triplicate (QA) samples and then stored frozen prior to analysis. CAS then shipped the triplicate homogenized (wet) sample to the QA laboratory (NCA) for analysis.
- NCA: Vegetation tissue field triplicate samples (wet) were prepared by flash freezing with liquid nitrogen and then were homogenized and stored at -20°C prior to sample digestions and analysis. Results reported by NCA were converted to dry-weight basis by applying the percent solids results from the primary laboratory.

Disagreements between results from the primary laboratory and the QA laboratory in 2005 were evaluated during data validation procedures. As a result of inquiries to the laboratory to ascertain disagreement in data, field triplicate results for vegetation samples collected in July 2005 were rejected because of uncertainty about the exact basis of samples received and the specific samples analyzed. A limited volume was received for the field triplicate samples, hindering the ability to re-extract and re-analyze samples and confirm the reported results.

Preparation of the 2005 vegetation tissue by drying at CAS at 60°C in comparison to flash freezing the wet (as received) sample with liquid nitrogen at NCA may account for the variability in results between the primary and QA laboratories.

Efforts to improve data quality were initiated during the 2006 vegetation analysis to ensure better comparability among data sets. The primary laboratory (CAS) was instructed to thoroughly prepare and homogenize the vegetation samples and to send the field triplicate sample as an aliquot dried at 60°C and ground for analysis of trace elements. Comparability in the data sets improved in 2006 and 2007 for vegetation samples as a result of the primary laboratory thoroughly preparing, homogenizing, grinding, and sending a dried aliquot of the sample to the QA laboratory.

Overall, the comparability in data sets for vegetation samples is considered excellent. The different sample-preparation techniques between the primary and QA laboratories during 2004 and 2005 were considered insignificant, as demonstrated by the excellent precision obtained from comparison of results for primary and field triplicate samples.

Completeness—Vegetation

The completeness goal for vegetation samples in the trace elements study was established in the 2005, 2006, and 2007 QAPPs (Appendix G) at 90 percent. Completeness was calculated from the amount of data determined to be valid after data validation in comparison to the total amount of data acquired. Rejected data were considered not valid.

Vegetation samples were collected during August and September 2004, July and August 2005, July and August 2006, and July, August, and September 2007. Vegetation tissue samples met the completeness goal for all parameters analyzed. Completeness was 100 percent for all parameters.

Sensitivity—Vegetation

Sample results reported as ND to the MDL were compared to the MRL DQO in the QAPPs. A summary of sensitivity for vegetation is presented in Table A-22.

Trace elements antimony, arsenic, beryllium, bismuth, cadmium, chromium, mercury, selenium, silver, thallium, tin, and vanadium were reported as ND for at least 10 percent of the vegetation data set of 1,048 samples. Inorganic parameters fluoride and total cyanide were reported as ND for at least 10 percent of the vegetation data set. At least 50 percent of chromium samples reported as ND also reported an MDL value that was greater than the MRL DQO for sensitivity.

Benchmark criteria for vegetation samples for the environmental baseline studies were not established or referenced in the QAPP. The effects on data quality or usability from the referenced parameters not meeting the MRL DQOs for sensitivity could not be assessed.

A.2.3.3 Soil

Soil samples were collected during 2004, 2005, 2006, and 2007 for the trace element studies. Samples were collected by consultants in accordance with their respective FSPs as follows:

- CH2M Hill during September 2004 in the mine study area.
- SLR during July and August 2005, July and August 2006, and July 2007 in the mine study area.
- BEESC during August and September 2004 and August 2006 in the transportation corridor.

Soil samples were analyzed for trace elements; the inorganic parameters chloride, fluoride, sulfate, total cyanide, and nitrogen as ammonia; and the organic parameters total organic carbon (TOC), DRO, and

RRO. Petroleum hydrocarbon samples for DRO and RRO were not collected for the 2007 data-collection activities.

SGS was designated the primary laboratory for soil analysis in 2004, 2005, and 2006. STL was designated the primary laboratory for soil analysis in 2007.

Precision—Soil

LCS analysis provides information on the analytical variability or laboratory precision without any effect from sample matrices. SGS used a solid SRM as the LCS matrix for both soil and sediment. Consequently, LCS results for sediment samples and soil samples were calculated together to ascertain the mean percent recovery and RSD for determining the analytical variability or precision. Individual RSD results for LCSs are presented in Table A-23 and summarized below:

- **Trace Elements:** LCSs for sediment and soil exhibited good precision, as indicated by RSD values less than 15 percent, with the exceptions of antimony at 22 percent, bismuth at 44 percent, and silver at 18 percent.
- **Inorganic Parameters:** LCSs for sediment and soil exhibited excellent precision, as indicated by RSD values of less than 15 percent.
- **Petroleum Hydrocarbon Compounds:** Sediment and soil samples exhibited excellent precision for DRO and RRO, with RSDs of 9 percent and 10 percent, respectively.
- **TOC:** Sediment and soil samples exhibited excellent precision for TOC with a 10 percent RSD.

Thirty pairs of primary-field duplicate sample pairs for soil were evaluated. Two hundred eighty-one primary soil samples were collected, giving a field duplicate frequency of 11 percent for this data set. Results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating mean and SD. Results for field precision for soil are presented in Table A-23 and summarized below:

- **Trace Elements:** Results for trace elements in soil exhibited an average RSD of 108 percent. A higher variability in measurement was observed for bismuth (136 percent RSD), potassium (123 percent RSD), thallium (124 percent RSD), and vanadium (125 percent RSD).
- **Inorganic Parameters:** Results for inorganic parameters in soil exhibited an average RSD of 82 percent. LD analysis also was performed for the inorganic parameters. Results are summarized in Table A-24.

Results for field triplicate samples were evaluated in comparison to results for primary samples and field duplicates. Field triplicate sample results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating RPDs in results for primary samples and field triplicate samples. Control charts for parameters in surface-soil samples are presented in Charts A-180 through A-214 in Attachment 1.

These RPD calculations and the related control charts are another means to assess the precision of the test methods as they are being employed by the laboratories and also the precision of the field sampling procedures. Two variables, field sampling and laboratory techniques, are being evaluated in one effort. A primary-field duplicate sample pair is analyzed by the one primary laboratory. Consideration of the measurement of this pair as precise demonstrates that the field sampling methods used for sampling and the method used for testing can yield precise results and are therefore appropriate. Verification of the precision for a primary-field duplicate sample pair also indicates that the field team and the laboratory are able to obtain precise results by implementing their methods. The methods are more rigorously tested by the addition of a third entity—a second laboratory. Obtaining good precision in the comparison of results between the two laboratories further supports the capacity of the field teams and laboratories to achieve reproducible or precise results by implementing their methods.

Parameters for which at least 20 percent of the field triplicate sample RPDs exceeded the UCLs are summarized below:

- **Inorganic Parameters:**
  - Cyanide in 10 of 12 soil samples evaluated exceeded the UCL established at 106 percent RPD.
  - Fluoride in one of three soil samples evaluated exceeded the UCL established at 100 percent RPD.
  - Sulfate in five of 12 soil samples evaluated exceeded the UCL established at 113 percent RPD.
  - Nitrogen as ammonia in 16 of 17 soil samples evaluated exceeded the UCL established at 92 percent RPD.
- **Trace Elements:**
  - Antimony in four of 16 soil samples evaluated exceeded the UCL established at 63 percent RPD.
  - Boron in two of seven soil samples evaluated exceeded the UCL established at 89 percent RPD.
  - Cadmium in six of 15 soil samples evaluated exceeded the UCL established at 102 percent RPD.
  - Mercury in four of 19 soil samples evaluated exceeded the UCL established at 108 percent RPD.
  - Selenium in five of 17 soil samples evaluated exceeded the UCL established at 79 percent RPD.
  - Silver in three of 14 soil samples evaluated exceeded the UCL established at 47 percent RPD.
  - Sodium in three of 20 soil samples evaluated exceeded the UCL established at 70 percent RPD.
  - Thallium in two of 16 soil samples evaluated exceeded the UCL established at 79 percent RPD.

For the soil data set, the precision is excellent overall. For, antimony, boron, cadmium, mercury, selenium, silver, sodium, and thallium, the variability demonstrated by the high control limits and small number of outliers among the plotted points of the primary-QA laboratory RPD is largely due to very few detections in the samples and low concentrations when the parameters were detected. The combination of a small number of detections among the primary and field duplicate samples and detections at low concentrations resulted in the high statistical variability with little difference in absolute concentrations.

Accuracy—Soil

Accuracy was calculated from the percent recoveries of laboratory-spiked parameters in analysis of LCSs and MS, MSD, and PE samples.

Results for soil and sediment LCSs were calculated together to ascertain the mean percent recovery. These data were combined because the laboratory used a solid SRM as the LCS matrix for both soil and sediment samples. LCS results exhibited excellent accuracy for all parameters, as indicated by mean percent recoveries that were within DQOs for accuracy.

The accuracy of MS and MSD samples was assessed during data validation to ascertain effects from the sample matrix. Individual project-specific samples were flagged to indicate bias in analysis, if applicable. Results are summarized below:

- MS results (2004, 2005, 2006, and 2007) for fluoride in soil and sediment samples exhibited low-biased recovery in analysis by EPA Method 300.0. Overall, the soil and sediment results of the primary laboratory (SGS) for fluoride are considered biased low.
- MS results (2005, 2006, and 2007) for total cyanide in soil samples exhibited low-biased recovery by SM4500CE-E. Overall, the soil results of the primary laboratory (SGS) for total cyanide are considered biased low.

PE samples in a solid matrix (soil) were included in the analytical scheme during the 2006 and 2007 data-collection activities. The samples were submitted to the laboratories (blind) by using bottles and chain-of-custody records typical for the project to mask the identity of the PE samples and make them appear to be field samples.

In 2006, ERA prepared and submitted PE samples blind to the primary laboratory (SGS) and QA laboratory (CAS) for analysis. ERA maintains accreditations for NQA USA ISO9001 and A2LA Proficiency Testing Providers.

In 2007, RTC prepared and submitted PE samples blind to the primary laboratory for soil (STL), primary laboratory for sediment (ACZ) and QA laboratory for soil and sediment (CAS) for analysis. RTC maintains accreditations for A2LA Proficiency Testing Providers.

The 2006 PE sample soil results are presented in Table A-25a and are summarized below:

- **Trace Elements:** 2006 PE sample results for trace elements in soil exhibited excellent accuracy, as indicated by acceptable results within the performance acceptance limits at both the primary and QA laboratories.
- **Inorganic Parameters:**
  - The 2006 PE results for fluoride slightly exceeded (were biased high) the upper performance acceptance limit for the QA laboratory. This result yielded a recovery of 143 percent relative

  to the fluoride value certified by ERA, which is above the QAPP DQO goal of 75 to 125 percent (2005 QAPP, in Appendix G).

  – The 2006 PE result for TOC in soil/sediment at the QA laboratory was reported with a biased-low value relative to performance acceptance limits. This result yielded a recovery of 20 percent relative to the TOC value certified by ERA, which is below the QAPP DQO goal of 75 to 125 percent (2005 QAPP, in Appendix G).

The 2007 PE sample soil results are presented in Table A-25b and summarized below:

- **Trace Elements:**
  - The 2007 PE sample results for trace elements aluminum and potassium exceeded (were biased high) the upper performance acceptance limits at the primary laboratory for sediments (ACZ). Aluminum yielded a recovery of 191 percent relative to the aluminum value certified by RTC. Potassium yielded a recovery of 173 percent relative to the potassium value certified by RTC. These trace elements both exceeded the QAPP DQO accuracy goal of 80 to 120 percent (2007 QAPP, in Appendix G).
- **Inorganic Parameters:**
  - The 2007 PE result for nitrogen as ammonia exceeded (biased high) the upper performance acceptance limit for the primary laboratory for soils (STL). This result yielded a recovery of 824 percent relative to the nitrogen as ammonia value certified by RTC, which is above the QAPP DQO goal of 75 to 125 percent (2007 QAPP, in Appendix G).

Overall, accuracy for soil and sediment analysis is excellent and acceptable, as demonstrated by SRM recoveries, blind PE sample recoveries within referenced control limits, and MS and MSD recoveries within the DQO for accuracy established in the QAPP. The following are general comments about accuracy based on evaluation of these QC parameters:

- The 2007 analysis (by ACZ) of primary sediment samples for aluminum and potassium may be considered biased high values.
- The 2007 analysis (by STL) of primary soil samples for nitrogen as ammonia may be considered biased high values.

Representativeness—Soil

Sampling techniques and sample-handling protocols (e.g., storage, preservation, and transportation) were developed, and documentation was established to demonstrate that protocols were consistently followed and that sample identification and integrity were ensured. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data as applicable.

Data are considered representative. Anomalies noted during data validation and issues related to sensitivity goals noted in the subsection “Sensitivity—Soil” below were insignificant in the overall effect on project data.

Comparability—Soil

The DQO of comparability was met by selecting methods for field sampling and laboratory analysis that were comparable throughout the trace elements studies. Field sampling methods were evaluated (Table A-26) throughout the trace element studies during QA field audits to ensure comparability among sampling teams collecting samples of similar media. The methods were implemented as written for each sampling event, with any deviations necessary to accommodate unexpected field conditions documented in field notes.

The laboratory analytical methods were evaluated to ensure comparability between the primary and QA laboratories. Analysis of sediment samples was conducted by using EPA-approved methods from the EPA water and wastewater manual (1983); *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al, 1998); *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996); and ADEC petroleum hydrocarbon methods (18 AAC 75). The analytical methods used for parameters were as follows:

- Trace elements (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Hg, Mo, Ni, K, Se, Ag, Na, Tl, Sn, V, and Zn) by EPA Methods 6010B and 6020.
- Trace elements (mercury) by EPA Method 7471A.
- Cyanide (total) by SM 4500CN-E (SGS) and 9012A (CAS).
- Chloride, fluoride, and sulfate by EPA Method 300.0.
- Ammonia as nitrogen by SM 4500NH3 (SGS) and 350.1 (CAS).
- TOC by EPA Methods 415.1 (SGS, in 2004), 9060 (SGS, in 2005), and SM D4129 (CAS).
- DRO by ADEC Method AK102.
- RRO by ADEC Method AK103.

The use of EPA-approved and -published methodologies allows for distinct comparisons of data collected during multiple sampling events. Laboratory methods have not changed substantially during the study period (2004 through 2007). The use of consistent laboratory methods has resulted in comparable data between the primary and QA laboratories during the course of the study.

In consideration of the methods and technologies employed in the field and at the laboratories, the data set for the trace element studies for soil is comparable.

Completeness—Soil

The completeness goal for soil samples in the trace elements study was established in the QAPP at 90 percent (2005, 2006, and 2007 QAPPs, in Appendix G). Completeness was calculated from the amount of data determined to be valid after data validation, compared to the total amount of data acquired. Rejected data were considered not valid.

Soil samples collected during 2004 through 2007 met the completeness goal for all parameters analyzed. Completeness was 100 percent for all parameters, with the exception of fluoride. One fluoride soil sample was rejected for a completeness of 99.6 percent.

Sensitivity—Soil

Sample results reported as ND to the MDL were compared to the MRL DQOs in the QAPPs (2005, 2006, and 2007 QAPPs, in Appendix G). A summary of sensitivity is presented in Table A-27.

Antimony, bismuth, boron, cadmium, molybdenum, silver, thallium, and tin were reported as ND for at least 10 percent of the soil data set. For at least 50 percent of antimony, cadmium, molybdenum, silver, and tin samples reported as ND, an MDL value that was greater than the MRL sensitivity DQO was also reported.

MRL DQOs for sensitivity were established in the QAPP at values considerably lower than the benchmark soil criteria. Neither data quality nor usability is significantly affected by the referenced parameters not meeting the MRL DQOs for sensitivity.

A.2.3.4 Fish and Mussel Tissues

Samples of fish tissue and mussel tissue were collected in the mine study area during 2004, 2005, 2006, 2007, and 2008 for the trace element studies. Samples were collected by consultants in accordance with their respective FSPs, as described below:

- HDR collected fish tissue during 2004 (August and September), 2005 (August), 2006 (August), 2007 (August), and 2008 (August and September) from rivers and streams in the mine study area.
- HDR collected mussel tissue during 2005 (June, September, and October) and 2006 (September) at Iliamna Lake.

Fish tissue samples were analyzed for trace elements. Mussel tissue samples were analyzed for trace elements and polynuclear aromatic hydrocarbon (PAH) compounds for the 2005 data-collection activities.

Precision—Fish and Mussel Tissues

The primary laboratory (CAS) performed LCS analysis for trace elements and PAHs. LCS analysis provides information on only the analytical variability or laboratory precision without effects from the sample matrix.

Most of the LCSs for fish and mussel tissue at CAS were prepared using certified fish tissue SRM (National Research Council Canada [NRCC] catalog numbers Dorm-2 and NRCC Dolt-3). These reference materials did not contain mercury. LCS results were calculated together to ascertain the mean percent recovery and RSD to determine the analytical variability or precision. Individual RSD results for LCSs are presented in Table A-28 and summarized below:

- **Trace Elements:** Tissue LCS results exhibited excellent precision, as demonstrated by RSDs for fish and mussel tissue at 10 percent or less, except for chromium (12 percent), lead (22 percent), and nickel (14 percent).
- **Polynuclear Aromatic Hydrocarbons:** Analysis of LCSs for PAH compounds was performed for Iliamna Lake mussel tissues. LCS exhibited excellent precision for PAH compounds, with all compounds having an RSD of 17 percent or less.

Five batches of samples for the September 2008 event were processed with LCSs prepared by using laboratory water fortified with trace elements. All mercury LCSs were prepared in this manner. Excellent precision for this type of LCS was demonstrated with RSDs of 10 percent or less.

Five pairs of primary-field duplicate sample pairs for fish and mussel tissues were evaluated for trace elements. Eight hundred eleven primary fish and mussel tissues samples were collected, giving a field duplicate frequency of 0.6 percent for this data set. One primary-field duplicate sample pair was collected for organics. Eight primary fish and mussel tissue samples were collected, giving a field duplicate frequency of 12 percent. Results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating mean and SD.

Field precision for mussel tissue is displayed in Table A-28. Primary-field duplicate and primary-field triplicate sample pairs of fish tissues were submitted for testing; however, in 2008, an evaluation by Pebble Partnership and Shaw of the dissection and homogenization procedures led to the conclusion that most of the field duplicate samples were actually laboratory duplicates analyzed at the same laboratory and most of the field triplicate fish samples were actually laboratory duplicates analyzed at a second laboratory. This conclusion was reached because all sample portions from the locations designated for a field triplicate sample were homogenized and then portions were meted out for the primary and field triplicate samples. Correctly done, the samples should have been divided up into primary and field triplicate samples before homogenization and should have been homogenized separately. A few select pairs were determined to have been processed correctly. The determination of which pairs were prepared correctly for this QA split was done by examination of preparation details documented on laboratory bench sheets. Argon performed this examination.

The corrective action subsequent to this conclusion was to reclassify the field triplicate samples to laboratory duplicates in the project database. This reclassification was accomplished by changing the QA designation to “LR” (laboratory replicate).

LD analysis also was performed for trace elements. Precision for LD samples of fish and mussel tissue is displayed in Table A-29.

Accuracy—Fish and Mussel Tissues

Accuracy was calculated from the percent recoveries of laboratory-spiked parameters in analysis of LCSs and the MS and MSD samples.

LCS fish and mussel samples at CAS were prepared by using a certified SRM (NRCC Dorm-2 and NRCC Dolt-3) for the parameters arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc. CAS prepared an aqueous-matrix LCS for the parameters antimony, beryllium, molybdenum, and thallium.

Accuracy for fish and mussel LCS is displayed in Table A-28. LCS results exhibited excellent accuracy for all parameters, as indicated by mean percent recoveries that were within DQOs for accuracy.

MS and MSD accuracy was assessed during the data validation to ascertain effects from sample matrix interference. Individual project-specific samples were flagged to indicate bias in analysis where necessary. MS and MSD results did not indicate an overall bias in recovery for the trace elements or PAH compounds.

Accuracy for analysis of fish and mussel tissue is excellent and acceptable, as demonstrated by matrix-specific SRM recoveries within referenced control limits and by LCS, MS, and MSD recoveries within the DQOs for accuracy established in the QAPP.

Representativeness—Fish and Mussel Tissues

Sampling techniques and sample-handling protocols (e.g., storage, preservation, and transportation) were developed, and documentation was established to demonstrate that protocols were consistently followed and sample identification and integrity were ensured. Tissue samples were frozen after sample collection to maintain the integrity of the tissue. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data as applicable.

All data for fish and mussel tissue are considered representative. Anomalies noted during data validation and issues related to comparability (as noted in the subsection "Comparability—Fish and Mussel Tissues") and sensitivity goals (as noted in the subsection "Sensitivity—Fish and Mussel Tissues") were insignificant in overall effect on project data.

Comparability—Fish and Mussel Tissues

The DQO of comparability was met by selecting methods for field sampling and laboratory analysis that were comparable throughout the trace element studies (Table A-30). Field sampling methods were evaluated during QA field audits to ensure comparability among sampling teams collecting fish and mussel tissues. The methods were implemented as written for each sampling event, with any deviations necessary to accommodate unexpected field conditions documented in field notes.

The individual laboratory analytical methods were evaluated to ensure comparability between the primary laboratory (CAS) and the QA laboratory (TA, formerly STL). Analysis of fish and mussel tissue was conducted by using EPA-approved methods from the EPA water and wastewater manual (1983) and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996). The analytical methods used for parameters were as follows:

- Trace elements (Sb, As, Be, Cd, Cr, Cu, Pb, Mo, Ni, Ag, Tl, and Zn) by EPA Methods 6010B and 6020.
- Trace elements (mercury) by EPA Method 1631.
- Trace elements (selenium) by EPA Methods 7740 (CAS) and 6020 (NCA).
- PAH by EPA Method 8270C SIM (2005, Iliamna Lake).

Preparation of fish and mussel tissue samples was conducted by using guidelines detailed in the Puget Sound Estuary Program, referencing *Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples* (EPA, 1997).

Field triplicate sample analyses were intended for both the mussel and fish tissues as a demonstration of field precision; however, ultimately, only the mussel tissue results are reported for this precision. The reason for the lack of field precision data for fish tissues is discussed above in the subsection “Precision—Fish and Mussel Tissues.” Comparability statements for the two laboratories reflect statements of laboratory precision only.

Sample preparation for fish and mussel tissue differed substantially between laboratories for the 2004 and 2005 data-collection activities. The differences in sample preparation introduced some variability in the laboratory duplicate results between the primary and QA/second laboratory. Laboratory preparatory methods are briefly explained below:

- CAS (primary): Tissue samples were stored frozen at -20°C before analysis. Prior to digestion, samples were homogenized and then freeze-dried. Results were reported on a dry-weight basis.
- NCA (QA): Tissue samples were prepared by EPA Method 3052, which is a microwave-assisted acid digestion, and were analyzed by EPA Method 6020. Results were converted to dry-weight basis by applying the CAS percent solids of a representative sample.

Efforts to improve data quality were initiated for the 2006 analysis of fish and mussel tissues to ensure better comparability in data sets. The primary laboratory (CAS) was instructed to thoroughly prepare, homogenize, and freeze-dry the tissue samples and to send the field triplicate sample as a freeze-dried aliquot for analysis for trace elements. Comparability in the data sets improved in 2006 and 2007 for fish tissue samples as a result of the primary laboratory thoroughly preparing, homogenizing, and freeze-drying the aliquot of the sample for the QA laboratory.

Completeness—Fish and Mussel Tissues

The completeness goal for fish and mussel tissue samples in the trace elements study was established in the QAPP at 90 percent (2005 through 2008 QAPPs, Appendix G). Completeness was calculated from the amount of data determined to be valid after data validation, compared to the total amount of data acquired. Rejected data were considered not valid.

Tissue samples met the completeness goal for all parameters analyzed. Completeness was 100 percent for all parameters.

Sensitivity—Fish and Mussel Tissues

Sample results reported as ND to the MDL were compared to the MRL DQOs goals in the QAPP. A summary of sensitivity for fish and mussel tissues is presented in Table A-31.

MRL DQOs for sensitivity established in the QAPP were met for fish and mussel tissue.

A.2.3.5 Surface Water—Seeps

Surface water samples from seep locations were collected by HDR in the mine study area. Sample collection followed procedures outlined in FSPs developed each year.

Precision—Surface Water Seeps

Precision was calculated from the RSD in results of LCSs, LD samples, and field duplicate samples. Sample results reported at levels less than the MRL were included in the statistical calculations of the mean ($\bar{x}$) and the SD of the measurements.

LCS analysis provides information on analytical variability or laboratory precision without influence from a field sample matrix. The laboratory uses in-house purified water for the LCS. Surface water and groundwater samples can be batched together under a single LCS. A single set of calculations of the mean and SD of LCS data points represents both matrices. Laboratory accuracy and precision are displayed in Table A-32.

LCS results for trace elements exhibit excellent accuracy for all parameters, as indicated by mean percent recoveries that were within DQOs for accuracy.

Field duplicate samples were included in the analytical scheme to assess sampling and analytical variability. This variability includes that resulting from sample matrix differences (heterogeneity), sample handling procedures, and the analytical measurement system. Field precision was calculated as the RPD between primary and field duplicate sample results. A percent RSD of the RPDs was calculated to assess the precision of these values.

For trace elements, total and dissolved, 394 primary-field duplicate sample pairs of surface water seep were evaluated. For inorganic parameters, 198 pairs were evaluated. The primary surface water seep samples collected included 1,654 samples for trace elements and 827 samples for inorganic parameters, yielding a field duplicate frequency of 24 percent for this data set. Primary results that were reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating the mean and SD. Field-precision values for surface water seeps are displayed in Table A-32 and are summarized below:

- **Trace Elements:** Trace elements in surface water exhibited an average RSD of 101 percent for their RPDs. Higher variability was observed for iron (124 percent), magnesium (131 percent), manganese (130 percent), molybdenum (137 percent), potassium (139 percent), and selenium (125 percent).
- **Inorganic Parameters**: An average RSD of 166 percent was calculated for the RPDs of inorganic parameters. Alkalinity (242 percent), chloride (195 percent), nitrate-nitrite (170 percent), pH (173 percent), specific conductance (491 percent), and sulfate (320 percent) demonstrated the highest amounts of variability. These parameters exhibited greater variability in comparison to surface water results.

Field triplicate samples from the identical sample points designated for field duplicates were collected and submitted to the QA laboratory (CAS). The intent of triplicate sampling is to assess the accuracy of the primary laboratory (SGS). This comparison is accomplished by a quantitative comparison of the data from the primary and QA laboratories through calculation of an RPD of the primary laboratory and QA laboratory sample results for the values for trace elements and inorganic parameters. These RPDs were plotted on control charts against an average ($\bar{x}$) of the RPD results of primary-field duplicate sample pairs and a UCL based on the RPDs of the field duplicate data [UCL = $\bar{x}$ + (3 * SD)] (Charts A-45 through A-79 in Attachment 1). The data points displayed in these charts reflect QA laboratory results with the RPD from the primary-field triplicate sample pairs listed to the right of each point.

These RPD calculations and the related control charts are another means to assess the precision of the test methods as they are being employed by the laboratories and also the precision of the field sampling procedures. Two variables, field sampling and laboratory techniques, are being evaluated in one effort. A primary-field duplicate sample pair is analyzed by the one primary laboratory. Consideration of the measurement of this pair as precise demonstrates that the field sampling methods used for sampling and the method used for testing can yield precise results and are therefore appropriate. Verification of the precision for a primary-field duplicate sample pair also indicates that the field team and the laboratory are able to obtain precise results by implementing their methods. The methods are more rigorously tested by the addition of a third entity—a second laboratory. Obtaining good precision in the comparison of results between the two laboratories further supports the capacity of the field teams and laboratories to achieve reproducible or precise results by implementing their methods.

Charts are not available for inorganic parameter cyanide, WAD CN, nitrogen as ammonia, thiocyanate, TSS, bismuth, and tin because of a lack of detections in the primary sample, the triplicate sample, or both.

The control charts exhibit excellent precision, which is demonstrated by more than one-third of the data points being at or below the average RPD. These results, statistically replicated between two laboratories, attest to the accuracy of the methods used for surface water seep matrices as employed at the primary laboratory. Exceptions exist, for example, in the cases of mercury and selenium, for which a limited number of detections resulted in a limited number of pairs for field duplicates and triplicates.

The inorganic parameters results for alkalinity, chloride, fluoride, sulfate, and total phosphorus show the highest percentage of RPDs for primary-field triplicate sample pairs above the RPD UCLs for the primary-field duplicate sample pairs:

- Total alkalinity exhibited variability—out of 69 primary-field triplicate sample pairs evaluated, RPDs for five of those pairs exceeded the UCL.
- Chloride exhibited variability—out of 69 primary-field triplicate sample pairs evaluated, RPDs for 21 of those pairs exceeded the UCL.
- For fluoride, none of the RPDs for primary-field triplicate sample pairs exceeded the UCL.
- Sulfate exhibited some variability—out of 72 primary-field triplicate sample pairs evaluated, RPDs for only one of those pairs exceeded the UCL.
- Total phosphorus exhibited some variability—out of 45 primary-field triplicate sample pairs evaluated; RPDs for only one of those pairs exceeded the UCL.

The trace element results for boron, cadmium, cobalt, iron, mercury, and silicon show the highest percentage of RPDs for primary-field triplicate sample pairs above the RPD UCLs for the primary-field duplicate sample pairs:

- Boron exhibited variability—out of 52 primary-field triplicate sample pairs evaluated, RPDs for six of those pairs exceeded the UCL.

- Cadmium exhibited variability—out of five primary-field triplicate sample pairs evaluated, RPDs for three of those pairs exceeded the UCL.
- Cobalt exhibited variability—out of 60 primary-field triplicate sample pairs evaluated, RPDs for 33 of those pairs exceeded the UCL.
- Iron exhibited variability—out of 58 primary-field triplicate sample pairs evaluated, RPDs for 17 of those pairs exceeded the UCL.
- Mercury exhibited variability—out of nine primary-field triplicate sample pairs evaluated, RPDs for one of those pairs exceeded the UCL.
- Silicon exhibited variability—out of 73 primary-field triplicate sample pairs evaluated, RPDs for six of those pairs exceeded the UCL.
- Cadmium, cobalt, and iron exhibited the highest percentages of RPDs for primary-field triplicate sample pairs above the RPD UCLs. Boron, cadmium, mercury, and silicon were detected in few samples at low concentrations. Higher statistical variability is present at the low concentrations. That higher variability combined with the small number of detections did not result in a viable data set to make precision statements for these parameters.

Accuracy—Surface Water Seeps

Accuracy was calculated from the percent recoveries of LCS QC samples and PE sample analysis. Similar to the precision calculations, LCS results for surface water and groundwater are combined into one calculation scheme for determining the mean and the SD.

The mean LCS recoveries demonstrated excellent recoveries for all trace elements, inorganic parameters, and organic parameters relative to the DQOs given in the QAPPs (2005 through 2008, in Appendix G).

MS and MSD sample accuracy was assessed during data validation to determine effects on accuracy from matrix interferences. Individual project-specific samples were flagged to indicate a bias in the analysis of the particular parent sample used to generate the MS/MSD set.

PE samples in an aqueous matrix (water) were included in the analytical scheme during the 2006, 2007, and 2008 data-collection activities. The results, which are further discussed in the subsection “Accuracy—Surface Water” in Section A.2.2.1.

The 2007 PE sample result for barium submitted to the primary laboratory (ACZ) for surface water seep samples was reported above the acceptance limits for the study at 200 percent relative to the RTC certified value and exceeded the QAPP DQOs of 85 to 115 percent (2005 through 2008, in Appendix G).

In 2008, RTC prepared and submitted PE samples blind to the primary laboratories for surface water (SGS and CAS). RTC maintains accreditations for A2LA Proficiency Testing Providers.

The 2008 PE water sample results were acceptable at the primary laboratory (SGS) and quality assurance laboratory (CAS) for surface water samples. The 2008 PE freshwater results are presented in Table A-5c.

Data assessment for accuracy demonstrated that the accuracy controls are stable within the laboratory because all LCS results are within the QAPP DQOs. The PE results for fluoride, sulfate, and total phosphorus exhibit a noticeably high bias. Considering that this apparent bias is from a single analysis, these particular outliers are not a significant cause for concern in terms of usability.

Representativeness—Surface Water Seeps

Sampling techniques and sample-handling protocols (e.g., storage, preservation, and transportation) were developed, and documentation was established to demonstrate that protocols were consistently followed and that sample identification and integrity were ensured. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. The results were considered during data validation.

QC measures to monitor for systematic background contamination in the field and laboratory environments were water blanks generated in the field by using laboratory water and method blanks generated at the laboratory with each batch of samples prepared and analyzed. Such contamination could have a significant effect on the accuracy of the data.

The data are considered acceptable and usable for project purposes. The significance of anomalies noted during data validation, including their overall impact on project data (if any), is briefly summarized in the subsections on completeness, sensitivity, and total and dissolved metals.

Comparability—Surface Water Seeps

The comparability objective was met by selecting field sampling and laboratory analytical methods that are comparable throughout the baseline environmental studies. Differences in methods or technologies may preclude making data comparisons or generating viable trending information.

The field sampling methods were evaluated (Table A-33) to ensure comparability among sampling teams collecting samples of similar media. The methods were implemented as written for each sampling event, with any deviations necessary to accommodate unexpected field conditions documented in field notes.

The laboratory analytical methods were evaluated to ensure comparability between the primary and QA laboratories. The methods selected were EPA-approved methods from the EPA water and wastewater manual (1983), *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al, 1998), and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996). The analytical methods used for parameters were as follows:

- Trace elements (Al, Sb, As, Ba, Be, Bi, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Na, Si, Ag, Tl, Sn, V, Zn) by EPA Method 200.8.
- Trace elements (mercury) by EPA Methods 245.1 (in 2004) and 1631 (in 2005, 2006, 2007, 2008).
- Chloride, fluoride, and sulfate by EPA Method 300.0.
- Nitrate/nitrite by EPA Method 353.2 and SM20 4500NO3-F.
- Acidity by EPA Method 305.2 and SM20 2310B.
- Alkalinity by SM20 2320B.
- Ammonia by SM20 4500NH3-F and SM20 4500NH3-G.

- Cation/anion balance SM20 1030E.
- Conductivity by SM20 2510B.
- Hardness by SM20 2340B.
- Total phosphorus by EPA Method 365.3 and SM20 4500P-B, E.
- Ortho-phosphorus (May 2006 through December 2006 and January 2007 through April 2007) by EPA Method 365.2.
- pH by EPA Method 150.1 and SM20 4500-H, B.
- Total dissolved solids by SM20 2540C.
- TSS by EPA Method 160.2 and SM20 2540D.
- Thiocyanate by SM20 4500-CN M.
- Total cyanide by SM20 4500-CN C, E and WAD CN by SM20 4500-CN I.

The use of EPA-approved and -published methodologies allows for distinct comparisons of data collected during multiple sampling events. The methods also provide a basis for using a QA laboratory to check the accuracy of the primary laboratory at a set frequency. Multiple methods are listed for some parameters because an EPA MUR issued on April 13, 2007, effectively removed some methods from the EPA-approved list and added others. The laboratory technologies used on each parameter are comparable, as evaluated by each laboratory upon issuance of the EPA MUR.

In consideration of the methods and technologies employed in the field and at the laboratories, the data sets for the surface water studies are comparable.

Completeness—Surface Water Seeps

The completeness goal for surface water quality was 90 percent. The completeness level for the sample collection of surface water seeps from April 2004 to December 2008 was met, with completeness calculated at 98 percent, calculated from 941 rejected data points out of a total of 46,987.

The nitrate/nitrite parameter constitutes nine unusable results because of analyses occurring beyond the 48-hour holding time. This exceedence of holding times occurred because of a change in holding time pertaining to seep and stream water samples collected between April 2004 and September 2004. During the 2004 field season, the holding time for nitrate and nitrite analysis was set at 28 days. For the 2005 field season, this holding time was changed to 48 hours, and data from all of the previous seasons were reevaluated for the new criterion.

Most other rejected data points are due to T vs D metals anomalies that did not pass data validation criteria, principally barium, copper, lead, nickel, and zinc. The completeness goals for these individual metals were not met. The number of rejected points for surface water seeps is much smaller than those for other surface water studies. However, these metals were included into an overall investigation into T vs D anomalies. This topic is further discussed in Section A.2.2.1 in the subsection “Total and Dissolved Trace Elements—Surface Water Seeps.”

The parameter ortho-phosphorus also did not meet the individual completeness goal based on comparison of results to total phosphorus data. Four of the 30 data points were rejected based on this evaluation during data validation.

Sensitivity—Surface Water Seeps

The laboratory MDLs were compared to the MRL goals in the QAPPs (2005 through 2008, in Appendix G) as part of the validation process. Approximately 94 percent of the reported results for the trace elements and inorganic parameters have MDLs that meet the MRL goals for the surface water data set. Four parameters—beryllium, boron, cadmium, and WAD cyanide—are associated with the majority of the results for which MDLs are higher than the MRL goals.

The exceedences of the MRL goals for trace elements were in some cases triggered by changes in the laboratory MRLs, as demonstrated by comparison of the MRL goals listed for each year in the summary table for surface water data, Table A-34. SGS implemented some refinements in the overall protocol to improve sensitivity entering into the 2006 season. Boron analysis improved following a change in method that lowered the MRL, though it was still above the QAPP MRL goal. For each of beryllium, cadmium, lead, and vanadium, the MDL exceeded the MRL goal for several data points with ND results. The MDLs varied slightly, with the method validation updates laboratories are required to perform at least annually. In each instance, they are close to the MRL goal (less than 1 μg/L difference). Overall, for approximately three-quarters of the data points at which MDLs for trace elements exceed the MRL, positive detections were reported in the samples for those trace elements. Hence, sensitivity goals were met for the majority of the data.

Total and Dissolved Trace Elements—Surface Water Seeps

The project laboratory made an initial comparison of sample results to ensure that in all instances values for dissolved metals were less than the related values for total metals. Situations for which dissolved metal results were greater than results for total metals were evaluated against criteria presented in Section 4.2 of the project QAPPs (2005 through 2008, in Appendix G) and in Section A.2.1.7 of this appendix.

This evaluation was performed at the laboratory before the final deliverables were reported and by Shaw and Argon during data validation. Far fewer data points are available for seeps than for other surface water studies; however, trace elements copper, lead, nickel, and zinc account for the majority of the anomalous comparisons that do not meet QAPP criteria.

The number of rejected points in the seep study does not in and of itself warrant corrective action; however, because of the frequency of rejected data observed in the surface water studies (see discussion in the subsection “Total and Dissolved Trace Elements—Surface Water” of Section A.2.2.1), action has been taken to address copper, nickel, and zinc. The corrective actions implemented for the subject metals were implemented for all freshwater studies.

Cation/Anion Balance—Surface Water Seep

The two cation and anion sums were compared according to the criteria established in *Standard Methods for the Examination of Water and Wastewater* (Clesceri et al., 1998), SM 1030E (summarized in the subsection “Cation/Anion Balance—Surface Water” in Section A.2.2.1). This evaluation was performed at the laboratory before the final deliverables were reported and by Shaw during data validation. The cation/anion balances for more than 99 percent of the sample collection points met the criteria.

A.2.4 MARINE STUDY

Marine studies were conducted by BEESC, along with Pentec Environmental and RWJ Consulting under contract to BEESC, during 2004 (September) and 2005 (May, July, and August) in Cook Inlet for marine water, marine sediment, and marine fish and bivalve tissues. Marine studies in 2008 were conducted solely by Pentec Environmental for marine water, marine sediment, marine plant, and marine fish and bivalve tissues.

Samples were submitted to the designated primary and QA laboratories as follows:

Date	Matrix	Primary Laboratory	QA Laboratory
September 2004	marine water, marine sediment	SGS	CAS
September 2004	marine fish and bivalve tissues	CAS	none
May 2005	marine fish and bivalve tissues	CAS	STL
July 2005	marine sediment	SGS	CAS
July 2005	marine fish and bivalve tissues	CAS	STL
August 2005	marine fish and bivalve tissues	CAS	none
May 2008	marine fish and bivalve tissues, marine plant, marine water	CAS	TA (formerly STL)
June 2008	marine fish and bivalve tissues	CAS	TA (formerly STL)
July 2008	marine fish and bivalve tissues, marine plant, marine water, marine sediment	CAS	TA (formerly STL)
August 2008	marine fish and bivalve tissues	CAS	TA (formerly STL)
September 2008	marine fish and bivalve tissues, marine plant, marine water	CAS	TA (formerly STL)

Fish and bivalve tissue samples were analyzed according to guidelines detailed in the Puget Sound Estuary Program, referencing *Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples* (EPA, 1997).

A.2.4.1 Marine Fish and Bivalve Tissue

Precision—Marine Fish and Bivalve Tissue

The primary laboratory (CAS) performed LCS analysis for trace elements. LCS analysis for fish and bivalve tissue at CAS was prepared by using certified fish tissue SRM (NRCC Dorm-2 and Dolt-3). LCS results were calculated together to ascertain the mean percent recovery and RSD to determine the analytical variability or precision.

Individual RSD results for tissue LCS are presented in Table A-35. LCS RSDs for trace elements in fish and bivalve tissues were 10 percent or less, with the exception of chromium at 11 percent, lead at 17 percent, nickel at 11 percent, and selenium at 14 percent, all of which are indicators of good precision. Historical data for Dolt-3 SRM have shown biased-high recoveries for lead and nickel in the SRM matrix, which contribute to the higher variability in measurement.

LD analysis for trace elements also was performed on tissues, and the RSDs are displayed in Tables A-36 and A-37.

Field precision for marine fish and bivalve tissue could not be determined because valid duplicates or triplicates were not submitted among the ninety-six samples submitted for testing. Pairs of primary-field triplicate samples were submitted for testing; however, in 2008, an evaluation by Argon, LLC and Shaw of the dissection and homogenization procedures led to the conclusion that field duplicate and triplicate samples were actually laboratory duplicates analyzed at a second laboratory. This conclusion was reached because~~,~~ all sample portions from the locations designated for a field duplicate and triplicate samples were homogenized and then portions were meted out for the primary and field duplicate and triplicate samples. Correctly done, the samples should have been divided up into primary and field duplicate and triplicate samples before homogenization, then homogenized separately.

The corrective action subsequent to this conclusion was to reclassify the field triplicate samples to laboratory duplicates in the project database. This reclassification was accomplished by changing the QA designation to “LR” (laboratory replicate).

Accuracy—Marine Fish and Bivalve Tissue

Accuracy was calculated from the percent recoveries of laboratory-spiked parameters in analysis of LCSs and the MS and MSD samples.

Most of the LCSs for fish and mussel tissue at CAS were prepared by using certified fish tissue SRM (NRCC Dorm-2 and Dolt-3). These reference materials did not contain mercury. LCS results were calculated together to ascertain the mean percent recovery and RSD for determining the analytical variability or precision. Individual RSD results for LCSs are presented in Table A-35. LCS results exhibited excellent accuracy for all parameters, as indicated by mean percent recoveries that were within DQOs for accuracy.

Eight batches of samples for the 2008 events were processed with LCSs prepared by using laboratory water fortified with trace elements. All mercury LCSs were prepared in this manner. Excellent precision for this type of LCS was demonstrated with RSDs of 10 percent or less.

The accuracy of MS and MSD samples was assessed during data validation to ascertain any effects from sample matrix interference. Individual project-specific samples were flagged to indicate bias in analysis, as necessary. MS and MSD results did not indicate an overall bias in recovery for the trace elements.

Accuracy for analysis of fish and bivalve tissue is excellent and acceptable, as demonstrated by matrix-specific SRM recoveries within referenced control limits and LCS, MS, and MSD recoveries within the DQOs for accuracy established in the QAPP (2005, in Appendix G).

Representativeness—Marine Fish and Bivalve Tissue

Tissue samples were frozen after sample collection to maintain integrity of the tissue matrix. Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data where applicable.

Data for marine tissue are considered representative. Anomalies noted during data validation and issues related to comparability (as noted in the subsection immediately below) and to sensitivity goals (as noted in the subsection “Sensibility—Marine Fish and Bivalve Tissue” below) were insignificant in their overall effects on project data.

Comparability—Marine Fish and Bivalve Tissue

Field sampling methods described in the FSPs for the marine studies were evaluated before data collection. Comparability statements are based on a limited data set, as discussed in the subsection “Precision—Fish and Mussel Tissues” in Section A.2.3.4.

Individual laboratory analytical methods were evaluated to ensure comparability between the primary laboratories and QA laboratories. Analysis of samples was conducted by using guidelines detailed in the Puget Sound Estuary Program, referencing *Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples* (EPA, 1997).

Preparation of samples of fish and mussel tissue differed between laboratories, as discussed in the subsection “Comparability—Fish and Mussel Tissue” in Section A.2.3.4. No sample sets of primary, field duplicate, and field triplicate samples were evaluated; therefore, a conclusion about the comparability of the analysis of marine tissue at the laboratories could not be reached.

Completeness—Marine Fish and Bivalve Tissue

The completeness goal for the marine studies was established in the 2005 and 2008 QAPPs at 90 percent (Appendix G). Completeness was calculated from the amount of data determined to be valid after data validation, compared to the total amount of data acquired. Rejected data were considered not valid.

Marine tissue samples met the completeness goal for all trace elements analyzed. Completeness was 100 percent for all parameters.

Sensitivity—Marine Fish and Bivalve Tissue

Sample results reported as ND to the MDL were compared to the MRL DQOs in the 2005 QAPP (Appendix G). Table A-38 presents a summary of sensitivity for marine tissue. MRL DQOs for sensitivity established in the QAPP were met for fish and bivalve tissue.

A.2.4.2 Marine Plant Tissue

Precision—Marine Plant Tissue

The primary laboratory (CAS) performed LCS analysis for trace elements. LCS analysis for plant tissue was prepared by using laboratory-grade water, a water quality (WQ) matrix, fortified with the targeted trace elements at known concentrations. This WQ matrix was also used as the LCS for select batches of marine fish and bivalve samples. All LCS samples of the WQ matrix type, regardless of association with a particular matrix type, were calculated together to ascertain the analytical variability or precision by calculation of the mean percent recovery and RSD.

Individual RSD results for the WQ matrix as an LCS are presented in Table A-35. The RSDs exhibit excellent precision, with RSDs of 10 percent or less.

LD analysis for trace elements also was performed on tissues, and the RSDs are displayed in Table A-37.

Four pairs of primary-field duplicate sample pairs for marine plant tissue were evaluated. Eight primary marine plant tissue samples were collected, giving a field duplicate frequency of 50 percent for this data set. Results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating mean and SD. For trace elements in marine plant tissue, the RPDs between results for the primary and field triplicate samples are precise and comparable to the field precision reported between the results for the primary sample and the field duplicate sample.

Accuracy—Marine Plant Tissue

Accuracy was calculated from the percent recoveries of laboratory-spiked parameters in analysis of the LCSs and the MS and MSD samples.

LCS samples for plant tissue at CAS were prepared by using laboratory-grade water fortified with trace elements as the matrix (WQ matrix). This WQ matrix also was used as the LCS for select batches of marine fish and bivalve samples. All LCSs of the WQ matrix type, regardless of association with animal or plant tissue, were calculated together to ascertain the mean percent recovery. Individual mean percent recoveries and RSD results for the LCSs are presented in Table A-35. LCS results exhibited excellent accuracy for all parameters, as indicated by mean percent recoveries that were within DQOs for accuracy.

The accuracy of MS and MSD samples was assessed during data validation to ascertain any effects from sample matrix interference. Individual project-specific samples used as the parent samples for MS/MSD sets were flagged to indicate bias in analysis, as necessary. MS and MSD results did not indicate an overall bias in recovery for the trace elements.

Accuracy for analysis of marine plant tissue is excellent and acceptable, as demonstrated by matrix-specific SRM recoveries within referenced control limits and LCS, MS, and MSD recoveries within the DQOs for accuracy established in the QAPP (2005 and 2008, in Appendix G).

Representativeness—Marine Plant Tissue

Tissue samples were frozen after sample collection to maintain integrity of the tissue matrix. Field blanks and field duplicates were used to assess field contamination and variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data if applicable.

Data for marine tissue are considered representative. No significant anomalies were noted during data validation.

Comparability—Marine Plant Tissue

Field sampling methods described in the FSPs for the marine studies were evaluated before data collection.

Individual laboratory analytical methods were evaluated to ensure comparability between the primary laboratories and QA laboratories. Analysis of samples was conducted by using EPA-approved methods from the EPA water and wastewater manual (1983) and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996).

Preparation of plant tissue samples differed between laboratories, as discussed in the subsection “Comparability—Vegetation” in Section A.2.3.2. Individual RSD results for the field triplicate samples are presented in Table A-39. Only three sets of primary, field duplicate, and field triplicate samples were evaluated; therefore, a conclusion about the comparability of the marine tissue analysis at the laboratories could not be reached.

Completeness—Marine Plant Tissue

The completeness goal of 90 percent for the marine studies was established in the 2005 and 2008 QAPPs (Appendix G). Completeness was calculated from the amount of data determined valid to be after data validation, compared to the total amount of data acquired. Rejected data were considered not valid.

Marine plant tissue samples met the completeness goal for all trace elements analyzed. Completeness was 100 percent for all parameters.

Sensitivity—Marine Plant Tissue

Sample results reported as ND to the MDL were compared to the MRL DQOs in the 2008 QAPP (Appendix G). A summary of sensitivity for marine plant tissue is presented in Table A-40. MRL DQOs for sensitivity established in the QAPP were met for marine plant tissue.

A.2.4.3 Marine Sediment

Precision—Marine Sediment

Forty-one marine sediment samples (2004 and 2005) were analyzed by SGS as the primary laboratory and 34 samples (2008) were analyzed by CAS as the primary laboratory. The following analyses were used to study parameters of interest in marine sediments:

- Low-level mercury analysis with EPA Method 1631 by CAS as the primary laboratory.
- Testing by SGS and CAS for the following:
  - Trace elements as totals and simultaneously extracted metals (SEM).
  - The inorganic parameters chloride, fluoride, sulfate, total cyanide, and nitrogen as ammonia.
  - Total Kjeldahl nitrogen.
  - The organic parameters GRO; DRO; RRO; TOC; and the volatile aromatic compounds benzene, toluene, ethylbenzene, and xylenes (collectively referred to as BTEX).
- PAH testing by the Geochemical and Environmental Research Group (GERG) laboratory of Texas A&M University in 2008.

LCS analysis provides information on analytical variability or laboratory precision without effects from sample matrix interference. SGS and CAS used a solid SRM as the LCS matrix for marine sediment. Individual RSD results for marine sediment LCSs are presented in Table A-41 and summarized below:

- **Trace Elements:** LCS RSDs for sediment were less than 10 percent, except for boron (12 percent), iron (13 percent), and selenium (11 percent), and overall exhibited excellent precision.
- **Inorganic Parameters:** LCSs for sediment were excellent, as indicated by RSD values of less than 15 percent.
- **Organic Parameters:** LCSs for sediment exhibited excellent precision for all organic parameters with all RSDs less than or equal to 10 percent except for RRO at 14 percent, which is within the DQOs for this parameter.

LD analysis also was performed on the marine sediments for inorganic parameters. The RPDs are displayed in Table A-42. The RPD values for the LDs are similar to the RPD values for field duplicates. Results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating the mean and SD. Field precision results for marine sediment are displayed in Table A-41 and summarized below:

- **Trace Elements:** Trace elements in marine sediment exhibited an average field duplicate RSD of 85 percent.
- **Inorganic Parameters:** Inorganic parameters in marine sediment exhibited an average RSD of 93 percent.
- **Organic Parameters:** Field precision was not calculated for GRO, DRO, RRO, or BTEX in marine sediment because of ND results or associated blank contamination. TOC in marine

sediment exhibited an RSD of 116 percent. PAH analytes exhibited an RSD of 149 percent or less.

Results for field triplicate samples were compared to results for primary samples and field duplicates. Field triplicate sample results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating RPDs between the results for primary samples and field triplicate samples. Control charts for trace element parameters in marine sediment samples are presented in Charts A-220 through A-253 in Attachment 1.

These RPD calculations and the related control charts are another means to assess the precision of the test methods as they are being employed by the laboratories and also the precision of the field sampling procedures. Two variables, field sampling and laboratory techniques, are being evaluated in one effort. A primary-field duplicate sample pair is analyzed by the one primary laboratory. Consideration of the measurement of this pair as precise demonstrates that the field sampling methods used for sampling and the method used for testing can yield precise results and are therefore appropriate. Verification of the precision for a primary-field duplicate sample pair also indicates that the field team and the laboratory are able to obtain precise results by implementing their methods. The methods are more rigorously tested by the addition of a third entity—a second laboratory. Obtaining good precision in the comparison of results between the two laboratories further supports the capacity of the field teams and laboratories to achieve reproducible or precise results by implementing their methods.

Parameters for which at least 20 percent of the field triplicate sample RPDs exceeded the UCLs are summarized as follows:

- **Inorganic Parameters:**
  - Nitrogen as ammonia in four of four field triplicate samples of marine sediment evaluated exceeded the UCL established at 42 percent RPD.
  - Sulfate in one of four field triplicate samples of marine sediment evaluated exceeded the UCL established at 81 percent RPD.
- **Trace Elements:**
  - Cadmium in four of five field triplicate samples of marine sediment evaluated exceeded the UCL established at 29 percent RPD.
  - Calcium in two of three field triplicate samples of marine sediment evaluated exceeded the UCL established at 18 percent RPD.
  - Lead in four of 11 field triplicate samples of marine sediment evaluated exceeded the UCL established at 48 percent RPD.
  - Selenium in five of six field triplicate samples of marine sediment evaluated exceeded the UCL established at 39 percent RPD.
  - Sodium in one of four field triplicate samples of marine sediment evaluated exceeded the UCL established at 53 percent RPD.
  - Thallium in one of three field triplicate samples of marine sediment evaluated exceeded the UCL established at 39 percent RPD.

- Tin in four of four field triplicate samples of marine sediment evaluated exceeded the UCL established at 7 percent RPD
- Vanadium in one of four field triplicate samples of marine sediment evaluated exceeded the UCL established at 22 percent RPD.

Accuracy—Marine Sediment

Individual RSD results for marine sediment LCSs are presented in Table A-41. LCS results exhibited excellent accuracy for trace elements, inorganic parameters, and organic parameters, as indicated by mean percent recoveries that were within DQOs for accuracy for each analyte.

The accuracy for MS and MSD samples was assessed during data validation to ascertain any effects from matrix interference. Individual project-specific samples were flagged to indicate a bias in analysis, if necessary. MS and MSD results did not indicate an overall bias in recovery for the trace elements, inorganic parameters, or organic parameters.

Accuracy for analysis of marine sediment is excellent and acceptable, as demonstrated by LCS, MS, and MSD recoveries within the DQOs for accuracy established in the 2005 QAPP (Appendix G).

Representativeness—Marine Sediment

Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data where applicable.

Data for marine sediment are considered representative. Anomalies noted during data validation and issues related to comparability (as noted in the subsection “Comparability—Marine Sediment” below) and to sensitivity goals (as noted in the subsection “Sensitivity—Marine Sediment” also below) were insignificant in their overall effects on project data.

Comparability—Marine Sediment

Field sampling methods described in the FSPs for the marine studies were evaluated before data collection.

Individual laboratory analytical methods were evaluated (Table A-43) to ensure comparability between the primary laboratories and QA laboratories. Analysis of samples was conducted by using EPA-approved methods from the EPA water and wastewater manual (1983) and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996) and by using guidelines detailed in the Puget Sound Estuary Program, referencing *Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples* (EPA, 1997).

A small number of primary-field triplicate sample pairs were eligible for this evaluation. Among the control charts for marine sediment (Charts A-220 through A-253), mercury is the only parameter that yielded a sufficient number of pairs, 24 eligible pairs, to make a comparability statement with any degree of confidence. Other pairs were eliminated because sample results reported as ND for either the primary sample, field triplicate sample, or both were removed from the population when calculating RPDs.

Completeness—Marine Sediment

The completeness goal for the marine studies was established in the 2005 and 2008 QAPPs at 90 percent (Appendix G). Completeness was calculated from the amount of data determined to be valid after data validation, compared to the total amount of data acquired. Rejected data were considered not valid.

Marine sediment samples met the completeness goal for all parameters analyzed. Completeness was 100 percent for all parameters.

Sensitivity—Marine Sediment

Sample results reported as ND to the MDL were compared to the MRL DQOs in the 2005 and 2008 QAPPs (Appendix G). A summary of sensitivity for marine sediment is presented in Table A-44. Parameters for which at least 10 percent of ND results exhibited an MDL greater than the MRL DQO are summarized below:

- MRLs for 15 of 37 marine sediment samples yielding ND results for fluoride exceeded the MRL DQO of 2 milligrams per kilogram (mg/kg).
- MRLs for 15 of 25 marine sediment samples yielding ND results for cadmium-SEM exceeded the MRL DQO of 0.2 mg/kg.
- MRLs for three of 25 marine sediment samples yielding ND results for lead-SEM exceeded the MRL DQO of 3 mg/kg.
- MRLs for all 25 marine sediment samples yielded ND results for mercury-SEM that exceeded the MRL DQO of 0.01 mg/kg.

Marine sediment samples collected and analyzed for BTEX in 2004 met the 2004 MRL DQOs for sensitivity; however, the 2005 samples did not meet the lower 2005 sensitivity goals for the following parameters:

- Benzene, toluene, and ethylbenzene in 7 of 32 marine sediment samples in 2005 were ND and exceeded the 2005 MRL DQO of 0.005 mg/kg.
- Xylenes in 7 of 32 marine sediment samples in 2005 were ND and exceeded the 2005 MRL DQO of 0.002 mg/kg.

A.2.4.4 Marine Water

Precision—Marine Water

Marine water samples collected during 2004 were analyzed by SGS as the primary laboratory and those collected in 2008 were analyzed by CAS. Both laboratories performed LCS analyses for trace elements; the inorganic parameters chloride, fluoride, sulfate, total cyanide, and nitrogen as ammonia; TSS; and the organic parameters GRO, DRO, RRO, and BTEX. Individual LCS RSD results for marine water are presented in Table A-45 and summarized below:

- **Trace Elements:** LCS RSDs for marine water exhibited excellent precision, with RSDs less than or equal to 11 percent.

- **Inorganic Parameters:** LCS results for marine water exhibited excellent precision at 4 percent or less, except for TSS with precision of 11 percent.
- **Organic Parameters**: LCS results for marine water exhibited excellent precision for GRO, with 6 percent or less RSD.

Seventeen primary-field duplicate sample pairs of marine water were evaluated for trace elements; however, only one or two pairs were available for evaluation of inorganic and organic parameters. Twenty-six primary marine water samples were collected, giving a field duplicate frequency of 65 percent for trace elements and four or eight percent for the inorganic and organic parameters for this data set. Results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating the mean and SD. Field precision for marine water is displayed in Table A-45 and summarized below:

- **Trace Elements**: Results for trace elements in primary-field duplicate sample pairs for marine water exhibited an average RPD of 105 percent. A higher variability in measurement was observed for arsenic (180 percent RPD), manganese (121 percent RPD), and thallium (146 percent RPD).

Field triplicate samples of marine water were evaluated for trace elements; the inorganic parameters chloride, fluoride, sulfate, total cyanide, and nitrogen as ammonia; TSS; and the organic parameters GRO, DRO, RRO, and BTEX. Results reported as ND and flagged “U” during data validation (from associated blank contamination) were removed from the population when calculating the RPD between results for primary and field triplicate samples.

For trace elements in marine water collected in 2004, the RPDs between results for primary and field triplicate samples were considered imprecise and not comparable to the field precision reported for the RPDs between primary samples and field duplicates. The imprecision is attributable to issues related to representativeness and comparability for the primary marine water samples, as discussed below in the subsections “Representativeness—Marine Water” and “Comparability—Marine Water,” respectively.

For trace elements in marine water collected in 2008, the RPDs between results for primary and field triplicate samples demonstrate comparability. The control charts plotting the RPDs of the marine water pairs are included in Attachment 1 (Charts A-261 to A-274). The chart for boron presents the highest percentage of points above the UCL, six out of 24 points

As indicated in Table A-46, most inorganic and trace element parameters yielded acceptable precision. Boron (184 percent RPD) and lead (155 percent RPD) stand out as having high precision. Variability with boron in both field and laboratory measurements suggests that such variability is due to the chemistry of this element, as opposed to being an indication of performances of the laboratory and field sampling crews.

Accuracy—Marine Water

Individual RSD results for marine water LCSs are presented in Table A-45. LCS results exhibited excellent accuracy for trace elements and the inorganic and organic parameters as indicated by mean percent recoveries that were within DQOs for accuracy for each parameter.

The accuracy for MS and MSD samples was assessed during data validation to ascertain effects on accuracy from matrix interference. Individual project-specific samples were flagged to indicate a bias in analysis, if necessary. MS and MSD results did not indicate an overall bias in recovery for the trace elements or for inorganic and organic parameters.

Accuracy for marine water analysis is excellent and acceptable, as demonstrated by LCS, MS, and MSD recoveries within the DQOs for accuracy established in the 2005 and 2008 QAPPs (Appendix G). However, the 2004 data are not accurate when compared to ambient concentrations of trace minerals in water from Puget Sound (see the subsection "Comparability—Marine Water" below for further discussion).

In 2008, RTC prepared and submitted PE samples blind to the primary laboratory for ocean water (CAS) and the quality assurance laboratory (TA). RTC maintains accreditations for A2LA Proficiency Testing Providers.

The 2008 PE marine water results are presented in Table A-6.

- **Marine Water:** The 2008 PE marine water sample results were acceptable except for one result each at CAS and TA.
  - CAS reported TSS above the acceptance limit at 170 percent of the certified value.
  - TA reported cadmium below the acceptance limits at 38 percent of the certified value.

Representativeness—Marine Water

Field blanks and field duplicates were used to assess field and transport contamination and any variation in sampling techniques. These results were assessed during data validation, with the subsequent qualifying of data where applicable.

Data for marine water from the primary laboratory (SGS) are not considered representative of ambient concentrations of trace elements in marine water (see the subsection immediately below).

Comparability—Marine Water

Field sampling methods described in the FSPs for the marine studies were evaluated before data collection.

Individual laboratory analytical methods were evaluated (Table A-47) to ensure comparability between the primary laboratories and QA laboratories. Analysis of samples was conducted by using EPA-approved methods from the EPA water and wastewater manual (1983) and *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods*, Publication SW846 (EPA, 1996) and by using guidelines detailed in the Puget Sound Estuary Program, referencing *Recommended Guidelines for Measuring Metals in Puget Sound Marine Water, Sediment, and Tissue Samples* (EPA, 1997).

Results for primary samples, field duplicates, and field triplicates of marine water collected from Cook Inlet were compared to the criteria for comparability in the 2005 and 2008 QAPPs (Appendix G) during data validation. Results for primary marine water samples collected in 2004 exhibited major disagreement with field triplicate results for the trace elements arsenic, copper, nickel, and selenium. The individual methods of analysis at the primary and QA laboratories were further reviewed.

Preparation and extraction of 2004 marine water samples collected from Cook Inlet differed substantially between the primary (SGS) and QA (CAS) laboratories. The different procedures may explain some of the disagreements between the 2004 sample results from the primary laboratory and the QA laboratory. Laboratory preparatory methods are briefly explained below:

- SGS (primary laboratory): Marine water samples were diluted before analysis to mitigate interference of calcium, potassium, sodium, and magnesium, which would saturate components of the instrument for inductively coupled plasma/mass spectroscopy (ICP-MS) and increase the risk of potential carryover to other sample analyses.
- CAS (QA laboratory): Marine water samples were prepared by using a reductive precipitation technique (tetrahydroborate). This method incorporates a chemical separation to remove interfering matrix components so that final analysis can be performed with ICP-MS. This technique is referenced in Appendix D of the EPA guidelines (1997) as an alternative method for the analysis of marine waters.

Results for 2004 marine water collected from Cook Inlet were compared to the summary of ambient concentrations of trace metals in water from Puget Sound in the EPA guidelines (1997), recognizing that the glacial silt in Cook Inlet waters does distinguish the project samples from Puget Sound waters. Results for the Pebble Project marine water and referenced values from the Puget Sound Estuary Program for arsenic, copper, nickel, and selenium are presented in Table A-48. Results for trace elements in the primary samples collected from Cook Inlet are significantly biased high in comparison to referenced values for water from the open ocean or Puget Sound locations. Field triplicate sample results are considered to be very comparable with the referenced values.

As a result of the evaluation of comparability described above, 2004 results from the primary laboratory for analysis of marine water are suspicious and are considered not representative of ambient concentrations of trace elements in seawater.

Subsequent analysis of water samples collected from Cook Inlet in 2008 were processed by using the reductive precipitation technique at both the primary laboratory (CAS) and QA laboratory (TA) to improve data quality and overall comparability. Argon, which performed the data validation, observed the improvement in comparability in the 2008 marine water data set.

Completeness—Marine Water

The completeness goal for the marine studies was established in the 2005 and 2008 QAPPs (Appendix G) at 90 percent. Completeness was calculated from the amount of data determined to be valid after data validation, compared to the total amount of data acquired. Rejected data were considered not valid.

Marine water samples combined from 2004 and 2008 sampling events met the overall completeness goal relative to the methods and criteria established in the QAPP at 96.1 percent completeness. Individual completeness figures for arsenic, copper, nickel, selenium, and zinc did not meet the completeness goal.

Results for fluoride in the 2004 marine water sampling event were rejected because the technical 28-day holding time for fluoride analysis was not met.

Completeness for the metals was affected by results of the comparability review discussed above regarding the metals testing SGS conducted as the primary laboratory on 2004 marine water. See the subsection “Comparability—Marine Water” for additional information. Copper, nickel, selenium and zinc completeness results were also adversely affected as a result of data validation of 2008 marine water samples, which were tested by CAS as the primary laboratory. Qualifications were required because the T vs D metals results failed the validation criteria. Also, these metals were identified as contaminants in associated equipment rinse blanks.

Sensitivity—Marine Water

Sample results reported as ND to the MDL were compared to the MRL DQOs in the 2004 QAPP (Appendix G). A summary of sensitivity for marine water is presented in Table A-49. Results for the trace elements aluminum, antimony, beryllium, cadmium, chromium, cobalt, iron, lead, manganese, selenium, silver, thallium, tin, vanadium, and zinc were ND and exceeded the 2004 MRL DQOs. SGS performed sample dilution to mitigate interferences from the saltwater brine matrix, and the dilution significantly elevated the MRLs above MRL DQOs.

A.3 SUMMARY OF DATA QUALITY

Data quality for water quality, trace elements, seeps, and the marine study is summarized below.

A.3.1 WATER QUALITY

Data quality for surface water and groundwater is thoroughly discussed in Section A.2.2. The information below summarizes those parameters that may have been affected by QA/QC results, sample-handling issues, or both.

A.3.1.1 Surface Water

The data quality for surface water is based on an assessment of QA/QC parameters. Results for the trace elements sodium and for the inorganic parameter alkalinity should be treated as estimates because of the level of variability observed in the accuracy, precision, and representativeness indicators.

The DQOs for precision (i.e., RPDs) in the QAPPs are guidelines for attempting to estimate the level of uncertainty in the concentrations for these test parameters. For the surface water data set, the precision is excellent overall. Manganese, nickel, silver, thallium, and tin show variability from the perspective of laboratory testing and field sampling. Variability for nickel in 2004 through 2006 was pronounced at the laboratory and elevated, although not quite as high, for field precision. An improvement in precision was observed during the 2007 field season for nickel.

Data assessment for accuracy demonstrates that the accuracy controls are stable within the laboratory because all LCS results are within the QAPP DQOs. The 2006 PE results for fluoride, sulfate, and total phosphorus exhibit a noticeably high bias. The 2007 PE result for barium was biased high. This result was reported by ACZ, which was only responsible for water samples from the seep study. Considering that the apparent bias is from a single analysis for these parameters, more weight should be given to the larger and statistically more significant LCS results. Consequently, these particular outliers are not considered to be a significant cause for concern in terms of data usability. However, sulfate data points are showing variation in the precision and accuracy measurements. Seasonal variations were observed in the sulfate concentrations, which should be considered when using the data. No bias was observed with the 2008 PE sample results.

Seven trace elements—barium, chromium, cobalt, copper, lead, nickel, and zinc—were the source of three-quarters of the results that did not meet the QAPP criteria for T vs D metals. Lead, nickel, and zinc outliers alone represent half of the outliers, with nickel the highest contributor.

The issue with cobalt was identified as a systematic trend during the 2004 sampling season. Data were examined, and a controlled experiment that was conducted confirmed cobalt as a contaminant that was leaching from the inline water sample filters used for dissolved metal analyses. That particular brand of filter was removed from the process and replaced at the start of the 2005 sampling season by a brand of filter that was not exhibiting contamination concerns.

Lead, nickel, and zinc exhibited repeated failures in the T vs D comparison during most of the 2005 sampling season and during the 2006 season. Although the filters are suspected to be part of the problem, the cause has not been proven. It is possible that the filters are contributing lead, nickel, and zinc to the samples; however, one challenge is that the filter specifications and certifications are at sensitivity levels above those being reported by the testing laboratories. It is also possible that the ambient conditions where filtering is taking place is also contributing to the failures. An approach alternative to investigating the filters and the environment was the implementation of a revised filtering protocol at the beginning of the 2007 sampling season. This protocol was devised to isolate the overall filtering procedure from influences such as airborne and working surface contamination. This change did reduce, but not eliminate, the T vs D metals anomalies for these metals.

One possible future improvement to the filtering protocol is filtering the streams and seeps samples at the sampling locations instead of at the base camp. (Currently, groundwater samples are filtered at the sampling locations.) Another possibility is setting up a “clean room” at the base camp specifically for filtering; the critical element being a positive pressure air handling system with multiple filter phases. Arranging for filtering in the controlled environment of SGS, a fixed laboratory in Anchorage, in a timely fashion has not been possible because of the limited transportation options leaving Iliamna for Anchorage.

The parameter ortho-phosphorus did not meet the individual completeness goal based on comparison of results to total phosphorus during data validation. A discussion of the investigation concerning the validation of this parameter is presented in the technical memorandum *Phosphorus Technical Memorandum*, dated December 6, 2010.

A.3.1.2 Groundwater

All quality indicators discussed in Section A.2.2.2 reflect a high level of data acceptance and usability. The intra- and inter-laboratory statistics demonstrate variability for alkalinity, chloride, lead, molybdenum, nickel, and sulfate. Concentrations for those parameters should be used with some measure of uncertainty. Variability for some other trace elements and inorganic parameters is present, but does not indicate systematic trends influenced by both sample-collection and laboratory-testing protocols. Seasonal trends are apparent; for example, for sulfate. At times of the year when sulfate concentrations are low, variability in the analysis becomes more significant on a percentage basis.

Manganese and molybdenum demonstrate notable variability based on field duplicate results, with RPDs ranging from 0 to 148 percent. The precision of the LDs for these two trace elements is tight, which suggests that the variability is related to sampling. Comparison of the field triplicate data to the primary laboratory results supports this conclusion. The inconsistency in sampling will manifest itself more dramatically in sampling conducted during seasonal changes.

Variability for some metals, for example, bismuth, cadmium, selenium, silver and thallium, did show variability, but largely because of a small number of detections from the sample population that were low, close to the MDL.

The parameter ortho-phosphorus did not meet the individual completeness goal based on comparison of results to total phosphorus during data validation. A discussion of the investigation concerning the validation of this parameter is presented in the technical memorandum *Phosphorus Technical Memorandum*, dated December 6, 2010.

A.3.2 TRACE ELEMENTS

Data quality and usability for trace elements was assessed for sediment, vegetation, soil, fish tissue, and bivalve tissue.

A.3.2.1 Sediment

The data quality for sediment is excellent, as indicated by the assessment of the key data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity of measurement in analysis. Overall these indicators met the DQOs as specified in the QAPP, with the following conditions noted: the trace elements manganese, molybdenum, potassium, and silver were found to have exhibited a high variability in measurement during the assessment of precision from duplicate sample results. The increased variability is not considered a data quality problem, but rather may be due to a random distribution of RPDs, possibly related to matrix heterogeneity.

Aluminum and potassium results for sediments in 2007 may have a high bias, indicated by the high result reported by the primary laboratory for the PE sample that year. Repeated testing of the sample yielded a similar result.

The usability of the trace element data for sediment was assessed during data validation, and data qualifier codes (flags) were appended to the data as necessary. The data are considered valid as qualified and are acceptable for use.

Trace element data for sediment are considered representative and comparable.

A.3.2.2 Vegetation

The data quality for vegetation is excellent, as indicated by the assessment of the key data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity of measurement in analysis. Overall these indicators met the DQOs as specified in the QAPP with the following conditions noted: the trace elements iron, magnesium, manganese, and potassium and the inorganic parameters chloride (2004 only) and fluoride were found to have exhibited a high variability in measurement during assessment of precision from duplicate sample results. The increased variability is not considered a data quality problem, but rather may be due to a random distribution of RPDs, possibly related to matrix heterogeneity.

The usability of the trace element data for vegetation was assessed during data validation, and data qualifier codes (flags) were appended to the data as necessary. The data are considered valid as qualified and are acceptable for use.

Trace element data for vegetation are considered representative and comparable.

A.3.2.3 Soil

The data quality for soil is excellent, as indicated by the assessment of the key data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity of measurement in analysis. Overall these indicators met the DQOs as specified in the QAPP, with the following conditions noted: the trace elements bismuth, potassium, and thallium were found to have exhibited a high variability in measurement during assessment of precision from duplicate sample results. The increased variability is not considered a data quality problem, but rather may be due to a random distribution of RPDs, possibly related to matrix heterogeneity. An additional comment for thallium is the limited number of sample detections, plus those detections were close to the MDL, which leaves a limited data set for statistical evaluations.

Nitrogen as ammonia in soils in 2007 may have a high bias, indicated by the high result reported by the primary laboratory for the PE sample that year.

The usability of the trace element data for soil was assessed during data validation, and data qualifier codes (flags) were appended to the data as necessary. The data are considered valid as qualified and are acceptable for use.

Trace element data for soil are considered representative and comparable.

A.3.2.4 Fish and Mussel Tissues

The data quality for fish and mussel tissue is excellent, as indicated by the assessment of the key data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity of measurement in analysis. Overall these indicators met the DQOs as specified in the QAPP, with the following conditions noted: the trace elements copper and zinc were found to have exhibited variability in measurement during assessment of precision from laboratory duplicate results, an indication of laboratory performance. The preparation of duplicates conducted at the laboratory of samples that had formerly been called field duplicates demonstrated variability for chromium, lead, and nickel. The difference between these two types of duplicates is that laboratory duplicates are created from one sample portion, whereas field duplicates are created by taking one portion from each of two sample portions.

Accuracy for analysis of fish and mussel tissue is excellent and acceptable, as indicated by the successful performance of known spiked matrices at the laboratory.

The usability of the trace element data for fish and mussel tissue was assessed during data validation, and data qualifier codes (flags) were appended to the data as necessary. The data are considered valid as qualified and are acceptable for use.

Trace elements data for fish and mussel are considered representative and comparable.

A.3.3 MARINE STUDY

Data quality and usability were assessed for the matrices of marine water, marine sediment, and marine fish and bivalve tissue.

A.3.3.1 Marine Tissues

The data quality for marine tissue is excellent as indicated by the assessment of the key data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity of measurement in analysis. Overall these indicators met the DQOs as specified in the QAPP.

The usability of the marine tissue data was assessed during data validation, and data qualifier codes (flags) were appended to the data as necessary. The data are considered valid as qualified and are acceptable for use. Trace elements data for marine tissues are considered representative and comparable.

A.3.3.2 Marine Sediment

The data quality for marine sediment is excellent, as indicted by the assessment of the key data quality indicators of precision, accuracy, representativeness, comparability, completeness, and sensitivity of measurement in analysis. Overall, these indicators met the DQOs as specified in the QAPP, with the following conditions noted: the trace elements cadmium, calcium, lead, selenium, and thallium were found to have exhibited variability in measurement during assessment of precision from duplicate sample results. The increased variability is not considered a data quality problem, but rather may be due to a random distribution of RPDs, possibly related to matrix heterogeneity, and to the small number of duplicate sample pairs available for evaluation.

The usability of the marine sediment data was assessed during data validation, and data qualifier codes (flags) were appended to the data as necessary. The data are considered valid as qualified and are acceptable for use.

Trace elements data for marine sediments are considered representative and comparable.

A.3.3.3 Marine Water

The data quality for marine water is acceptable, as indicated by the assessment of the key data quality indicators of precision, accuracy, completeness, and sensitivity of measurement in analysis. Overall these indicators met the DQOs as specified in the QAPP. However, the key data quality indicators of comparability and representativeness were not met for arsenic, copper, nickel, and selenium in the 2004 samples. The trace elements arsenic, copper, nickel, selenium, and zinc exhibited unacceptable variability in measurement noted during assessment of precision from the results for primary samples and field triplicate samples. The imprecision is attributable to comparability and representativeness issues for the primary marine water samples.

The usability of the marine water data was assessed during data validation, and data qualifier codes (flags) were appended to the data as necessary. Marine water data for 2004 from the primary laboratory are considered not representative of ambient concentrations of trace elements in seawater (see Table A-47 for a summary of the results for arsenic, copper, nickel, and selenium). Marine water data for 2008 are considered valid as qualified (as applicable) and are acceptable for use.

A.4 REFERENCES

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A.5 GLOSSARY

Accuracy—a measure of the degree to which a measurement agrees with a known or true value. Accuracy is typically expressed as a percentage.

Aliquot—a measured portion.

Comparability—the level of confidence with which one data set can be qualitatively compared with another. The conditions and techniques under which each data set is generated are reviewed to determine whether a similar or the same result can be obtained by an alternative technique.

Completeness—an assessment of the number of usable data points compared to the total number of data points collected. Usability is determined during data validation that is independent of the entity that generated the data. Completeness is typically expressed as a percentage.

Diesel range organics—defined by the Alaska Department of Environmental Conservation as all hydrocarbon material containing anywhere from 10 to 24 carbon atoms as n-alkanes.

Double blind performance evaluation samples—samples fabricated by using the site matrix and fortified with known constituents of concern that are inserted within a shipment of regular field samples to the laboratory. The laboratory is not aware it is receiving a test sample, much less the concentration of constituents added to the matrix. These samples are a blind test of the accuracy of test methods as they are implemented by the laboratory.

Equipment rinsate sample—laboratory-purified water used to rinse field equipment that comes in contact with the sample. A rinse is conducted after each sampling location. The rinse is typically discarded; however, at a specific frequency (5 percent for this project), a rinsate is retained and submitted to the laboratory for testing. This quality control measure assesses the effectiveness of the rinse procedure for removing contaminants.

Field blank (deionized water blank).—a sample of the laboratory-purified used to decontaminate field equipment that is tested to verify that it is not a contamination source. The water is collected directly into sample containers without coming into contact with field equipment.

Field duplicate—a second portion of sample that is collected in addition to and immediately after the primary sample to assess the reproducibility of the field procedures.

Field triplicate—a one third portion of a sample collected in addition to and immediately after the primary and duplicate samples to assess the reproducibility of the procedures of the primary laboratory. This triplicate sample is sent to a second laboratory, which is known as the quality assurance laboratory.

Gasoline range organics—defined by the Alaska Department of Environmental Conservation as all hydrocarbon material containing anywhere from six to nine carbon atoms as n-alkanes.

Inorganic parameter—an inorganic compound that is also known as a water-quality indicator. Examples are pH, conductivity, solids, chloride, nitrate, and sulfate.

Laboratory control sample—a sample in which a known amount of an element or parameter being tested is added to a purified matrix similar in nature to field samples being tested to assess the efficiency of the analytical method as it is employed by the laboratory. The results of this analysis are expressed as a percent recovery.

Laboratory duplicate—a laboratory sample consisting of one of separate portions of a sample taken from the sample container(s) filled in the field that is prepared and analyzed separately. The duplicate is a test of the precision or reproducibility of an analytical method as it is employed at the laboratory for a given sample matrix.

Matrix spike sample—a sample in which a known amount of an element or parameter being tested is added to a sample of the matrix collected in the field to assess the effect of the matrix, if any, on the efficiency of the analytical method as it is employed by the laboratory. The results of this analysis are expressed as a percent recovery.

Method blank—a sample in which a purified matrix similar in nature to field samples being tested is analyzed to assess the possibility of background contamination at the laboratory that may occur during storage, preparation, or analysis of samples.

Method detection limit—the lowest possible concentration at which an element or parameter can be detected with 99 percent confidence that it is truly present.

Method reporting limit—the lowest possible concentration at which the concentration of an element or parameter can be calculated with 99 percent confidence in the value.

Organic parameter—a carbon-based compound for which samples are analyzed (a targeted list for the Pebble Project environmental baseline studies is given in the Quality Assurance Project Plan). Sub-groups of this classification include volatile organics (solvents, petroleum-related compounds, and chlorinated and brominated products), semivolatile organics (heavier weight aromatic hydrocarbons, ethers, solvents, pesticides, and herbicides), pesticides and polychlorinated biphenyls and petroleum hydrocarbons (gasoline-, diesel-, and residual-range organics).

Performance evaluation sample—a quality control sample prepared by a company independent of the laboratory to assess the level of accuracy and representativeness of the data being generated by the laboratory. This sample is a matrix (e.g., water, soil, animal tissue) similar to the matrix being tested by the laboratory for the project. A known amount of the element or parameter being tested is added to the matrix.

Precision—a measure of reproducibility among independent measurements.

Quality assurance —a systematic process of verifying whether a product or protocol is meeting specified requirements that increase confidence in the product or outcome of a protocol. An effective QA program improves work processes by incorporating consistencies and efficiencies during the program development phase of a project.

Quality Assurance Project Plan—a document that outlines the quality assurance and quality control protocols for field and laboratory activities to be followed by all companies participating in these activities. The establishment of these protocols is intended to assure consistency and ultimate generation of data of known quality.

Quality control—a procedure or set of procedures to ensure a product or service meets a defined set of criteria, determined by a customer’s needs or the specifications of a regulatory entity.

Relative percent difference—a comparison of two values to assess the level of agreement between them, otherwise known as precision. The calculation is the absolute value of the difference between two values, divided by their average, and multiplied by 100.

Relative standard deviation—a statistical calculation for determining the precision of three or more values. The calculation is the standard deviation of the values, divided by their average, and multiplied by 100. The value is expressed as a percentage (percent relative standard deviation or percent recovery standard deviation).

Representativeness—a measure of how closely an outcome reflects the actual concentration or distribution of a constituent in the sample matrix. Representativeness is sometimes expressed by calculation of a relative percent difference, standard deviation, or percent relative standard deviation.

Residual range organics—defined by the Alaska Department of Environmental Conservation as all hydrocarbon material containing anywhere from 25 to 36 carbon atoms as n-alkanes.

Seep—groundwater that flows from a specific point in the ground. A seep is typically lower in volume and flow rate relative to a stream or river.

Sensitivity—a measure of the lowest possible concentration that can be reliably detected by a given method and/or piece of equipment. This lowest detectable concentration is referred to as the method detection limit. Sensitivity also refers to the lowest possible concentration at which a method and/or piece of equipment can reliably report a concentration. This quantitative value is referred to as the method reporting limit.

Standard reference material—a matrix (aqueous or solid) that is experimentally and statistically certified to contain a set list of elements and/or parameters. A standard reference material commonly is used for performance evaluation samples and laboratory control samples to assess accuracy in the laboratory.

Trace elements—(a) when referring to analyses, naturally occurring elements (mostly metals) that are being tested for in various matrices. The list of elements being targeted for testing can vary depending on the matrix. (b) In Pebble Project documents, also a reference to the trace elements program, which is one component of the environmental baseline studies.

Transportation corridor—the possible area in which a road may be located to connect the mine study area to the port study area.

Trip blank—a purified matrix similar in nature to the matrix being tested, in the same container type and size, and having the same preservative (if any) as is being used for the subject test. This blank is prepared at the laboratory and included in the bottle kit prepared for the field sampling teams. This blank accompanies the empty sample containers to the field and stays with the samples during storage at the site and during transportation back to the laboratory. The intent is to monitor for the possibility of airborne contamination of the containers or samples and cross-contamination between samples.

Mine study area—area in the vicinity of the ore body where baseline environmental studies are being conducted.

TABLES

TABLE A-1

Number of Environmental Samples Collected and Parameters Analyzed

Sample Type	Samples Analyzed per Year					Total Samples Analyzed	Total Parameters Analyzed[c]
	2004[a]	2005[a,b]	2006[b]	2007[b]	2008		
Surface Water Streams, Mine Study Area	341	491	422	734	559	2547	188,478
Surface Water Seeps, Mine Study Area	24	62	145	477	119	827	61,198
Soil, Mine Study Area	107	114	49	36	0	306	10,404
Sediment, Mine Study Area	96	83	58	42	0	279	9,486
Vegetation, Mine Study Area	102	252	217	284	0	855	23,940
Aquatic Vegetation, Mine Study Area	0	3	58	43	0	104	2,912
Groundwater, Mine Study Area	54	150	166	171	213	754	55,796
Fish Tissue, Mine Study Area	299	290	60	83	64	796	11,144
Lake Mussels, Mine Study Area	0	9	7	1	0	17	238
Mammal Tissue, Mine Study Area	0	0	0	6	0	6	90
Surface Water, Transportation Corridor	89	133	8	6	0	236	17,464
Groundwater, Transportation Corridor	10	18	0	0	0	28	2,072
Sediment, Transportation Corridor	48	64	7	7	0	126	4,284
Vegetation, Transportation Corridor	194	0	63	60	0	317	8,876
Soil, Transportation Corridor	25	0	9	0	0	34	1,156
Marine Water	14	0	0	0	47	61	4514
Marine Sediment	41	9	0	0	34	84	2,856
Marine Fish	5	11	0	0	55	71	994
Marine Mussels, Bivalves, Crabs, Snails	15	0	0	0	10	25	350
Marine Vegetation	0	0	0	0	12	12	336
Wetland Surface Water			36	168		204	1428
Wetland Groundwater			19	6		25	175
Wetland Soil	0	0	0	0	302	302	1208
Totals	**1,464**	**1,689**	**1,324**	**2,124**	**1,415**	**8,014**	**409,399**

Notes:

All totals were generated in 2009 using the sample tables in the database.

Trip blanks are excluded.

a. These numbers replace counts used in the past

b. Duplicate QA fish samples were changed to laboratory duplicates in late 2008, resulting in lower fish counts for the period of 2004 to 2008.

c. Analyte count is based on an approximate average number of analytes typically tested for each matrix. This is not an actual count per year.

TABLE A-2a
Summary of Parameters Analyzed for Each Sample Type

Parameter	Surface Water	Ground-water	Surface Soil	Sediment	Vegetation	Terrestrial Fish Tissue	Marine Fish Tissue	Terrestrial Bivalve Tissue	Marine Bivalve Tissue
Wet Chemistry									
pH	2004-2008	2004-2008	2007						
Specific Conductance	2004-2008	2004-2008							
Acidity	2004-2008	2004-2008							
Alkalinity	2004-2008	2004-2008							
Ammonia	2004-2008	2004-2008	2004-2007	2004-2007	2004				
AVS-SEM[a]				2006					
Chloride	2004-2008	2004-2008	2004-2007	2004-2007	2004				
Cyanide, total	2004-2008	2004-2008	2004-2007	2004-2007	2004-2007				
Cyanide, WAD	2004-2008	2004-2008							
Fluoride	2004-2008	2004-2008	2004-2007	2004-2007	2004				
Nitrite and Nitrate	2004-2008	2004-2008							
Orthophosphate	2006-2007	2006-2007							
Phosphorus	2004-2008	2004-2008							
Sulfate	2004-2008	2004-2008	2004-2007	2004-2007	2004				
Sulfur				2006					
Thiocyanate	2004-2008	2004-2008							
Total Dissolved Solids	2004-2008	2004-2008							
Total Suspended Solids	2004-2008	2004-2008							
Metals									
Mercury	2004-2008	2004-2008	2004-2007	2004-2007	2004-2007	2004-2008	2008	2005	2004, 2008
Metals[b]	2004-2008	2004-2008	2004-2007	2004-2007	2004-2007	2004-2008	2004-2005, 2008	2005	2004, 2008
Organics									
Saturated Hydrocarbons									2008
VOCs	2004-2007			2005 & 2007					
SVOCs	2004-2007			2005 & 2007					2008
Dissolved Organic Carbon[c]	2004-2008	2008							
Total Organic Carbon	2007		2004-2007	2005 & 2007					
Fuels	2007		2004-2006	2005 & 2007					
Pesticides	2004-2005								
PCBs	2005 & 2007								

Notes:
a. AVS-SEM = acid volatile sulfides-simultaneously extracted metals (Cd, Cu, Pb, Hg, Ni, Zn)
b. Al, Sb, As, Ba, Be, Bi, B, Ca, Cd, Co, Cr, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si, Ag, Na, Tl, Sn, V, Zn
Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Mo, Ni, Se, Ag, Tl, and Zn analyzed in fish and bivalve tissue.
c. Dissolved organic carbon analyzed on streams samples.
PAH = polynuclear aromatic hydrocarbon
SVOC = semivolatile organic compound
VOC = volatile organic compound
WAD = weak acid dissociable

TABLE A-2b

Summary of Completeness Measure

	Completeness (%)									
Analyte	**Surface Water**	**Ground-water**	**Sediment**	**Soil**	**Vege-tation**	**Fish and Mussel Tissue**	**Marine Fish and Bivalve**	**Marine Plant Tissue**	**Marine Sediment**	**Marine Water**
Inorganic Parameters										
Acidity, total	100	100	NA	NA	NA	NA	NA	NA	NA	NA
Acid-Volatile Sulfide	NA	NA	100	NA	NA	NA	NA	NA	100	NA
Alkalinity, total	100	100	NA	NA	NA	NA	NA	NA	NA	NA
Ammonia, as Nitrogen	100	100	100	100	100	NA	NA	NA	100	100
Chloride	100	100	100	100	100	NA	NA	NA	100	100
Total Cyanide	99.9	100	100	100	100	NA	NA	NA	100	100
Cyanide, weak acid dissociable	99.8	100	100	NA	NA	NA	NA	NA	NA	NA
Fluoride	99.8	100	99.3	99.6	100	NA	NA	NA	100	**0**
Hardness, total	100	100	NA	NA	NA	NA	NA	NA	NA	100
Hardness, dissolved	100	100	NA	NA	NA	NA	NA	NA	NA	100
Ion Balance	100	100	NA	NA	NA	NA	NA	NA	NA	NA
Nitrogen, total Kjeldahl	NA	NA	NA	NA	NA	NA	NA	NA	100	NA
Nitrogen, Nitrate	100	100	NA	NA	NA	NA	NA	NA	NA	NA
Nitrogen, Nitrate-Nitrite	97.9	99.8	NA	NA	NA	NA	NA	NA	NA	NA
Nitrogen, Nitrite	100	100	NA	NA	NA	NA	NA	NA	NA	NA
pH	100	100	NA	100	NA	NA	NA	NA	NA	NA
Phosphorus, Total (as P)	100	100	NA	NA	NA	NA	NA	NA	NA	NA
Phosphorus, Total as Orthophosphate	**86.9**	**63**	NA	NA	NA	NA	NA	NA	NA	NA
Specific Conductance	100	100	NA	NA	NA	NA	NA	NA	NA	NA
Sulfate	99.9	100	100	100	100	NA	NA	NA	100	100
Thiocyanate	99.8	99.3	NA	NA	NA	NA	NA	NA	NA	NA
Total Dissolved Solids	100	100	NA	NA	NA	NA	NA	NA	NA	NA
Total Lipids	NA	NA	NA	NA	NA	100	100	NA	NA	NA
Total Solids	100	100	100	100	100	100	100	100	100	NA
Total Suspended Solids	100	100	NA	NA	NA	NA	NA	NA	NA	100

	Completeness (%)									
Analyte	**Surface Water**	**Ground-water**	**Sediment**	**Soil**	**Vege-tation**	**Fish and Mussel Tissue**	**Marine Fish and Bivalve**	**Marine Plant Tissue**	**Marine Sediment**	**Marine Water**
Metals										
Aluminum, total	100	100	100	100	100	NA	NA	NA	100	100
Aluminum, dissolved	97.9	97.3	NA	NA	NA	NA	NA	NA	NA	100
Antimony, total	100	100	100	100	100	100	100	100	100	100
Antimony, dissolved	96.4	95.9	NA	NA	NA	NA	NA	NA	NA	100
Arsenic, total	100	100	100	100	100	100	100	100	100	**84.6**
Arsenic, dissolved	99.4	99.5	NA	NA	NA	NA	NA	NA	NA	**84.6**
Barium, total	100	100	100	100	100	NA	NA	NA	100	100
Barium, dissolved	**89.4**	99.1	NA	NA	NA	NA	NA	NA	NA	100
Beryllium, total	100	100	100	100	100	100	100	100	100	100
Beryllium, dissolved	100	99.6	NA	NA	NA	NA	NA	NA	NA	96.2
Bismuth, total	100	100	100	100	100	NA	NA	NA	100	100
Bismuth, dissolved	99.5	99.8	NA	NA	NA	NA	NA	NA	NA	100
Boron, total	100	100	100	100	100	NA	100	100	100	NA
Boron, dissolved	98.4	97	NA	NA	NA	NA	NA	NA	NA	100
Cadmium, total	100	100	100	100	100	100	100	100	100	100
Cadmium, dissolved	99.6	99.6	NA	NA	NA	NA	NA	NA	NA	96.2
Cadmium, SEM	NA	NA	100	NA	NA	NA	NA	NA	100	NA
Calcium, total	100	100	100	100	100	NA	NA	NA	100	100
Calcium, dissolved	98.3	99.6	NA	NA	NA	NA	NA	NA	NA	100
Chromium, total	100	100	100	100	100	100	100	100	100	100
Chromium, dissolved	91.6	98.2	NA	NA	NA	NA	NA	NA	NA	92.3
Cobalt, total	100	100	100	100	100	NA	NA	NA	100	100
Cobalt, dissolved	**88.2**	97.9	NA	NA	NA	NA	NA	NA	NA	100
Copper, total	100	100	100	100	100	100	100	100	100	**84.6**
Copper, dissolved	**80.2**	96.8	NA	NA	NA	NA	NA	NA	NA	**80.8**
Copper, SEM	NA	NA	100	NA	NA	NA	NA	NA	100	NA
Iron, total	100	100	100	100	100	NA	NA	NA	100	100
Iron, dissolved	98.7	99.5	NA	NA	NA	NA	NA	NA	NA	100
Lead, total	100	100	100	100	100	100	100	100	100	100
Lead, dissolved	**80.1**	92.5	NA	NA	NA	NA	NA	NA	NA	96.2
Lead, SEM	NA	NA	100	NA	NA	NA	NA	NA	100	NA
Magnesium, total	100	100	100	100	100	NA	NA	NA	100	100
Magnesium, dissolved	98	99.3	NA	NA	NA	NA	NA	NA	NA	100

Analyte	Completeness (%)									
	Surface Water	Ground-water	Sediment	Soil	Vege-tation	Fish and Mussel Tissue	Marine Fish and Bivalve	Marine Plant Tissue	Marine Sediment	Marine Water
Metals (cont.)										
Manganese, total	100	100	100	100	100	NA	NA	NA	100	100
Manganese, dissolved	95.3	97.7	NA	NA	NA	NA	NA	NA	NA	100
Mercury, total	100	100	100	100	100	100	100	100	100	100
Mercury, dissolved	NA	99.8	NA	NA	NA	NA	NA	NA	NA	NA
Mercury, methyl-	NA	NA	NA	NA	NA	100	NA	NA	NA	NA
Mercury, SEM	NA	NA	100	NA	NA	NA	NA	NA	100	
Molybdenum, total	100	100	100	100	100	100	100	100	100	100
Molybdenum, dissolved	94.8	93.2	NA	NA	NA	NA	NA	NA	NA	100
Nickel, total	100	100	100	100	100	100	100	100	100	84.6
Nickel, dissolved	66.5	93.2	NA	NA	NA	NA	NA	NA	NA	84.6
Nickel, SEM	NA	NA	100	NA	NA	NA	NA	NA	100	NA
Potassium, total	100	100	100	100	100	NA	NA	NA	100	100
Potassium, dissolved	97.4	98.9	NA	NA	NA	NA	NA	NA	NA	100
Selenium, total	100	100	100	100	100	100	100	100	100	80
Selenium, dissolved	100	99.8	NA	NA	NA	NA	NA	NA	NA	75
Silicon, total	100	100	NA	NA	NA	NA	NA	NA	NA	100
Silver, total	100	100	100	100	100	100	100	100	100	100
Silver, dissolved	99.6	99.5	NA	NA	NA	NA	NA	NA	NA	100
Sodium, total	100	100	100	100	100	NA	NA	NA	100	100
Sodium, dissolved	98.3	98.9	NA	NA	NA	NA	NA	NA	NA	100
Thallium, total	100	100	100	100	100	100	100	100	100	100
Thallium, dissolved	99.4	99.8	NA	NA	NA	NA	NA	NA	NA	100
Tin, total	100	100	100	100	100	NA	100	100	100	100
Tin, dissolved	99.5	99.8	NA	NA	NA	NA	NA	NA	NA	100
Vanadium, total	100	100	100	100	100	NA	NA	NA	100	100
Vanadium, dissolved	99.4	98.8	NA	NA	NA	NA	NA	NA	NA	100
Zinc, total	100	100	100	100	100	100	100	100	100	100
Zinc, dissolved	75.7	91.1	NA	NA	NA	NA	NA	NA	NA	84.6
Zinc, SEM	NA	NA	100	NA	NA	NA	NA	NA	100	NA

	Completeness (%)									
Analyte	**Surface Water**	**Ground-water**	**Sediment**	**Soil**	**Vege-tation**	**Fish and Mussel Tissue**	**Marine Fish and Bivalve**	**Marine Plant Tissue**	**Marine Sediment**	**Marine Water**
Organics										
Dissolved Organic Carbon	100	100	100	100	NA	NA	NA	NA	NA	NA
Total Organic Carbon	100	NA	NA	NA	NA	NA	100	NA	100	NA
Diesel Range Organics	100	NA	100	100	NA	NA	100	NA	100	100
Gasoline Range Organics	100	NA	85.7	NA	NA	NA	100	NA	100	100
Residual Range Organics	100	NA	100	100	NA	NA	100	NA	100	110
Pesticides	100	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polychlorinated Biphenyls (PCBs)	100	NA	NA	NA	NA	NA	NA	NA	NA	NA
Volatile and Semivolatile Organic Compounds	100	NA	100	NA	NA	100	100	NA	100	100
Totals	97.9	99.1	100	100	100	100		100	100	96.1

Notes:

a. Units for specific conductance are micromhos/centimeter (mmhos/cm).

— = DQO not established

NA = not applicable, parameter was not scheduled for analysis

ND = not detected

SEM = simultaneously extracted metals

TABLE A-3
Field Audit Summary

			2004	**2005**		**2006**		**2007**		**2008**	
Study	**Study Area**	**Field Team**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**	**Winter**	**Summer**
Water Quality	Transportation Corridor	BEESC — streams	x	x	x		x				
	Mine Study Area	HDR — streams		x	x	x		x	x	x	x
		HDR — seeps			x	x	x	x	x	x	x
		HDR — Iliamna Lake			x				x		
		SLR — groundwater			x	x		x	x	x	x
		CH2M Hill — streams/seeps	x								
Trace Elements	Transportation Corridor	BEESC — veg/soil	x		x		x				
	Mine Study Area	SLR — veg/soil			x		x		x		
		HDR — fish tissues	x		x		x				
		HDR — Iliamna Lake			x				x		
		CH2M Hill — vegetation/soil	x								

TABLE A-4a

Summary of Primary/QA Analytical Laboratories for Environmental Baseline Studies, April 2004 through May 2007

Media	Primary Laboratory	QA Laboratory
WS and WG (all parameters except low-level Hg)	SGS – Anchorage, AK	CAS – Kelso, WA
WS and WG (low-level Hg only)	TA – Portland, OR	CAS – Kelso, WA
Soil/Sediment[a]	SGS – Anchorage, AK	CAS – Kelso, WA
Soil/Sediment[b,c]	CAS – Kelso, WA	TA – Pittsburg, PA,[b] and Austin, TX[c]
Fish and Bivalve Tissue	CAS – Kelso, WA	TA – Tacoma, WA
Vegetation	CAS – Kelso, WA	TA – Tacoma, WA
Mammal	CAS – Kelso, WA	TA – Tacoma, WA
Marine Water	CAS – Kelso, WA	TA - Portland, OR, and Tacoma, WA
Marine Sediment	CAS – Kelso, WA	TA - Portland, OR, and Tacoma, WA
	Texas A&M GERG – College Station, TX	
Marine Fish/Mussels	CAS – Kelso, WA	TA - Tacoma, WA
	Texas A&M GERG – College Station, TX	TA - Tacoma, WA

Notes:

a. CN, Cl, F, SO_4, NH_3, metals, Hg (2004-2006)

b. Acid volatile sulfides—simultaneously extractable metals (Cd, Cu, Pb, Ni, Zn, Hg)

c. Total sulfur

CAS = Columbia Analytical Services, Inc.

GERG = Geochemical and Environmental Research Group

SGS = SGS North America, Inc.

TA – Portland, OR = TestAmerica, Inc., formerly known as North Creek Analytical, Inc. (NCA)

TA – Tacoma, WA = TestAmerica, Inc., formerly known as Severn Trent Laboratories (STL)

WG = groundwater

WS = surface water

TABLE A-4b

Summary of Primary/QA Analytical Laboratories for Environmental Baseline Studies, June 2007 through December 2007

Media	Primary Laboratory	QA Laboratory
WS (excluding seeps) and WG (all parameters except low-level Hg)	SGS – Anchorage, AK	CAS – Kelso, WA
WS (Seeps, all parameters except low-level Hg)	ACZ – Steamboat Springs, CO	CAS – Kelso, WA
WS and WG (low-level Hg only)	TA – Portland, OR	CAS – Kelso, WA
Soil	ACZ – Steamboat Springs, CO	CAS – Kelso, WA
Sediment[a]	TA – Tacoma, WA	CAS – Kelso, WA
Fish and Bivalve Tissue	CAS – Kelso, WA	TA – Tacoma, WA
Vegetation	CAS – Kelso, WA	TA – Tacoma, WA

Notes:

a. CN, Cl, F, SO_4, NH_3, metals, Hg

ACZ = ACZ Laboratories, Inc

CAS = Columbia Analytical Services, Inc.

SGS = SGS North America, Inc.

TA – Portland, OR = TestAmerica, Inc., formerly known as North Creek Analytical, Inc. (NCA)

TA – Tacoma, WA = TestAmerica, Inc., formerly known as Severn Trent Laboratories (STL)

WG = groundwater

WS = surface water

TABLE A-4c

Summary of Primary/QA Analytical Laboratories for Environmental Baseline Studies, January 2008 through December 2008

Media	Primary Laboratory	QA Laboratory
WS (seeps and no seeps) and WG	SGS – Anchorage, AK	CAS – Kelso, WA
Soil	SGS – Anchorage, AK	-
Fish and Bivalve Tissue	CAS – Kelso, WA	-
Vegetation, Terrestrial	CAS – Kelso, WA	TA - Tacoma, WA
Marine Vegetation	CAS – Kelso, WA	TA - Tacoma, WA
Marine Water	CAS – Kelso, WA	TA - Tacoma, WA
Marine Sediment	CAS – Kelso, WA	TA - Tacoma, WA
	Texas A&M GERG – College	TA - Tacoma, WA
Marine Fish/Mussels	CAS – Kelso, WA	TA - Tacoma, WA
	Texas A&M GERG – College	TA - Tacoma, WA
Mammal Tissue	CAS – Kelso, WA	TA - Tacoma, WA

Notes:

CAS = Columbia Analytical Services, Inc.

GERG = Geochemical and Environmental Research Group

SGS = SGS North America, Inc.

TA – Tacoma, WA = TestAmerica, Inc., formerly known as Severn Trent Laboratories (STL)

WG = groundwater

WS = surface water

TABLE A-5a

2006 Results for Blind Performance Evaluation of Water Samples

Parameter	ERA Certified Value	Units	Performance Acceptance Limit	SGS Result	Difference from Certified Value, SGS	CAS Result	Difference from Certified Value, CAS	NCA Result	Difference from Certified Value, NCA
Inorganic Parameters									
Total Dissolved Solids @ 180°C	37.0	mg/L	32.0 - 42.0	**42.5**	115%	**52**	141%	NR	
Total Suspended Solids	10.0	mg/L	8.27 - 10.8	10.3	103%	**6.0**	60%	NR	
Total Alkalinity as $CaCO_3$	7.40	mg/L	6.70 - 8.10	7.0	95%	**ND, <0.8**	<11%	NR	
Specific Conductance, @ 25°C	59.4	µmhos/cm	55.2 - 63.6	**50**	84%	**64**	108%	NR	
Chloride	11.2	mg/L	10.3 - 12.3	12.1	108%	11.2	100%	NR	
Fluoride	0.460	mg/L	0.420 - 0.512	**1.66**	361%	**0.4**	87%	NR	
Sulfate	1.82	mg/L	1.60 - 2.06	**10.1**	556%	1.7	94%	NR	
Acidity as $CaCO_3$	70.6	mg/L	66.0 - 73.6	67.5	96%	**ND, <2**	<3%	NR	
WAD Cyanide	0.050	mg/L	0.0365 - 0.0628	**0.028**	56%	**0.13**	260%	NR	
Total Cyanide	0.10	mg/L	0.0731 - 0.125	**0.062**	62%	**0.13**	130%	NR	
Thiocyanate	6.06	mg/L	4.24 - 7.88	6.0	99%	7.0	116%	NR	
Ammonia as Nitrogen	0.613	mg/L	0.520 - 0.706	**0.499**	81%	0.63	103%	NR	
Nitrate as Nitrogen	0.719	mg/L	0.633 - 0.795	**ND, <0.031**	<43%	NR		NR	
Nitrate and Nitrite	0.719	mg/L	0.648 - 0.788	**0.843**	117%	**0.64**	89%	NR	
Orthophosphate	0.243	mg/L	0.214 - 0.272	**0.290**	119%	NR		NR	
Total Phosphorus	0.131	mg/L	0.111 - 0.143	**0.364**	278%	**0.38**	290%	NR	
Metals (Total)									
Aluminum	29.0	µg/L	25.8 - 32.6	28.9	100%	31.8	110%	NR	
Antimony	22.1	µg/L	19.2 - 24.1	19.6	89%	19.8	90%	NR	
Arsenic	40.0	µg/L	34.1 - 40.8	34.2	86%	37.8	94%	NR	
Barium	26.6	µg/L	24.7 - 29.0	25.5	96%	25.2	95%	NR	
Beryllium	16.9	µg/L	15.5 - 18.1	16.6	99%	**18.5**	110%	NR	
Boron	68.0	µg/L	60.5 - 74.5	67.2	99%	69.4	102%	NR	
Cadmium	25.4	µg/L	22.7 - 26.3	**22.5**	89%	23.2	92%	NR	
Chromium	12.4	µg/L	11.5 - 13.5	12.4	100%	**13.7**	110%	NR	
Cobalt	20.2	µg/L	18.4 - 21.9	19.2	95%	21.2	105%	NR	
Copper	26.5	µg/L	24.0 - 29.4	27.0	102%	28.0	106%	NR	
Iron	15.0	µg/L	13.3 - 16.7	**12.4**	83%	15.2	101%	NR	
Lead	45.4	µg/L	41.7 - 49.8	42.9	95%	**40.5**	89%	NR	
Manganese	57.5	µg/L	54.0 - 64.0	59.3	103%	58.0	101%	NR	

Parameter	ERA Certified Value	Units	Performance Acceptance Limit	SGS Result	Difference from Certified Value, SGS	CAS Result	Difference from Certified Value, CAS	NCA Result	Difference from Certified Value, NCA
Molybdenum	21.9	µg/L	19.9 - 23.5	20.6	94%	21.3	97%	NR	
Nickel	11.0	µg/L	10.1 - 12.0	10.1	92%	11.5	105%	NR	
Selenium	14.2	µg/L	12.4 - 15.7	13.0	92%	13.8	98%	NR	
Silver	10.5	µg/L	9.40 - 11.6	10.1	96%	9.96	95%	NR	
Thallium	11.4	µg/L	10.0 - 12.8	10.5	92%	10.5	92%	NR	
Vanadium	25.9	µg/L	23.4 - 27.7	24.8	96%	26.2	101%	NR	
Zinc	26.4	µg/L	24.2 - 28.7	24.5	93%	28.2	107%	NR	
Calcium	469	µg/L	403 - 535	463	99%	454	97%	NR	
Magnesium	203	µg/L	175 - 231	208	102%	194	96%	NR	
Potassium	304	µg/L	258 - 350	296	97%	298	98%	NR	
Sodium	356	µg/L	303 - 409	356	100%	349	98%	NR	
Total Mercury	13.9	ng/L	10.7 - 17.1	NA	NA	12.8	92%	11.3	81%

Notes:

Bold = does not meet performance acceptance limits

$CaCO_3$ = calcium carbonate

µg/L = microgram per liter

µmhos/cm = micromhos per centimeter

mg/L = milligram per liter

ng/L = nanogram per liter

NR = not requested

TABLE A-5b

2007 Results for Blind Performance Evaluation of Water Samples

Parameter	RTC Certified Value	Units	Performance Acceptance Limit	SGS Result	Difference from Certified Value, SGS	CAS Result	Difference from Certified Value, CAS	ACZ Result	Difference from Certified Value, ACZ	NCA Result	Difference from Certified Value, TA[a]
Inorganic Parameters											
Total Dissolved Solids @ 180°C	98.3	mg/L	83.6 - 113	88.8	90%	98	100%	100	102%	NR	
Total Alkalinity as $CaCO_3$	13.3	mg/L	9.81 - 18.7	**46.3**	348%	10	75%	14	105%	NR	
Specific Conductance, @ 25°C	185.0	µmhos/cm	167 - 203	185	100%	187	101%	193	104%	NR	
Chloride	41.3	mg/L	34.8 - 48.4	38.7	94%	42.2	102%	39.2	95%	NR	
Fluoride	0.890	mg/L	0.656 - 1.12	0.828	93%	0.7	79%	1	112%	NR	
Sulfate	7.83	mg/L	5.25 - 10.2	7.39	94%	6.9	88%	8.7	111%	NR	
WAD Cyanide	0.710	mg/L	0.444 - 0.977	0.75	106%	0.73	103%	0.77	108%	NR	
Total Cyanide	1.46	mg/L	0.981 - 1.93	1.6	110%	1.6	110%	1.28	88%	NR	
Total Organic Carbon[b]	16.7	mg/L	13.8 - 19.6	16.8	101%	16.9	101%	16.0	96%	NR	
Ammonia as Nitrogen	0.100	mg/L	0.000 - 0.202	0.185	185%	0.029	29%	NA	NA	NR	
Ammonia as Nitrogen	8.20	mg/L	6.04 - 10.3	NA	NA	NA	NA	8.58	105%	NR	
Nitrate and Nitrite	1.390	mg/L	1.13 - 1.64	1.16	83%	NA	NA	1.39	100%	NR	
Trace Elements (Total)											
Aluminum	47.7	µg/L	33.4 - 62.0	48.1	101%	55.7	117%	59	124%	NR	
Antimony	0.800	µg/L	0.560 - 1.04	0.816	102%	0.873	109%	ND, <2	<250%	NR	
Arsenic	0.49	µg/L	0.343 - 0.637	0.398	81%	0.57	116%	ND, <0.5	<100%	NR	
Barium	0.600	µg/L	0.420 - 0.780	0.616	103%	0.61	102%	**1.2**	200%	NR	
Boron	29.9	µg/L	20.9 - 38.9	29.5	99%	36.9	123%	35.2	118%	NR	
Calcium	1120	µg/L	784 - 1460	1150	103%	1140	102%	1200	107%	NR	
Chromium	6.22	µg/L	4.05 - 8.39	6.22	100%	6.25	100%	8.2	132%	NR	
Copper	62.5	µg/L	53.3 - 71.9	61.6	99%	60.2	96%	64.2	103%	NR	
Iron	670	µg/L	590 - 759	662	99%	679	101%	740	110%	NR	
Lead	36.4	µg/L	30.9 - 41.9	35.8	98%	36.3	100%	39.6	109%	NR	
Magnesium	661	µg/L	562 - 760	624	94%	633	96%	700	106%	NR	
Manganese	17.3	µg/L	14.7 - 19.9	17.4	101%	17.3	100%	18	104%	NR	
Molybdenum	1.40	µg/L	0.980 - 1.82	1.35	96%	1.47	105%	1.8	129%	NR	
Nickel	10.1	µg/L	7.07 - 13.1	10.1	100%	10.0	99%	12	119%	NR	
Potassium	292	µg/L	248 - 336	312	107%	324	111%	ND, <300	<103%	NR	
Silver	0.49	µg/L	0.343 - 0.637	0.408	83%	**0.261**	53%	0.51	104%	NR	
Sodium	918	µg/L	643 - 1190	894	97%	892	97%	1000	109%	NR	
Zinc	36.5	µg/L	25.5 - 47.5	34.7	95%	35.6	98%	40	110%	NR	
Total Mercury	0.15	ng/L	0.105 - 0.195	NR	NR	0.118	79%	NR		0.151	100.7%

Parameter	RTC Certified Value	Units	Performance Acceptance Limit	SGS Result	Difference from Certified Value, SGS	CAS Result	Difference from Certified Value, CAS	ACZ Result	Difference from Certified Value, ACZ	NCA Result	Difference from Certified Value, TA[a]
Metals (Dissolved)											
Aluminum	47.1	µg/L	39.9 - 54.3	46.0	98%	47.9	102%	52	110%	NR	
Antimony	0.360	µg/L	0.252 - 0.468	0.387	108%	0.418	116%	**33**	9167%	NR	
Arsenic	0.390	µg/L	0.273 - 0.507	0.341	87%	0.42	108%	ND, <0.5	<128%	NR	
Barium	0.510	µg/L	0.357 - 0.663	0.453	89%	0.45	88%	**1**	196%	NR	
Boron	30.3	µg/L	21.2 - 39.4	25.9	85%	30.4	100%	31.4	104%	NR	
Calcium	1120	µg/L	952 - 1290	1110	99%	1140	102%	1200	107%	NR	
Chromium	6.01	µg/L	4.21 - 7.81	6.11	102%	5.94	99%	7.1	118%	NR	
Copper	62.8	µg/L	53.6 - 72.2	59.7	95%	60.6	96%	62.1	99%	NR	
Iron	670	µg/L	590 - 759	643.0	96%	690.0	103%	680	101%	NR	
Lead	46.6	µg/L	39.6 - 53.6	44.5	95%	47.7	102%	47.1	101%	NR	
Magnesium	661	µg/L	562 - 760	611	92%	627	95%	700	106%	NR	
Manganese	16.2	µg/L	13.8 - 18.6	16.1	99%	15.8	98%	16.2	100%	NR	
Molybdenum	1.12	µg/L	0.784 - 1.46	1.07	96%	1.16	104%	1.2	107%	NR	
Nickel	19.4	µg/L	13.6 - 25.2	18.6	96%	18.2	94%	20	103%	NR	
Potassium	294	µg/L	250 - 338	295.0	100%	308	105%	ND, <300	<102%	NR	
Silicon	3640	µg/L	3090 - 4190	3260	90%	3430	94%	3600	99%	NR	
Silver	0.43	µg/L	0.301 - 0.559	0.410	95%	0.305	71%	0.44	102%	NR	
Sodium	917	µg/L	642 - 1190	860	94%	876	96%	900	98%	NR	
Zinc	65.8	µg/L	46.1 - 85.5	59.6	91%	62.5	95%	66	100%	NR	

Notes:

a. Test America, Inc. (TA), of Portland, Oregon (formerly known as North Creek Analytical, Inc. [NCA])

b. Total organic carbon for ACZ analyzed out of holding time

Bold = does not meet performance acceptance limits

NA = not applicable

ND = not detected, MDL shown

NR = not requested

TABLE A-5c

2008 Results for Blind Performance Evaluation of Freshwater Samples

Parameter	RTC Certified Value	Units	Performance Acceptance Limit	SGS Result	Difference from Certified Value, SGS	CAS Result	Difference from Certified Value, CAS
Inorganic Parameters							
Total Dissolved Solids @ 180°C	25.20	mg/L	17.6 - 32.8	20	79%	22	87%
Total Alkalinity as $CaCO_3$	13.00	mg/L	8.62 - 17.4	12.3	95%	13	100%
Specific Conductance, @ 25°C	55.00	µmhos/cm	49.5 - 60.5	56.4	103%	57	104%
Corrosivity (pH)	7.50	units	6.75 - 8.25	7.35	98%	7.85	105%
Chloride	6.35	mg/L	3.97 - 8.72	6.41	101%	5.4	85%
Sulfate	2.55	mg/L	0.799 - 4.29	2.08	82%	2.3	90%
Thiocyanate	0.42	mg/L	0 - 0.546	0.37	88%	ND, <0.1	<24%
Total Cyanide	0.02	mg/L	0.0131 - 0.0192	0.014	70%	0.017	85%
Total Organic Carbon	4.72	mg/L	3.68 - 5.76	4.31	91%	4.7	100%
Ammonia as Nitrogen	6.82	mg/L	3.77 - 9.87	9.85	144%	6.74	99%
Nitrate and Nitrite	1.06	mg/L	0.742 - 1.38	1.18	111%	0.99	93%
Metals (Total)							
Aluminum	105.00	µg/L	88.8 - 121	115	110%	99	94%
Arsenic	2.00	µg/L	1.40 - 2.60	2.35	118%	1.74	87%
Barium	0.58	µg/L	0.406 - 0.754	0.588	101%	0.6	103%
Chromium	1.98	µg/L	1.39 - 2.57	2.04	103%	1.92	97%
Copper	1.01	µg/L	0 - 4.84	1.38	137%	1.38	137%
Lead	1.10	µg/L	0.935 - 1.26	1.18	107%	1.09	99%
Nickel	2.61	µg/L	1.83 - 3.39	2.62	100%	2.57	98%
Silver	0.74	µg/L	0.518 - 0.962	0.848	115%	0.613	83%
Zinc	6.05	µg/L	4.24 - 7.87	5.75	95%	6.3	104%
Total Mercury	0.08	µg/L	0.0569 - 0.106	**0.221**	276%	0.0862	108%

Parameter	RTC Certified Value	Units	Performance Acceptance Limit	SGS Result	Difference from Certified Value, SGS	CAS Result	Difference from Certified Value, CAS
Metals (Dissolved)							
Aluminum	105.00	µg/L	88.8 - 121	115	110%	96	91%
Arsenic	1.98	µg/L	1.39 - 2.57	2.51	127%	1.86	94%
Barium	0.71	µg/L	0.497 - 0.923	0.697	98%	0.71	100%
Chromium	2.00	µg/L	1.40 - 2.60	2.07	104%	2.08	104%
Copper	1.03	µg/L	0 - 4.86	1.38	134%	1.31	127%
Lead	1.52	µg/L	1.29 - 1.75	1.52	100%	1.51	99%
Nickel	4.10	µg/L	2.87 - 5.33	4.58	112%	4.42	108%
Silver	0.45	µg/L	0.112 - 0.787	0.735	163%	0.388	86%
Zinc	7.75	µg/L	5.42 - 10.1	8.78	113%	9.9	128%

Notes:

Bold = does not meet performance acceptance limits

ND = not detected, MDL shown

TABLE A-6

2008 Results for Blind Performance Evaluation of Water Samples - Ocean Water Matrix

Parameter	RTC Certified Value	Units	Performance Acceptance Limit	Test America Result	Difference from Certified Value, TA	CAS Result	Difference from Certified Value, CAS
Inorganic Parameters							
Total Suspended Solids	20.00	mg/L	9.26 - 30.7	19	95%	**34**	170%
Metals (Total)							
Aluminum	331.00	µg/L	280 - 382	331	100%	286	86%
Arsenic	7.23	µg/L	5.06 - 9.40	8.4	116%	6.22	86%
Barium	32.80	µg/L	23.0 - 42.6	33	101%	31.5	96%
Boron	3190.00	µg/L	2230 - 4150	2800	88%	2690	84%
Cadmium	4.19	µg/L	2.93 - 5.45	**1.6**	38%	3.1	74%
Chromium	0.70	µg/L	0.490 - 0.910	0.60	86%	0.67	96%
Copper	0.30	µg/L	0 - 4.06	2.8	933%	0.664	221%
Iron	100.00	µg/L	70.8 - 130	130	130%	95.5	96%
Lead	0.60	µg/L	0.330 - 0.870	0.86	143%	0.573	96%
Manganese	12.70	µg/L	8.89 - 16.5	15	118%	12	94%
Silver	0.20	µg/L	0 - 0.260	0.19	95%	0.243	122%
Zinc	25.00	µg/L	17.5 - 32.5	27	108%	18.1	72%
Total Mercury	3.8	ng/L	2.66 - 4.94	3.03	80%	4.38	115%
Metals (Dissolved)							
Aluminum	331.00	µg/L	280 - 382	370	112%	295	89%
Arsenic	7.23	µg/L	5.06 - 9.40	8.2	113%	6.54	90%
Barium	32.80	µg/L	23.0 - 42.6	33	101%	32.1	98%
Boron	3190.00	µg/L	2230 - 4150	2600	82%	2690	84%
Cadmium	4.19	µg/L	2.93 - 5.45	3.6	86%	3.22	77%
Chromium	0.70	µg/L	0.490 - 0.910	0.82	117%	0.82	117%
Copper	0.30	µg/L	0 - 4.06	1	333%	0.663	221%
Iron	100.00	µg/L	70.8 - 130	100	100%	97.4	97%
Lead	0.60	µg/L	0.330 - 0.870	0.6	100%	0.517	86%
Manganese	12.70	µg/L	8.89 - 16.5	15	118%	12	94%
Silver	0.20	µg/L	0 - 0.260	0.094	47%	0.229	114%
Zinc	25.00	µg/L	17.5 - 32.5	25	100%	28.1	112%

Notes:

Bold = does not meet performance acceptance limits

TABLE A-7
Surface Water, Accuracy and Precision (Except Seeps)

	Laboratory Accuracy and Precision[a]				**Field Precision**			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Acidity, total	140	100	3.7	4%	61	18	16.2	91%
Alkalinity, total	507	100	5.4	5%	197	5.5	11.8	215%
Ammonia, as Nitrogen	709	97	7.8	8%	25	41	44.2	108%
Chloride	683	99	3.3	3%	219	5.1	11.5	225%
Cyanide, total	625	99	11.8	12%	10	26	21.0	81%
Cyanide, weak acid dissociable	599	98	10.8	11%	7	18	29.3	163%
Fluoride	645	102	9.2	9%	111	15	19.9	132%
Nitrogen as Nitrate-Nitrite	643	100	5.9	6%	142	34	41.2	121%
pH	625	100	0.90	1%	198	1.6	1.9	119%
Total Phosphorus	493	99	8.3	8%	126	27	29.4	110%
Phosphorus, Total Orthophosphate	90	98	2.9	3%	16	28	25.0	90%
Specific Conductance	553	100	3.5	4%	198	3.5	9.3	266%
Sulfate	680	100	7.1	7%	219	7.3	23.1	316%
Thiocyanate	412	99	3.9	4%	57	30	31.7	105%
Total Dissolved Solids	490	107	11.2	10%	195	24	27.6	117%
Total Suspended Solids	445	98	6.4	7%	162	27	27.1	99%
Metals								
Aluminum	643	101	5.8	6%	352	18	22.4	125%
Antimony	625	101	6.8	7%	190	25	33.6	137%
Arsenic	620	100	4.5	5%	164	13	14.2	108%
Barium	640	100	4.9	5%	384	6.9	10.5	152%
Beryllium	620	100	5.7	6%	7	32	28.4	90%
Bismuth	616	99	5.2	5%	11	40	41.6	105%
Boron	615	100	7.6	8%	49	13	17.6	135%
Cadmium	621	100	4.9	5%	15	22	26.1	119%
Calcium	637	101	5.8	6%	410	5.3	6.4	121%
Chromium	627	100	5.5	6%	214	25	25.1	100%
Cobalt	623	100	5.1	5%	303	16	19.4	120%
Copper	629	100	4.9	5%	322	21	26.5	124%
Iron	630	103	5.6	5%	347	13	18.5	138%
Lead	624	99	4.8	5%	55	62	53.8	87%
Magnesium	636	101	5.7	6%	409	5.0	6.1	122%
Manganese	620	100	4.9	5%	383	12	19.9	173%
Mercury	871	98	18.2	19%	34	37	40.4	110%
Molybdenum	620	99	6.2	6%	339	12	16.7	136%
Nickel	621	100	5.2	5%	235	19	25.3	133%
Potassium	635	101	5.4	5%	400	6.0	7.3	122%
Selenium	623	99	5.2	5%	19	19	22.3	115%
Silicon	507	102	6.2	6%	218	7.2	12.7	176%
Silver	621	100	6.4	6%	6	53	44.4	83%
Sodium	635	102	5.9	6%	408	5.6	8.7	155%
Thallium	620	98	5.7	6%	11	32	32.3	101%
Tin	618	99	7.3	7%	3	12	5.5	45%
Vanadium	622	100	5.4	5%	120	16	14.8	90%
Zinc	627	100	5.5	6%	194	30	31.8	107%

	Laboratory Accuracy and Precision[a]				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Organics								
Dissolved Organic Carbon	9	99	3.8	4%	53	12	18.9	155%
Total Organic Carbon	107	102	4.2	4%	3	3.0	2.6	87%
Diesel Range Organics	20	98	8.0	8%	NA	NA	NA	NA
Gasoline Range Organics	32	98	9.3	9%	—	—	—	—
Residual Range Organics	20	102	9.6	9%	—	—	—	—
Pesticides								
Aldrin	18	91	16.2	18%	NA	NA	NA	NA
alpha-BHC	25	89	7.2	8%	NA	NA	NA	NA
beta-BHC	25	94	7.7	8%	NA	NA	NA	NA
delta-BHC	25	93	10.8	12%	NA	NA	NA	NA
gamma-BHC (Lindane)	25	90	7.5	8%	NA	NA	NA	NA
alpha-Chlordane	22	93	5.7	6%	NA	NA	NA	NA
gamma-Chlordane	22	91	6.2	7%	NA	NA	NA	NA
4,4'-DDD	25	92	9.4	10%	NA	NA	NA	NA
4,4'-DDE	25	97	8.2	8%	NA	NA	NA	NA
4,4'-DDT	25	95	11.7	12%	NA	NA	NA	NA
Dieldrin	25	95	6.9	7%	NA	NA	NA	NA
Endosulfan I	25	101	12.2	12%	NA	NA	NA	NA
Endosulfan II	25	91	15.8	17%	NA	NA	NA	NA
Endosulfan sulfate	25	88	14.7	17%	NA	NA	NA	NA
Endrin	25	99	10.1	10%	NA	NA	NA	NA
Endrin aldehyde	25	99	12.3	12%	NA	NA	NA	NA
Endrin ketone	18	95	7.3	8%	NA	NA	NA	NA
Heptachlor	25	89	9.5	11%	NA	NA	NA	NA
Heptachlor epoxide	25	92	5.7	6%	NA	NA	NA	NA
Methoxychlor	25	94	18.7	20%	NA	NA	NA	NA
Polychlorinated Biphenyls								
PCB-1016 (Aroclor 1016)	16	139	39.7	29%	NA	NA	NA	NA
PCB-1248 (Aroclor 1248)	2	91	4.9	5%	NA	NA	NA	NA
PCB-1254 (Arcolor 1254)	3	106	7.8	7%	NA	NA	NA	NA
PCB-1260 (Aroclor 1260)	16	91	5.1	6%	NA	NA	NA	NA
Volatile Organic Compounds								
Acetone	39	100	12.8	13%	NA	NA	NA	NA
Acrylonitrile	10	103	3.9	4%	NA	NA	NA	NA
Bromodichloromethane	39	104	7.4	7%	NA	NA	NA	NA
Bromobenzene	39	101	6.5	6%	NA	NA	NA	NA
Bromochloromethane	39	103	8.7	8%	NA	NA	NA	NA
Bromomethane	39	103	20.2	20%	NA	NA	NA	NA
n-Butylbenzene	39	104	6.7	6%	NA	NA	NA	NA
sec-Butylbenzene	39	109	7.5	7%	NA	NA	NA	NA
tert-Butylbenzene	39	105	7.9	8%	NA	NA	NA	NA
Benzene	39	103	7.3	7%	1	18	—	—
Toluene	39	99	4.8	5%	1	5.0	—	—
Carbon disulfide	39	100	11.2	11%	NA	NA	NA	NA
2-Chloroethyl vinyl ether	29	107	16.7	16%	NA	NA	NA	NA
Chlorobenzene	39	102	6.3	6%	NA	NA	NA	NA
1-Chlorohexane	10	100	3.7	4%	NA	NA	NA	NA
2-Chlorotoluene	39	104	6.1	6%	NA	NA	NA	NA

	Laboratory Accuracy and Precision[a]				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
4-Chlorotoluene	39	104	6.4	6%	NA	NA	NA	NA
Chloroethane	39	98	9.7	10%	NA	NA	NA	NA
Chloromethane	39	92	11.5	13%	NA	NA	NA	NA
Carbon tetrachloride	39	105	9.9	9%	NA	NA	NA	NA
4-Isopropyltoluene	39	102	7.6	7%	NA	NA	NA	NA
Dibromochloromethane	39	104	6.5	6%	NA	NA	NA	NA
1,2-Dibromoethane	31	103	4.2	4%	NA	NA	NA	NA
1,2-Dibromo-3-chloropropane	39	97	8.4	9%	NA	NA	NA	NA
Dibromomethane	39	103	7.2	7%	NA	NA	NA	NA
Dichlorodifluoromethane	31	97	14	15%	NA	NA	NA	NA
1,1-Dichloroethane	39	102	7.4	7%	NA	NA	NA	NA
1,2-Dichloroethane	39	104	6.7	6%	NA	NA	NA	NA
1,2-Dichlorobenzene	70	82	20.4	25%	NA	NA	NA	NA
1,3-Dichlorobenzene	70	83	22.2	27%	NA	NA	NA	NA
1,4-Dichlorobenzene	70	84	23.6	28%	NA	NA	NA	NA
1,1-Dichloroethene	39	104	7.8	7%	NA	NA	NA	NA
cis-1,2-Dichloroethene	39	103	6.3	6%	NA	NA	NA	NA
trans-1,2-Dichloroethene	39	102	8.0	8%	NA	NA	NA	NA
1,1-Dichloropropene	39	102	7.3	7%	NA	NA	NA	NA
cis-1,3-Dichloropropene	39	106	5.7	5%	NA	NA	NA	NA
trans-1,3-Dichloropropene	39	104	8.0	8%	NA	NA	NA	NA
1,2-Dichloropropane	39	103	7.1	7%	NA	NA	NA	NA
1,3-Dichloropropane	39	102	4.2	4%	NA	NA	NA	NA
2,2-Dichloropropane	39	108	18.1	17%	NA	NA	NA	NA
trans-1,4-Dichloro-2-butene	10	142	4.0	3%	NA	NA	NA	NA
Ethylbenzene	39	105	6.7	6%	NA	NA	NA	NA
Trichlorofluoromethane	39	100	9.9	10%	NA	NA	NA	NA
Hexachlorobutadiene	71	82	18.0	22%	NA	NA	NA	NA
2-Hexanone	39	101	9.9	10%	NA	NA	NA	NA
Methyl iodide	22	104	12.7	12%	NA	NA	NA	NA
Isopropylbenzene	39	102	9.6	9%	NA	NA	NA	NA
2-Butanone	39	103	11.9	11%	NA	NA	NA	NA
4-Methyl-2-pentanone	39	104	7.4	7%	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	32	102	6.5	6%	NA	NA	NA	NA
Methylene chloride	39	99	9.1	9%	NA	NA	NA	NA
Naphthalene	70	88	20.8	24%	NA	NA	NA	NA
n-Propylbenzene	39	106	6.7	6%	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	39	101	7.7	8%	NA	NA	NA	NA
Tetrachloroethene (PCE)	39	101	6.9	7%	NA	NA	NA	NA
Styrene	39	105	6.7	6%	NA	NA	NA	NA
Bromoform	39	104	8.8	8%	NA	NA	NA	NA
1,1,1,2-Tetrachloroethane	39	102	8.2	8%	NA	NA	NA	NA
1,1,1-Trichloroethane	39	103	8.6	8%	NA	NA	NA	NA
1,1,2-Trichloroethane	39	102	5.2	5%	NA	NA	NA	NA
1,2,3-Trichlorobenzene	39	99	8.6	9%	NA	NA	NA	NA
1,2,4-Trichlorobenzene	70	85	20.9	25%	NA	NA	NA	NA
Trichloroethene (TCE)	39	102	6.1	6%	NA	NA	NA	NA
Chloroform	39	102	7.8	8%	NA	NA	NA	NA
1,2,3-Trichloropropane	39	102	8.0	8%	NA	NA	NA	NA
1,2,4-Trimethylbenzene	39	107	5.8	5%	NA	NA	NA	NA

	Laboratory Accuracy and Precision[a]				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
1,3,5-Trimethylbenzene	39	107	6.3	6%	NA	NA	NA	NA
Vinyl acetate	10	89	27.4	31%	NA	NA	NA	NA
Vinyl chloride	39	98	11.8	12%	NA	NA	NA	NA
Xylene, Isomers m & p	39	104	6.0	6%	NA	NA	NA	NA
o-Xylene	39	104	7.2	7%	NA	NA	NA	NA
Semivolatile Organic Compounds								
Acenaphthene	36	80	9.2	11%	NA	NA	NA	NA
Acenaphthylene	36	81	9.7	12%	NA	NA	NA	NA
Acetophenone	11	76	13.4	18%	NA	NA	NA	NA
Aniline	36	65	15.2	23%	NA	NA	NA	NA
Anthracene	36	88	7.7	9%	NA	NA	NA	NA
Azobenzene	27	87	8.7	10%	NA	NA	NA	NA
Benzyl butyl phthalate	36	94	9.9	10%	NA	NA	NA	NA
bis-(2-Chloroethoxy)methane	36	74	11.2	15%	NA	NA	NA	NA
bis-(2-Chloroethyl)ether	36	69	12.5	18%	NA	NA	NA	NA
bis(2-Chloroisopropyl)ether	36	69	12.0	17%	NA	NA	NA	NA
bis-(2-Ethylhexyl)phthalate	36	91	8.6	9%	NA	NA	NA	NA
4-Bromophenyl phenyl ether	36	79	8.4	11%	NA	NA	NA	NA
Benzo(a)anthracene	36	91	7.8	9%	NA	NA	NA	NA
Benzoic acid	36	49	28.0	57%	NA	NA	NA	NA
Benzo(a)pyrene	36	91	8.9	10%	NA	NA	NA	NA
Benzo(b)fluoranthene	36	91	7.6	8%	NA	NA	NA	NA
Benzo(g,h,i)perylene	36	87	11.8	13%	NA	NA	NA	NA
Benzo(k)fluoranthene	36	91	9.1	10%	NA	NA	NA	NA
Benzyl alcohol	36	69	14.2	21%	NA	NA	NA	NA
4-Chloro-3-methylphenol	36	79	10.8	14%	NA	NA	NA	NA
Chrysene	36	92	8.2	9%	NA	NA	NA	NA
4-Chloroaniline	36	77	11.4	15%	NA	NA	NA	NA
2-Chlorophenol	36	66	14.4	22%	NA	NA	NA	NA
2-Chloronaphthalene	36	71	10.9	15%	NA	NA	NA	NA
4-Chlorophenyl phenyl ether	36	83	7.3	9%	NA	NA	NA	NA
Dibenzo(a,h)anthracene	36	92	9.6	11%	NA	NA	NA	NA
Dibenzofuran	36	81	9.1	11%	NA	NA	NA	NA
3,3'-Dichlorobenzidine	36	81	16.5	20%	NA	NA	NA	NA
2,4-Dichlorophenol	36	73	11.9	16%	NA	NA	NA	NA
2,6-Dichlorophenol	5	61	6.6	11%	NA	NA	NA	NA
Diethyl phthalate	36	90	10.7	12%	NA	NA	NA	NA
2,4-Dimethylphenol	36	70	10.4	15%	NA	NA	NA	NA
Dimethyl phthalate	36	84	12.0	14%	NA	NA	NA	NA
2-Methyl-4,6-dinitrophenol	36	91	13.7	15%	NA	NA	NA	NA
Di-n-butyl phthalate	36	90	10.5	12%	NA	NA	NA	NA
Di-n-octyl phthalate	36	94	10.2	11%	NA	NA	NA	NA
2,4-Dinitrophenol	36	85	17.1	20%	NA	NA	NA	NA
2,4-Dinitrotoluene	36	94	9.1	10%	NA	NA	NA	NA
2,6-Dinitrotoluene	36	90	8.2	9%	NA	NA	NA	NA
Fluorene	36	85	8.2	10%	NA	NA	NA	NA
Fluoranthene	36	91	10.1	11%	NA	NA	NA	NA
Hexachlorobutadiene	71	82	18.0	22%	NA	NA	NA	NA
Hexachlorocyclopentadiene	36	46	16.6	36%	NA	NA	NA	NA
Hexachlorobenzene	36	85	7.7	9%	NA	NA	NA	NA

	Laboratory Accuracy and Precision[a]				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Hexachloroethane	36	62	15.4	25%	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	36	90	10.2	11%	NA	NA	NA	NA
Isophorone	36	81	12.6	16%	NA	NA	NA	NA
2-Methylphenol (o-Cresol)	36	69	14.7	21%	NA	NA	NA	NA
3-Methylphenol/4-Methylphenol Coelution	25	64	14.9	23%	NA	NA	NA	NA
2-Methylnaphthalene	36	74	12.6	17%	NA	NA	NA	NA
Naphthalene	70	88	20.8	24%	NA	NA	NA	NA
n-Nitrosodimethylamine	36	58	23.1	40%	NA	NA	NA	NA
n-Nitrosodiphenylamine	36	84	11.1	13%	NA	NA	NA	NA
n-Nitrosodi-n-propylamine	36	77	12.5	16%	NA	NA	NA	NA
2-Nitroaniline	36	90	9.1	10%	NA	NA	NA	NA
3-Nitroaniline	36	92	9.7	10%	NA	NA	NA	NA
4-Nitroaniline	36	96	11.8	12%	NA	NA	NA	NA
Nitrobenzene	36	72	12.5	18%	NA	NA	NA	NA
2-Nitrophenol	36	71	12.1	17%	NA	NA	NA	NA
4-Nitrophenol	36	66	27.6	42%	NA	NA	NA	NA
Pentachlorophenol	36	81	10.6	13%	NA	NA	NA	NA
Phenanthrene	36	87	7.9	9%	NA	NA	NA	NA
Phenol	36	55	24.5	45%	NA	NA	NA	NA
Pyrene	36	90	9.3	10%	NA	NA	NA	NA
1,2,4-Trichlorobenzene	70	85	20.9	25%	NA	NA	NA	NA
2,4,5-Trichlorophenol	36	81	11.2	14%	NA	NA	NA	NA
2,4,6-Trichlorophenol	36	78	11.5	15%	NA	NA	NA	NA
1,2-Dichlorobenzene	70	82	20.4	25%	NA	NA	NA	NA
1,3-Dichlorobenzene	70	83	22.2	27%	NA	NA	NA	NA
1,4-Dichlorobenzene	70	84	23.6	28%	NA	NA	NA	NA

Notes:

a. LCS accuracy and precision statistics based on surface water and groundwater data.

— = insufficient sample count to calculate statistics

LCS = laboratory control sample

n = number of samples

n-pairs = number of primary and duplicate pairs

NA = not applicable, analyte was not detected in the sample

RPD = relative percent difference

RSD = relative standard deviation

SD = standard deviation

TABLE A-8

Surface Water, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Acidity, total	111	7.1	8.8	124%
Alkalinity, total	306	2.4	4.0	171%
Ammonia, as Nitrogen	44	30	31.6	105%
Chloride	444	1.9	2.6	138%
Total Cyanide	15	21	19.9	95%
Cyanide, weak acid dissociable	13	25	26.5	106%
Fluoride	230	14	16.9	125%
Nitrogen as Nitrate-Nitrite	167	14	17.7	128%
pH	375	0.5	0.7	136%
Total Phosphorus	200	21	29.4	140%
Phosphorus, Total as Orthophosphate	37	16	16.2	102%
Specific Conductance	378	1.4	2.7	193%
Sulfate	445	1.3	2.0	149%
Thiocyanate	246	2.8	4.7	171%
Total Dissolved Solids	304	9.8	10.8	111%
Total Suspended Solids	193	21	23.0	108%
Organics [a]				
Dissolved Organic Carbon	48	1.9	1.5	81%
Total Organic Carbon	2	4.5	3.5	79%
Diesel Range Organics	1	5.0	—	—
Gasoline Range Organics	4	3.8	3.6	70%
Residual Range Organics	1	5.0	—	—
Metals				
Aluminum	424	4.5	6.9	153%
Antimony	401	3.5	6.8	199%
Arsenic	406	3.3	6.3	190%
Barium	445	3.5	6.1	177%
Beryllium	399	3.6	6.4	175%
Bismuth	383	3.1	4.7	151%
Boron	406	3.3	3.5	106%
Cadmium	388	2.8	2.8	101%
Calcium	410	3.1	4.6	145%
Chromium	413	4.1	7.6	184%
Cobalt	410	3.6	6.6	185%
Copper	431	3.5	6.5	186%
Iron	423	3.3	4.5	137%
Lead	395	3.2	6.2	193%
Magnesium	409	2.9	2.9	100%
Manganese	422	3.5	7.1	201%
Mercury	350	3.5	4.2	121%
Molybdenum	399	3.7	7.1	194%
Nickel	401	4.1	10.7	261%
Potassium	409	3.1	3.1	102%
Selenium	412	3.1	3.2	104%
Silicon	147	3.2	4.3	135%
Silver	390	3.4	7.5	222%
Sodium	408	3.1	3.5	113%

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Thallium	393	3.9	8.3	214%
Tin	391	3.3	6.9	206%
Vanadium	414	3.8	6.8	176%
Zinc	414	3.5	6.3	182%
Pesticides [a]				
Aldrin	6	9.7	7.9	82%
alpha-BHC	6	12	9.5	82%
beta-BHC	6	9.7	7.9	82%
delta-BHC	6	9.8	7.2	73%
gamma-BHC (Lindane)	6	10	8.7	86%
alpha-Chlordane	6	11	7.8	73%
gamma-Chlordane	6	10	8.8	84%
4,4'-DDD	6	9.7	7.7	80%
4,4'-DDE	6	9.8	7.7	78%
4,4'-DDT	6	9.0	7.5	83%
Dieldrin	6	10	8.0	79%
Endosulfan I	6	10	9.0	86%
Endosulfan II	6	8.0	6.3	78%
Endosulfan sulfate	6	8.2	7.0	86%
Endrin	6	9.3	8.1	87%
Endrin aldehyde	6	12	12.1	102%
Endrin ketone	6	12	6.0	51%
Heptachlor	6	11	8.8	83%
Heptachlor epoxide	6	10	7.8	78%
Methoxychlor	6	11	7.2	66%
Polychlorinated Biphenyls [a]				
PCB-1016 (Aroclor 1016)	4	8.5	11.4	134%
PCB-1248 (Aroclor 1248)	—	—	—	—
PCB-1254 (Arcolor 1254)	—	—	—	—
PCB-1260 (Aroclor 1260)	4	9.8	11.7	120%
Volatile Organic Compounds [a]				
Acetone	6	3.8	1.7	45%
Acrylonitrile	3	4.3	2.1	48%
Bromodichloromethane	6	1.5	1.4	92%
Bromobenzene	6	2.2	2.1	99%
Bromochloromethane	6	3.7	5.8	157%
Bromomethane	6	6.2	2.8	45%
n-Butylbenzene	6	3.3	2.7	80%
sec-Butylbenzene	6	3.0	3.2	105%
tert-Butylbenzene	6	2.3	3.4	145%
Benzene	6	1.8	1.5	80%
Toluene	6	3.0	3.7	123%
Carbon disulfide	6	2.7	1.8	66%
2-Chloroethyl vinyl ether	1	68	—	—
Chlorobenzene	6	2.8	3.3	117%
1-Chlorohexane	3	1.0	1.0	100%
2-Chlorotoluene	6	2.3	3.0	129%
4-Chlorotoluene	6	2.7	1.9	70%
Chloroethane	6	2.0	1.7	84%
Chloromethane	6	3.2	1.5	46%

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Carbon tetrachloride	6	1.0	1.0	118%
4-Isopropyltoluene	6	2.7	2.1	77%
Dibromochloromethane	6	2.0	4.0	200%
1,2-Dibromoethane	4	1.8	1.0	55%
1,2-Dibromo-3-chloropropane	6	3.7	3.9	106%
Dibromomethane	6	3.3	6.7	202%
Dichlorodifluoromethane	4	1.0	1.2	115%
1,1-Dichloroethane	6	2.2	1.2	54%
1,2-Dichloroethane	6	2.7	2.4	91%
1,2-Dichlorobenzene	6	2.0	1.5	77%
1,3-Dichlorobenzene	6	2.7	3.4	127%
1,4-Dichlorobenzene	6	1.7	1.4	82%
1,1-Dichloroethene	6	1.7	0.52	31%
cis-1,2-Dichloroethene	6	1.2	1.2	100%
trans-1,2-Dichloroethene	6	2.2	1.7	80%
1,1-Dichloropropene	6	2.5	2.5	100%
cis-1,3-Dichloropropene	6	1.7	1.0	62%
trans-1,3-Dichloropropene	6	2.3	2.3	100%
1,2-Dichloropropane	6	2.0	2.9	145%
1,3-Dichloropropane	6	3.0	4.5	151%
2,2-Dichloropropane	6	2.5	1.6	66%
trans-1,4-Dichloro-2-butene	3	2.7	2.1	78%
Ethylbenzene	6	2.3	3.3	143%
Trichlorofluoromethane	6	2.0	1.3	63%
Hexachlorobutadiene	5	5.0	3.7	75%
2-Hexanone	6	4.7	4.3	92%
Methyl iodide	5	5.0	2.9	58%
Isopropylbenzene	6	3.2	3.9	122%
2-Butanone	6	4.0	4.1	104%
4-Methyl-2-pentanone	6	4.8	5.3	111%
Methyl-tert-butyl ether (MTBE)	6	2.5	2.6	104%
Methylene chloride	6	3.0	2.8	92%
Naphthalene	6	4.7	3.4	73%
n-Propylbenzene	6	2.5	1.9	75%
1,1,2,2-Tetrachloroethane	6	4.0	3.9	97%
Tetrachloroethene (PCE)	6	2.8	3.8	133%
Styrene	6	2.7	3.7	138%
Bromoform	6	2.3	4.8	204%
1,1,1,2-Tetrachloroethane	6	3.8	4.5	118%
1,1,1-Trichloroethane	6	2.0	2.7	134%
1,1,2-Trichloroethane	6	2.2	3.9	179%
1,2,3-Trichlorobenzene	6	2.5	2.7	110%
1,2,4-Trichlorobenzene	6	4.7	4.3	92%
Trichloroethene (TCE)	6	4.0	4.3	107%
Chloroform	6	1.7	2.0	118%
1,2,3-Trichloropropane	6	3.0	2.9	97%
1,2,4-Trimethylbenzene	6	2.0	1.8	89%
1,3,5-Trimethylbenzene	6	2.3	2.5	107%
Vinyl acetate	3	2.7	3.8	142%

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Vinyl chloride	6	2.8	1.9	68%
Xylene, Isomers m & p	6	2.7	3.7	138%
o-Xylene	6	2.7	3.2	120%
Semivolatile Organic Compounds [a]				
Acenaphthene	7	7.7	4.4	57%
Acenaphthylene	7	6.4	4.3	67%
Acetophenone	2	12	7.8	62%
Aniline	7	19	9.7	52%
Anthracene	7	4.4	3.9	87%
Azobenzene	7	6.6	3.6	55%
Benzyl butyl phthalate	7	5.9	3.9	66%
bis-(2-Chloroethoxy)methane	7	10	6.6	64%
bis-(2-Chloroethyl)ether	7	11	5.2	46%
bis(2-Chloroisopropyl)ether	7	9.6	5.5	58%
bis-(2-Ethylhexyl)phthalate	7	5.7	5.2	91%
4-Bromophenyl phenyl ether	7	4.7	4.9	104%
Benzo(a)anthracene	7	4.7	2.4	52%
Benzoic acid	6	15	12.1	82%
Benzo(a)pyrene	7	4.6	4.1	89%
Benzo(b)fluoranthene	7	4.0	5.1	127%
Benzo(g,h,i)perylene	7	5.4	3.0	56%
Benzo(k)fluoranthene	7	5.7	4.8	83%
Benzyl alcohol	7	14	5.6	41%
4-Chloro-3-methylphenol	7	7.6	4.7	62%
Chrysene	7	4.1	3.1	74%
4-Chloroaniline	7	8.1	6.6	81%
2-Chlorophenol	7	12	7.1	58%
2-Chloronaphthalene	7	8.9	4.6	52%
4-Chlorophenyl phenyl ether	7	6.3	3.3	52%
Dibenzo(a,h)anthracene	7	3.9	4.3	111%
Dibenzofuran	7	5.9	3.6	62%
3,3'-Dichlorobenzidine	7	6.0	2.3	38%
2,4-Dichlorophenol	7	8.9	5.0	57%
2,6-Dichlorophenol	1	17	—	—
Diethyl phthalate	7	6.1	5.4	88%
2,4-Dimethylphenol	7	10	5.6	53%
Dimethyl phthalate	7	5.7	5.2	91%
2-Methyl-4,6-dinitrophenol	8	15	20.3	132%
Di-n-butyl phthalate	7	4.6	6.3	79%
Di-n-octyl phthalate	7	7.9	3.1	40%
2,4-Dinitrophenol	6	22	33.6	152%
2,4-Dinitrotoluene	7	6.0	4.7	79%
2,6-Dinitrotoluene	7	6.9	4.5	65%
Fluorene	7	6.0	3.7	6200%
Fluoranthene	7	5.6	3.6	65%
Hexachlorobutadiene	7	9.1	7.1	77%
Hexachlorocyclopentadiene	8	46	64.2	140%
Hexachlorobenzene	7	4.6	4.4	97%
Hexachloroethane	7	9.6	6.5	68%
Indeno(1,2,3-cd)pyrene	7	4.9	4.1	85%
Isophorone	7	9.0	6.9	76%

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
2-Methylphenol (o-Cresol)	7	12	5.7	46%
3-Methylphenol/4-Methylphenol Coelution	7	13	3.0	24%
2-Methylnaphthalene	7	9.3	5.0	53%
Naphthalene	6	9.8	4.8	48%
n-Nitrosodimethylamine	7	17	8.4	50%
n-Nitrosodiphenylamine	7	4.0	3.8	96%
n-Nitrosodi-n-propylamine	7	9.7	5.2	54%
2-Nitroaniline	7	6.7	3.5	53%
3-Nitroaniline	7	5.7	3.1	55%
4-Nitroaniline	7	7.4	6.0	81%
Nitrobenzene	7	9.3	4.9	53%
2-Nitrophenol	7	11	5.0	47%
4-Nitrophenol	7	11	11.1	98%
Pentachlorophenol	10	21	16.8	81%
Phenanthrene	7	4.1	3.4	83%
Phenol	7	15	8.0	54%
Pyrene	7	7.6	4.0	52%
1,2,4-Trichlorobenzene	6	9.7	5.8	60%
2,4,5-Trichlorophenol	7	6.6	4.8	72%
2,4,6-Trichlorophenol	7	6.6	5.0	76%
1,2-Dichlorobenzene	6	8.8	7.8	88%
1,3-Dichlorobenzene	6	9.7	9.7	101%
1,4-Dichlorobenzene	6	8.3	9.5	114%

Notes:

a. Data for surface water excluding seeps

— = insufficient sample count to calculate statistics

TABLE A-9

Surface Water, Laboratory Comparability (Except Seeps)

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Acidity, total	48	39	35.9	91%
Alkalinity, total	196	11	13.4	127%
Ammonia, as Nitrogen	5	113	45.6	40%
Chloride	214	16	13.0	82%
Total Cyanide	4	20	23.1	115%
Cyanide, weak acid dissociable	1	186	—	—
Fluoride	69	44	31.5	72%
Nitrogen as Nitrate-Nitrite	130	56	44.0	79%
pH	197	3.6	3.5	96%
Total Phosphorus	119	55	44.3	81%
Phosphorus, Total as Orthophosphate	nc	nc	nc	nc
Specific Conductance	197	25	44.3	175%
Sulfate	216	11	18.6	168%
Thiocyanate	8	93	44.7	48%
Total Dissolved Solids	193	33	30.8	93%
Total Suspended Solids	19	65	54.2	83%
Metals				
Aluminum	342	25	24.5	99%
Antimony	148	36	41.6	116%
Arsenic	183	22	23.2	104%
Barium	387	8.4	11.7	139%
Beryllium	8	39	35.1	90%
Bismuth	5	108	67.0	62%
Boron	64	45	41.8	92%
Cadmium	17	38	37.7	100%
Calcium	409	7.4	6.3	85%
Chromium	137	37	28.0	75%
Cobalt	314	31	30.9	100%
Copper	315	32	35.4	111%
Iron	318	23	27.4	120%
Lead	52	82	54.0	66%
Magnesium	411	8.3	6.5	79%
Manganese	372	15	22.5	152%
Mercury	28	50	37.7	76%
Molybdenum	345	17	21.1	123%
Nickel	220	44	31.9	72%
Potassium	314	9.6	10	103%
Selenium	13	34	27.1	81%
Silicon	210	10	12.3	122%
Silver	10	72	43.4	61%
Sodium	408	7.6	7.2	95%
Thallium	4	47	46.4	98%
Tin	2	121	73.5	61%
Vanadium	135	32	27.1	86%
Zinc	183	50	42.4	85%

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Organics				
Dissolved Organic Carbon	50	29	28.1	98%
Total Organic Carbon	3	35	15.3	46%
Diesel Range Organics	NA	NA	NA	NA
Gasoline Range Organics	NA	NA	NA	NA
Residual Range Organics	0	—	—	—
Pesticides				
Aldrin	NA	NA	NA	NA
alpha-BHC	NA	NA	NA	NA
beta-BHC	NA	NA	NA	NA
delta-BHC	NA	NA	NA	NA
gamma-BHC (Lindane)	NA	NA	NA	NA
alpha-Chlordane	NA	NA	NA	NA
gamma-Chlordane	NA	NA	NA	NA
4,4'-DDD	NA	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA
4,4'-DDT	NA	NA	NA	NA
Dieldrin	NA	NA	NA	NA
Endosulfan I	NA	NA	NA	NA
Endosulfan II	NA	NA	NA	NA
Endosulfan sulfate	NA	NA	NA	NA
Endrin	NA	NA	NA	NA
Endrin aldehyde	NA	NA	NA	NA
Endrin ketone	nc	nc	nc	nc
Heptachlor	NA	NA	NA	NA
Heptachlor epoxide	NA	NA	NA	NA
Methoxychlor	NA	NA	NA	NA
Polychlorinated Biphenyls				
PCB-1016 (Aroclor 1016)	NA	NA	NA	NA
PCB-1248 (Aroclor 1248)	NA	NA	NA	NA
PCB-1254 (Arcolor 1254)	NA	NA	NA	NA
PCB-1260 (Aroclor 1260)	NA	NA	NA	NA
Volatile Organic Compounds				
Acetone	NA	NA	NA	NA
Acrylonitrile	NA	NA	NA	NA
Bromodichloromethane	NA	NA	NA	NA
Bromobenzene	NA	NA	NA	NA
Bromochloromethane	NA	NA	NA	NA
Bromomethane	NA	NA	NA	NA
n-Butylbenzene	NA	NA	NA	NA
sec-Butylbenzene	NA	NA	NA	NA
tert-Butylbenzene	NA	NA	NA	NA
Benzene	NA	NA	NA	NA
Toluene	0	—	—	—
Carbon disulfide	NA	NA	NA	NA
2-Chloroethyl vinyl ether	NA	NA	NA	NA
Chlorobenzene	NA	NA	NA	NA
1-Chlorohexane	nc	nc	nc	nc
2-Chlorotoluene	NA	NA	NA	NA

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
4-Chlorotoluene	NA	NA	NA	NA
Chloroethane	NA	NA	NA	NA
Chloromethane	NA	NA	NA	NA
Carbon tetrachloride	NA	NA	NA	NA
4-Isopropyltoluene	NA	NA	NA	NA
Dibromochloromethane	NA	NA	NA	NA
1,2-Dibromoethane	NA	NA	NA	NA
1,2-Dibromo-3-chloropropane	NA	NA	NA	NA
Dibromomethane	NA	NA	NA	NA
Dichlorodifluoromethane	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA
1,1-Dichloroethene	NA	NA	NA	NA
cis-1,2-Dichloroethene	NA	NA	NA	NA
trans-1,2-Dichloroethene	NA	NA	NA	NA
1,1-Dichloropropene	NA	NA	NA	NA
cis-1,3-Dichloropropene	NA	NA	NA	NA
trans-1,3-Dichloropropene	NA	NA	NA	NA
1,2-Dichloropropane	NA	NA	NA	NA
1,3-Dichloropropane	NA	NA	NA	NA
2,2-Dichloropropane	NA	NA	NA	NA
trans-1,4-Dichloro-2-butene	NA	NA	NA	NA
Ethylbenzene	NA	NA	NA	NA
Trichlorofluoromethane	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA
2-Hexanone	NA	NA	NA	NA
Methyl iodide	NA	NA	NA	NA
Isopropylbenzene	NA	NA	NA	NA
2-Butanone	NA	NA	NA	NA
4-Methyl-2-pentanone	NA	NA	NA	NA
Methyl-tert-butyl ether (MTBE)	NA	NA	NA	NA
Methylene chloride	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA
n-Propylbenzene	NA	NA	NA	NA
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA
Tetrachloroethene (PCE)	NA	NA	NA	NA
Styrene	NA	NA	NA	NA
Bromoform	NA	NA	NA	NA
1,1,1,2-Tetrachloroethane	NA	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA
1,2,3-Trichlorobenzene	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	NA	NA
Trichloroethene (TCE)	1	79	—	—
Chloroform	NA	NA	NA	NA
1,2,3-Trichloropropane	NA	NA	NA	NA
1,2,4-Trimethylbenzene	NA	NA	NA	NA

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
1,3,5-Trimethylbenzene	NA	NA	NA	NA
Vinyl acetate	NA	NA	NA	NA
Vinyl chloride	NA	NA	NA	NA
Xylene, Isomers m & p	NA	NA	NA	NA
o-Xylene	NA	NA	NA	NA
Semivolatile Organic Compounds				
Acenaphthene	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA
Acetophenone	NA	NA	NA	NA
Aniline	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA
Azobenzene	NA	NA	NA	NA
Benzyl butyl phthalate	NA	NA	NA	NA
bis-(2-Chloroethoxy)methane	NA	NA	NA	NA
bis-(2-Chloroethyl)ether	NA	NA	NA	NA
bis(2-Chloroisopropyl)ether	NA	NA	NA	NA
bis-(2-Ethylhexyl)phthalate	NA	NA	NA	NA
4-Bromophenyl phenyl ether	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA
Benzoic acid	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA
Benzyl alcohol	NA	NA	NA	NA
4-Chloro-3-methylphenol	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA
4-Chloroaniline	NA	NA	NA	NA
2-Chlorophenol	NA	NA	NA	NA
2-Chloronaphthalene	NA	NA	NA	NA
4-Chlorophenyl phenyl ether	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA
3,3'-Dichlorobenzidine	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA
2,6-Dichlorophenol	NA	NA	NA	NA
Diethyl phthalate	NA	NA	NA	NA
2,4-Dimethylphenol	NA	NA	NA	NA
Dimethyl phthalate	NA	NA	NA	NA
2-Methyl-4,6-dinitrophenol	NA	NA	NA	NA
Di-n-butyl phthalate	NA	NA	NA	NA
Di-n-octyl phthalate	NA	NA	NA	NA
2,4-Dinitrophenol	NA	NA	NA	NA
2,4-Dinitrotoluene	NA	NA	NA	NA
2,6-Dinitrotoluene	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA
Hexachlorobutadiene	NA	NA	NA	NA
Hexachlorocyclopentadiene	NA	NA	NA	NA
Hexachlorobenzene	NA	NA	NA	NA

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Hexachloroethane	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA
Isophorone	NA	NA	NA	NA
2-Methylphenol (o-Cresol)	NA	NA	NA	NA
3-Methylphenol/4-Methylphenol Coelution	NA	NA	NA	NA
2-Methylnaphthalene	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA
n-Nitrosodimethylamine	NA	NA	NA	NA
n-Nitrosodiphenylamine	NA	NA	NA	NA
n-Nitrosodi-n-propylamine	NA	NA	NA	NA
2-Nitroaniline	NA	NA	NA	NA
3-Nitroaniline	NA	NA	NA	NA
4-Nitroaniline	NA	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA
2-Nitrophenol	NA	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA
Phenol	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA
1,2,4-Trichlorobenzene	NA	NA	NA	NA
2,4,5-Trichlorophenol	NA	NA	NA	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA
1,2-Dichlorobenzene	NA	NA	NA	NA
1,3-Dichlorobenzene	NA	NA	NA	NA
1,4-Dichlorobenzene	NA	NA	NA	NA

Notes:
— = insufficient sample count to calculate statistics
NA = not applicable, analyte was not detected in the sample
nc = primary and triplicate pair not collected

TABLE A-10

Summary of Sensitivity for Surface Water (Except Seeps)

Analyte	Total No. of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Inorganic Parameters								
Acidity, total	1787	1077	0	10	10	10	10	10
Alkalinity, total	1723	27	0	10	10	10	10	10
Ammonia, as Nitrogen	1788	1113	3	0.1	0.1	0.1	0.1	0.1
Chloride	1950	2	0	0.2	0.2	0.2	0.2	0.1
Total Cyanide	1785	1515	0	0.01	0.01	0.01	0.005	0.005
Cyanide, weak acid dissociable	2094	1772	0	0.01	0.01	0.01	0.005	0.005
Fluoride	1888	625	1	0.1	0.1	0.1	0.2	0.1
Nitrogen, Nitrate-Nitrite	1788	236	0	2	0.1	0.1	0.1	0.1
Phosphorus, Total (as P)	1788	349	208	0.01	0.01	0.01	0.01	0.01
Phosphorus, Total as Orthophosphate	350	144	0	NA	NA	0.2	—	NA
Specific Conductance	1788	0	0	2[a]	2[a]	2[a]	1[a]	1[a]
Sulfate	1950	7	0	0.2	0.2	0.2	0.2	0.2
Thiocyanate	1788	1163	0	1	1	1	1	1
Total Dissolved Solids	1818	12	0	10	10	10	10	10
Total Suspended Solids	1788	220	1	5	5	5	5	0.5
Organics								
Dissolved Organic Carbon	542	14	0	NA	NA	NA	0.5	0.5
Total Organic Carbon	31	0	0	NA	NA	NA	0.5	NA
Diesel Range Organics	37	37	0	NA	NA	NA	NA	—
Gasoline Range Organics	37	25	0	NA	NA	NA	NA	—
Residual Range Organics	37	12	0	NA	NA	NA	NA	—
Metals								
Aluminum	3574	14	0	0.025	0.001	0.001	0.002	0.002
Antimony	3574	962	9	0.0002	0.00005	0.00005	0.00005	0.00005
Arsenic	3574	2160	7	0.0005	0.0005	0.0005	0.0005	0.0005
Barium	3574	0	0	0.0003	0.00005	0.00005	0.00005	0.00005
Beryllium	3574	3447	611	0.00003	0.00002	0.00002	0.00005	0.00005
Bismuth	3570	3284	9	0.005	0.0001	0.0001	0.00005	0.00005
Boron	3574	2723	901	0.01	0.0005	0.0005	0.005	0.005
Cadmium	3574	3099	604	0.0001	0.00002	0.00002	0.00005	0.00005
Calcium	3736	1	0	0.05	0.05	0.05	0.05	0.05
Chromium	3574	582	7	0.0002	0.0002	0.0002	0.0002	0.0002
Cobalt	3574	177	2	0.0001	0.00002	0.00002	0.00002	0.00002
Copper	3574	8	5	0.0002	0.0001	0.0001	0.0001	0.0001
Iron	3574	113	0	0.02	0.02	0.02	0.02	0.02
Lead	3574	1407	277	0.0002	0.00002	0.00002	0.0001	0.0001
Magnesium	3736	1	0	0.02	0.02	0.02	0.02	0.02

Analyte	Total No. of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L) 2004	2005	2006	2007	2008
Manganese	3574	13	1	0.001	0.00005	0.00005	0.00005	0.00005
Mercury	1769	899	0	0.000005	0.000005	0.000005	0.000005	0.000005
Molybdenum	3574	306	489	0.001	0.00005	0.00005	0.00005	0.00005
Nickel	3573	29	7	0.0002	0.0002	0.0002	0.0002	0.0002
Potassium	3736	8	7	0.05	0.05	0.05	0.05	0.05
Selenium	3574	3254	2	0.001	0.001	0.001	0.001	0.001
Silicon	1949	4	1	0.5	0.1	0.1	0.1	0.1
Silver	3574	3386	18	0.00002	0.00002	0.00002	0.00002	0.00002
Sodium	3736	1	0	0.1	0.1	0.1	0.1	0.1
Thallium	3574	3321	16	0.00005	0.00001	0.00001	0.00002	0.00002
Tin	3574	3438	5	0.001	0.0001	0.0001	0.0002	0.0002
Vanadium	3574	2130	424	0.0004	0.0002	0.0002	0.001	0.001
Zinc	3574	66	5	0.0015	0.0005	0.0005	0.001	0.001
Pesticides								
4,4'-DDD	52	52	46	0.000005	0.000005	NA	NA	NA
4,4'-DDE	52	52	46	0.000005	0.000005	NA	NA	NA
4,4'-DDT	52	52	46	0.000008	0.000008	NA	NA	NA
Aldrin	52	52	46	0.000005	0.000005	NA	NA	NA
alpha-BHC	52	52	46	0.000005	0.000005	NA	NA	NA
alpha-Chlordane	52	52	0	0.0001	0.0001	NA	NA	NA
beta-BHC	52	52	46	0.000007	0.000007	NA	NA	NA
delta-BHC	52	52	46	0.000005	0.000005	NA	NA	NA
Dieldrin	52	52	46	0.000005	0.000005	NA	NA	NA
Endosulfan I	52	52	46	0.000005	0.000005	NA	NA	NA
Endosulfan II	52	52	46	0.000007	0.000007	NA	NA	NA
Endosulfan sulfate	52	52	46	0.000006	0.000006	NA	NA	NA
Endrin	52	52	46	0.000006	0.000006	NA	NA	NA
Endrin aldehyde	52	52	46	0.000008	0.000008	NA	NA	NA
Endrin ketone	52	52	0	—	0.00003	NA	NA	NA
gamma-BHC (Lindane)	52	52	46	0.000005	0.000005	NA	NA	NA
gamma-Chlordane	52	52	0	0.0001	0.0001	NA	NA	NA
Heptachlor	52	52	46	0.000006	0.000006	NA	NA	NA
Heptachlor epoxide	52	52	46	0.000006	0.000006	NA	NA	NA
Methoxychlor	52	52	46	0.000007	0.000007	NA	NA	NA
Toxaphene	52	52	46	0.0001	0.0001	NA	NA	NA

Analyte	Total No. of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Polychlorinated Biphenyls (PCBs)								
PCB-1016 (Aroclor 1016)	51	51	0	NA	0.0001	NA	0.0001	NA
PCB-1248 (Aroclor 1248)	51	51	0	NA	0.0001	NA	0.0001	NA
PCB-1254 (Arcolor 1254)	51	51	0	NA	0.0001	NA	0.0001	NA
PCB-1260 (Aroclor 1260)	51	51	0	NA	0.0001	NA	0.0001	NA
Volatile Organic Compounds								
1,1,1,2-Tetrachloroethane	84	84	0	—	0.0005	NA	0.0005	NA
1,1,1-Trichloroethane	84	84	0	—	0.001	NA	0.001	NA
1,1,2,2-Tetrachloroethane	84	84	0	—	0.0005	NA	0.0005	NA
1,1,2-Trichloroethane	84	84	0	—	0.001	NA	0.001	NA
1,1-Dichloroethane	84	84	0	—	0.001	NA	0.001	NA
1,1-Dichloroethene	84	84	0	—	0.001	NA	0.001	NA
1,1-Dichloropropene	84	84	0	—	0.001	NA	0.001	NA
1,2,3-Trichlorobenzene	84	84	0	—	0.001	NA	0.001	NA
1,2,3-Trichloropropane	84	84	0	—	0.001	NA	0.001	NA
1,2,4-Trichlorobenzene	84	84	0	—	0.001	NA	0.001	NA
1,2,4-Trimethylbenzene	84	84	0	—	0.001	NA	0.001	NA
1,2-Dibromo-3-chloropropane	84	84	0	—	0.002	NA	0.002	NA
1,2-Dibromoethane	53	53	0	—	0.001	NA	0.001	NA
1,2-Dichlorobenzene	84	84	0	—	0.001	NA	0.001	NA
1,2-Dichloroethane	84	84	0	—	0.0005	NA	0.0005	NA
1,2-Dichloropropane	84	84	0	—	0.001	NA	0.001	NA
1,3,5-Trimethylbenzene	84	84	0	—	0.001	NA	0.001	NA
1,3-Dichlorobenzene	84	84	0	—	0.001	NA	0.001	NA
1,3-Dichloropropane	84	84	0	—	0.0004	NA	0.0004	NA
1,4-Dichlorobenzene	84	84	0	—	0.0005	NA	0.0005	NA
2,2-Dichloropropane	84	84	0	—	0.001	NA	0.001	NA
1-Chlorohexane	17	17	0	—	—	NA	—	NA
2-Butanone	84	81	0	—	0.01	NA	0.01	NA
2-Chloroethyl vinyl ether	84	84	0	—	0.01	NA	0.01	NA
2-Chlorotoluene	84	84	0	—	0.001	NA	0.001	NA
2-Hexanone	84	84	0	—	0.01	NA	0.01	NA
4-Chlorotoluene	84	84	0	—	0.001	NA	0.001	NA
4-Isopropyltoluene	84	84	0	—	0.001	NA	0.001	NA
4-Methyl-2-pentanone	84	84	0	—	0.01	NA	0.01	NA
Acetone	84	84	0	—	0.01	NA	0.01	NA
Acrylonitrile	17	17	0	—	—	NA	—	NA
Benzene	84	83	0	—	0.0004	NA	0.0004	NA
Bromobenzene	84	84	0	—	0.001	NA	0.001	NA
Bromochloromethane	84	84	0	—	0.001	NA	0.001	NA

Analyte	Total No. of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Bromodichloromethane	84	84	0	—	0.0005	NA	0.0005	NA
Bromoform	84	84	0	—	0.001	NA	0.001	NA
Bromomethane	84	84	0	—	0.003	NA	0.003	NA
Carbon disulfide	84	83	0	—	0.002	NA	0.002	NA
Carbon tetrachloride	84	84	0	—	0.001	NA	0.001	NA
Chlorobenzene	84	84	0	—	0.0005	NA	0.0005	NA
Chloroethane	84	84	0	—	0.001	NA	0.001	NA
Chloroform	84	84	0	—	0.0004	NA	0.0004	NA
Chloromethane	84	84	0	—	0.001	NA	0.001	NA
cis-1,2-Dichloroethene	84	84	0	—	0.001	NA	0.001	NA
cis-1,3-Dichloropropene	84	84	0	—	0.0005	NA	0.0005	NA
Dibromochloromethane	84	84	0	—	0.0005	NA	0.0005	NA
Dibromomethane	84	84	0	—	0.001	NA	0.001	NA
Dichlorodifluoromethane	53	53	0	—	—	NA	NA	NA
Ethylbenzene	84	84	0	—	0.001	NA	0.001	NA
Hexachlorobutadiene	69	69	0	—	0.0006	NA	—	NA
Isopropylbenzene	84	84	0	—	0.001	NA	0.001	NA
Methyl iodide	69	69	0	—	0.001	NA	0.001	NA
Methylene chloride	84	84	0	—	0.001	NA	0.005	NA
Methyl-tert-butyl ether (MTBE)	84	84	0	—	0.005	NA	0.005	NA
Naphthalene	84	82	0	—	0.001	NA	0.002	NA
n-Butylbenzene	84	84	0	—	0.001	NA	0.001	NA
n-Propylbenzene	84	84	0	—	0.001	NA	0.001	NA
o-Xylene	84	84	0	—	0.001	NA	0.001	NA
sec-Butylbenzene	84	84	0	—	0.001	NA	0.001	NA
Styrene	84	84	0	—	0.001	NA	0.001	NA
tert-Butylbenzene	84	84	0	—	0.001	NA	0.001	NA
Tetrachloroethene (PCE)	84	84	0	—	0.001	NA	0.001	NA
Toluene	84	76	0	—	0.001	NA	0.001	NA
trans-1,2-Dichloroethene	84	84	0	—	0.001	NA	0.001	NA
trans-1,3-Dichloropropene	84	84	0	—	0.001	NA	0.001	NA
trans-1,4-Dichloro-2-butene	17	17	0	—	NA	NA	NA	NA
Trichloroethene (TCE)	85	84	0	—	0.001	NA	0.001	NA
Trichlorofluoromethane	84	84	0	—	0.001	NA	0.001	NA
Vinyl acetate	17	17	0	—	NA	NA	NA	NA
Vinyl chloride	84	84	0	—	0.001	NA	0.001	NA
Xylene, Isomers m & p	84	84	0	—	0.002	NA	0.002	NA

Analyte	Total No. of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Semivolatile Organic Compounds								
1,2,4-Trichlorobenzene	67	67	0	—	0.01	NA	0.01	NA
1,2-Dichlorobenzene	67	67	0	—	0.01	NA	0.01	NA
1,3-Dichlorobenzene	67	67	0	—	0.01	NA	0.01	NA
1,4-Dichlorobenzene	67	67	0	—	0.01	NA	0.01	NA
2,4,5-Trichlorophenol	83	83	0	—	0.01	NA	0.01	NA
2,4,6-Trichlorophenol	83	83	0	—	0.01	NA	0.01	NA
2,4-Dichlorophenol	83	83	0	—	0.01	NA	0.01	NA
2,4-Dimethylphenol	83	83	0	—	0.01	NA	0.01	NA
2,4-Dinitrophenol	83	83	0	—	0.07	NA	0.07	NA
2,4-Dinitrotoluene	83	83	0	—	0.01	NA	0.01	NA
2,6-Dichlorophenol	15	15	0	—	0.01	NA	0.01	NA
2,6-Dinitrotoluene	83	83	0	—	0.01	NA	0.01	NA
2-Chloronaphthalene	83	83	0	—	0.01	NA	0.01	NA
2-Chlorophenol	83	83	0	—	0.01	NA	0.01	NA
2-Methyl-4,6-dinitrophenol	83	83	0	—	0.05	NA	0.05	NA
2-Methylnaphthalene	83	83	0	—	0.01	NA	0.01	NA
2-Methylphenol (o-Cresol)	83	83	0	—	0.01	NA	0.01	NA
2-Nitroaniline	83	83	0	—	0.01	NA	0.01	NA
2-Nitrophenol	83	83	0	—	0.01	NA	0.01	NA
3,3'-Dichlorobenzidine	83	83	0	—	0.01	NA	0.01	NA
3-Methylphenol/4-Methylphenol Coelution	83	83	0	—	0.02	NA	0.02	NA
3-Nitroaniline	83	83	0	—	0.01	NA	0.01	NA
4-Bromophenyl phenyl ether	83	83	0	—	0.01	NA	0.01	NA
4-Chloro-3-methylphenol	83	83	0	—	0.01	NA	0.01	NA
4-Chloroaniline	83	83	0	—	0.01	NA	0.01	NA
4-Chlorophenyl phenyl ether	83	83	0	—	0.01	NA	0.01	NA
4-Nitroaniline	83	81	0	—	0.01	NA	0.01	NA
4-Nitrophenol	83	83	0	—	0.05	NA	0.05	NA
Acenaphthene	83	83	0	—	0.01	NA	0.01	NA
Acenaphthylene	83	83	0	—	0.01	NA	0.01	NA
Acetophenone	46	46	0	—	0.01	NA	0.01	NA
Aniline	83	83	0	—	0.01	NA	0.01	NA
Anthracene	83	83	0	—	0.01	NA	0.01	NA
Azobenzene	83	83	0	—	0.01	NA	0.01	NA
Benzo(a)anthracene	83	83	0	—	0.01	NA	0.01	NA
Benzo(a)pyrene	83	83	0	—	0.01	NA	0.01	NA
Benzo(b)fluoranthene	83	83	0	—	0.01	NA	0.01	NA
Benzo(g,h,i)perylene	83	83	0	—	0.01	NA	0.01	NA
Benzo(k)fluoranthene	83	83	0	—	0.01	NA	0.01	NA

Analyte	Total No. of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L) 2004	2005	2006	2007	2008
Benzoic acid	83	83	0	—	0.05	NA	0.05	NA
Benzyl alcohol	83	83	0	—	0.01	NA	0.01	NA
Benzyl butyl phthalate	83	83	0	—	0.01	NA	0.01	NA
bis-(2-Chloroethoxy)methane	83	83	0	—	0.01	NA	0.01	NA
bis-(2-Chloroethyl)ether	83	83	0	—	0.01	NA	0.01	NA
bis(2-Chloroisopropyl)ether	83	83	0	—	0.01	NA	0.01	NA
bis-(2-Ethylhexyl)phthalate	83	83	0	—	0.01	NA	0.01	NA
Chrysene	83	83	0	—	0.01	NA	0.01	NA
Dibenzo(a,h)anthracene	83	83	0	—	0.01	NA	0.01	NA
Dibenzofuran	83	83	0	—	0.01	NA	0.01	NA
Diethyl phthalate	83	83	0	—	0.01	NA	0.01	NA
Dimethyl phthalate	83	83	0	—	0.01	NA	0.01	NA
Di-n-butyl phthalate	83	83	0	—	0.01	NA	0.01	NA
Di-n-octyl phthalate	83	83	0	—	0.01	NA	0.01	NA
Fluoranthene	83	83	0	—	0.01	NA	0.01	NA
Fluorene	83	83	0	—	0.01	NA	0.01	NA
Hexachlorobenzene	83	83	0	—	0.01	NA	0.01	NA
Hexachlorobutadiene	82	82	0	—	0.01	NA	0.01	NA
Hexachlorocyclopentadiene	83	83	0	—	0.03	NA	0.03	NA
Hexachloroethane	83	83	0	—	0.01	NA	0.01	NA
Indeno(1,2,3-cd)pyrene	83	83	0	—	0.01	NA	0.01	NA
Isophorone	83	83	0	—	0.01	NA	0.01	NA
Naphthalene	67	67	0	—	0.01	NA	0.01	NA
Nitrobenzene	83	83	0	—	0.01	NA	0.01	NA
n-Nitrosodimethylamine	83	83	0	—	0.01	NA	0.01	NA
n-Nitrosodi-n-propylamine	83	83	0	—	0.01	NA	0.01	NA
n-Nitrosodiphenylamine	83	83	0	—	0.01	NA	0.01	NA
Pentachlorophenol	83	83	0	—	0.05	NA	0.05	NA
Phenanthrene	83	83	0	—	0.01	NA	0.01	NA
Phenol	83	83	0	—	0.01	NA	0.01	NA
Pyrene	83	83	0	—	0.01	NA	0.01	NA

Notes:

a. Units for specific conductance are micromhos/centimeter (mmhos/cm).

— = DQO not established

NA = not applicable, parameter was not scheduled for analysis

ND = not detected

TABLE A-11

Groundwater, Accuracy and Precision

	Laboratory Accuracy and Precision[a]				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Metals								
Aluminum	643	101	5.8	6%	81	38	45.1	118%
Antimony	625	101	6.8	7%	82	21	24.6	116%
Arsenic	620	100	4.5	5%	56	9.9	11.5	115%
Barium	640	100	4.9	5%	133	8.0	13.6	169%
Beryllium	620	100	5.7	6%	10	21	19.2	92%
Bismuth	616	99	5.2	5%	2	32	3.5	11%
Boron	615	100	7.6	8%	27	16	23.3	142%
Cadmium	621	100	4.9	5%	12	14	15.4	112%
Calcium	637	101	5.8	6%	141	5.3	6.1	115%
Chromium	627	100	5.5	6%	111	23	30.0	132%
Cobalt	623	100	5.1	5%	109	16	18.7	116%
Copper	629	100	4.9	5%	123	25	28.1	114%
Iron	630	103	5.6	5%	75	29	33.9	115%
Lead	624	99	4.8	5%	29	27	31.3	117%
Magnesium	636	101	5.7	6%	141	4.7	4.5	95%
Manganese	620	100	4.9	5%	123	21	31.3	150%
Mercury	871	98	18.2	19%	4	36	38.8	109%
Molybdenum	620	99	6.2	6%	122	14	29.4	205%
Nickel	621	100	5.2	5%	123	15	21.2	142%
Potassium	635	101	5.4	5%	142	6.3	11.1	177%
Selenium	623	99	5.2	5%	14	32	40.5	127%
Silicon	507	102	6.2	6%	72	4.7	4.9	103%
Silver	621	100	6.4	6%	7	30	15.1	50%
Sodium	635	102	5.9	6%	142	5.0	4.7	94%
Thallium	620	98	5.7	6%	7	47	66.3	142%
Tin	618	99	7.3	7%	8	31	22.1	71%
Vanadium	622	100	5.4	5%	69	14	19.5	136%
Zinc	627	100	5.5	6%	66	25	26.7	106%

	Laboratory Accuracy and Precision[a]				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Acidity, total	140	100	3.7	4%	42	18	16.4	91%
Alkalinity, total	507	100	5.4	5%	69	3.5	5.7	162%
Ammonia, as Nitrogen	709	97	7.8	8%	5	3.0	4.0	133%
Dissolved Organic Carbon	9	99	3.8	4%	1	16	—	—
Total Organic Carbon	107	102	4.2	4%	nc	nc	nc	nc
Chloride	683	99	3.3	3%	72	4.7	9.1	193%
Cyanide, total	625	99	11.8	12%	2	3.5	5.0	141%
Cyanide, weak acid dissociable	599	98	10.8	11%	1	44	—	—
Fluoride	645	102	9.2	9%	48	17	22.1	130%
Nitrogen as Nitrate-Nitrite	643	100	5.9	6%	57	22	28.0	128%
pH	625	100	0.90	0.9%	70	1.4	1.4	98%
Total Phosphorus	493	99	8.3	8%	60	32	42.6	132%
Orthophosphate	90	98	2.9	3%	4	17	14.7	85%
Specific Conductance	553	100	3.5	4%	70	5.3	17.7	336%
Sulfate	680	100	7.1	7%	72	2.6	5.6	213%
Thiocyanate	412	99	3.9	4%	18	31	29.7	97%
Total Dissolved Solids	490	107	11.2	10%	69	12	12.4	102%
Total Suspended Solids	445	98	6.4	7%	27	45	50.4	112%

Notes:

a. Laboratory accuracy and precision based on surface water and groundwater matrices.

— = insufficient sample count to calculate statistics

nc = primary duplicate pair not collected

TABLE A-12

Groundwater, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Metals				
Aluminum	96	5.7	9.4	166%
Antimony	95	3.2	3.7	115%
Arsenic	95	3.1	3.1	102%
Barium	94	3.2	2.8	85%
Beryllium	91	3.6	3.0	83%
Bismuth	89	2.8	2.4	86%
Boron	95	3.1	2.7	88%
Cadmium	90	2.9	3.0	102%
Calcium	97	3.2	4.4	134%
Chromium	95	3.1	2.8	88%
Cobalt	95	3.7	5.7	157%
Copper	94	2.9	2.8	97%
Iron	93	3.8	3.9	101%
Lead	92	3.4	6.6	193%
Magnesium	94	2.6	2.5	96%
Manganese	95	3.3	3.5	108%
Mercury	154	3.1	4.7	153%
Molybdenum	95	3.1	3.2	101%
Nickel	94	4.9	17.0	347%
Potassium	94	3.1	3.8	125%
Selenium	95	3.1	2.7	89%
Silicon	41	7.0	17.0	243%
Silver	91	4.1	10.0	252%
Sodium	95	3.2	4.3	136%
Thallium	91	4.0	9.3	232%
Tin	90	3.3	3.4	103%
Vanadium	95	3.4	3.9	115%
Zinc	94	3.1	3.0	95%
Inorganic Parameters				
Acidity, total	49	6.2	7.9	128%
Alkalinity, total	80	1.7	2.8	163%
Ammonia, as Nitrogen	8	7.5	5.0	67%
Dissolved Organic Carbon	7	1.4	0.79	55%
Chloride	125	1.7	2.8	168%
Cyanide, total	4	23	10.7	46%
Cyanide, weak acid dissociable	0	—	—	—
Fluoride	76	10	12.9	128%
Nitrogen as Nitrate-Nitrite	37	19	29.1	156%
pH	88	1.0	0.9	149%
Total Phosphorus	68	15	23.3	161%
Orthophosphate	18	16	16.4	101%
Specific Conductance	93	1.8	2.8	152%
Sulfate	125	1.1	1.4	127%
Thiocyanate	76	2.6	3.4	130%
Total Dissolved Solids	91	7.7	14.7	192%
Total Suspended Solids	30	37	44.6	119%

Note:
— = insufficient sample count to calculate statistics

TABLE A-13

Groundwater Comparability

Analyte	**n-pairs**	**Mean Field Triplicate RPD (%)**	**SD**	**RSD**
Metals				
Aluminum	73	53	51.8	98%
Antimony	62	24	27.0	114%
Arsenic	65	19	21.2	112%
Barium	133	11	16.0	149%
Beryllium	12	42	30.4	73%
Bismuth	0	—	—	—
Boron	38	53	47.5	90%
Cadmium	10	37	29.2	80%
Calcium	139	6.7	7.3	109%
Chromium	110	35	32.3	91%
Cobalt	108	31	27.8	90%
Copper	108	43	35.8	84%
Iron	66	75	58.3	78%
Lead	29	57	50.7	90%
Magnesium	139	7.3	6.2	86%
Manganese	124	31	41.0	131%
Mercury	2	64	74.2	115%
Molybdenum	121	16	26.8	172%
Nickel	117	30	28.0	95%
Potassium	113	11	13.0	123%
Selenium	9	9.3	6.3	68%
Silicon	70	8.0	5.5	69%
Silver	7	54	28.8	53%
Sodium	140	6.6	5.3	79%
Thallium	4	37	55.0	150%
Tin	5	87	56.9	66%
Vanadium	76	27	27.0	99%
Zinc	58	52	41.2	80%
Inorganic Parameters				
Acidity, total	46	36	28.8	81%
Alkalinity, total	68	7.8	8.4	108%
Ammonia, as Nitrogen	0	—	—	—
Dissolved Organic Carbon	2	70	6.4	9%
Chloride	70	15	10.7	70%
Cyanide, total	0	—	—	—
Cyanide, weak acid dissociable	0	—	—	—
Fluoride	32	35	28.2	80%
Nitrogen as Nitrate-Nitrite	47	42	27.7	67%
pH	70	4.4	4.5	101%
Total Phosphorus	59	59	55.6	95%
Orthophosphate	0	—	—	—
Specific Conductance	70	35	57.0	165%
Sulfate	70	10	10.4	102%
Thiocyanate	4	124	45.3	37%
Total Dissolved Solids	65	30	28.2	95%
Total Suspended Solids	7	67	61.6	92%

Note:
— = insufficient sample count to calculate statistics

TABLE A-14

Summary of Sensitivity for Groundwater

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Metals								
Aluminum	1121	16	1	0.025	0.001	0.001	0.002	0.002
Antimony	1121	242	3	0.0002	0.00005	0.00005	0.00005	0.00005
Arsenic	1121	499	3	0.0005	0.0005	0.0005	0.0005	0.0005
Barium	1121	0	0	0.0003	0.00005	0.00005	0.00005	0.00005
Beryllium	1121	1010	242	0.00003	0.00002	0.00002	0.00005	0.00005
Bismuth	1111	975	2	0.005	0.0001	0.0001	0.00005	0.00005
Boron	1121	719	237	0.01	0.0005	0.0005	0.005	0.005
Cadmium	1121	956	247	0.0001	0.00002	0.00002	0.00005	0.00005
Calcium	1144	0	0	0.05	0.05	0.05	0.05	0.05
Chromium	1121	103	2	0.0002	0.0002	0.0002	0.0002	0.0002
Cobalt	1121	69	0	0.0001	0.00002	0.00002	0.00002	0.00002
Copper	1121	0	0	0.0002	0.0001	0.0001	0.0001	0.0001
Iron	1121	230	1	0.02	0.02	0.02	0.02	0.02
Lead	1121	461	105	0.0002	0.00002	0.00002	0.0001	0.0001
Magnesium	1144	0	0	0.02	0.02	0.02	0.02	0.02
Manganese	1121	22	0	0.001	0.00005	0.00005	0.00005	0.00005
Mercury	1092	918	0	0.0002	0.0002	0.000005	0.000005	0.000005
Molybdenum	1121	58	0	0.001	0.00005	0.00005	0.00005	0.00005
Nickel	1121	0	0	0.0002	0.0002	0.0002	0.0002	0.0002
Potassium	1144	0	0	0.05	0.05	0.05	0.05	0.05
Selenium	1121	912	3	0.001	0.001	0.001	0.001	0.001
Silicon	583	0	0	0.5	0.1	0.1	0.1	0.1
Silver	1121	1034	3	0.00002	0.00002	0.00002	0.00002	0.00002
Sodium	1144	1	0	0.1	0.1	0.1	0.1	0.1
Thallium	1121	1006	4	0.00005	0.00001	0.00001	0.00002	0.00002
Tin	1121	976	3	0.001	0.0001	0.0001	0.0002	0.0002
Vanadium	1121	540	122	0.0004	0.0002	0.0002	0.001	0.001
Zinc	1121	86	1	0.0015	0.0005	0.0005	0.001	0.001

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Inorganic Parameters								
Acidity, total	560	130	0	10	10	10	10	10
Alkalinity, total	560	18	0	10	10	10	10	10
Ammonia, as Nitrogen	560	326	0	0.1	0.1	0.1	0.1	0.1
Dissolved Organic Carbon	107	37	0	NA	NA	NA	NA	0.5
Chloride	583	0	0	0.2	0.2	0.2	0.2	0.1
Total Cyanide	560	491	0	0.01	0.01	0.01	0.005	0.005
WAD Cyanide	688	623	0	0.01	0.01	0.01	0.005	0.005
Fluoride	560	164	1	0.1	0.1	0.1	0.2	0.1
Nitrogen, Nitrate-Nitrite	560	87	0	2	0.1	0.1	0.1	0.1
Total Phosphorus	560	40	23	0.01	0.01	0.01	0.01	0.01
Orthophosphate	100	23	0	NA	NA	0.2	—	NA
Specific Conductance[a]	560	0	0	2	2	2	1	1
Sulfate	583	0	0	0.2	0.2	0.2	0.2	0.1
Thiocyanate	560	398	0	1	1	1	1	1
Total Dissolved Solids	560	3	0	10	10	10	10	10
Total Suspended Solids	560	269	0	5	5	5	5	0.5

Notes:

a. Specific conductance units = μmhos/cm

— = DQO not established

NA = not applicable, parameter was not scheduled for analysis

TABLE A-15

Sediment, Accuracy and Precision

	Laboratory Accuracy and Precision[a]				**Field Precision[b]**			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Acid-Volatile Sulfide	8	85	2.9	3%	2	68	19.1	28%
Ammonia, as Nitrogen	112	97	9.0	9%	39	29	30.0	103%
Chloride	88	100	14.1	14%	34	34	25.0	75%
Fluoride	103	106	14.3	14%	19	61	49.4	81%
Sulfate	85	105	12.2	12%	40	34	28.8	82%
Cyanide, Weak Acid Dissociable[c]	3	112	8.1	7%	3	68	39.0	58%
Total Cyanide	160	99	12.8	13%	18	37	43.8	119%
Total Solids					44	11	11.5	104%
Metals								
Aluminum	103	102	11.1	11%	41	13	13.9	101%
Antimony	104	98	21.1	22%	29	23	20.5	91%
Arsenic	103	100	5.8	6%	40	22	20.8	94%
Barium	105	103	7.1	7%	41	17	16.2	95%
Beryllium	100	101	9.1	9%	37	15	16.3	105%
Bismuth	74	107	47.2	44%	5	23	22.0	97%
Boron	103	95	9.8	10%	17	23	21.1	91%
Cadmium	103	100	6.6	7%	27	22	21.9	100%
Cadmium-SEM[c]	6	102	3.5	3%	3	1.7	2.9	173%
Calcium	102	102	7.9	8%	41	14	13.8	99%
Chromium	102	102	8.5	8%	41	19	14.9	76%
Cobalt	102	100	10.7	11%	41	15	15.7	107%
Copper	103	102	6.5	6%	41	16	16.0	102%
Copper-SEM[c]	6	100	1.0	1%	8	10	13.8	135%
Iron	103	102	10.5	10%	40	14	12.5	86%
Lead	103	99	8.4	8%	41	16	17.5	112%
Lead-SEM[c]	6	101	2.8	3%	6	16	31.5	197%
Magnesium	102	102	7.3	7%	41	14	12.9	94%
Manganese	106	103	7.8	8%	41	15	18.6	121%
Mercury	123	97	10.9	11%	13	57	42.5	75%
Mercury-SEM[c]	7	96	10.0	10%	NA	NA	NA	NA
Molybdenum	101	98	10.1	10%	27	19	21.8	116%
Nickel	104	102	7.3	7%	41	16	15.5	95%
Nickel-SEM[c]	6	100	4.0	4%	8	16	23.8	145%
Potassium	102	102	6.6	6%	41	14	17.7	122%
Selenium	103	101	8.8	9%	19	29	21.0	73%
Silver	103	100	17.9	18%	16	19	25.5	136%
Sodium	102	101	7.2	7%	39	13	11.8	89%
Sulfur[c]	1	99	—	—	8	20	22.5	110%
Thallium	99	99	7.4	7%	23	30	28.7	97%
Tin	99	100	14.0	14%	4	23	17.1	74%
Vanadium	103	100	9.4	9%	41	17	13.7	82%
Zinc	101	101	6.8	7%	40	12	11.5	96%
Zinc-SEM[c]	6	102	2.2	2%	8	7.1	6.7	95%

	Laboratory Accuracy and Precision[a]				Field Precision[b]			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Organics [d]								
Total Organic Carbon	28	101	10.4	10%	2	28	7.8	27%
Gasoline-range Organics	9	102	6.2	6%	nc	nc	nc	nc
Diesel-range Organics	20	92	8.6	9%	nc	nc	nc	nc
Residual-range Organics	20	96	10.0	10%	nc	nc	nc	nc
Benzene	2	103	4.2	4%	nc	nc	nc	nc
Ethylbenzene	2	102	2.8	3%	nc	nc	nc	nc
o-Xylene	2	100	2.8	3%	nc	nc	nc	nc
Toluene	2	98	4.9	5%	nc	nc	nc	nc
Xylene, Isomers m & p	2	101	4.2	4%	nc	nc	nc	nc
1-Methylnaphthalene	2	78	12.0	15%	nc	nc	nc	nc
2-Methylnaphthalene	2	74	11.3	15%	nc	nc	nc	nc
Acenaphthene	2	80	14.8	19%	nc	nc	nc	nc
Acenaphthylene	2	78	15.6	20%	nc	nc	nc	nc
Anthracene	2	69	18.4	27%	nc	nc	nc	nc
Benzo(a)anthracene	2	87	17.0	20%	nc	nc	nc	nc
Benzo(a)pyrene	2	66	10.6	16%	nc	nc	nc	nc
Benzo(b)fluoranthene	2	92	17.0	18%	nc	nc	nc	nc
Benzo(g,h,i)perylene	2	94	24.7	26%	nc	nc	nc	nc
Benzo(k)fluoranthene	2	89	24.0	27%	nc	nc	nc	nc
Chrysene	2	94	20.5	22%	nc	nc	nc	nc
Dibenzo(a,h)anthracene	2	94	30.4	32%	nc	nc	nc	nc
Fluoranthene	2	90	12.0	13%	nc	nc	nc	nc
Fluorene	2	82	19.1	23%	nc	nc	nc	nc
Indeno(1,2,3-cd)pyrene	2	94	29.0	31%	nc	nc	nc	nc
Naphthalene	2	74	9.2	12%	nc	nc	nc	nc
Phenanthrene	2	86	21.9	25%	nc	nc	nc	nc
Pyrene	2	91	12.7	14%	nc	nc	nc	nc

Notes:

a. Laboratory accuracy and precision calculated from soil and sediment LCS data

b. Field precision calculated from sediment field duplicate data

c. LCS values from sediment data only

d. VOCs/SVOCs reported only if enough data were present to calculate statistics

Gray shaded cells = data not available, analyte not analyzed

— = insufficient sample count to calculate statistics

NA = not applicable, analyte was not detected in the sample

nc = field duplicates not collected

TABLE A-16

Sediment, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Acid-Volatile Sulfide	1	89	—	—
Ammonia, as Nitrogen	47	21	21.8	103%
Chloride	47	19	21.6	116%
Fluoride	33	10	8.8	85%
Sulfate	59	15	19.1	130%
Cyanide, Weak Acid Dissociable	2	43	38.2	89%
Total Cyanide	40	22	21.0	98%
Total Organic Carbon	3	5	6.1	122%
Total Solids	13	2	3.8	204%
Metals				
Aluminum	64	30	39.6	133%
Antimony	55	62	84.4	135%
Arsenic	51	39	66.9	171%
Barium	54	45	68.7	154%
Beryllium	50	40	69.0	171%
Bismuth	47	46	74.1	162%
Boron	47	26	46.5	181%
Cadmium	48	41	70.5	170%
Cadmium-SEM	2	11	15.6	141%
Calcium	59	35	52.2	149%
Chromium	52	39	66.3	169%
Cobalt	52	42	70.5	168%
Copper	52	41	67.8	165%
Copper-SEM	5	9.2	10.8	118%
Iron	65	49	62.5	128%
Lead	51	39	68.3	174%
Lead-SEM	4	9.0	4.0	44%
Magnesium	59	36	48.4	135%
Manganese	61	48	64.0	134%
Mercury	27	4.5	5.3	117%
Mercury-SEM	0	NA	NA	NA
Molybdenum	51	43	71.3	165%
Nickel	51	39	67.3	173%
Nickel-SEM	5	22	14.4	65%
Potassium	53	37	58.7	159%
Selenium	51	44	71.2	161%
Silver	47	48	75.3	157%
Sodium	54	43	63.7	150%
Sulfur	4	4.0	6.7	167%
Thallium	47	47	75.3	160%
Tin	46	44	72.9	167%
Vanadium	55	45	70.0	156%
Zinc	51	40	67.0	167%
Zinc-SEM	5	9.8	7.6	77%

Notes:

— = insufficient sample count to calculate statistics

NA = not applicable, analyte was not detected in the sample

TABLE A-17

Sediment Comparability

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Acid-Volatile Sulfide	1	123	—	—
Ammonia, as Nitrogen	32	142	53.5	38%
Chloride	11	105	47.6	45%
Fluoride	2	97	102	105%
Sulfate	26	99	57.3	58%
Cyanide, Weak Acid Dissociable	NA	NA	NA	NA
Total Cyanide	6	94	30.0	32%
Total Solids	47	16	16.7	104%
Metals				
Aluminum	33	22	15.2	69%
Antimony	25	63	47.8	76%
Arsenic	33	27	18.9	69%
Barium	33	20	18.3	93%
Beryllium	31	27	30.2	112%
Bismuth	4	48	35.0	73%
Boron	8	70	48.3	69%
Cadmium	22	68	49.5	73%
Cadmium-SEM	3	72	47.5	66%
Calcium	33	23	19.7	87%
Chromium	33	27	17.8	67%
Cobalt	33	18	18.0	98%
Copper	33	21	17.7	85%
Copper-SEM	8	56	46.5	82%
Iron	32	21	15.5	74%
Lead	33	23	26.3	113%
Lead-SEM	6	58	41.5	72%
Magnesium	33	18	12.5	70%
Manganese	33	20	16.6	82%
Mercury	10	72	50.4	69%
Mercury-SEM	NA	NA	NA	NA
Molybdenum	22	33	33.7	102%
Nickel	33	19	18.9	99%
Nickel-SEM	8	73	39.5	54%
Potassium	29	26	26.4	102%
Selenium	13	71	55.3	78%
Silver	15	45	48.1	107%
Sodium	32	29	30.0	104%
Sulfur	8	69	33.5	48%
Thallium	22	45	44.9	100%
Tin	1	7	—	—
Vanadium	33	28	17.0	61%
Zinc	32	20	11.4	56%
Zinc-SEM	8	63	48.6	77%
Organics [a]				
Total Organic Carbon	2	7.5	4.9	66%

Notes:

a. Organics data reported only if enough data were present to calculate statistics

— = insufficient sample count to calculate statistics

NA = not applicable, analyte was not detected in the sample

TABLE A-18

Summary of Sensitivity for Sediment

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg)			
				2004	2005	2006	2007
Inorganic Parameters							
Acid-Volatile Sulfide	42	32	21	NA	NA	0.5	NA
Chloride	306	44	1	1	1	1	10
Fluoride	306	112	7	2	2	2	2.5
Sulfate	306	6	0	2	2	2	2.5
Cyanide, Weak Acid Dissociab	14	0	0	NA	NA	—	NA
Total Cyanide	317	130	33	0.2	0.2	0.2	0.025
Total Solids	**223**	0	**0**	—	—	—	—
Nitrogen as Ammonia	318	18	18	0.2	0.2	0.2	2.5
Metals							
Aluminum	321	0	0	2	2	2	0.5
Antimony	321	67	31	0.05	0.05	0.05	0.3
Arsenic	321	9	8	0.5	0.5	0.5	0.3
Barium	321	0	0	0.05	0.05	0.05	0.05
Beryllium	321	16	16	0.02	0.02	0.02	0.05
Bismuth	321	234	123	—	0.05	0.05	50
Boron	320	183	38	20	20	20	0.25
Cadmium	321	69	68	0.05	0.05	0.05	0.05
Cadmium-SEM	43	23	9	NA	NA	0.2	NA
Calcium	321	0	0	10	10	10	100
Chromium	321	0	0	0.2	0.2	0.2	0.05
Cobalt	321	2	2	0.02	0.02	0.02	0.025
Copper	321	0	0	0.1	0.1	0.1	0.25
Copper-SEM	43	0	0	NA	NA	0.4	NA
Iron	321	1	0	4	4	4	10
Lead	321	0	0	0.05	0.05	0.05	0.05
Lead-SEM	43	16	13	NA	NA	3	NA
Magnesium	321	0	0	4	4	4	100
Manganese	321	0	0	0.05	0.05	0.05	0.3
Mercury	321	179	29	0.02	0.02	0.02	0.1
Mercury-SEM	43	42	31	NA	NA	10	NA
Molybdenum	321	66	66	0.05	0.05	0.05	0.3
Nickel	321	0	0	0.2	0.2	0.2	0.3
Nickel-SEM	43	4	4	NA	NA	0.5	NA
Potassium	321	2	1	400	400	400	100
Selenium	321	84	5	1	1	1	0.05
Silver	321	167	167	0.02	0.02	0.02	0.025
Sodium	321	32	26	20	20	20	100
Thallium	321	93	12	0.02	0.02	0.02	0.05
Tin	321	14	10	1	1	1	0.05
Vanadium	321	1	1	0.2	0.2	0.2	0.1
Zinc	321	3	3	0.5	0.5	0.5	1
Zinc-SEM	43	0	0	NA	NA	0.4	NA
Organics							
Total Organic Carbon[a]	45	0	0	NA	0.05	NA	0.05
Diesel Range Organics	12	0	0	NA	40	NA	20
Gasoline Range Organics	7	7	0	NA	5	NA	2.5

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg)			
				2004	2005	2006	2007
Residual Range Organics	12	0	0	NA	100	NA	100
Benzene	6	6	1	NA	0.005	NA	0.013
Ethylbenzene	6	6	4	NA	0.005	NA	0.025
o-Xylene	6	6	5	NA	0.002	NA	0.05
Toluene	6	6	5	NA	0.005	NA	0.05
Xylene, Isomers m & p	6	6	5	NA	0.002	NA	0.05
1-Methylnaphthalene	6	6	0	NA	—	NA	0.006
2-Methylnaphthalene	6	6	0	NA	0.005	NA	0.006
Acenaphthene	6	6	0	NA	0.005	NA	0.005
Acenaphthylene	6	5	0	NA	0.005	NA	0.006
Anthracene	6	5	0	NA	0.005	NA	0.006
Benzo(a)anthracene	6	5	0	NA	0.005	NA	0.006
Benzo(a)pyrene	6	5	0	NA	0.005	NA	0.006
Benzo(b)fluoranthene	6	5	0	NA	0.005	NA	0.006
Benzo(g,h,i)perylene	6	5	0	NA	0.005	NA	0.006
Benzo(k)fluoranthene	6	5	0	NA	0.005	NA	0.006
Chrysene	6	5	0	NA	0.005	NA	0.006
Dibenzo(a,h)anthracene	6	6	0	NA	0.005	NA	0.006
Fluoranthene	6	5	0	NA	0.005	NA	0.006
Fluorene	6	6	0	NA	0.005	NA	0.006
Indeno(1,2,3-cd)pyrene	6	5	0	NA	0.005	NA	0.006
Naphthalene	6	5	0	NA	0.005	NA	0.006
Phenanthrene	6	5	0	NA	0.005	NA	0.006
Pyrene	6	5	0	NA	0.005	NA	0.006

Notes:

a. The MRL unit reported for total organic carbon is percent.

— = MRL DQO not established

NA = not applicable, analyte not scheduled for analysis

TABLE A-19

Vegetation, Accuracy and Precision

	Laboratory Accuracy and Precision				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters - TQ								
Chloride	13	95	43.3	45%	23	43	44.5	103%
Fluoride	15	100	8.4	8%	20	27	41.2	154%
Sulfate	12	102	10.4	10%	23	51	40.0	79%
Total Cyanide	70	100	7.4	7%	19	68	45.6	67%
Nitrogen as Ammonia	NA	NA	NA	NA	22	27	25.2	93%
Total Solids[a]	NA	NA	NA	NA	123	4.2	6.3	150%
Inorganic Parameters - WQ								
Chloride	32	97	1.4	1%	NA	NA	NA	NA
Fluoride	4	101	0.5	0.5%	NA	NA	NA	NA
Nitrogen as Ammonia	24	96	1.6	2%	NA	NA	NA	NA
Sulfate	29	93	2.0	2%	NA	NA	NA	NA
Metals - WQ								
Aluminum	113	99	5.5	6%	115	20	24.6	123%
Antimony	77	97	7.1	7%	62	33	31.0	94%
Arsenic	76	101	5.0	5%	37	30	33.7	112%
Barium	81	101	4.0	4%	115	12	14.4	120%
Beryllium	74	101	5.9	6%	29	22	19.1	87%
Bismuth	64	97	4.7	5%	12	32	37.9	118%
Boron	81	100	4.9	5%	95	11	10.8	98%
Cadmium	76	100	4.2	4%	89	20	19.8	99%
Calcium	79	99	3.9	4%	115	6.0	6.7	112%
Chromium	80	101	4.0	4%	27	21	22.6	108%
Cobalt	76	101	5.2	5%	113	14	15.5	111%
Copper	74	101	4.7	5%	115	15	24.4	163%
Iron	81	101	11.1	11%	115	15	21.5	143%
Lead	76	99	3.9	4%	105	26	27.6	106%
Magnesium	81	97	4.1	4%	115	5.7	7.8	137%
Manganese	82	99	4.5	5%	115	10	16.1	161%
Mercury	76	102	7.4	7%	97	19	18.9	99%
Molybdenum	76	102	3.9	4%	95	14	17.6	126%
Nickel	74	100	4.7	5%	115	29	33.2	114%
Potassium	80	99	4.4	4%	115	6.5	13.3	205%
Selenium	75	101	7.4	7%	15	40	42.6	106%
Silver	78	98	6.0	6%	31	28	30.7	110%
Sodium	80	100	5.7	6%	113	14	14.0	100%
Thallium	76	100	7.6	8%	50	22	22.3	101%
Tin	72	100	4.2	4%	8	16	17.1	107%
Vanadium	76	101	4.5	4%	98	26	23.6	91%
Zinc	81	97	5.0	5%	115	9.0	10.3	114%

Notes:

a. LCS not analyzed for total solids.

— = insufficient sample count to calculate statistics

NA = not applicable

TQ = standard reference material (SRM) for vegetation or aquatic animal tissue, as appropriate, with externally certified constituent concentrations

WQ = laboratory water fortified with known metal concentrations

TABLE A-20

Vegetation, Precision from Laboratory Duplicates

Analyte	n	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Ammonia, as Nitrogen	16	15	10.8	74%
Chloride	17	3.5	4.0	114%
Fluoride	15	14	16.1	118%
Sulfate	17	6.2	6.3	101%
Total Cyanide	16	38	53.3	139%
Total Solids	97	4.2	9.2	220%
Metals				
Aluminum	167	5.7	5.7	102%
Antimony	33	32	28.7	90%
Arsenic	16	12	23.7	194%
Barium	62	3.5	3.9	111%
Beryllium	13	5.5	6.8	123%
Bismuth	16	58	41.7	71%
Boron	53	9.2	12.6	137%
Cadmium	47	11	13.5	126%
Calcium	62	2.5	2.3	93%
Chromium	21	20	26.6	133%
Cobalt	62	5.3	6.8	128%
Copper	62	3.6	3.7	105%
Iron	62	4.8	6.9	144%
Lead	61	14	22.2	158%
Magnesium	62	1.9	1.9	95%
Manganese	62	1.9	1.9	101%
Mercury	56	16	16.6	102%
Molybdenum	49	12	17.2	140%
Nickel	62	5.4	6.1	113%
Potassium	62	2.4	4.0	164%
Selenium	8	23	30.5	135%
Silver	15	20	21.3	109%
Sodium	59	8.9	9.6	107%
Thallium	28	29	47.0	161%
Tin	3	27	5.8	21%
Vanadium	52	22	19.8	92%
Zinc	62	2.5	2.3	93%

TABLE A-21

Vegetation Comparability

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Ammonia, as Nitrogen	21	135	53.4	40%
Chloride	22	37	40.3	109%
Fluoride	22	188	23.5	13%
Sulfate	22	84	49.0	58%
Total Cyanide	6	71	59.3	84%
Total Solids	90	9.1	23.5	258%
Metals				
Aluminum	71	32	33.9	106%
Antimony	11	93	72.3	78%
Arsenic	16	86	52.9	62%
Barium	105	27	22.7	84%
Beryllium	1	46	—	—
Bismuth	3	199	0.6	0%
Boron	3	32	33.6	105%
Cadmium	47	46	50.5	110%
Calcium	105	17	26.0	153%
Chromium	14	97	52.5	54%
Cobalt	72	31	26.9	87%
Copper	105	23	25.0	109%
Iron	100	24	28.4	118%
Lead	37	64	52.5	82%
Magnesium	105	15	22.8	152%
Manganese	105	22	27.9	127%
Mercury	16	63	44.5	71%
Molybdenum	28	27	22.5	83%
Nickel	64	47	46.6	99%
Potassium	105	14	16.6	119%
Selenium	5	45	50.4	112%
Silver	12	81	63.0	78%
Sodium	63	51	62.7	123%
Thallium	22	77	74.0	96%
Tin	2	54	53.7	99%
Vanadium	41	74	54.1	73%
Zinc	102	21	19.4	92%

Note:

— = insufficient sample count to calculate statistics

TABLE A-22

Summary of Sensitivity for Vegetation

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg)			
				2004	2005	2006	2007
Inorganic Parameters							
Ammonia, as Nitrogen	250	19	19	0.2	NA	NA	NA
Chloride	250	6	6	1	NA	NA	NA
Fluoride	250	43	0	2	NA	NA	NA
Sulfate	250	1	1	2	NA	NA	NA
Total Cyanide	1048	703	189	0.2	0.2	0.2	0.5
Metals							
Aluminum	1050	3	3	2	2	2	2
Antimony	1048	381	1	0.05	0.05	0.05	0.05
Arsenic	1048	726	0	0.5	0.5	0.5	0.5
Barium	1048	0	0	0.05	0.05	0.05	0.05
Beryllium	1048	829	21	0.02	0.02	0.02	0.02
Bismuth	1048	696	90	NA	0.05	0.05	0.02
Boron	1048	70	0	20	20	20	20
Cadmium	1048	159	0	0.05	0.05	0.05	0.05
Calcium	1048	0	0	10	10	10	10
Chromium	1030	606	415	0.2	0.2	0.2	2
Cobalt	1048	4	0	0.02	0.02	0.02	0.02
Copper	1048	0	0	0.1	0.1	0.1	0.1
Iron	1048	0	0	4	4	4	4
Lead	1048	14	0	0.05	0.05	0.05	0.05
Magnesium	1048	0	0	4	4	4	4
Manganese	1048	0	0	0.05	0.05	0.05	1
Mercury	1048	137	19	0.02	0.02	0.02	0.02
Molybdenum	1048	89	0	0.05	0.05	0.05	0.05
Nickel	1048	0	0	0.2	0.2	0.2	0.2
Potassium	1048	1	0	400	400	400	400
Selenium	1030	847	0	1	1	1	1
Silver	1048	580	0	0.02	0.02	0.02	0.02
Sodium	1048	19	0	20	20	20	20
Thallium	1048	507	21	0.02	0.02	0.02	0.02
Tin	1030	317	1	10	10	10	10
Vanadium	1048	107	0	0.2	0.2	0.2	0.2
Zinc	1048	0	0	0.5	0.5	0.5	0.5

Notes:

NA = not applicable, analyte not scheduled for analysis

ND = not detected

TABLE A-23

Soil, Accuracy and Precision

	Laboratory Accuracy and Precision[a]				**Field Precision[b]**			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Ammonia, as Nitrogen	112	97	9.0	9%	28	27	21.5	79%
Chloride	88	100	14.1	14%	16	38	31.8	83%
Fluoride	103	106	14.3	14%	6	30	23.4	77%
pH	1	98	—	—	3	2.7	3.1	115%
Total Cyanide	160	99	12.8	13%	24	30	25.5	84%
Total Solids[c]	NA	NA	NA	NA	32	9.0	15.1	168%
Sulfate	85	105	12.2	12%	24	31	27.4	89%
Metals								
Aluminum	103	102	11.1	11%	30	22	33.0	152%
Antimony	104	98	21.1	22%	19	17	15.5	93%
Arsenic	103	100	5.8	6%	24	25	27.3	109%
Barium	105	103	7.1	7%	30	17	18.1	107%
Beryllium	100	101	9.1	9%	28	21	18.7	90%
Bismuth	74	107	47.2	44%	8	8.0	11.2	140%
Boron	103	95	9.8	10%	9	25	21.3	85%
Cadmium	103	100	6.6	7%	17	27	25.4	96%
Calcium	102	102	7.9	8%	30	18	20.7	118%
Chromium	102	102	8.5	8%	27	18	20.5	117%
Cobalt	102	100	10.7	11%	27	25	24.6	99%
Copper	103	102	6.5	6%	30	20	19.0	97%
Iron	103	102	10.5	10%	30	30	29.8	99%
Lead	103	99	8.4	8%	30	17	18.7	112%
Magnesium	102	102	7.3	7%	30	21	24.0	117%
Manganese	106	103	7.8	8%	30	33	37.3	115%
Mercury	123	97	10.8	11%	26	28	26.6	95%
Molybdenum	101	98	10.1	10%	17	29	25.9	90%
Nickel	104	102	7.3	7%	30	22	20.2	93%
Potassium	102	102	6.6	6%	28	17	20.3	123%
Selenium	103	101	8.8	9%	24	22	19.3	90%
Silver	103	100	17.9	18%	13	13	11.5	91%
Sodium	102	101	7.2	7%	25	16	18.1	112%
Thallium	99	99	7.4	8%	17	17	20.8	124%
Tin	99	100	14.0	14%	0	—	—	—
Vanadium	103	100	9.4	9%	25	24	29.6	125%
Zinc	101	101	6.8	7%	30	22	27.2	125%
Organics								
Total Organic Carbon	28	101	10.4	10%	12	31	35.4	115%
Diesel Range Organics	20	92	8.6	9%	4	19	4.3	23%
Residual Range Organics	20	96	10.0	10%	6	29	26.2	91%

Notes:

a. Laboratory accuracy and precision calculated from soil and sediment LCS data

b. Field precision calculated from soil field duplicate data

c. LCS not analyzed for total solids

— = insufficient sample count to calculate statistics

NA = not applicable

TABLE A-24

Soil, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Ammonia, as Nitrogen	28	20	15.4	78%
Chloride	27	17	15.2	92%
Fluoride	7	27	33.2	124%
pH	2	0	0.0	—
Sulfate	39	25	26.4	106%
Total Cyanide	43	37	28.1	77%
Total Solids	12	3.2	3.7	118%
Metals				
Aluminum	34	36	33.3	92%
Antimony	27	79	91.0	116%
Arsenic	22	52	76.4	148%
Barium	26	73	81.1	112%
Beryllium	23	57	80.5	141%
Bismuth	23	58	80.6	140%
Boron	22	30	50.9	170%
Cadmium	23	58	81.0	141%
Calcium	31	64	67.2	105%
Chromium	22	51	75.2	147%
Cobalt	23	57	80.5	141%
Copper	23	57	79.5	140%
Iron	37	63	59.4	95%
Lead	22	50	76.1	152%
Magnesium	34	60	58.0	97%
Manganese	33	70	66.0	94%
Mercury	20	3.2	4.4	139%
Molybdenum	23	57	81.4	143%
Nickel	24	55	79.3	145%
Potassium	24	59	74.8	127%
Selenium	22	51	77.2	151%
Silver	23	59	82.8	140%
Sodium	25	61	75.4	124%
Thallium	23	59	81.9	139%
Tin	20	57	81.7	143%
Vanadium	27	59	74.4	127%
Zinc	24	54	74.5	138%
Organics				
Total Organic Carbon	4	18	12.5	71%
Diesel Range Organics	3	1.7	2.9	173%
Residual Range Organics	3	3.0	5.2	173%

Note:
— = insufficient sample count to calculate statistics

TABLE A-25a

2006 Results for Blind Performance Evaluation of Soil Samples

Parameter	ERA Certified Value (mg/kg)	Performance Acceptance Limits (mg/kg)	SGS Result (mg/kg)	Difference from Certified Value, SGS	CAS Result (mg/kg)	Difference from Certified Value, CAS
Metals by Method SW6010B, SW7471A						
Boron	130	72.7 - 187	129	99%	138	106%
Calcium	3640	2880 - 4400	NA	NA	3710	102%
Iron	14500	7340 - 21600	NA	NA	14600	191%
Magnesium	3000	2310 - 3690	NA	NA	2890	96%
Mercury	4180	2850 - 5520	3720	89%	3950	94%
Potassium	2410	1720.0 - 3100	NA	NA	2390	99%
Sodium	574	319.0 - 829	NA	NA	576	100%
Tin	107	74.7 - 139	NA	NA	112	105%
Metals by Method SW6020						
Aluminum	8270	4320.0 - 12200	6840	83%	7260	88%
Antimony	56	D.L. - 153	49.6	89%	43.4	78%
Arsenic	255	196.0 - 314	254	100%	262	103%
Barium	469	370.0 - 568	439	94%	511	109%
Beryllium	86	66.8 - 106	72.5	84%	91.2	106%
Cadmium	119	94.7 - 143	99.6	84%	130	109%
Calcium	3760	2980.0 - 4540	3240	86%	NA	NA
Chromium	71	55.7 - 87	68.1	96%	67.9	95%
Cobalt	80	64.0 - 95	72.1	91%	83.4	105%
Copper	96	77.6 - 115	92.6	96%	102	106%
Iron	13200	6590.0 - 19900	13400	102%	NA	NA
Lead	169	133.0 - 205	163	96%	174	103%
Magnesium	2990	2230.0 - 3750	2700	90%	NA	NA
Manganese	364	292.0 - 436	332	91%	364	100%
Molybdenum	80	60.9 - 98	76.5	96%	86.4	109%
Nickel	101	82.0 - 120	84.0	83%	103.0	102%
Potassium	2420	1670.0 - 3170	2160	89%	NA	NA
Selenium	171	129.0 - 213	180	105%	195	114%
Silver	116	36.0 - 196	121	104%	125	108%
Sodium	575	418.0 - 732	462	80%	NA	NA
Thallium	203	155.0 - 251	201	99%	208	102%

Parameter	ERA Certified Value (mg/kg)	Performance Acceptance Limits (mg/kg)	SGS Result (mg/kg)	Difference from Certified Value, SGS	CAS Result (mg/kg)	Difference from Certified Value, CAS
Tin	104	47.8 - 160	108	104%	NA	NA
Vanadium	134	101.0 - 166	140	104%	130	97%
Zinc	202	159.0 - 244	177	88%	208	103%
Anions and Nutrients						
Total Cyanide	3.30	0.092 - 4.15	0.63	19.09%	3.5	106%
Chloride	9.92	7.32 - 12.5	10.6	106.85%	7.6	77%
Fluoride	4.48	3.43 - 5.53	3.91	87.28%	**6.4**	143%
Sulfate	10.80	8.61 - 13.0	12.1	112.04%	11.8	109%
Total Organic Carbon	0.838	0.424 - 1.25	1.06	126.49%	**0.17**	20%

Notes:

Bold = does not meet performance acceptance limits

NA = not applicable

TABLE A-25b
2007 Results for Blind Performance Evaluation of Soil Samples

Parameter	RTC Certified Value (mg/kg)	Performance Acceptance Limits (mg/kg)	ACZ Result (mg/kg)	Difference from Certified Value, ACZ	CAS Result (mg/kg)	Difference from Certified Value, CAS	STL Result (mg/kg)	Difference from Certified Value, STL
Metals by Method SW6010B, SW7471A								
Aluminum	9200	3950.0 - 14400	**17600**	191%	7140	78%	-	-
Barium	83.0	50.9 - 115	103	124%	72	87%	-	-
Bismuth	0.300	0.00 - 0.600	ND, <4	<1333%	-	-	ND, <0.42	<140%
Boron	8.60	0.00 - 24.3	-	-	3.9	45%	ND, <1.7	<20%
Calcium	23500	16800 - 30200	23700	101%	24000	102%	22000	94%
Iron	17100	10100 - 24100	19400	113%	16800	98%	15000	88%
Magnesium	13600	10200 - 17000	14700	108%	13400	99%	12000	88%
Manganese	184	140 - 228	199	108%	189	103%	-	-
Mercury	0.221	0.0908 - 0.351	0.22	100%	0.224	101%	0.35	158%
Potassium	2070	833 - 3310	**3590**	173%	1860	90%	1700	82%
Sodium	401	186 - 616	380	95%	308	77%	420	105%
Titanium	80	44.0 - 116	-	-	98.1	123%	46	58%
Zinc	69.9	42.6 - 97.2	-	-	66.0	94%	-	-
Metals by Method SW6020								
Aluminum	9200	3950.0 - 14400	-	-	-	-	7300	79%
Antimony	0.360	0.198 - 0.522	ND, <1	<278%	0.21	58%	0.37	103%
Arsenic	6.60	2.40 - 10.8	8.2	124%	5.47	83%	7.8	118%
Barium	83.0	50.9 - 115	-	-	-	-	96	116%
Bismuth	0.300	0.00 - 0.600	-	-	0.28	93%	-	-
Beryllium	0.470	0.0500 - 0.890	0.69	147%	0.44	94%	0.48	102%
Boron	8.60	0.00 - 24.3	22	256%	-	-	-	-
Cadmium	0.520	0.193 - 0.847	0.54	104%	0.284	55%	0.50	96%
Chromium	14.3	0.290 - 28.3	26.1	183%	-	-	18	126%
Cobalt	6.04	4.66 - 7.42	6.85	113%	-	-	7.0	116%
Copper	16.1	10.4 - 21.8	16.6	103%	-	-	16	99%
Lead	15.0	9.78 - 20.2	16.8	112%	15.8	105%	15	100%
Manganese	184	140 - 228	-	-	-	-	200	109%
Molybdenum	1.16	0.849 - 1.47	1	86%	0.92	79%	1.2	103%
Nickel	17.5	12.5 - 22.5	19.5	111%	17.6	101%	20	114%
Selenium	0.800	0 - 1.02	0.72	90%	ND, <0.2	<25%	0.6	75%

Parameter	RTC Certified Value (mg/kg)	Performance Acceptance Limits (mg/kg)	ACZ Result (mg/kg)	Difference from Certified Value, ACZ	CAS Result (mg/kg)	Difference from Certified Value, CAS	STL Result (mg/kg)	Difference from Certified Value, STL
Silver	0.237	0.163 - 0.311	0.3	127%	0.19	80%	0.22	93%
Thallium	1.00	0.00 - 5.00	1.0	100%	-	-	0.18	18%
Vanadium	22.1	10.2 - 34.0	**45.2**	205%	22.4	101%	24	109%
Zinc	69.9	42.6 - 97.2	76	109%	-	-	70	100%
Anions and Nutrients								
Ammonia, as Nitrogen	17.0	5.78 - 28.2	13.3	78%	16.6	98%	**140**	824%
Total Cyanide	6.04	3.32 - 8.76	6.9	114%	7.2	119%	4.9	81%
Chloride	13.5	7.42 - 19.6	10	74%	14.0	104%	15	111%
Fluoride	8.90	0.00 - 14.20	2	22%	ND, <0.13	<1%	9.6	108%
Sulfate	290.00	116.00 - 464.0	160	55%	348	120%	330	114%

Notes:

Bold = does not meet performance acceptance limits

NA = not applicable

ND = not detected, MDL shown

TABLE A-26

Soil Comparability

	Comparability			
Analyte	**n-pairs**	**Mean Field Triplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters				
Ammonia, as Nitrogen	17	181	32.0	18%
Chloride	7	11	20.5	18%
Fluoride	3	78	40.5	52%
pH	3	4.3	4.9	115%
Total Cyanide	12	136	48.8	36%
Total Solids	27	8.0	11.5	144%
Sulfate	12	99	49.1	50%
Metals				
Aluminum	25	33	37.6	114%
Antimony	16	42	31.5	76%
Arsenic	21	39	37.7	96%
Barium	25	31	33.2	106%
Beryllium	23	25	22.8	93%
Bismuth	7	22.0	34.0	154%
Boron	7	64	31.9	50%
Cadmium	15	79	48.9	61%
Calcium	25	31	31.3	100%
Chromium	23	38	32.4	86%
Cobalt	23	39	42.0	109%
Copper	25	34	29.5	87%
Iron	25	42	39.6	95%
Lead	25	31	30.2	98%
Magnesium	25	31	31.3	101%
Manganese	25	43	49.1	114%
Mercury	19	67	50.7	76%
Molybdenum	15	20	26.5	131%
Nickel	25	37	33.2	89%
Potassium	19	46	34.5	75%
Selenium	17	63	45.8	72%
Silver	14	31	36.4	118%
Sodium	20	36	36.4	101%
Thallium	16	31	36.8	118%
Tin	0	—	—	—
Vanadium	21	38	30.1	79%
Zinc	25	39	37.4	97%
Organics				
Total Organic Carbon	9	56	41.3	74%
Diesel Range Organics	3	49	27.7	57%
Residual Range Organics	4	46	41.7	90%

Note:
— = insufficient sample count to calculate statistics

TABLE A-27

Summary of Sensitivity for Soil

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg)			
				2004	2005	2006	2007
Inorganic Parameters							
Ammonia, as Nitrogen	279	21	0	0.2	0.2	0.2	2.5
Chloride	279	91	10	1	1	1	10
Fluoride	279	213	23	2	2	2	2.5
pH	30	0	0	—	—	—	—
Sulfate	279	26	12	2	2	2	2.5
Total Cyanide	281	40	29	0.2	0.2	0.2	0.025
Total Solids	285	0	0	—	—	—	—
Metals							
Aluminum	281	0	0	2	2	2	0.5
Antimony	281	43	37	0.05	0.05	0.05	0.3
Arsenic	281	21	21	0.5	0.5	0.5	0.3
Barium	281	0	0	0.05	0.05	0.05	0.05
Beryllium	281	27	26	0.02	0.02	0.02	0.05
Bismuth	280	166	64	—	0.05	0.05	50
Boron	281	186	37	20	20	20	0.25
Cadmium	281	114	114	0.05	0.05	0.05	0.05
Calcium	281	0	0	10	10	10	100
Chromium	281	3	3	0.2	0.2	0.2	0.05
Cobalt	281	7	7	0.02	0.02	0.02	0.025
Copper	281	0	0	0.1	0.1	0.1	0.25
Iron	281	0	0	4	4	4	10
Lead	281	1	1	0.05	0.05	0.05	0.05
Magnesium	281	0	0	4	4	4	100
Manganese	281	0	0	0.05	0.05	0.05	0.3
Mercury	281	17	5	0.02	0.02	0.02	0.1
Molybdenum	281	65	65	0.05	0.05	0.05	0.3
Nickel	281	4	3	0.2	0.2	0.2	0.3
Potassium	281	18	2	400	400	400	100
Selenium	281	21	1	1	1	1	0.05
Silver	281	151	151	0.02	0.02	0.02	0.025
Sodium	281	24	24	20	20	20	100
Thallium	281	81	26	0.02	0.02	0.02	0.05
Tin	281	50	40	1	1	1	0.05
Vanadium	281	27	27	0.2	0.2	0.2	0.1
Zinc	281	1	1	0.5	0.5	0.5	1
Organics							
Total Organic Carbon	176	0	0	0.05	0.05	NA	0.05
Diesel Range Organics	32	0	0	20	20	NA	NA
Residual Range Organics	32	0	0	100	100	NA	NA

Notes:

— = DQO not established

NA = not applicable since parameters not scheduled for analysis

ND = not detected

TABLE A-28

Fish and Mussel Tissue, Accuracy and Precision

	Laboratory Accuracy and Precision				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Total Solids[a]					5	12	5.9	48%
Metals - TQ								
Antimony					1	0	—	—
Arsenic	126	103	6.7	7%	5	44	30.5	70%
Beryllium					1	15	—	—
Cadmium	74	104	6.4	6%	3	61	54.4	90%
Chromium	45	101	12.4	12%	NA	NA	NA	NA
Copper	125	98	9.7	10%	5	55	52.4	95%
Lead	118	95	21.2	22%	3	61	53.2	87%
Mercury	25	105	8.9	9%	5	68	39.0	57%
Methyl Mercury	—	—	—	—	3	87	17.2	20%
Molybdenum	6	112	4.8	4%	1	2.0	—	—
Nickel	125	104	14.8	14%	5	60	30.3	50%
Selenium	67	102	9.9	10%	4	44	36.6	83%
Silver	62	101	7.1	7%	3	69	69.5	100%
Thallium					1	0	—	—
Zinc	65	105	6.9	7%	1	5.0	—	—
Metals - WQ								
Antimony	5	95	3.0	3%				
Arsenic	5	96	3.0	3%				
Beryllium	5	98	4.4	5%				
Cadmium	5	98	1.9	2%				
Chromium	5	95	3.6	4%				
Copper	5	92	2.7	3%				
Lead	5	88	8.3	9%				
Mercury	126	103	10	10%				
Molybdenum	5	98	3.1	3%				
Nickel	5	92	4.8	5%				
Selenium	5	88	5.2	6%				
Silver	5	99	1.9	2%				
Thallium	5	93	3.4	4%				
Zinc	5	95	1.9	2%				
Organics								
2-Methylnaphthalene	8	84	5.4	6%	NA	NA	NA	NA
Acenaphthene	8	84	4.8	6%	NA	NA	NA	NA
Acenaphthylene	8	84	5.6	7%	NA	NA	NA	NA
Anthracene	8	87	6.1	7%	NA	NA	NA	NA
Benzo(a)anthracene	8	88	7.8	9%	NA	NA	NA	NA
Benzo(a)pyrene	8	92	9.5	10%	NA	NA	NA	NA
Benzo(b)fluoranthene	8	94	10.4	11%	NA	NA	NA	NA
Benzo(g,h,i)perylene	8	89	9.6	11%	NA	NA	NA	NA
Benzo(k)fluoranthene	8	91	8.7	10%	NA	NA	NA	NA
Chrysene	8	89	6.8	8%	NA	NA	NA	NA

	Laboratory Accuracy and Precision				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Dibenzo(a,h)anthracene	8	94	11.1	12%	NA	NA	NA	NA
Dibenzofuran	8	86	5.4	6%	NA	NA	NA	NA
Fluoranthene	8	87	6.5	8%	NA	NA	NA	NA
Fluorene	8	85	4.6	5%	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	8	96	16.7	17%	NA	NA	NA	NA
Naphthalene	8	79	6.2	8%	1	41	—	—
Phenanthrene	8	85	3.5	4%	1	43	—	—
Pyrene	8	86	6.4	7%	NA	NA	NA	NA
Total Lipids[a]					1	8.0	—	—

Notes:

a. LCS not analyzed for lipids or total solids

Gray shaded cells = data not available, analyte not analyzed

— = insufficient sample count to calculate statistics

WQ = laboratory water fortified with known metal concentrations

TABLE A-29

Fish and Mussel Tissue, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Total Solids	84	2.5	3.6	142%
Metals				
Antimony	6	14.2	11.7	83%
Arsenic	66	12.4	15.5	125%
Beryllium	8	19.8	23.6	119%
Cadmium	55	13.2	11.2	85%
Chromium	32	20.0	18.2	91%
Copper	68	5.9	13.9	236%
Lead	47	15.6	18.3	117%
Mercury	2	20.0	18.4	92%
Methyl mercury	3	5.7	5.0	88%
Molybdenum	22	10.5	10.4	99%
Nickel	66	12.2	17.3	141%
Selenium	64	14.1	16.1	114%
Silver	48	11.1	9.6	87%
Thallium	38	8.0	10.1	127%
Zinc	39	6.0	9.8	164%
Organics				
Total Lipids	5	8.2	10.6	129%

TABLE A-30

Fish and Mussel Tissue, Comparability

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Total Solids	0	—	—	—
Metals				
Antimony	1	200	—	—
Arsenic	2	23	19.8	86%
Beryllium	0	—	—	—
Cadmium	2	38	29.0	76%
Chromium	0	—	—	—
Copper	5	35	22.7	65%
Lead	2	115	35.4	31%
Mercury	4	111	79.0	71%
Methyl Mercury	4	74	60.3	81%
Molybdenum	0	—	—	—
Nickel	5	141	60.4	43%
Selenium	5	29	20.4	70%
Silver	2	41	5.7	14%
Thallium	0	—	—	—
Zinc	1	35	—	—
Organics				
2-Methylnaphthalene	NA	NA	NA	NA
Acenaphthene	NA	NA	NA	NA
Acenaphthylene	NA	NA	NA	NA
Anthracene	NA	NA	NA	NA
Benzo(a)anthracene	NA	NA	NA	NA
Benzo(a)pyrene	NA	NA	NA	NA
Benzo(b)fluoranthene	NA	NA	NA	NA
Benzo(g,h,i)perylene	NA	NA	NA	NA
Benzo(k)fluoranthene	NA	NA	NA	NA
Chrysene	NA	NA	NA	NA
Dibenzo(a,h)anthracene	NA	NA	NA	NA
Dibenzofuran	NA	NA	NA	NA
Fluoranthene	NA	NA	NA	NA
Fluorene	NA	NA	NA	NA
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA
Naphthalene	NA	NA	NA	NA
Phenanthrene	NA	NA	NA	NA
Pyrene	NA	NA	NA	NA
Total Lipids	0	—	—	—

Notes:

— = insufficient sample count to calculate statistics

NA = not applicable; analyte was not detected in the sample

TABLE A-31

Summary of Sensitivity for Fish and Mussel Tissue

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg)				
				2004	2005	2006	2007	2008
Inorganic Parameters								
Total solids	798	0	—	—	—	—	—	—
Metals								
Antimony	811	718	0	0.05	0.05	0.05	0.05	0.05
Arsenic	811	12	0	0.5	0.5	0.5	0.5	0.5
Beryllium	508	459	0	NA	0.02	0.02	0.02	0.02
Cadmium	811	201	21	0.02	0.02	0.02	0.02	0.02
Chromium	508	204	2	NA	0.5	0.5	0.5	0.5
Copper	811	0	0	0.1	0.1	0.1	0.1	0.1
Lead	811	171	2	0.02	0.02	0.02	0.02	0.02
Mercury	817	1	0	0.001	0.001	0.001	0.001	0.001
Methyl Mercury	38	0	0	—	NA	NA	NA	NA
Molybdenum	508	170	1	NA	0.05	0.05	0.05	0.05
Nickel	811	51	0	0.2	0.2	0.2	0.2	0.2
Selenium	811	36	0	1	1	1	1	1
Silver	811	281	0	0.02	0.02	0.02	0.02	0.02
Thallium	508	3	0	NA	0.02	0.02	0.02	0.02
Zinc	508	0	0	NA	0.5	0.5	0.5	0.5
Organics								
2-Methylnaphthalene	8	3	1	NA	0.005	NA	0.005	0.005
Acenaphthene	8	7	1	NA	0.005	NA	0.005	0.005
Acenaphthylene	8	6	1	NA	0.005	NA	0.005	0.005
Anthracene	8	7	1	NA	0.005	NA	0.005	0.005
Benzo(a)anthracene	8	7	1	NA	0.005	NA	0.005	0.005
Benzo(a)pyrene	8	7	1	NA	0.005	NA	0.005	0.005
Benzo(b)fluoranthene	8	8	1	NA	0.005	NA	0.005	0.005
Benzo(g,h,i)perylene	8	7	1	NA	0.005	NA	0.005	0.005
Benzo(k)fluoranthene	8	8	1	NA	0.005	NA	0.005	0.005
Chrysene	8	7	2	NA	0.005	NA	0.005	0.005
Dibenzo(a,h)anthracene	8	7	1	NA	0.005	NA	0.005	0.005

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg)				
				2004	2005	2006	2007	2008
Dibenzofuran	8	5	1	NA	0.005	NA	0.005	0.005
Fluoranthene	8	7	7	NA	0.005	NA	0.005	0.005
Fluorene	8	4	1	NA	0.005	NA	0.005	0.005
Indeno(1,2,3-cd)pyrene	8	8	1	NA	0.005	NA	0.005	0.005
Naphthalene	8	3	2	NA	0.005	NA	0.005	0.005
Phenanthrene	8	1	1	NA	0.005	NA	0.005	0.005
Pyrene	8	7	6	NA	0.005	NA	0.005	0.005
Total lipids	8	0	—	—	—	—	—	—

Notes:
— = DQO not established
NA = not applicable, parameter not scheduled for analysis

TABLE A-32

Surface Water, Accuracy and Precision (Seeps)

	Laboratory Accuracy and Precision[a]				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Acidity, total	140	100	3.7	4%	18	18	13.3	72%
Alkalinity, total	507	100	5.4	5%	69	4.3	10.4	242%
Ammonia, as Nitrogen	709	97	7.8	8%	5	35	13.6	39%
Chloride	683	99	3.3	3%	73	3.8	7.4	195%
Cyanide, total	625	99	11.8	12%	NA	NA	NA	NA
Cyanide, weak acid dissociable	599	98	10.8	11%	2	0	0.0	—
Fluoride	645	102	9.2	9%	30	23	25.2	109%
Nitrogen as Nitrate-Nitrite	643	100	5.9	6%	68	24	40.8	170%
pH	625	100	0.90	0.9%	73	1.5	2.6	173%
Total Phosphorus	493	99	8.3	8%	45	27	33.1	121%
Phosphorus, Total Orthophosphate	90	98	2.9	3%	8	19	14.2	76%
Specific Conductance	553	100	3.5	4%	73	4.3	21.1	491%
Sulfate	680	100	7.1	7%	72	7.9	25.3	320%
Thiocyanate	412	99	3.9	4%	7	35	31.4	91%
Total Dissolved Solids	490	107	11.2	10%	72	15	23.2	157%
Total Suspended Solids	445	98	6.4	7%	18	68	43.6	64%
Metals								
Aluminum	643	101	5.8	6%	90	36	34.1	95%
Antimony	625	101	6.8	7%	43	21	19.6	95%
Arsenic	620	100	4.5	5%	62	7.7	8.7	113%
Barium	640	100	4.9	5%	121	10	11.3	110%
Beryllium	620	100	5.7	6%	3	18	7.8	43%
Bismuth	616	99	5.2	5%	4	23	19.6	84%
Boron	615	100	7.6	8%	52	15	12.3	83%
Cadmium	621	100	4.9	5%	5	6.4	3.9	61%
Calcium	637	101	5.8	6%	143	4.1	3.8	93%
Chromium	627	100	5.5	6%	75	23	23.3	100%
Cobalt	623	100	5.1	5%	60	13	12.5	96%
Copper	629	100	4.9	5%	50	27	31.4	115%
Iron	630	103	5.6	5%	58	20	25.2	124%
Lead	624	99	4.8	5%	9	55	37.4	68%
Magnesium	636	101	5.7	6%	142	4.9	6.4	131%
Manganese	620	100	4.9	5%	65	34	44.6	130%
Mercury	871	98	18.2	19%	9	27	24.7	91%
Molybdenum	620	99	6.2	6%	70	8.1	11.1	137%
Nickel	621	100	5.2	5%	49	14.1	13.8	98%
Potassium	635	101	5.4	5%	105	8.4	11.7	139%
Selenium	623	99	5.2	5%	8	27	33.7	125%
Silicon	507	102	6.2	6%	73	3.4	3.1	91%
Silver	621	100	6.4	6%	1	104	—	—
Sodium	635	102	5.9	6%	144	3.9	3.9	100%
Thallium	620	98	5.7	6%	5	64	58.6	91%
Tin	618	99	7.3	7%	1	146	—	—
Vanadium	622	100	5.4	5%	55	12	14.0	118%
Zinc	627	100	5.5	6%	39	38	36.8	96%

Notes:

a. LCS accuracy and precision statistics based on surface water and groundwater data

— = insufficient sample count to calculate statistics

NA = not applicable, analyte was not detected in the sample

TABLE A-33

Surface Water, Laboratory Comparability (Seeps)

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Acidity, total	17	36	44.5	122%
Alkalinity, total	69	12	11.9	102%
Ammonia, as Nitrogen	0	—	—	—
Chloride	73	27	16.9	63%
Total Cyanide	0	—	—	—
Cyanide, weak acid dissociable	2	67	0.0	0%
Fluoride	17	31	27.9	91%
Nitrogen as Nitrate-Nitrite	66	34	40.1	117%
pH	73	5.9	5.1	86%
Total Phosphorus	41	51	40.1	79%
Phosphorus, Total as Orthophosphate	nc	nc	nc	nc
Specific Conductance	73	14	23.9	176%
Sulfate	73	15	22.2	148%
Thiocyanate	0	—	—	—
Total Dissolved Solids	71	33	29.3	88%
Total Suspended Solids	1	8.0	—	—
Metals				
Aluminum	84	50	46.2	93%
Antimony	36	28	25.0	91%
Arsenic	66	12	13.1	110%
Barium	124	14	15.6	112%
Beryllium	3	14	5.9	41%
Bismuth	0	—	—	—
Boron	42	33	27.3	82%
Cadmium	6	33	28.5	86%
Calcium	145	5.7	4.8	84%
Chromium	71	35	26.3	75%
Cobalt	70	54	44.1	82%
Copper	47	37	36.5	98%
Iron	40	86	55.5	65%
Lead	8	92	63.8	70%
Magnesium	145	8.5	6.9	82%
Manganese	57	44	43.2	99%
Mercury	5	58	34.4	59%
Molybdenum	76	12	12.2	99%
Nickel	45	51	49.8	98%
Potassium	106	13	12.8	108%
Selenium	4	53	30.8	58%
Silicon	73	6.2	4.1	67%
Silver	2	90	47.4	52%
Sodium	146	8.5	16.2	190%
Thallium	2	12	8.5	71%
Tin	1	140	—	—
Vanadium	63	24	22.8	95%
Zinc	43	50	44.0	87%

Notes:

a. Organics data for surface water, excluding seeps

— = insufficient sample count to calculate statistics

nc = triplicate sample not collected

TABLE A-34

Summary of Sensitivity for Surface Water (Seeps)

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Inorganic Parameters								
Acidity, total	650	439	1	10	10	10	10	10
Alkalinity, total	650	51	0	10	10	10	20	10
Ammonia, as Nitrogen	639	436	0	0.1	0.1	0.1	0.5	0.1
Chloride	650	1	0	0.2	0.2	0.2	3	0.1
Total Cyanide	650	628	0	0.01	0.01	0.01	0.3	0.005
Cyanide, weak acid dissociable	1140	1079	464	0.01	0.01	0.01	0.005	0.005
Fluoride	650	336	0	0.1	0.1	0.1	0.5	0.1
Nitrogen, Nitrate-Nitrite	639	28	0	2	0.1	0.1	0.1	0.1
Phosphorus, Total (as P)	639	198	16	0.01	0.01	0.01	0.05	0.01
Phosphorus, Total as Orthophosphate	107	40	0	NA	NA	0.2	—	NA
Specific Conductance	650	0	0	2[a]	2[a]	2[a]	10[a]	1[a]
Sulfate	650	14	0	0.2	0.2	0.2	3	0.1
Thiocyanate	639	577	0	1	1	1	0.5	1
Total Dissolved Solids	650	5	0	10	10	10	20	10
Total Suspended Solids	650	388	1	5	5	5	20	0.5
Metals								
Aluminum	1300	9	0	0.025	0.001	0.001	0.005	0.002
Antimony	1300	864	0	0.0002	0.00005	0.00005	0.002	0.00005
Arsenic	1300	833	1	0.0005	0.0005	0.0005	0.001	0.0005
Barium	1300	0	0	0.0003	0.00005	0.00005	0.0005	0.00005
Beryllium	1300	1219	204	0.00003	0.00002	0.00002	0.0005	0.00005
Bismuth	1300	1197	0	0.005	0.0001	0.0001	0.2	0.00005
Boron	1300	631	402	0.01	0.0005	0.0005	0.001	0.005
Cadmium	1300	1185	207	0.0001	0.00002	0.00002	0.0005	0.00005
Calcium	1300	0	0	0.05	0.05	0.05	1	0.05
Chromium	1300	224	1	0.0002	0.0002	0.0002	0.0005	0.0002
Cobalt	1300	566	0	0.0001	0.00002	0.00002	0.0003	0.00002
Copper	1300	497	0	0.0002	0.0001	0.0001	0.003	0.0001
Iron	1300	567	1	0.02	0.02	0.02	0.05	0.02
Lead	1300	847	74	0.0002	0.00002	0.00002	0.0005	0.0001

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Magnesium	1300	20	0	0.02	0.02	0.02	1	0.02
Manganese	1300	459	9	0.001	0.00005	0.00005	0.003	0.00005
Mercury	639	390	0	0.000005	0.000005	0.000005	0.000005	0.000005
Molybdenum	1300	576	1	0.001	0.00005	0.00005	0.003	0.00005
Nickel	1300	514	0	0.0002	0.0002	0.0002	0.003	0.0002
Potassium	1300	255	0	0.05	0.05	0.05	2	0.05
Selenium	1300	1023	2	0.001	0.001	0.001	0.0005	0.001
Silicon	650	0	0	0.5	0.1	0.1	0.9	0.1
Silver	1300	1234	3	0.00002	0.00002	0.00002	0.0003	0.00002
Sodium	1300	0	0	0.1	0.1	0.1	2	0.1
Thallium	1300	1028	3	0.00005	0.00001	0.00001	0.0005	0.00002
Tin	1300	1252	2	0.001	0.0001	0.0001	0.0005	0.0002
Vanadium	1300	697	147	0.0004	0.0002	0.0002	0.001	0.001
Zinc	1300	435	0	0.0015	0.0005	0.0005	0.01	0.001

Notes:

a. Units for specific conductance are micromhos per centimeter (mmhos/cm)

— = DQO not established

NA = not applicable, analyte not scheduled for analysis

ND = not detected

TABLE A-35

Marine Plant, Fish, and Bivalve Tissue, Accuracy and Plant Tissue Precision

	Laboratory Accuracy and Precision				**Field Precision[a]**			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Total Solids	—	—	—	—	2	14	6.4	44%
Metals - TQ Matrix (Fish and Bivalve Tissue Only)								
Antimony					4	16	19.1	115%
Arsenic	22	104	4.6	4%	4	23	25.4	111%
Beryllium					0	NA	NA	NA
Boron					4	10	8.3	87%
Cadmium	17	111	6.7	6%	4	21	23.7	113%
Chromium	19	93	10.2	11%	4	77	71.9	93%
Copper	22	96	7.5	8%	4	45	48.3	107%
Lead	22	94	16.5	17%	4	32	32.8	103%
Mercury	1	97	—	—	4	89	57.0	64%
Molybdenum	8	113	4.1	4%	4	9.0	5.8	64%
Nickel	22	102	11.6	11%	4	20	19.8	101%
Selenium	12	96	13.2	14%	0	NA	NA	NA
Silver	5	101	9.6	10%	4	58	47.8	82%
Thallium					4	24	9.9	41%
Tin					0	—	—	—
Zinc	20	98	10.0	10%	4	35	30.7	88%
Metals - WQ Matrix (Fish, Bivalve, and Vegetation Tissue Only)								
Antimony	8	101	4.3	4%				
Arsenic	8	104	5.5	5%				
Beryllium	8	100	4.8	5%				
Boron	7	102	7.0	7%				
Cadmium	8	104	4.4	4%				
Chromium	8	99	5.7	6%				
Copper	8	100	3.8	4%				
Lead	8	101	2.5	2%				
Mercury	28	106	8.9	8%				
Molybdenum	8	100	2.1	2%				
Nickel	8	99	3.8	4%				
Selenium	8	93	9.6	10%				
Silver	8	97	4.3	4%				
Thallium	8	101	3.6	4%				
Tin	6	102	3.6	4%				
Zinc	8	103	6.8	7%				

Notes:

a. Field precision RPD calculations are for marine plant tissue only.

Gray shaded cells = data not available, analyte not analyzed

— = insufficient sample count to calculate statistics

NA = not applicable, analyte was not detected in the sample

TQ = standard reference material (SRM) for vegetation or aquatic animal tissue, as appropriate, with externally certified constituent concentrations

WQ = laboratory water fortified with known metal concentrations

TABLE A-36

Marine Fish and Bivalve Tissue, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Total Solids	14	0.9	1.3	137%
Metals				
Antimony	2	53	53.7	101%
Arsenic	10	2.7	1.7	63%
Beryllium	1	27	—	—
Boron	6	3.7	3.6	99%
Cadmium	10	14	17.9	124%
Chromium	6	14	13.3	94%
Copper	10	8.3	13.2	159%
Lead	8	6.1	7.0	115%
Mercury	6	10	8.0	78%
Molybdenum	6	9.2	5.0	55%
Nickel	9	11	6.9	65%
Selenium	10	15	12.6	86%
Silver	6	6.2	5.7	93%
Thallium	3	23	6.1	26%
Tin	4	3.9	2.6	67%
Zinc	8	5.2	4.7	90%

Note:
— = insufficient sample count to calculate statistics

TABLE A-37

Marine Plant Tissue, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Total Solids	3	3	3.5	115%
Metals				
Antimony	4	2.8	2.8	100%
Arsenic	4	2.8	3.6	131%
Beryllium	4	4.2	5.0	117%
Boron	4	3.0	0.8	27%
Cadmium	4	3.8	3.1	83%
Chromium	4	2.8	2.2	81%
Copper	4	3.5	4.5	129%
Lead	4	4.2	4.6	108%
Mercury	4	19	28.9	150%
Molybdenum	4	3.2	3.6	111%
Nickel	4	2.8	2.9	104%
Selenium	4	5.0	5.4	107%
Silver	4	3.2	2.9	88%
Thallium	4	3.5	3.9	111%
Tin	4	3.2	2.6	81%
Zinc	4	4.2	4.3	101%

TABLE A-38

Summary of Sensitivity for Marine Fish and Bivalve Tissue

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs[a] (mg/kg) 2004	2005	2006	2007	2008
Metals								
Antimony	96	47	0	0.05	0.05	NA	NA	0.05
Arsenic	96	0	0	0.5	0.5	NA	NA	0.5
Beryllium	76	63	0	NA	0.02	NA	NA	0.02
Boron	65	12	0	NA	NA	NA	NA	5
Cadmium	96	19	0	0.02	0.02	NA	NA	0.02
Chromium	76	22	0	NA	0.5	NA	NA	0.5
Copper	96	0	0	0.1	0.1	NA	NA	0.1
Lead	96	1	0	0.02	0.02	NA	NA	0.02
Mercury	96	0	0	0.001	0.001	NA	NA	0.001
Molybdenum	76	11	0	NA	0.05	NA	NA	0.05
Nickel	96	6	0	0.2	0.2	NA	NA	0.2
Selenium	96	0	0	1	1	NA	NA	1
Silver	96	23	0	0.02	0.02	NA	NA	0.02
Thallium	76	29	0	NA	0.02	NA	NA	0.02
Tin	65	18	0	NA	NA	NA	NA	5
Zinc	76	0	0	NA	0.5	NA	NA	0.5
Organics								
Lipid, Percent	10	0	0	NA	NA	NA	NA	0.10%
Polynuclear Aromatic Hydrocarbon (PAH), Total	10	0	0	NA	NA	NA	NA	0.005

Notes:

a. Lipid MRL DQOs reported in percent

— = DQO not established

NA = not applicable, analyte not scheduled for analysis

TABLE A-39

Marine Plant Tissue Comparability

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Total Solids	2	15	19.8	132%
Metals - WQ Matrix				
Antimony	2	78	0	0%
Arsenic	3	18	19.4	110%
Beryllium	0	NA	NA	NA
Boron	3	32	26.4	81%
Cadmium	3	17	10.0	60%
Chromium	3	65	73.4	112%
Copper	3	33	20.4	62%
Lead	0	—	—	—
Mercury	2	47	28.3	60%
Molybdenum	0	—	—	—
Nickel	3	15	19.2	128%
Selenium	0	NA	NA	NA
Silver	0	—	—	—
Thallium	0	—	—	—
Tin	0	—	—	—
Zinc	3	24	19.4	80%

Notes:
— = insufficient sample count to calculate statistics
NA = not applicable, analyte was not detected in the sample
WQ = laboratory water fortified with known metal concentrations

TABLE A-40

Summary of Sensitivity for Marine Plant Tissue

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg) 2008
Inorganic parameters				
Total Solids	8	0	0	—
Metals				
Antimony	8	0	0	0.05
Arsenic	8	0	0	0.5
Beryllium	8	7	0	0.02
Boron	8	0	0	5
Cadmium	8	0	0	0.02
Chromium	8	0	0	0.5
Copper	8	0	0	0.1
Lead	8	0	0	0.02
Mercury	8	0	0	0.001
Molybdenum	8	0	0	0.05
Nickel	8	0	0	0.2
Selenium	8	7	0	1
Silver	8	0	0	0.02
Thallium	8	0	0	0.02
Tin	8	4	0	5
Zinc	8	0	0	0.5

Note:

— = DQO not established

TABLE A-41

Marine Sediment, Accuracy and Precision

	Laboratory Accuracy and Precision				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Ammonia, as Nitrogen	13	94	12.4	13%	4	18	8.2	47%
Chloride	9	98	3.7	4%	4	22	24.5	114%
Fluoride	10	97	4.6	5%	1	11	—	—
Sulfate	9	100	4.0	4%	4	26	18.2	69%
Total Cyanide	13	103	12.6	12%	3	37	20.7	56%
Nitrogen, Kjeldahl Total	11	109	12.1	11%	4	14	6.9	51%
Acid-Volatile Sulfide	5	94	5.8	6%	3	30	39.6	132%
Total Solids					14	8.6	16.0	185%
Metals								
Aluminum	11	98	8.0	8%	11	19	14.1	76%
Antimony	11	100	8.4	8%	11	31	23.9	77%
Arsenic	11	104	5.2	5%	11	35	47.6	135%
Barium	11	104	4.1	4%	11	38	47.8	127%
Berylium[a]	7	103	6.6	6%	4	20	4.5	22%
Bismuth[a]	5	99	7.2	7%	3	19	10.5	56%
Boron[a]	7	99	12.1	12%	4	40	31.4	78%
Cadmium	11	104	6.4	6%	7	9.4	6.5	69%
Calcium[a]	7	98	6.8	7%	4	6.2	4.0	64%
Chromium	11	102	6.2	6%	11	27	31.0	114%
Cobalt	11	103	6.5	6%	11	24	24.1	100%
Copper	11	104	5.1	5%	11	27	23.9	89%
Iron	11	101	13.5	13%	11	18	16.1	91%
Lead	11	104	6.1	6%	11	37	44.2	120%
Magnesium[a]	7	99	6.3	6%	4	5.8	4.6	80%
Manganese	11	100	6.2	6%	11	12	10.2	84%
Mercury	14	102	5.3	5%	24	48	59.0	123%
Molybdenum[a]	7	102	8.0	8%	3	22	16.0	74%
Nickel	11	104	5.9	6%	11	29	36.4	124%
Potassium[a]	7	104	3.2	3%	4	8.5	4.8	56%
Selenium	11	107	11.5	11%	7	7.6	10.4	137%
Silver	11	104	5.4	5%	8	15	7.7	52%
Sodium[a]	7	99	6.5	6%	4	19	11.5	61%
Thallium[a]	7	98	6.0	6%	3	22	5.8	27%
Tin	11	101	5.4	5%	3	3.7	1.2	31%
Vanadium[a]	7	103	3.6	4%	4	5.8	5.4	94%
Zinc	11	103	9.0	9%	11	31	39.2	126%
Simultaneously Extracted Metals								
Cadmium-SEM	1	98	—	—	0	—	—	—
Copper-SEM	1	99	—	—	3	36	50.0	138%
Lead-SEM	1	101	—	—	2	1.0	1.4	141%
Mercury-SEM	1	88	—	—	0	—	—	—
Nickel-SEM	1	99	—	—	2	6.0	0	0%
Zinc-SEM	1	106	—	—	3	31	43.3	140%
Organics								
Total Organic Carbon	12	106	5.7	5%	11	22	25.6	116%

TABLE A-41

Marine Sediment, Accuracy and Precision

	Laboratory Accuracy and Precision				Field Precision			
Analyte	n	Mean LCS % Recovery	SD	RSD	n-pairs	Mean Field Duplicate RPD (%)	SD	RSD
Gasoline Range Organics	16	106	9.5	9%	1	17	—	—
Diesel Range Organics	11	96	9.2	10%	1	8.0	—	—
Residual Range Organics	11	94	13.0	14%	0	—	—	—
Benzene	12	104	8.7	8%	0	NA	NA	NA
Ethylbenzene	12	100	2.9	3%	0	NA	NA	NA
o-Xylene	12	104	3.7	4%	0	NA	NA	NA
Toluene	12	94	4.6	5%	0	NA	NA	NA
Xylene, Isomers m & p	12	102	2.3	2%	0	NA	NA	NA
1-Methylnaphthalene					12	23	15.0	65%
2,6-Dimethylnaphthalene					6	27	18.7	70%
Benzo(e)pyrene					5	19	18.8	101%
Biphenyl					6	23	17.3	76%
C1 - Naphthalenes					6	26	19.4	73%
C10 as n-Decane					3	15	15.1	103%
C11 as n-Undecane					5	20	11.5	58%
C12 as n-Dodecane					2	22	24.0	109%
C13 as n-Tridecane					6	19	16.4	87%
C14 as n-Tetradecane					6	20	17.6	88%
C17 as n-Heptadecane					3	15	16.8	114%
C1-Chrysenes					4	14	12.6	88%
C1-Dibenzothiophenes					4	21	21.8	103%
C1-Fluorenes					4	22	13.6	63%
C1-Phenanthrenes/Anthrace					5	21	17.2	82%
C22 as n-Docosane					2	13	8.5	65%
C24 as n-Tetracosane					4	8.5	5.2	61%
C26 as n-Hexacosane					5	22	18.2	82%
C28 as n-Octacosane					4	25	15.7	63%
C2-Chrysenes					2	20	24.7	121%
C2-Dibenzothiophenes					3	19	25.7	138%
C2-Fluorenes					2	24	0.71	3%
C2-Naphthalenes					6	24	20.4	83%
C2-Phenanthrenes/Anthrace					5	18	13.7	76%
C30 as n-Triacontane					4	20	19.6	98%
C3-Fluorenes					2	25	17.0	68%
C3-Naphthalenes					4	27	13.0	48%
C3-Phenanthrenes/Anthrace					5	39	42.3	109%
C4-Naphthalenes					2	40	36.1	91%
D26 - C12					6	10	7.8	76%
D42 - C20					6	13	6.9	53%
D50 - C24					6	13	7.1	55%
D62 - C30					6	14	8.4	58%
Dibenzothiophene					5	23	18.0	77%
Dotriacontane					2	24	19.1	81%
Heneicosane					9	19	13.5	71%
Hexacosane					4	8.5	3.0	35%
1,6,7-trimethyl-naphthalene					5	21	23.1	110%

TABLE A-41

Marine Sediment, Accuracy and Precision

	Laboratory Accuracy and Precision				**Field Precision**			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
n-C31					5	21	8.3	39%
Nonacosane					13	20	12.3	63%
Perylene					5	14	12.1	85%
Tetratriacontane					2	14	10.6	73%
Total Alkanes					6	22	11.2	51%
Total Resolved					6	29	10.7	37%
Total UCM					6	36	31.3	88%
Tritriacontane					5	26	25.3	97%
PAHs								
PAH, Total					6	10	11.5	117%
Total NS&T PAHs					6	13	11.5	86%
Total PAHs					6	50	66.0	133%
Total PAHs without Perylene					6	14	13.0	94%
2-Methylnaphthalene	2	78	2.1	3%	9	52	56.9	109%
Acenaphthene	3	74	4.0	5%	0	NA	NA	NA
Acenaphthylene	2	76	0.71	0.9%	0	NA	NA	NA
Anthracene	2	78	2.1	3%	0	NA	NA	NA
Benzo(a)anthracene	2	82	0.71	0.9%	4	15	13.0	87%
Benzo(a)pyrene	3	87	2.5	3%	0	NA	NA	NA
Benzo(b)fluoranthene	2	88	2.1	2%	5	14	18.2	132%
Benzo(g,h,i)perylene	2	84	0.71	0.8%	2	26	0.71	3%
Benzo(k)fluoranthene	2	88	3.5	4%	3	14	20.3	149%
Chrysene	2	85	0	0%	5	20	14.1	71%
Dibenzo(a,h)anthracene	2	75	2.8	4%	0	NA	NA	NA
Dibenzofuran	2	79	1.4	2%	0	—	—	—
Fluoranthene	2	79	0	0%	5	15	12.8	83%
Fluorene	2	76	1.4	2%	5	21	17.9	87%
Indeno(1,2,3-cd)pyrene	2	76	2.8	4%	0	NA	NA	NA
Naphthalene	2	73	1.4	2%	6	23	18.3	79%
Phenanthrene	2	78	0.71	0.9%	9	58	60.5	127%
Pyrene	3	90	5.5	6%	4	17	9.0	54%

Notes:

a. Results for 2004 and 2005 only

Gray shaded cells = data not available, analyte not analyzed

— = insufficient sample count to calculate statistics

NS&T = National Status and Trends

UCM = unresolved complex mixture

TABLE A-42

Marine Sediment, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Ammonia, as Nitrogen	5	13	15.5	115%
Chloride	8	42	39.9	95%
Fluoride	3	22	12.2	55%
Sulfate	8	42	29.7	71%
Total Cyanide	4	36	31.2	86%
Nitrogen, Kjeldahl Total	5	21	23.0	109%
Acid-Volatile Sulfide	2	7.0	4.2	61%
Total Organic Carbon	7	4.6	3.2	70%
Total Solids	9	1.0	1.7	166%
Metals				
Aluminum	2	4.5	3.5	79%
Antimony	1	9.0	—	—
Arsenic	1	4.0	—	—
Barium	1	5.0	—	—
Cadmium	1	3.0	—	—
Chromium	1	2.0	—	—
Cobalt	1	7.0	—	—
Copper	1	3.0	—	—
Iron	2	4.0	2.8	71%
Lead	1	5.0	—	—
Manganese	1	5.0	—	—
Mercury	4	7.0	8.1	115%
Nickel	1	4.0	—	—
Selenium	1	40	—	—
Silver	1	7.0	—	—
Tin	0	NA	NA	NA
Zinc	1	5.0	—	—
SEM Metals				
Cadmium-SEM	0	NA	NA	NA
Copper-SEM	3	5.7	3.1	54%
Lead-SEM	2	5.5	4.9	90%
Mercury-SEM	3	NA	NA	NA
Nickel-SEM	3	6.7	2.9	43%
Zinc-SEM	3	7.3	4.0	55%
Sieve				
Clay	3	5.3	7.6	142%
Sieve No. 10, Percent Passing	3	114	74.2	65%
Sieve No. 140, Percent Passing	3	7.7	4.7	62%
Sieve No. 20, Percent Passing	3	75	75.0	100%
Sieve No. 230, Percent Passing	3	10	13.3	138%
Sieve No. 4, Percent Passing	1	9.0	—	—
Sieve No. 40, Percent Passing	3	33	13.2	40%
Sieve No. 60, Percent Passing	3	13	15.7	121%
Silt	3	10	3.5	35%

Notes:

— = insufficient sample count to calculate statistics

NA = not applicable, analyte was not detected in the sample

TABLE A-43

Marine Sediment, Comparability

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Ammonia, as Nitrogen	4	84	39.9	47%
Chloride	4	28	13.7	49%
Fluoride	0	NA	NA	NA
Sulfate	4	43	33.4	77%
Total Cyanide	0	NA	NA	NA
Nitrogen, Kjeldahl Total	3	42	24.7	59%
Acid-Volatile Sulfide	2	32	28.3	88%
Total Solids	36	9.2	14.9	162%
Metals				
Aluminum	11	29	27.4	95%
Antimony	9	60	48.3	81%
Arsenic	11	41	33.8	83%
Barium	11	41	49.6	120%
Cadmium	6	48	32.4	68%
Chromium	11	29	22.3	77%
Cobalt	11	22	17.8	80%
Copper	11	26	14.9	57%
Iron	11	22	19.0	86%
Lead	11	39	44.9	116%
Manganese	11	15	11.0	76%
Mercury	24	50	52.6	105%
Nickel	11	34	28.4	83%
Selenium	6	69	41.0	60%
Silver	7	30	43.3	145%
Tin	4	64	67.8	107%
Zinc	11	37	23.8	64%
Simultaneously Extracted Metals				
Cadmium-SEM	0	NA	NA	NA
Copper-SEM	3	51	64.4	127%
Lead-SEM	2	28	0.71	2%
Mercury-SEM	0	NA	NA	NA
Nickel-SEM	2	26	5.7	22%
Zinc-SEM	3	40	42.0	106%
Organics				
Total Organic Carbon	11	32	26.7	82%
Gasoline Range Organics	0	—	—	—
Diesel Range Organics	1	76	NA	NA
Residual Range Organics	4	42	44.4	106%
Benzene	0	NA	NA	NA
Ethylbenzene	0	NA	NA	NA
o-Xylene	0	NA	NA	NA
Toluene	0	NA	NA	NA
Xylene, Isomers m & p	0	NA	NA	NA
PAHs				
2-Methylnaphthalene	0	NA	NA	NA
Acenaphthene	0	NA	NA	NA

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Acenaphthylene	0	NA	NA	NA
Anthracene	0	NA	NA	NA
Benzo(a)anthracene	0	NA	NA	NA
Benzo(a)pyrene	0	NA	NA	NA
Benzo(b)fluoranthene	0	NA	NA	NA
Benzo(g,h,i)perylene	0	NA	NA	NA
Benzo(k)fluoranthene	0	NA	NA	NA
Chrysene	0	NA	NA	NA
Dibenzo(a,h)anthracene	0	NA	NA	NA
Fluoranthene	0	NA	NA	NA
Fluorene	0	NA	NA	NA
Indeno(1,2,3-cd)pyrene	0	NA	NA	NA
Naphthalene	0	NA	NA	NA
Phenanthrene	0	NA	NA	NA
Pyrene	0	NA	NA	NA

Notes:
— = insufficient sample count to calculate statistics
NA = not applicable, analyte was not detected in the sample

TABLE A-44

Summary of Sensitivity for Marine Sediment

Analyte	Total Number of Samples	No . of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg) 2004	2005	2006	2007	2008
Inorganic Parameters								
Ammonia, as Nitrogen	37	0	0	0.2	0.2	NA	NA	NA
Chloride	37	0	0	1	1	NA	NA	NA
Fluoride	37	21	15	2	2	NA	NA	NA
Sulfate	37	0	0	2	2	NA	NA	NA
Total Cyanide	62	27	0	0.06	0.2	NA	NA	0.2
Nitrogen, Kjeldahl Total	37	0	0	—	—	NA	NA	NA
Acid-Volatile Sulfide	25	4	0.0	NA	NA	NA	NA	—
Total Solids	79	0	0	NA	NA	NA	NA	—
Metals								
Aluminum	62	0	0	2	2	NA	NA	2
Antimony	62	0	0	0.1	0.05	NA	NA	0.05
Arsenic	62	0	0	1.8	0.5	NA	NA	0.5
Barium	62	0	0	0.3	0.05	NA	NA	0.05
Cadmium	62	12	0	0.2	0.05	NA	NA	0.05
Chromium	62	0	0	0.4	0.2	NA	NA	2
Cobalt	62	0	0	0.5	0.02	NA	NA	0.02
Copper	62	0	0	0.6	0.1	NA	NA	0.1
Iron	62	0	0	10	4	NA	NA	4
Lead	62	0	0	0.2	0.05	NA	NA	0.05
Manganese	62	0	0	0.2	0.05	NA	NA	0.1
Mercury[a]	88	2	0	0.04	0.04	NA	NA	0.02
Nickel	62	0	0	0.2	0.2	NA	NA	0.2
Selenium	62	13	0	0.5	1	NA	NA	1
Silver	62	2	0	0.1	0.02	NA	NA	0.02
Tin	62	6	6	1	1	NA	NA	1
Zinc	62	0	0	1	0.5	NA	NA	0.5
AVS-SEM Metals								
Cadmium-SEM	25	25	15	NA	NA	NA	NA	0.2
Copper-SEM	25	0	0	NA	NA	NA	NA	0.4
Lead-SEM	25	3	3	NA	NA	NA	NA	3
Mercury-SEM	25	25	25	NA	NA	NA	NA	0.01
Nickel-SEM	25	1	1	NA	NA	NA	NA	0.5
Zinc-SEM	25	0	0	NA	NA	NA	NA	0.4
Organics								
Total Organic Carbon[b]	62	0	0	0.05	0.05	NA	NA	0.05
SHC, Total	25	0	0	NA	NA	NA	NA	0.3
Gasoline Range Organics	32	23	0	2.5	5	NA	NA	NA
Diesel Range Organics	33	2	0	20	40	NA	NA	NA
Residual Range Organics	33	0	0	20	100	NA	NA	NA
Total Petroleum Hydrocarbons	25	0	0					
Benzene	32	32	7	0.013	0.005	NA	NA	NA
Toluene	32	32	7	0.05	0.005	NA	NA	NA
Ethylbenzene	32	32	7	0.025	0.005	NA	NA	NA
Xylene, Isomers m & p	32	32	7	0.05	0.002	NA	NA	NA
o-Xylene	32	32	7	0.025	0.002	NA	NA	NA
1-Methylnaphthalene	25	0	0	NA	NA	NA	NA	—
1-Methylphenanthrene	25	0	0	NA	NA	NA	NA	—
2,6-Dimethylnaphthalene	25	0	0	NA	NA	NA	NA	—
Benzo(e)pyrene	25	1	0	NA	NA	NA	NA	—
Biphenyl	25	0	0	NA	NA	NA	NA	—
C1 - Naphthalenes	25	0	0	NA	NA	NA	NA	—
C10 as n-Decane	25	3	0	NA	NA	NA	NA	—

Analyte	Total Number of Samples	No . of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg) 2004	2005	2006	2007	2008
C11 as n-Undecane	25	2	0	NA	NA	NA	NA	—
C12 as n-Dodecane	25	5	0	NA	NA	NA	NA	—
C13 as n-Tridecane	25	0	0	NA	NA	NA	NA	—
C14 as n-Tetradecane	25	0	0	NA	NA	NA	NA	—
C15 as n-Pentadecane	25	20	0	NA	NA	NA	NA	—
C16 as n-Hexadecane	25	25	0	NA	NA	NA	NA	—
C17 as n-Heptadecane	25	8	0	NA	NA	NA	NA	—
C18 as n-Octadecane	25	25	0	NA	NA	NA	NA	—
C1-Chrysenes	25	3	0	NA	NA	NA	NA	—
C1-Fluoranthenes/Pyrenes	25	16	0	NA	NA	NA	NA	—
C1-Dibenzothiophenes	25	3	0	NA	NA	NA	NA	—
C1-Fluorenes	25	4	0	NA	NA	NA	NA	—
C1-Phenanthrenes/Anthrace	25	1	0	NA	NA	NA	NA	—
C2-Fluoranthenes/Pyrenes	25	19	0	NA	NA	NA	NA	—
C20 as n-Eicosane	25	21	0	NA	NA	NA	NA	—
C22 as n-Docosane	25	11	0	NA	NA	NA	NA	—
C24 as n-Tetracosane	25	9	0	NA	NA	NA	NA	—
C26 as n-Hexacosane	25	1	0	NA	NA	NA	NA	—
C28 as n-Octacosane	25	8	0	NA	NA	NA	NA	—
C2-Chrysenes	25	11	0	NA	NA	NA	NA	—
C2-Dibenzothiophenes	25	10	0	NA	NA	NA	NA	—
C2-Fluorenes	25	13	0	NA	NA	NA	NA	—
C2-Naphthalenes	25	0	0	NA	NA	NA	NA	—
C2-Phenanthrenes/Anthrace	25	1	0	NA	NA	NA	NA	—
C3-Fluoranthenes/Pyrenes	25	25	0	NA	NA	NA	NA	—
C30 as n-Triacontane	25	6	0	NA	NA	NA	NA	—
C3-Chrysenes	25	14	0	NA	NA	NA	NA	—
C3-Dibenzothiophenes	25	20	0	NA	NA	NA	NA	—
C3-Fluorenes	25	13	0	NA	NA	NA	NA	—
C3-Naphthalenes	25	2	0	NA	NA	NA	NA	—
C3-Phenanthrenes/Anthrace	25	2	0	NA	NA	NA	NA	—
C4-Chrysenes	25	23	0	NA	NA	NA	NA	—
C4-Naphthalenes	25	12	0	NA	NA	NA	NA	—
C4-Phenanthrenes/Anthrace	25	12	0	NA	NA	NA	NA	—
D26 - C12	25	0	0	NA	NA	NA	NA	—
D42 - C20	25	0	0	NA	NA	NA	NA	—
D50 - C24	25	0	0	NA	NA	NA	NA	—
D62 - C30	25	0	0	NA	NA	NA	NA	—
Dibenzothiophene	25	1	0	NA	NA	NA	NA	—
Dotriacontane	25	17	0	NA	NA	NA	NA	—
Heneicosane	25	10	0	NA	NA	NA	NA	—
Heptacosane	25	0	0	NA	NA	NA	NA	—
Hexacosane	25	3	0	NA	NA	NA	NA	—
1,6,7-trimethyl-naphthalene	25	1	0	NA	NA	NA	NA	—
n-C31	25	1	0	NA	NA	NA	NA	—
Nonacosane	25	0	0	NA	NA	NA	NA	—
Nonadecane	25	8	0	NA	NA	NA	NA	—
Pentacosane	25	25	0	NA	NA	NA	NA	—
Pentatriacontane	25	25	0	NA	NA	NA	NA	—
Perylene	25	1	0	NA	NA	NA	NA	—
Phytane	25	25	0	NA	NA	NA	NA	—
Pristane	25	21	0	NA	NA	NA	NA	—
Tetratriacontane	25	13	0	NA	NA	NA	NA	—
Total Alkanes	25	0	0	NA	NA	NA	NA	—

Analyte	Total Number of Samples	No . of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/kg)				
				2004	2005	2006	2007	2008
Total Resolved	25	0	0	NA	NA	NA	NA	—
Total UCM	25	0	0	NA	NA	NA	NA	—
Tritriacontane	25	1	0	NA	NA	NA	NA	—
PAHs								
PAH, Total	25	0	0	NA	NA	NA	NA	0.005
Total NS&T PAHs	25	0	0	NA	NA	NA	NA	—
Total PAHs without Perylene	25	0	0	NA	NA	NA	NA	—
2-Methylnaphthalene	32	1	0	NA	NA	NA	NA	—
Acenaphthene	32	32	0	NA	NA	NA	NA	—
Acenaphthylene	32	28	0	NA	NA	NA	NA	—
Anthracene	32	21	0	NA	NA	NA	NA	—
Benzo(a)anthracene	32	9	0	NA	NA	NA	NA	—
Benzo(a)pyrene	32	25	0	NA	NA	NA	NA	—
Benzo(b)fluoranthene	32	7	0	NA	NA	NA	NA	—
Benzo(g,h,i)perylene	32	13	0	NA	NA	NA	NA	—
Benzo(k)fluoranthene	32	18	0	NA	NA	NA	NA	—
Chrysene	32	6	0	NA	NA	NA	NA	—
Dibenzo(a,h)anthracene	32	28	0	NA	NA	NA	NA	—
Dibenzofuran	7	2	0	NA	NA	NA	NA	—
Fluoranthene	32	5	0	NA	NA	NA	NA	—
Fluorene	32	5	0	NA	NA	NA	NA	—
Indeno(1,2,3-cd)pyrene	32	25	0	NA	NA	NA	NA	—
Naphthalene	32	0	0	NA	NA	NA	NA	—
Phenanthrene	32	1	0	NA	NA	NA	NA	—
Pyrene	32	5	0	NA	NA	NA	NA	—

Notes:

a. Mercury in marine sediments was analyzed by EPA Method 7471A and EPA Method 1631 (EPA, 2001b) for the September 2004 data-collection activities.

b. DQO unit for total organic carbon is percent.

— = DQO not established

NA = not applicable, analyte not scheduled for analysis

SHC = saturated hydrocarbon

TABLE A-45

Marine Water, Accuracy and Precision

	Laboratory Accuracy and Precision				Field Precision			
Analyte	**n**	**Mean LCS % Recovery**	**SD**	**RSD**	**n-pairs**	**Mean Field Duplicate RPD (%)**	**SD**	**RSD**
Inorganic Parameters								
Ammonia, as Nitrogen	13	99	3.5	4%	2	16	9.9	62%
Chloride	6	97	3.2	3%	0	—	—	—
Fluoride	6	101	4.0	4%	0	NA	NA	NA
Sulfate	6	97	3.9	4%	1	8.0	—	—
Total Cyanide	3	107	4.6	4%	0	NA	NA	NA
Total Suspended Solids	8	98	10.6	11%	17	54	45.5	84%
Hardness	NA	NA	NA	NA	2	7.0	8.5	121%
Metals								
Aluminum	18	103	6.4	6%	16	25	21.0	84%
Antimony	20	100	2.6	3%	0	—	—	—
Arsenic	19	99	2.9	3%	34	39	70.6	180%
Barium	18	101	2.6	3%	34	33	29.0	89%
Beryllium	18	89	9.8	11%	5	12	10.2	85%
Boron	17	99	5.6	6%	34	5.1	6.1	118%
Cadmium	19	100	2.9	3%	26	11	9.8	92%
Chromium	19	99	3.8	4%	14	19	16.0	84%
Cobalt	19	100	3.8	4%	26	33	35.8	109%
Copper	19	102	4.0	4%	23	17	18.4	110%
Iron	16	105	3.4	3%	26	20	22.3	112%
Lead	19	97	3.9	4%	19	57	62.0	108%
Manganese	18	101	3.6	4%	21	47	57.2	121%
Mercury	26	98	10.8	11%	3	39	22.2	57%
Nickel	19	101	3.2	3%	26	12	11.7	99%
Selenium	18	97	10.1	10%	0	—	—	—
Silver	19	100	2.7	3%	5	52	58.1	111%
Thallium	19	96	4.3	5%	7	14	20.0	146%
Tin	20	99	2.5	3%	0	NA	NA	NA
Vanadium	18	97	4.5	5%	0	NA	NA	NA
Zinc	19	102	3.9	4%	20	40	32.2	80%
Organics								
Gasoline Range Organics	4	108	6.4	6%	0	—	—	—
Diesel Range Organics	3	90	4.0	5%	0	—	—	—
Residual Range Organics	3	94	5.3	6%	1	103	—	—
Benzene	3	99	4.2	4%	0	NA	NA	NA
Ethylbenzene	3	100	0.6	0.6%	0	NA	NA	NA
o-Xylene	3	96	2.0	2%	0	NA	NA	NA
Toluene	3	93	5.5	6%	0	NA	NA	NA
Xylene, Isomers m & p	3	99	1.7	2%	0	NA	NA	NA

Notes:

— = insufficient sample count to calculate statistics

NA = not applicable, analyte was not detected in the sample

TABLE A-46

Marine Water, Precision from Laboratory Duplicates

Analyte	n-pairs	Mean Laboratory Duplicate RPD (%)	SD	RSD
Inorganic Parameters				
Ammonia, as Nitrogen	2	13	8.5	65%
Chloride	1	3.0	—	—
Fluoride	0	R	—	—
Sulfate	1	2.0	—	—
Total Cyanide	1	0	—	—
Total Suspended Solids	7	5.1	5.7	110%
Metals				
Aluminum	12	1.5	1.3	88%
Antimony	12	1.5	1.2	78%
Arsenic	9	1.9	1.5	77%
Barium	12	1.7	1.2	74%
Beryllium	9	4.2	3.5	82%
Bismuth	1	1.6	—	—
Boron	13	1.1	2.0	184%
Cadmium	9	2.9	2.0	70%
Calcium	1	1.6	—	—
Chromium	9	1.3	1.4	106%
Cobalt	9	3.3	3.5	104%
Copper	9	1	1.3	143%
Iron	12	1.2	0.97	77%
Lead	9	3.4	5.3	155%
Magnesium	2	5.5	3.5	64%
Manganese	12	1.5	1.0	67%
Mercury	5	9.2	4.9	53%
Molybdenum	1	1.0	—	—
Nickel	9	1.3	1.0	75%
Potassium	1	6.0	—	—
Selenium	9	5.4	5.3	98%
Silicon	1	2.0	—	—
Silver	9	1.6	1.9	121%
Sodium	2	6.0	7.1	118%
Thallium	9	2.3	2.4	103%
Tin	12	2.5	0.91	36%
Vanadium	12	1.7	1.6	93%
Zinc	9	1.4	0.53	36%
Organics				
Gasoline Range Organics	1	7.3	—	—
Diesel Range Organics	2	18	0	0
Residual Range Organics	2	18	0	0
Benzene	1	1.8	—	—
Toluene	1	2.5	—	—
Ethylbenzene	1	2.0	—	—
Xylene, Isomers m & p	1	2.0	—	—
o-Xylene	1	2.0	—	—

Notes:

— = insufficient sample count to calculate statistics

R = usable data points not available to generate an RPD value

TABLE A-47

Marine Water, Comparability

Analyte	n-pairs	Mean Field Triplicate RPD (%)	SD	RSD
Inorganic Parameters				
Ammonia, as Nitrogen	3	141	22.9	16%
Chloride	1	29	—	—
Fluoride	0	NA	NA	NA
Sulfate	1	75	—	—
Total Cyanide	0	NA	NA	NA
Total Suspended Solids	17	107	43.8	41%
Metals				
Aluminum	8	20	19.3	94%
Antimony	0	—	—	—
Arsenic	26	59	11.4	19%
Barium	33	46	26.7	58%
Beryllium	0	—	—	—
Boron	33	16	11.9	76%
Cadmium	0	—	—	—
Chromium	6	70	22.9	33%
Cobalt	7	62	35.2	56%
Copper	7	39	47.7	123%
Iron	8	25	24.0	95%
Lead	3	37	22.3	61%
Manganese	23	67	52.3	79%
Mercury	4	60	23.7	39%
Nickel	0	—	—	—
Selenium	0	—	—	—
Silver	3	186	12.9	7%
Thallium	0	—	—	—
Tin	0	—	—	—
Vanadium	0	—	—	—
Zinc	2	125	46.7	37%
Organics				
Diesel Range Organics	0	—	—	—
Residual Range Organics	0	—	—	—
Benzene	0	NA	NA	NA
Ethylbenzene	0	NA	NA	NA
o-Xylene	0	NA	NA	NA
Toluene	0	NA	NA	NA
Xylene, Isomers m & p	0	NA	NA	NA

Notes:
— = insufficient sample count to calculate statistics
NA = not applicable, analyte was not detected in the sample

TABLE A-48

2004 Marine Water, Summary of Results for Arsenic, Copper, Nickel, and Selenium

Sample Type	Location	Sample Identification	Parameter	Result (µg/L)	MRL (µg/L)	Dilution
Primary	MPS1	083104MPS1MBW001	Arsenic	38.9J	40	20
QC Duplicate	MPS1	083104MPS1MBW201	Arsenic	58.6	40	20
QA Triplicate	MPS1	083104MPS1MBW302	Arsenic	1.27	0.67	1
QA Triplicate	MPS1	083104MPS1MBW301	Arsenic	1.2	0.67	1
Primary	MPS2	090104MPS2MBW001	Arsenic	62.2	40	20
Primary	MPS3	090104MPS3MBW001	Arsenic	46	40	20
Primary	MPS4	083104MPS4MBW001	Arsenic	50.8	40	20
PSEP Reference	Admiralty Island	—	Arsenic	NR	—	—
PSEP Reference	Open Ocean Seawater	—	Arsenic	1.26	—	—
Primary	MPS1	083104MPS1MBW001	Copper	16.9	16	20
QC Duplicate	MPS1	083104MPS1MBW201	Copper	21.6	16	20
QA Triplicate	MPS1	083104MPS1MBW302	Copper	0.854	0.133	1
QA Triplicate	MPS1	083104MPS1MBW301	Copper	0.511	0.133	1
Primary	MPS2	090104MPS2MBW001	Copper	25.3	16	20
Primary	MPS3	090104MPS3MBW001	Copper	20.8	16	20
Primary	MPS4	083104MPS4MBW001	Copper	22	16	20
PSEP Reference	Admiralty Island	—	Copper	0.19	—	—
PSEP Reference	Open Ocean Seawater	—	Copper	0.228	—	—
Primary	MPS1	083104MPS1MBW001	Nickel	32.9	16	20
QC Duplicate	MPS1	083104MPS1MBW201	Nickel	35.3	16	20
QA Triplicate	MPS1	083104MPS1MBW302	Nickel	0.63	0.27	1
QA Triplicate	MPS1	083104MPS1MBW301	Nickel	0.54	0.27	1
Primary	MPS2	090104MPS2MBW001	Nickel	40.1	16	20
Primary	MPS3	090104MPS3MBW001	Nickel	35.9	16	20
Primary	MPS4	083104MPS4MBW001	Nickel	34	16	20
PSEP Reference	Admiralty Island	—	Nickel	0.31	--	--
PSEP Reference	Open Ocean Seawater	—	Nickel	0.228	--	--
Primary	MPS1	083104MPS1MBW001	Selenium	154	80	20
QC Duplicate	MPS1	083104MPS1MBW201	Selenium	186	80	20
QA Triplicate	MPS1	083104MPS1MBW302	Selenium	0.3J	1	2
QA Triplicate	MPS1	083104MPS1MBW301	Selenium	ND	1	2
Primary	MPS2	090104MPS2MBW001	Selenium	177	80	20
Primary	MPS3	090104MPS3MBW001	Selenium	143	80	20
Primary	MPS4	083104MPS4MBW001	Selenium	174	80	20
PSEP Reference	Admiralty Island	—	NR	—	—	—
PSEP Reference	Open Ocean Seawater	—	NR	—	—	—

Notes:

— = not available

NR = not referenced in PSEP document (EPA, 1997)

PSEP = Puget Sound Estuary Program (EPA, 1997)

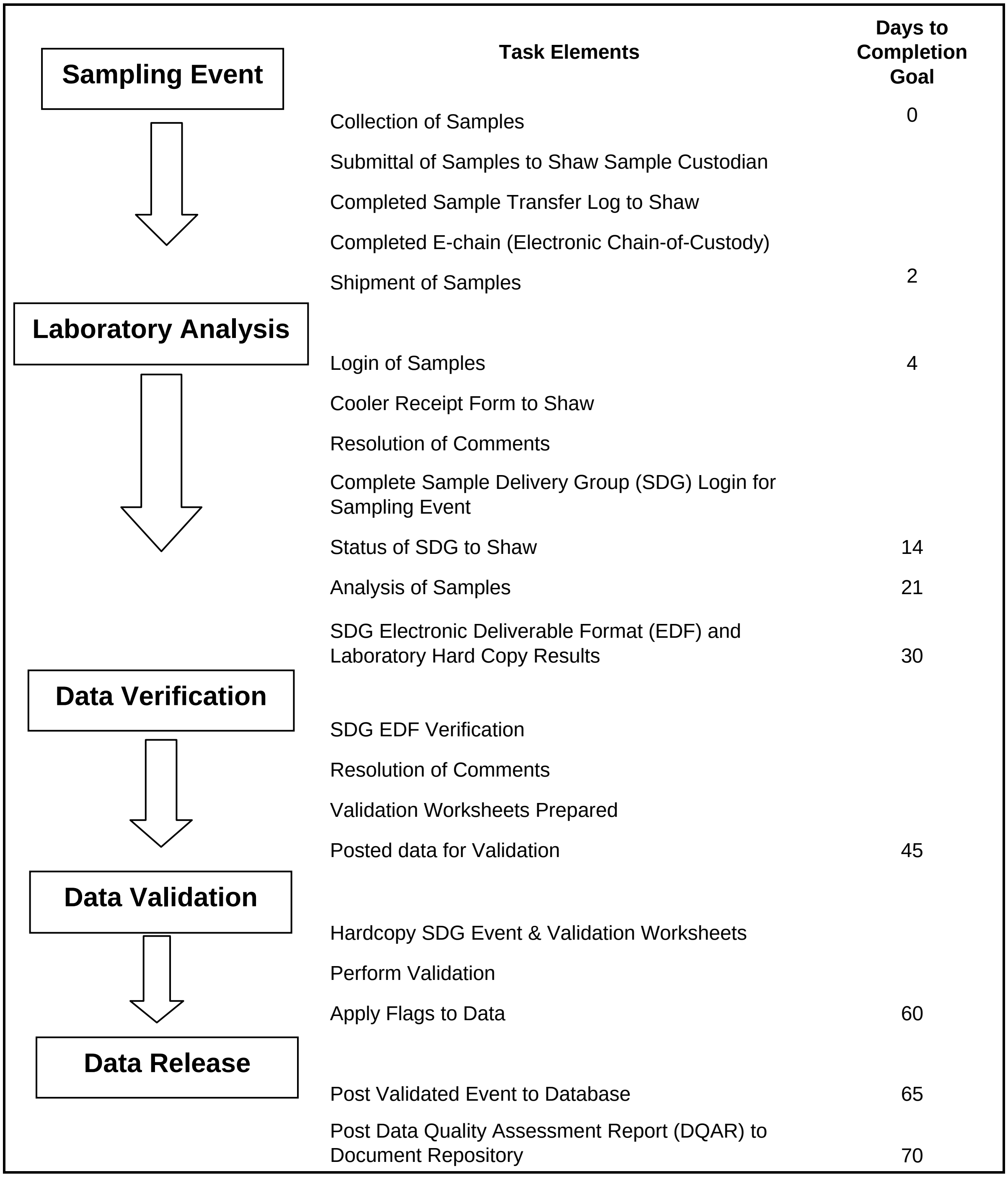
TABLE A-49

Summary of Sensitivity for Marine Water

Analyte	Total Number of Samples	No. of Samples with ND Results	No. of ND Samples for Which MDL Does Not Meet DQO	MRL DQOs (mg/L)				
				2004	2005	2006	2007	2008
Inorganic Parameters								
Ammonia, as Nitrogen	26	6	0	0.1	NA	NA	NA	0.1
Chloride	4	0	0	0.1	NA	NA	NA	NA
Fluoride	4	4	4	0.1	NA	NA	NA	NA
Sulfate	4	0	0	0.1	NA	NA	NA	NA
Total Cyanide	4	4	0	0.005	NA	NA	NA	0.01
Total Suspended Solids	26	0	0	5	NA	NA	NA	5
Hardness	8	0	0	—	—	—	—	—
Metals								
Aluminum	51	19	7	0.025	NA	NA	NA	0.05
Antimony	51	33	33	0.001	NA	NA	NA	0.00005
Arsenic	52	0	0	0.005	NA	NA	NA	0.0005
Barium	51	0	0	0.003	NA	NA	NA	0.005
Beryllium	52	19	8	0.004	NA	NA	NA	0.00002
Boron	51	0	0	—	NA	NA	NA	0.01
Cadmium	52	8	8	0.0005	NA	NA	NA	0.0002
Chromium	52	8	8	0.001	NA	NA	NA	0.0002
Cobalt	52	7	0	0.004	NA	NA	NA	0.00002
Copper	52	0	0	0.001	NA	NA	NA	0.0001
Iron	51	6	6	0.25	NA	NA	NA	0.02
Lead	52	8	8	0.0002	NA	NA	NA	0.00002
Manganese	51	7	7	0.001	NA	NA	NA	0.005
Mercury, low level	27	0	0	0.000005	NA	NA	NA	0.000005
Nickel	52	0	0	0.002	NA	NA	NA	0.0002
Potassium	8	0	0	0.5	NA	NA	NA	NA
Selenium	40	28	0	0.001	NA	NA	NA	0.001
Silver	52	17	8	0.00002	NA	NA	NA	0.00002
Thallium	52	7	7	0.00005	NA	NA	NA	0.00002
Tin	51	51	51	0.001	NA	NA	NA	0.0001
Vanadium	51	45	8	0.0004	NA	NA	NA	0.01
Zinc	52	8	8	0.0015	NA	NA	NA	0.0005
Organics								
Gasoline Range Organics	4	0	0	0.3	NA	NA	NA	NA
Diesel Range Organics	4	0	0	0.1	NA	NA	NA	NA
Residual Range Organics	4	0	0	0.5	NA	NA	NA	NA
VOCs								
Benzene	4	4	0	0.0004	NA	NA	NA	NA
Ethylbenzene	4	4	0	0.001	NA	NA	NA	NA
o-xylene	4	4	0	0.001	NA	NA	NA	NA
Toluene	4	4	0	0.001	NA	NA	NA	NA
Xylene, m&p	4	4	0	0.002	NA	NA	NA	NA

Notes:
— = DQO not established
NA = not applicable, analyte not scheduled for analysis

FIGURES



	Task Elements	Days to Completion Goal
Sampling Event	Collection of Samples	0
	Submittal of Samples to Shaw Sample Custodian	
	Completed Sample Transfer Log to Shaw	
	Completed E-chain (Electronic Chain-of-Custody)	
	Shipment of Samples	2
Laboratory Analysis	Login of Samples	4
	Cooler Receipt Form to Shaw	
	Resolution of Comments	
	Complete Sample Delivery Group (SDG) Login for Sampling Event	
	Status of SDG to Shaw	14
	Analysis of Samples	21
	SDG Electronic Deliverable Format (EDF) and Laboratory Hard Copy Results	30
Data Verification	SDG EDF Verification	
	Resolution of Comments	
	Validation Worksheets Prepared	
	Posted data for Validation	45
Data Validation	Hardcopy SDG Event & Validation Worksheets	
	Perform Validation	
	Apply Flags to Data	60
Data Release	Post Validated Event to Database	65
	Post Data Quality Assessment Report (DQAR) to Document Repository	70

FIGURE A-1
Flow of Data for the Pebble Project

ATTACHMENT 1

CONTROL CHARTS

Control Charts A-1 through A-44, April 2004-December 2008 Surface Water (Except Seeps)

Control Charts A-45 through A-79, May 2004-November 2008 Surface Water (Seeps)

Control Charts A-80 through A-118, September 2004-October 2008 Groundwater

Control Charts A-119 through A-149, 2004-2007 Sediment

Control Charts A-150 through A-179, 2004-2007 Vegetation

Control Charts A-180 through A-214, 2004-2007 Soil

Control Charts A-215 through A-219, 2004-2005 Fish and Mussel Tissue

Control Charts A-220 through A-253, 2004-2008 Marine Sediment

Control Charts A-254 through A-260, 2008 Marine Vegetation

Control Charts A-261 through A-274, 2004-2008 Marine Water

Chart A-1: Total Acidity Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

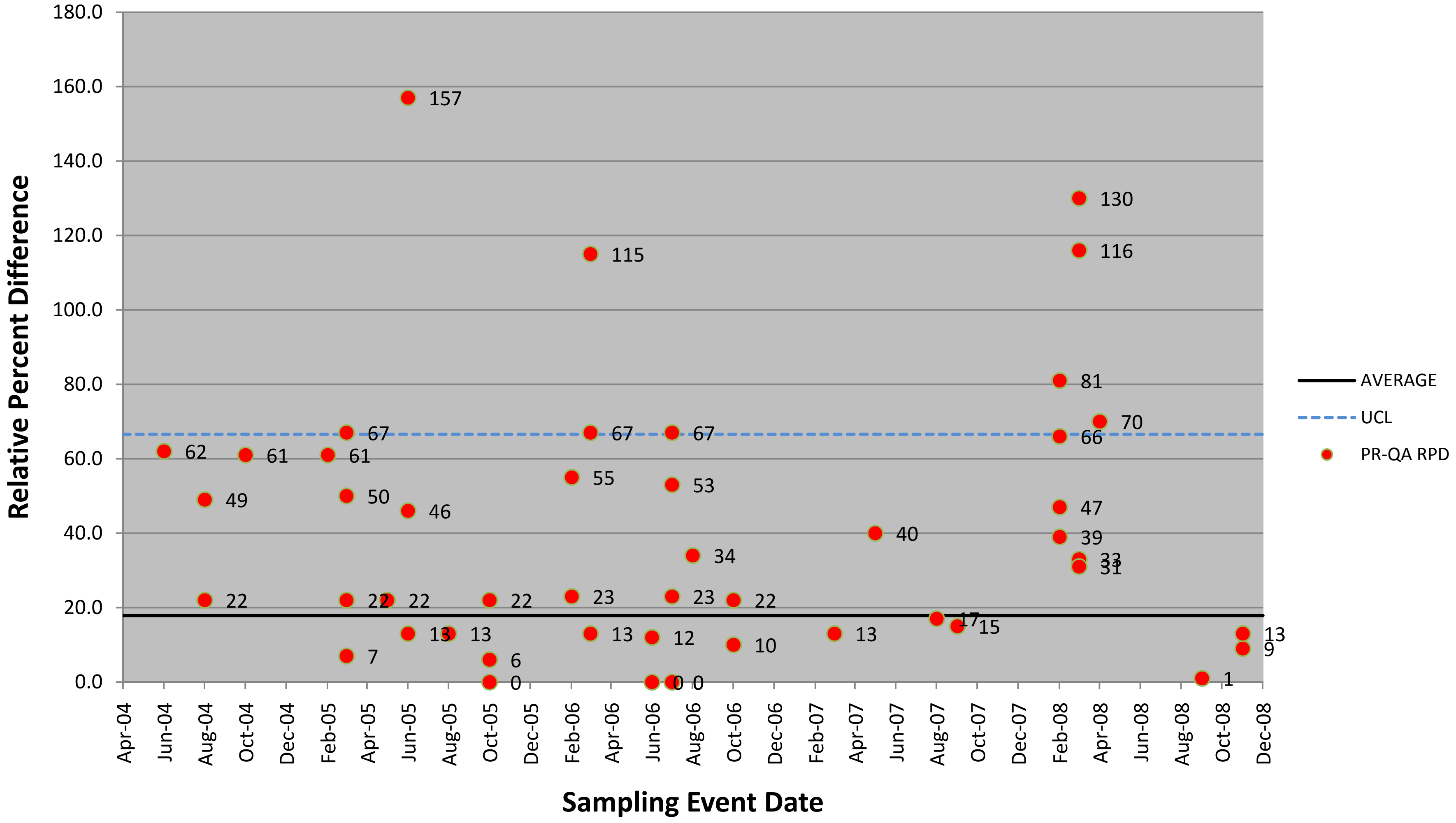


Chart A-2: Total Alkalinity Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

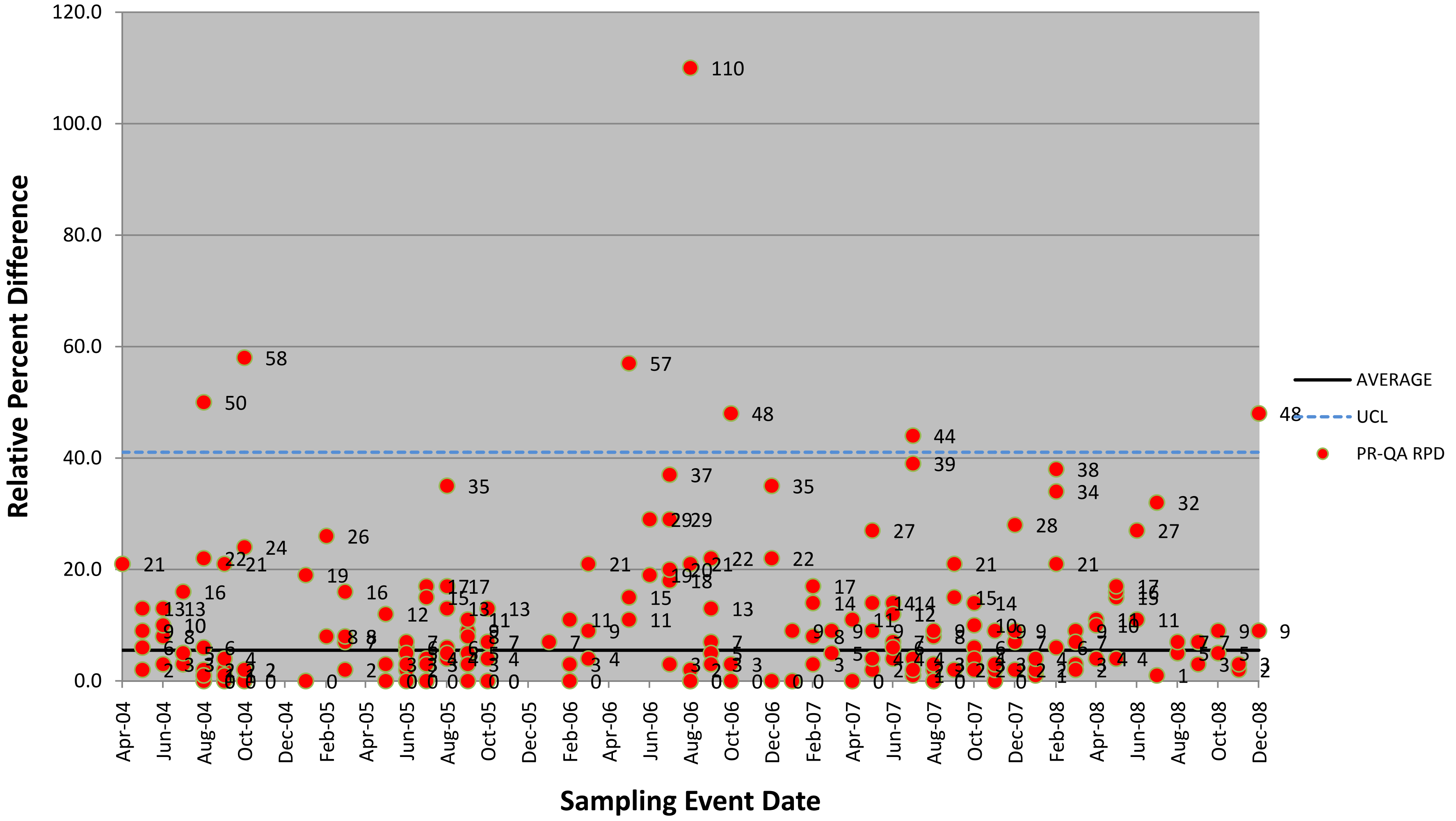


Chart A-3: Chloride Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

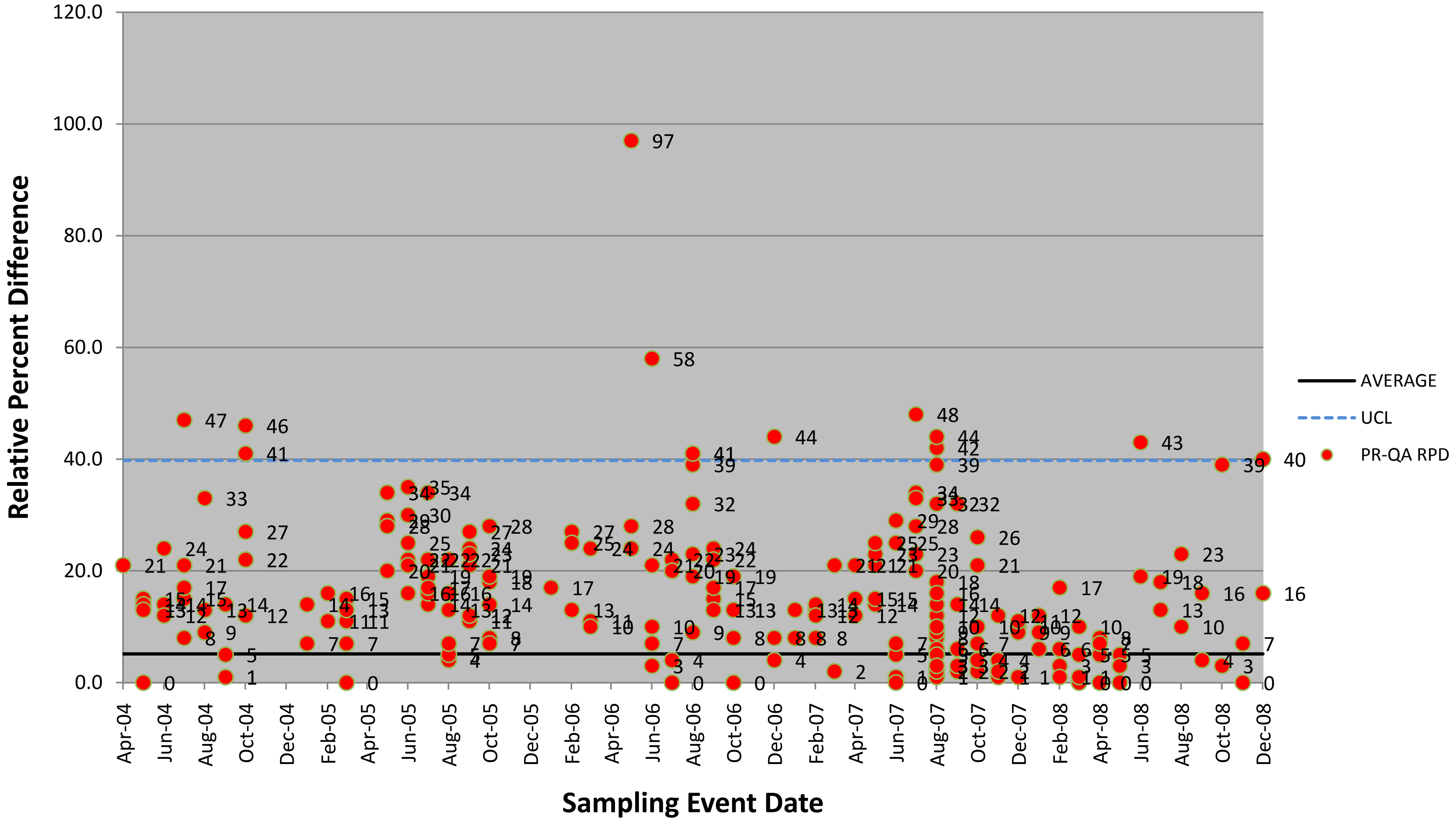


Chart A-4: Cyanide Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

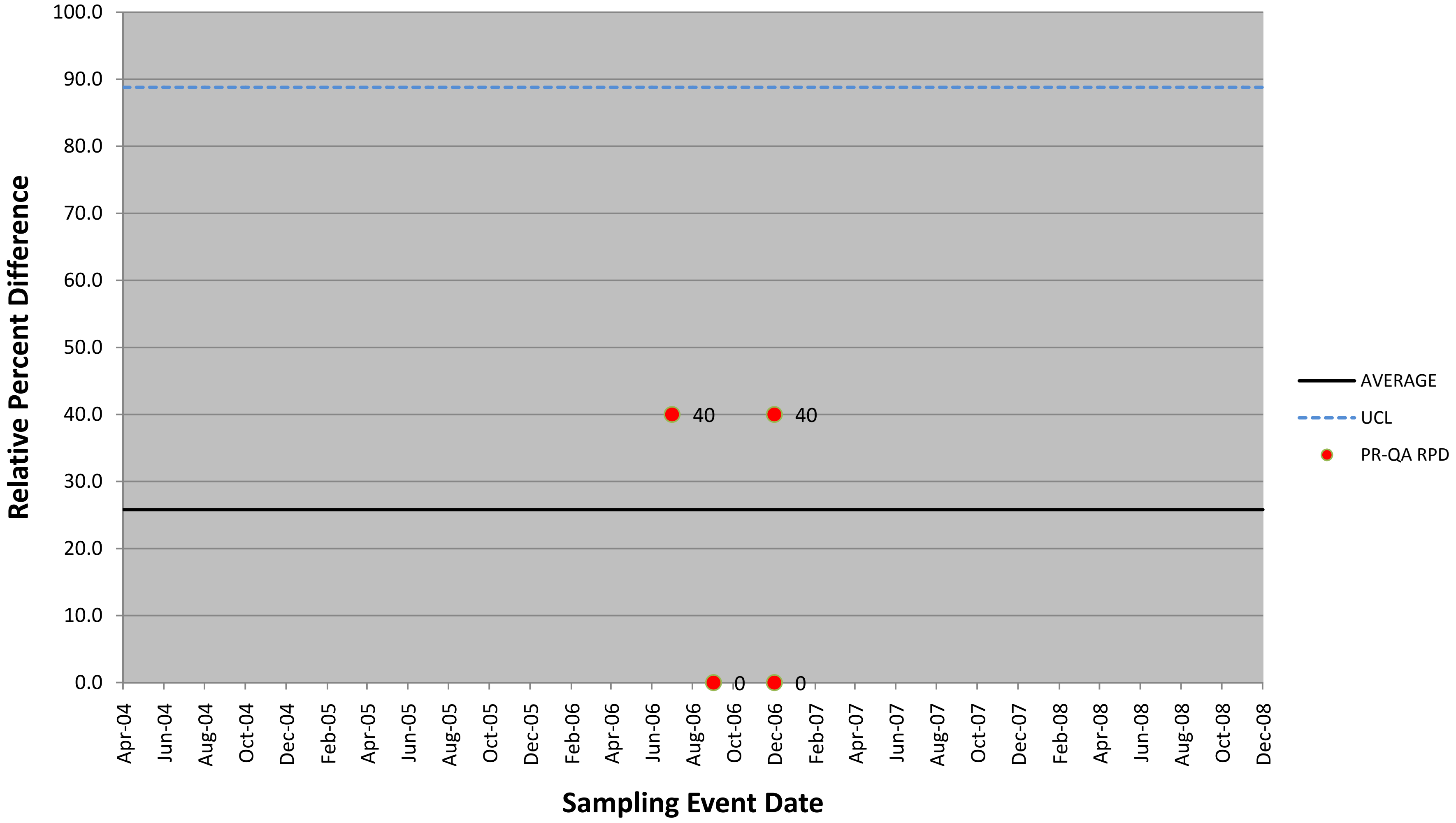


Chart A-5: Dissolved Organic Carbon Control Chart for June 2007-December 2008 Surface Water (Except Seeps)

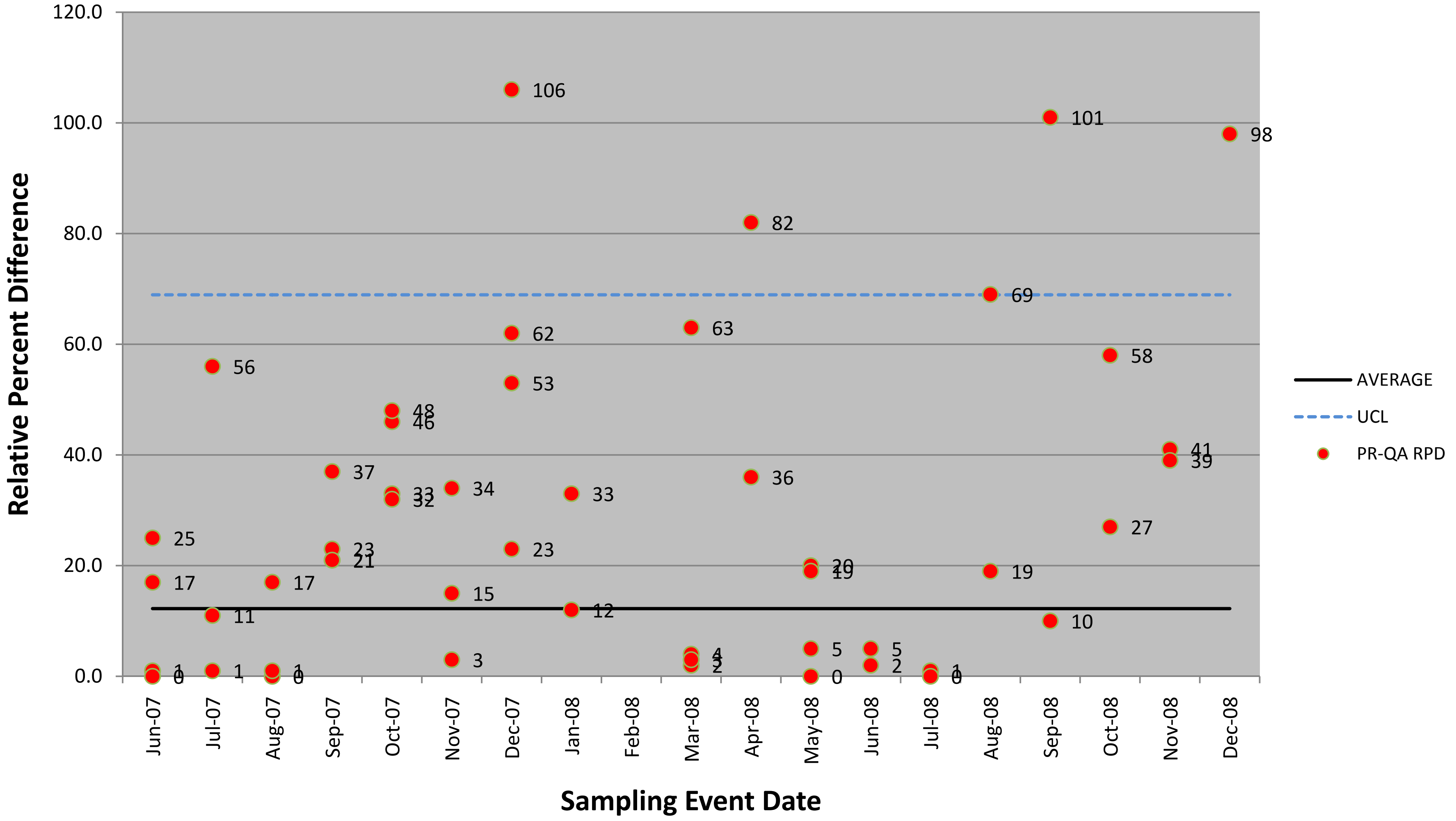


Chart A-6: Fluoride Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

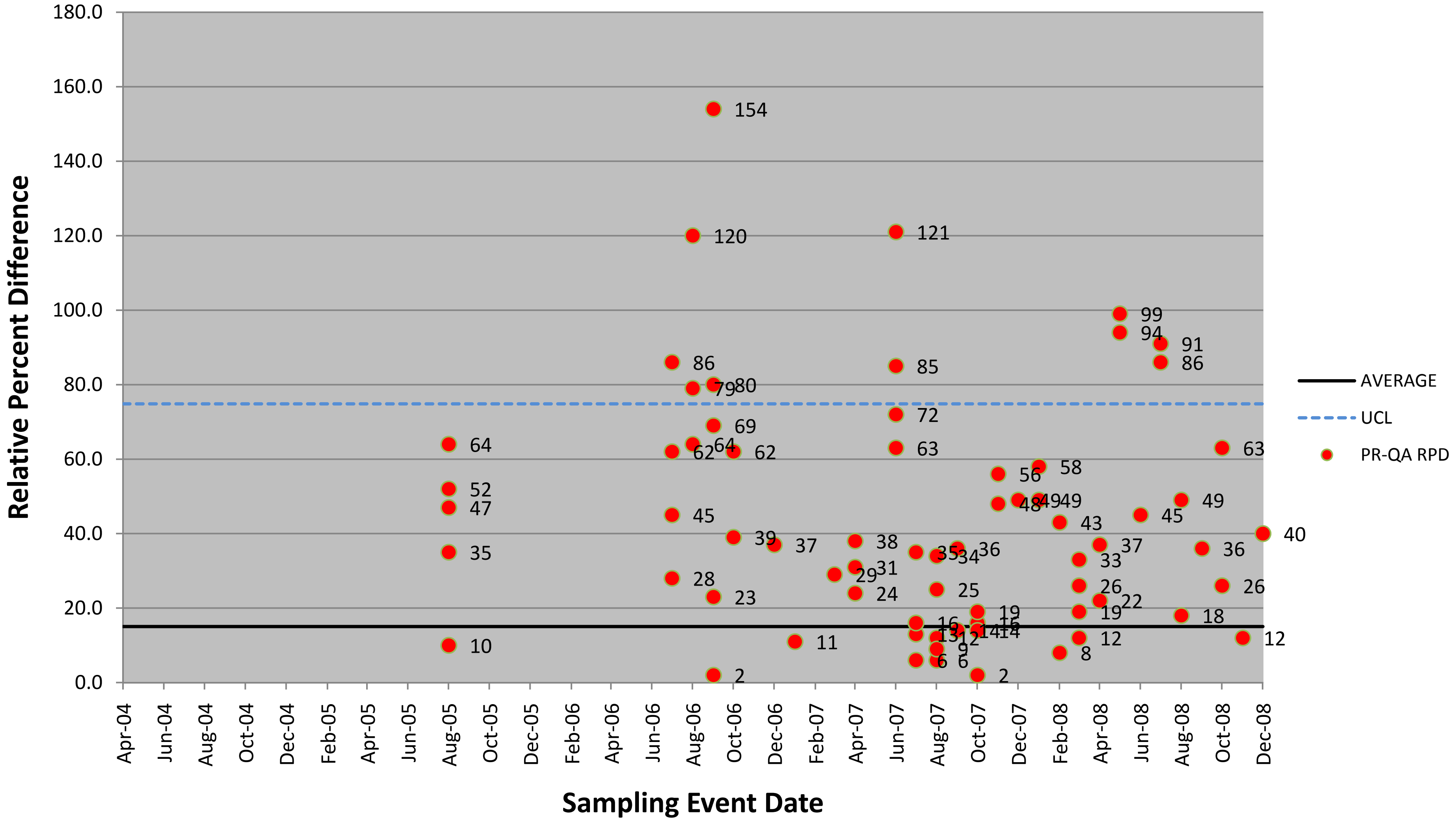


Chart A-7: Hardness as $CaCO_3$ Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

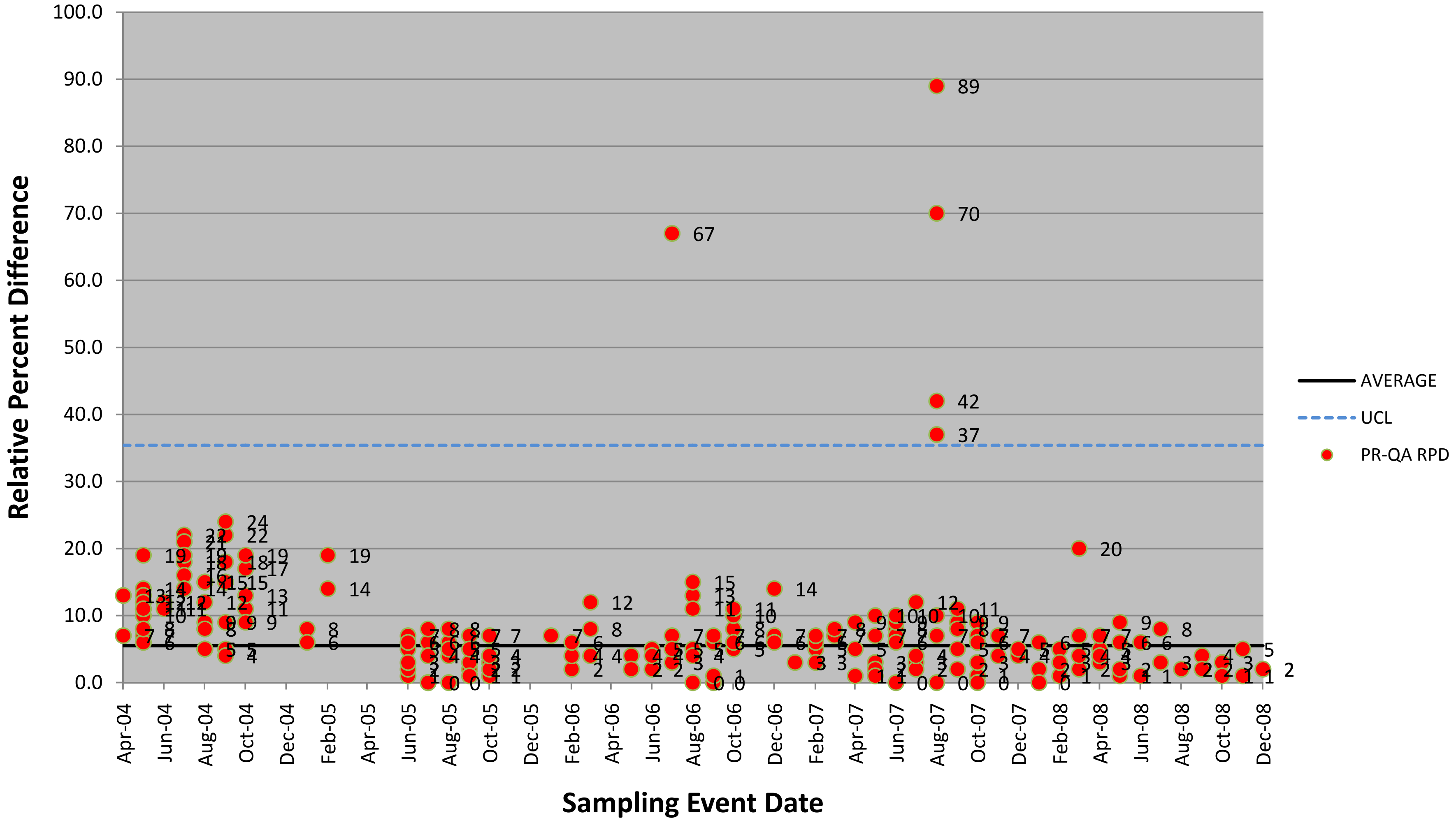


Chart A-8: Nitrogen: Ammonia (as N) Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

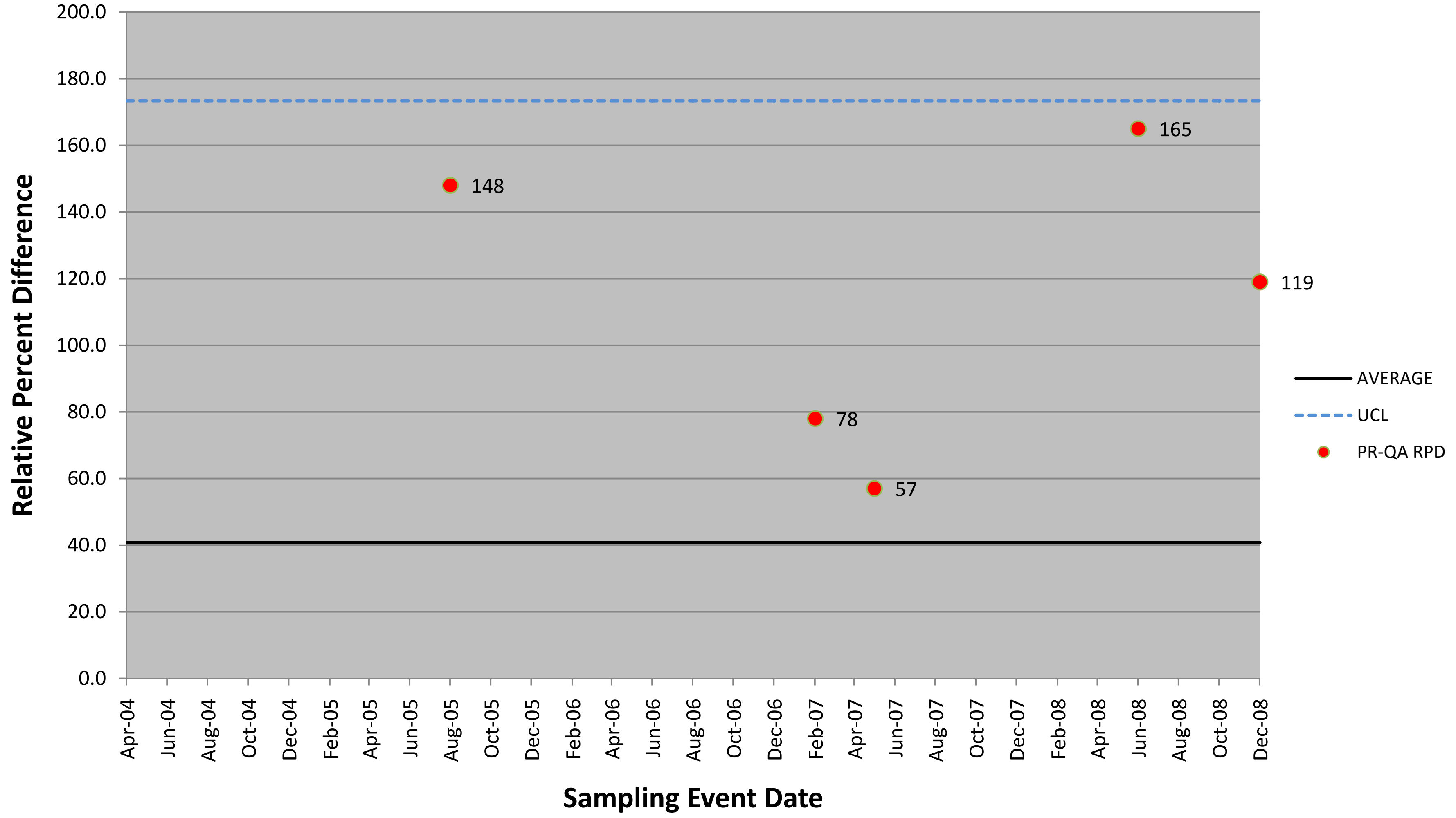


Chart A-9: Nitrogen: Nitrate-Nitrite Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

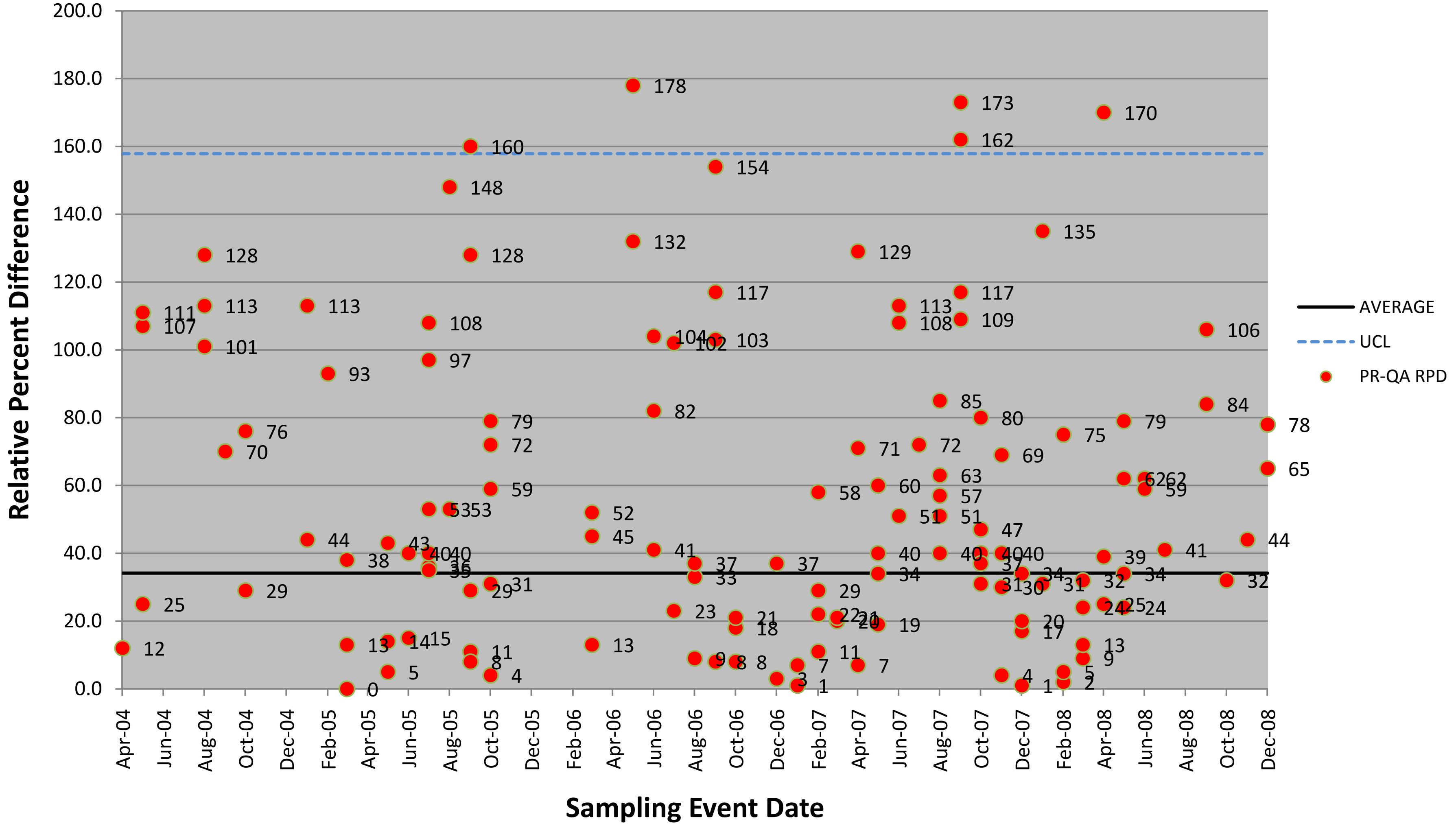


Chart A-10: pH Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

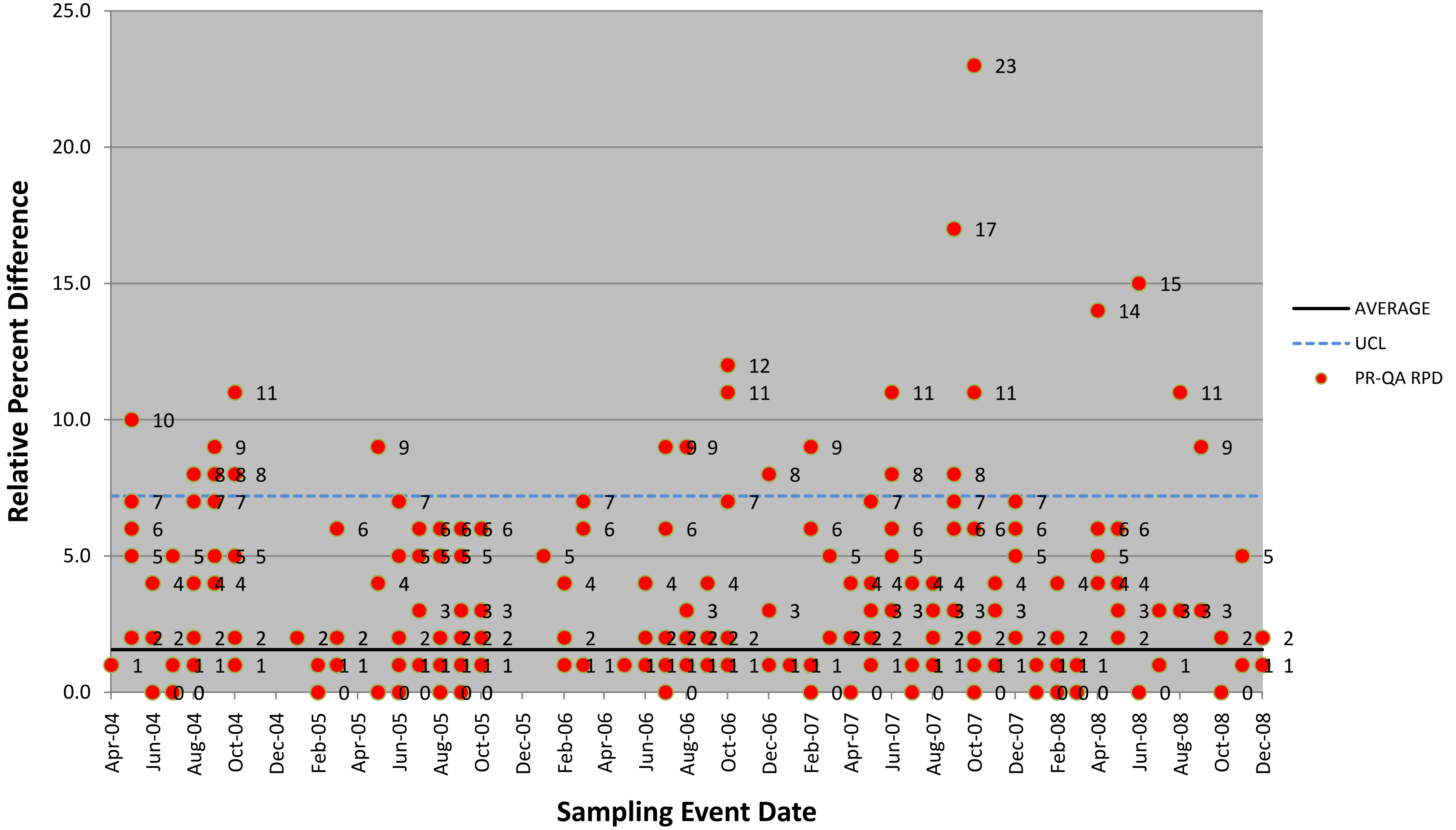


Chart A-11: Phosphorus: Total (as P) Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

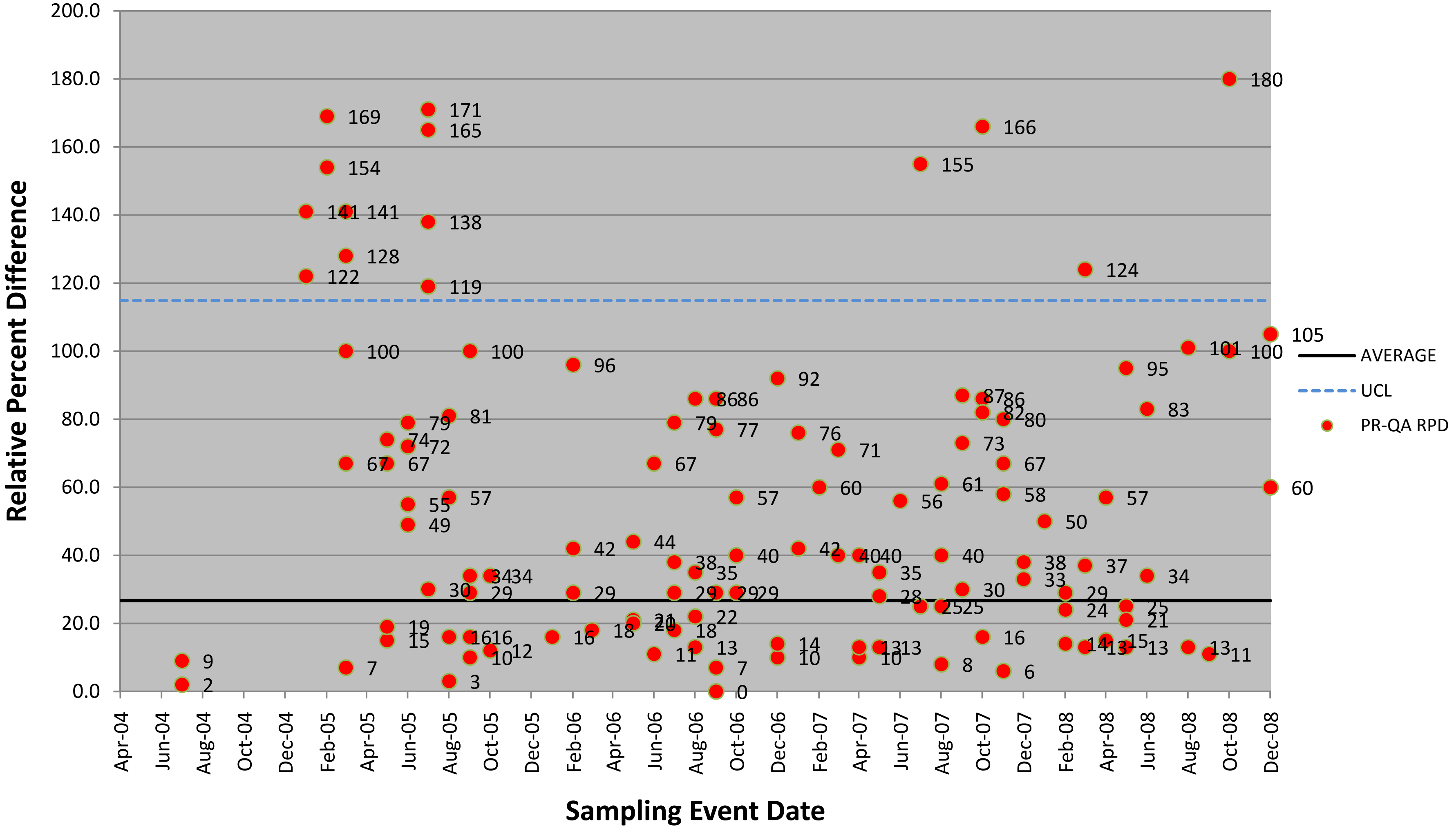


Chart A-12: Specific Conductance Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

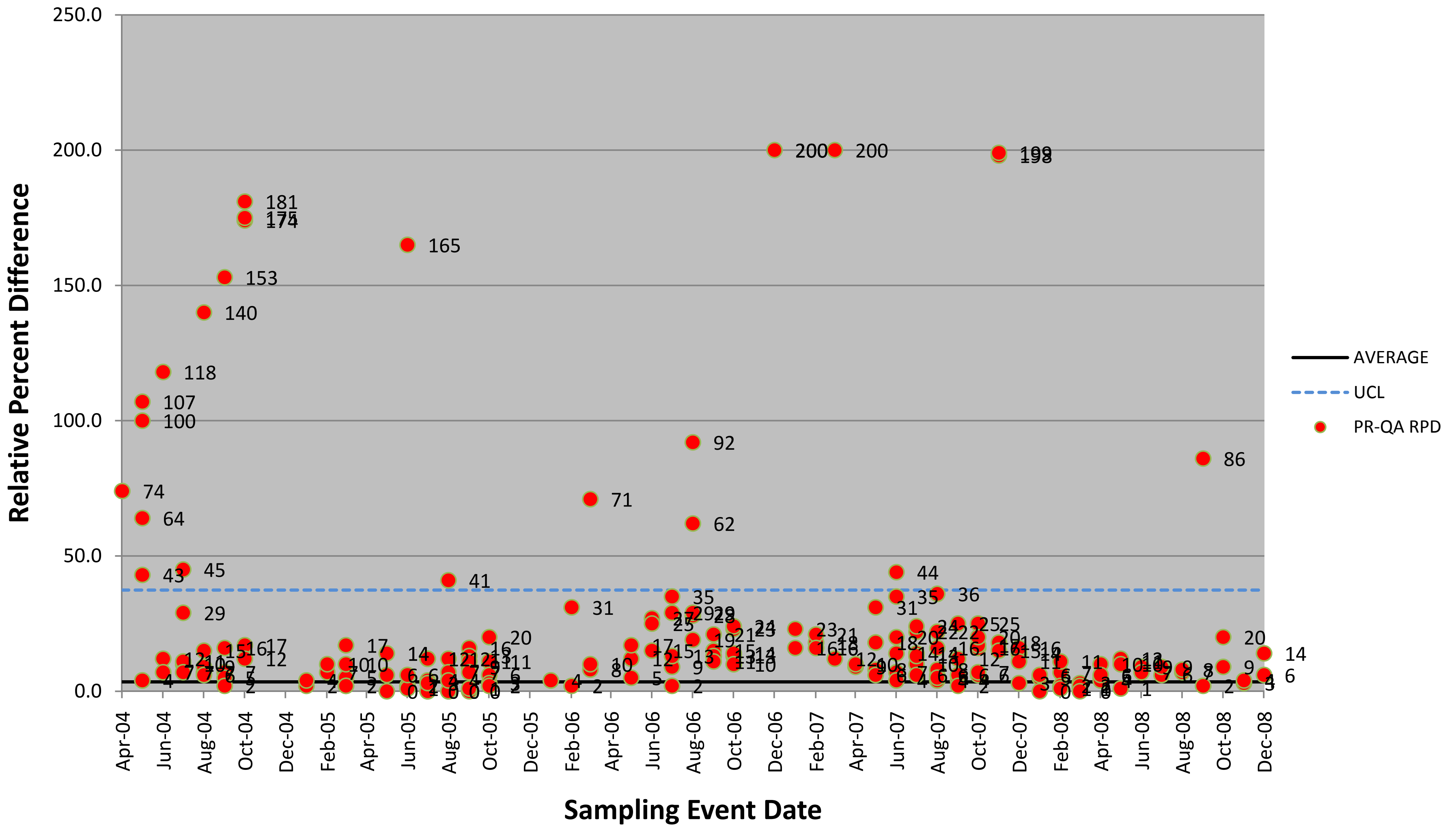
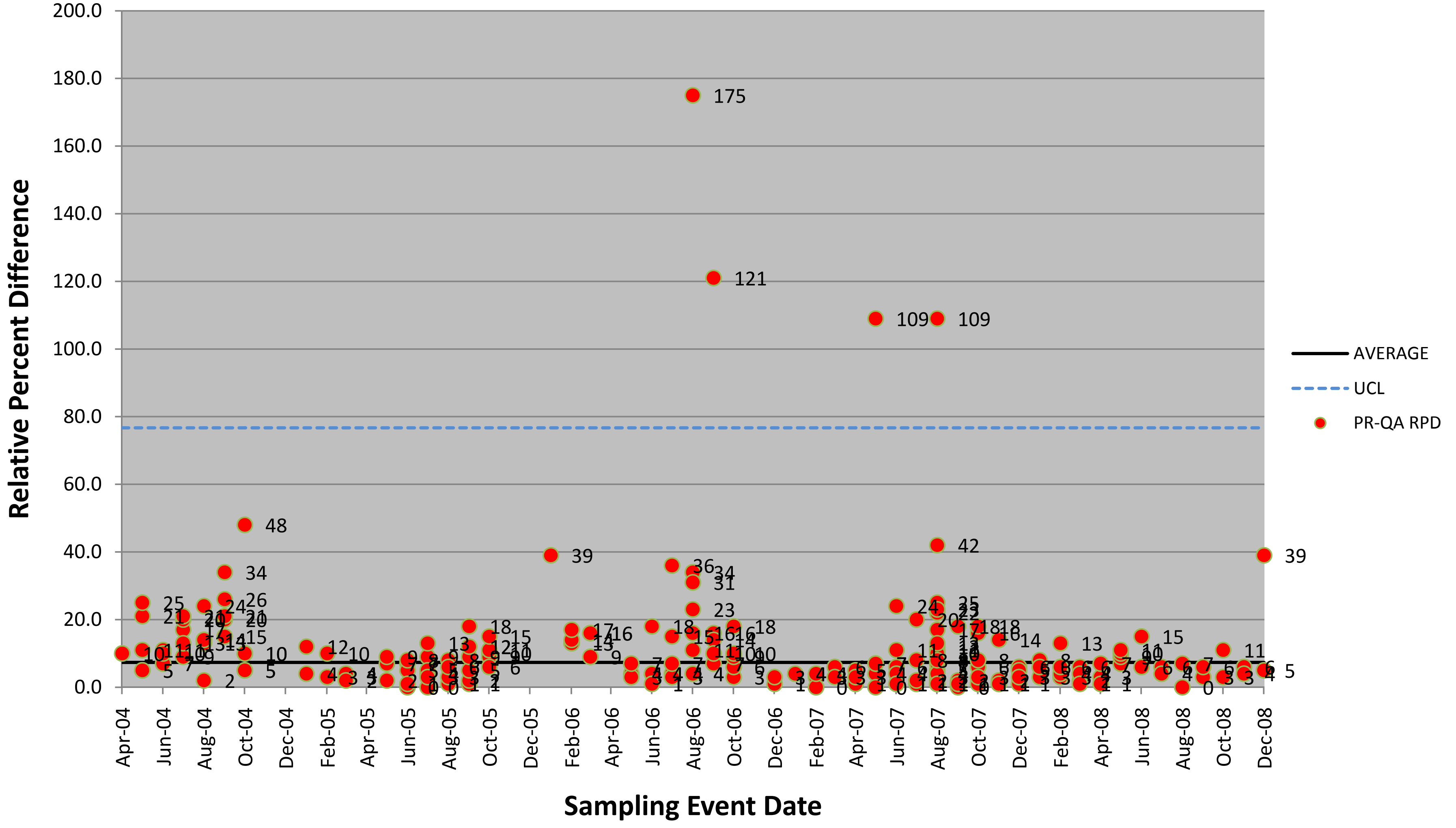


Chart A-13: Sulfate Control Chart for April 2004-December 2008 Surface Water (Except Seeps)



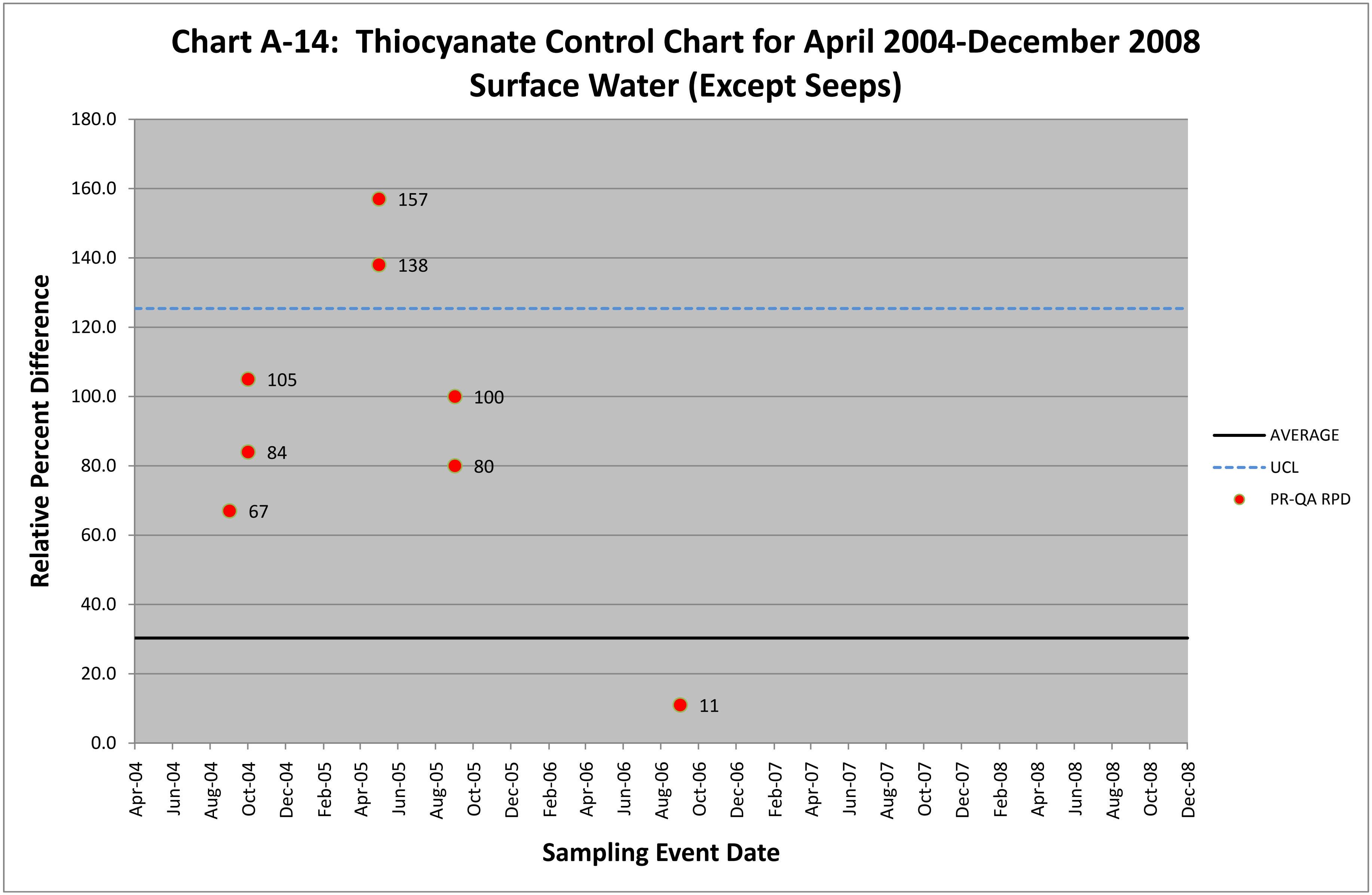


Chart A-14: Thiocyanate Control Chart for April 2004-December 2008
Surface Water (Except Seeps)
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
157
138
105
100
84
80
67
11
Apr-04
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08
Jun-08
Aug-08
Oct-08
Dec-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-15: Total Dissolved Solids Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

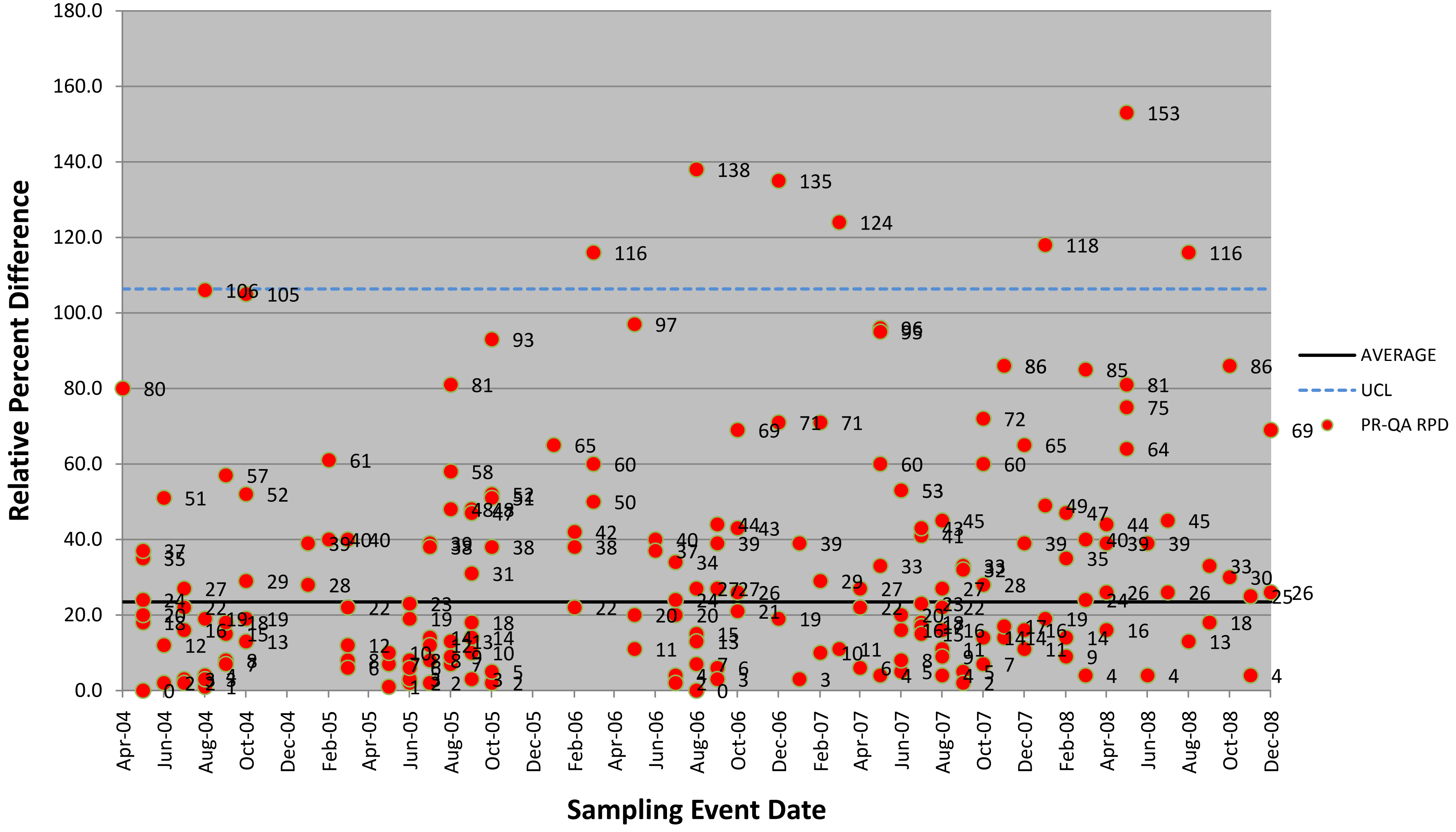


Chart A-16: Total Organic Carbon Control Chart for June 2007-September 2007 Surface Water (Except Seeps)

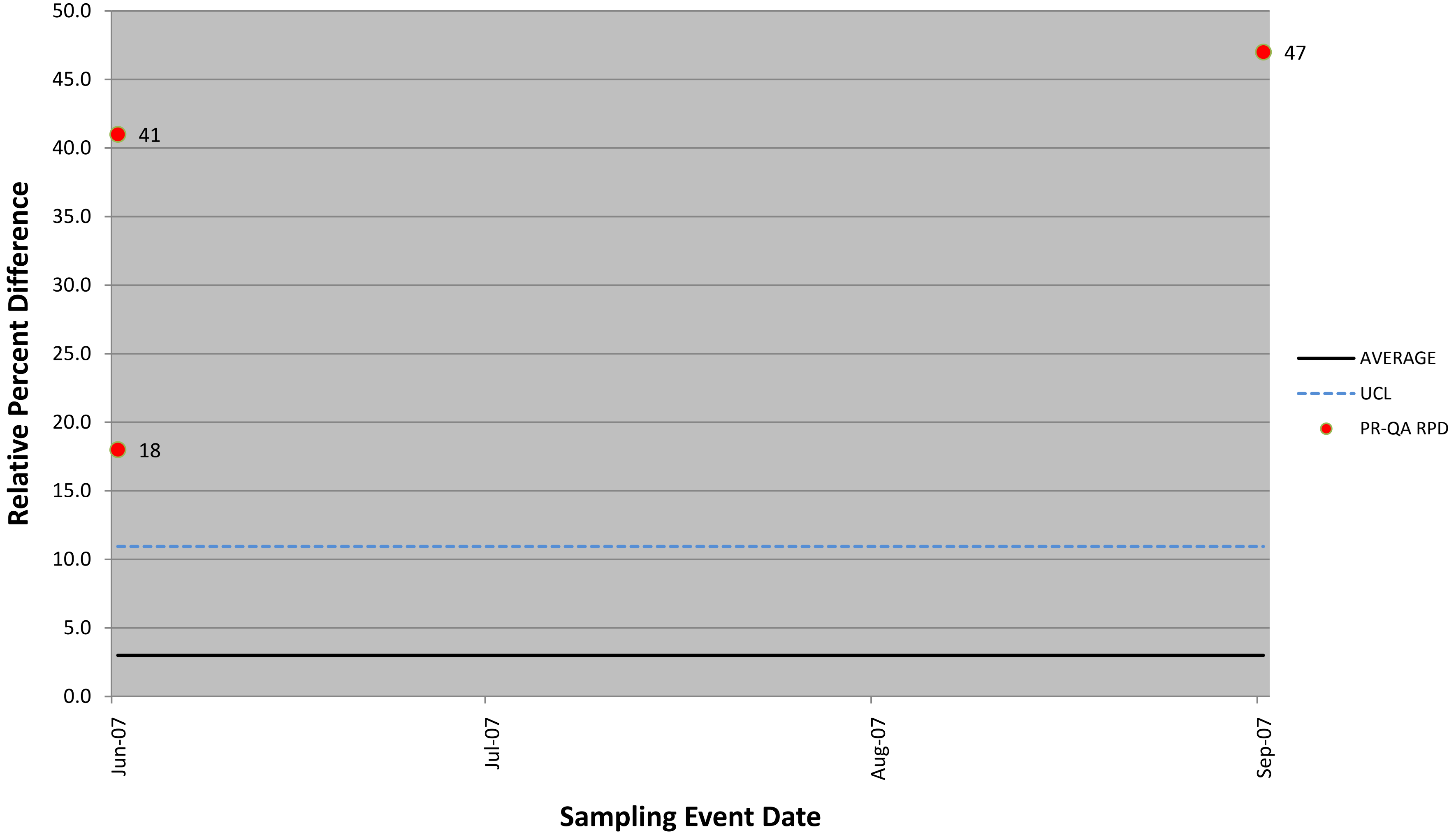
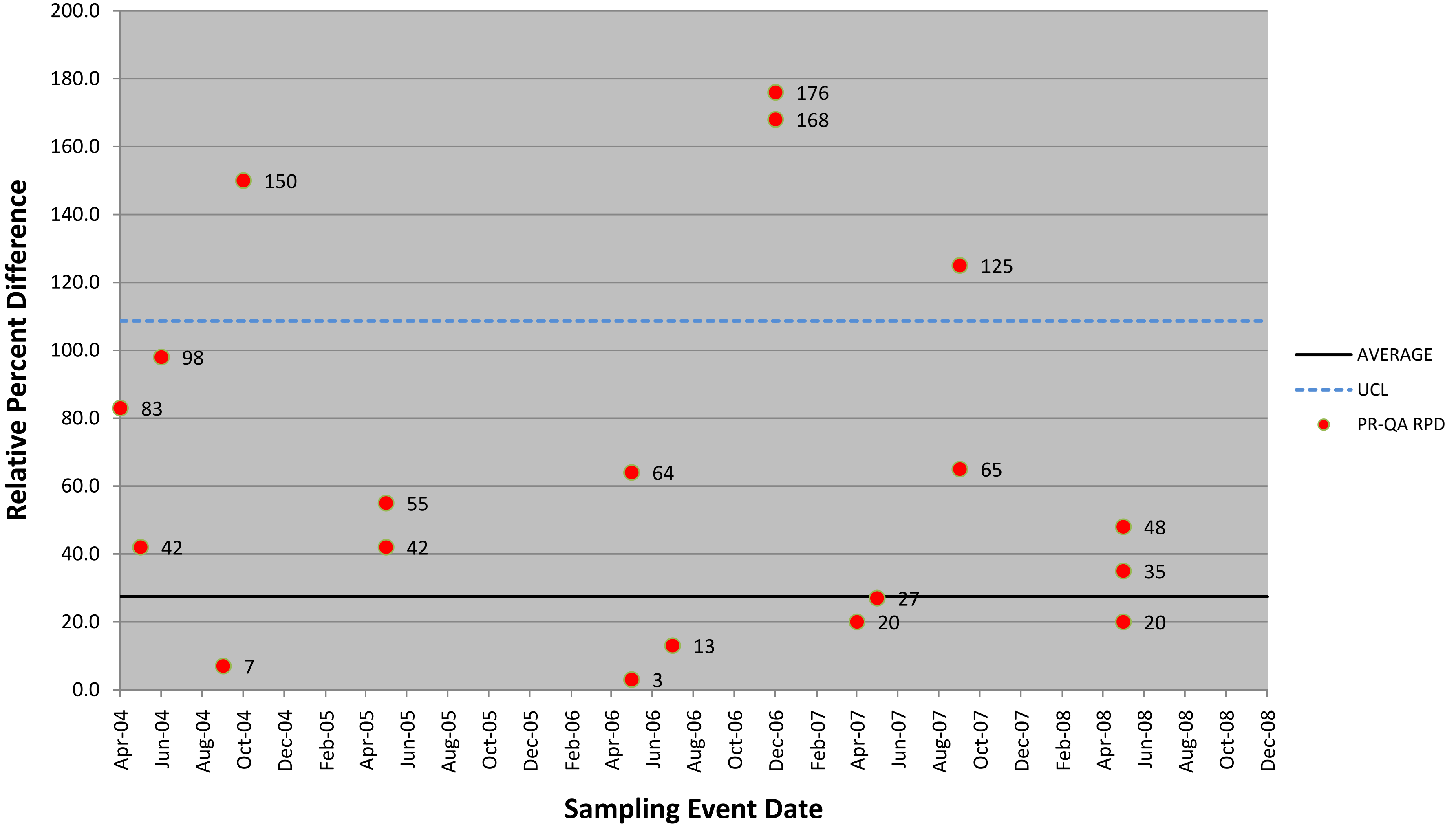


Chart A-17: Total Suspended Solids Control Chart for April 2004-December 2008 Surface Water (Except Seeps)



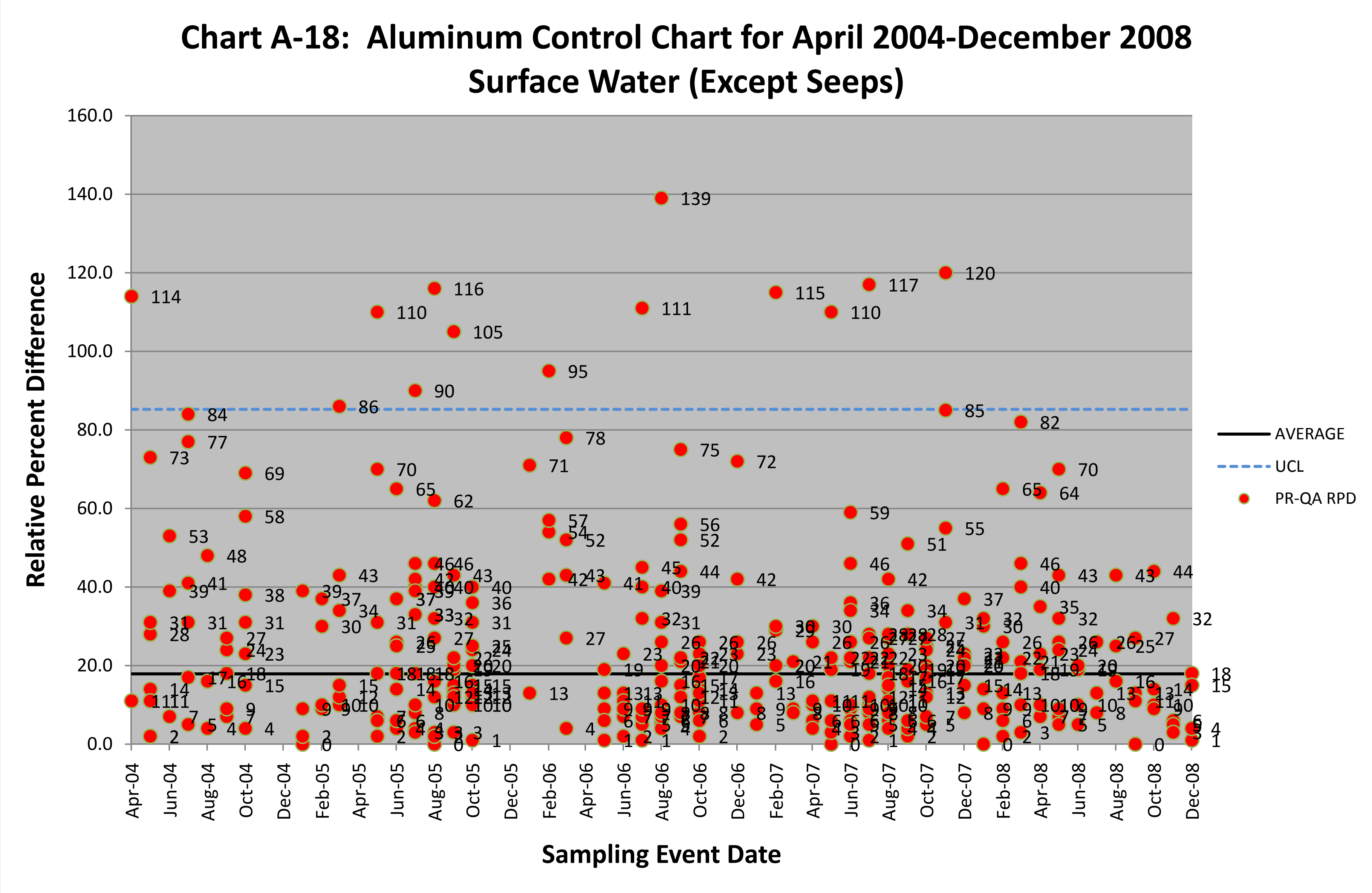
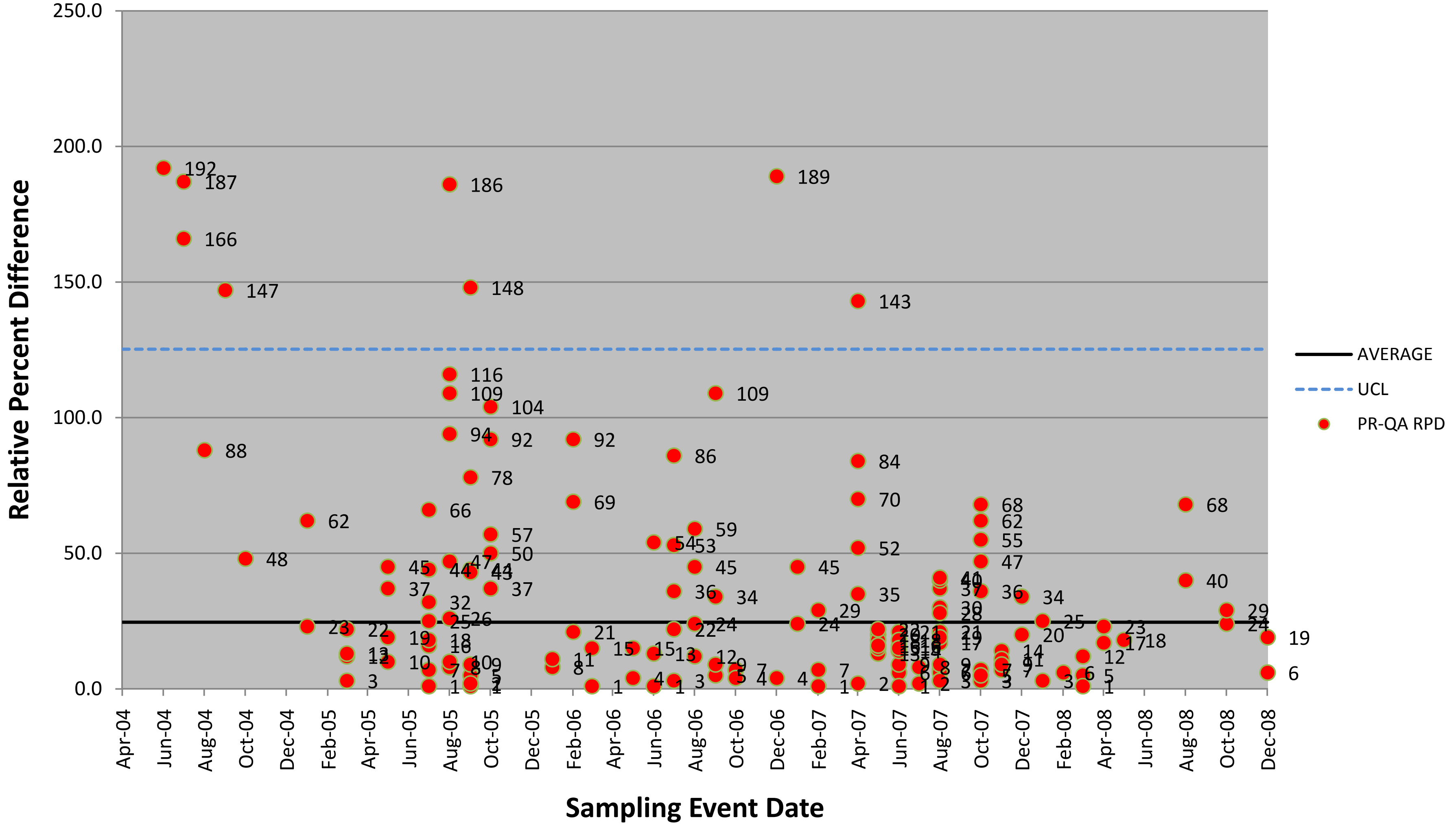


Chart A-18: Aluminum Control Chart for April 2004-December 2008
Surface Water (Except Seeps)
Relative Percent Difference
Sampling Event Date
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Apr-04
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08
Jun-08
Aug-08
Oct-08
Dec-08
AVERAGE
UCL
PR-QA RPD
139
120
117
116
115
114
111
110
105
95
90
86
85
84
82
78
77
75
73
72
71
70
69
65
64
62

Chart A-19: Antimony Control Chart for April 2004-December 2008 Surface Water (Except Seeps)



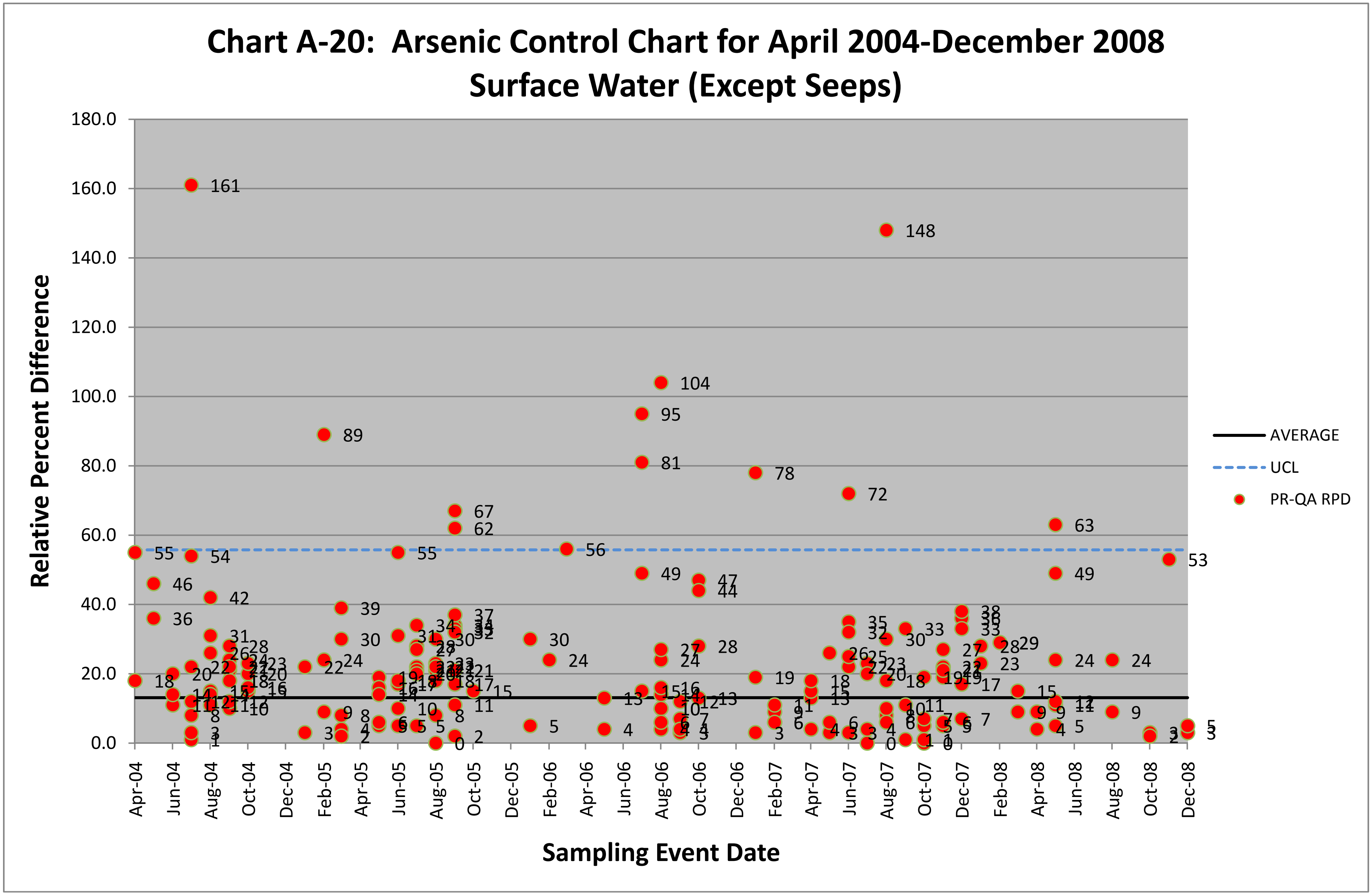


Chart A-20: Arsenic Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

Chart A-21: Barium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

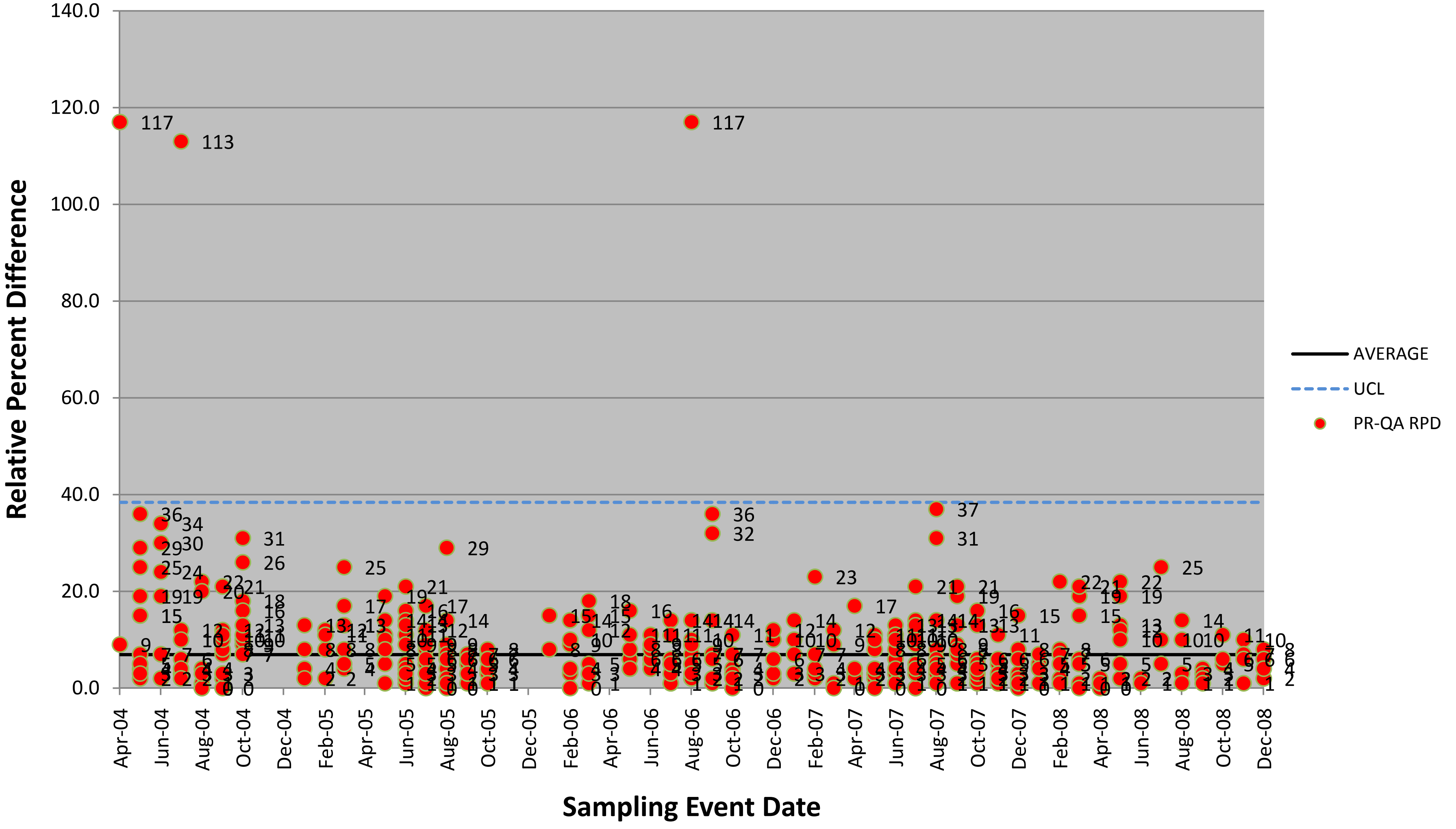
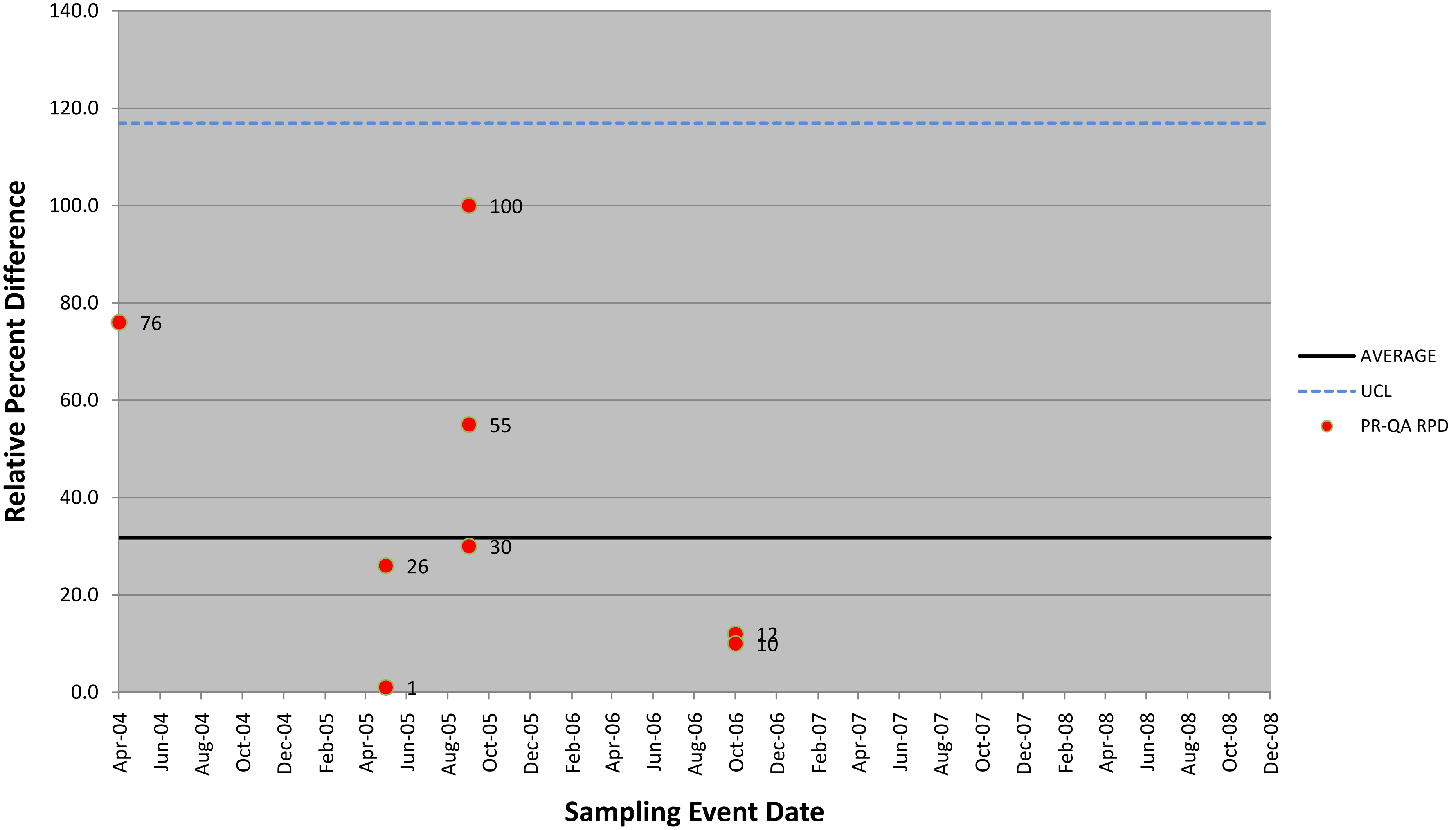


Chart A-22: Beryllium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)



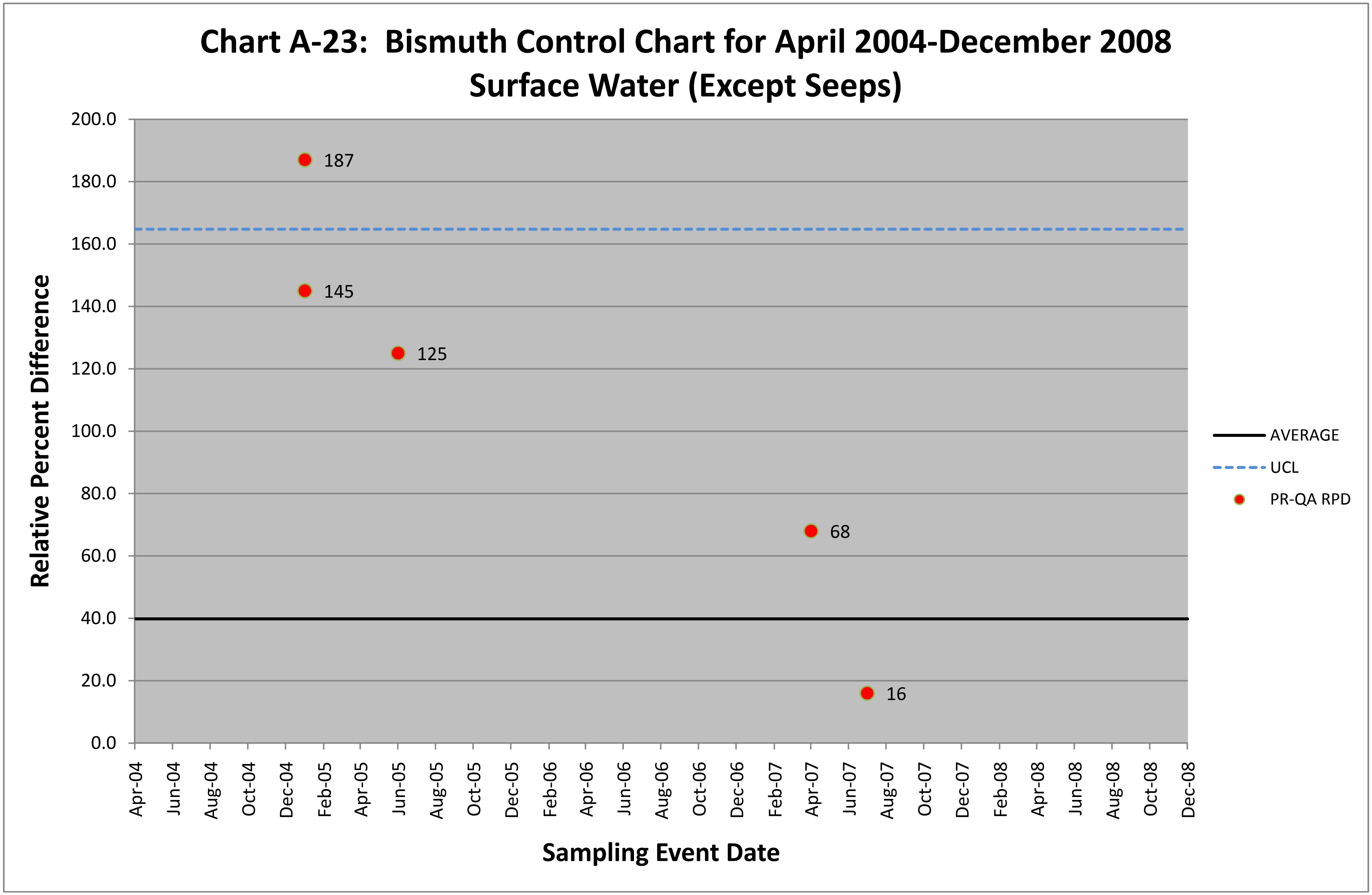
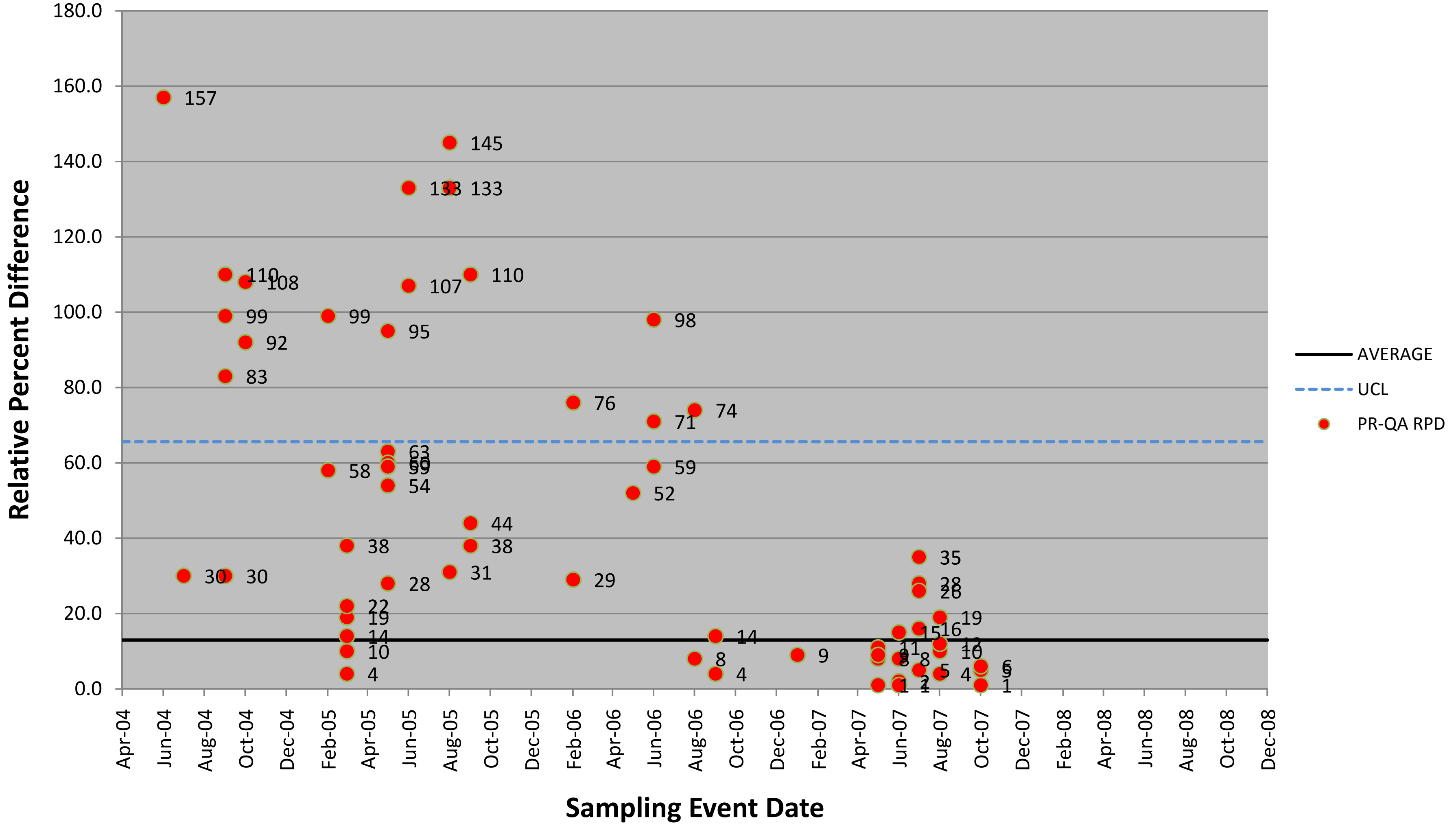


Chart A-23: Bismuth Control Chart for April 2004-December 2008
Surface Water (Except Seeps)
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
187
145
125
68
16
AVERAGE
UCL
PR-QA RPD
Apr-04
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08
Jun-08
Aug-08
Oct-08
Dec-08
Sampling Event Date

Chart A-24: Boron Control Chart for April 2004-December 2008
Surface Water (Except Seeps)



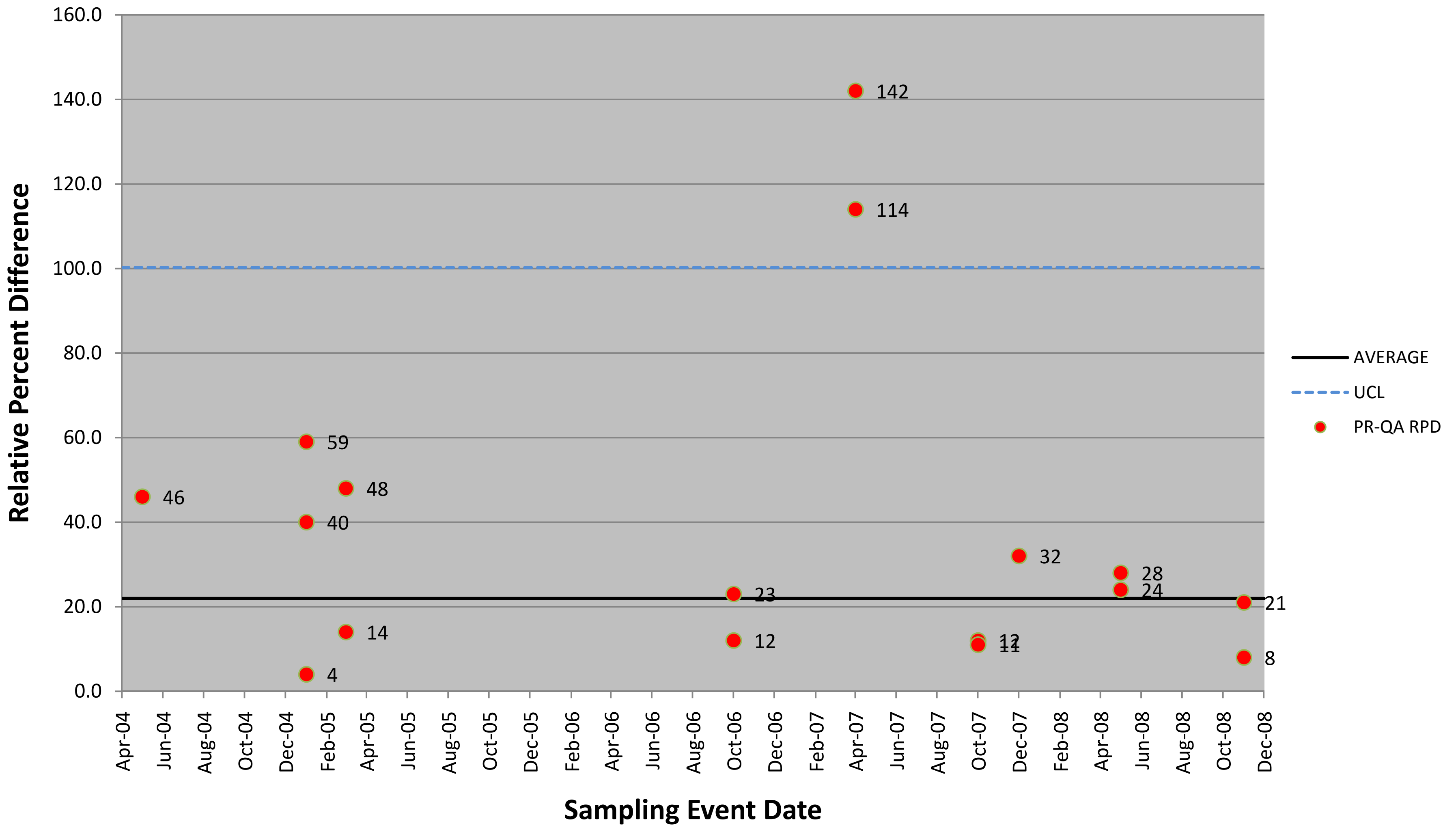
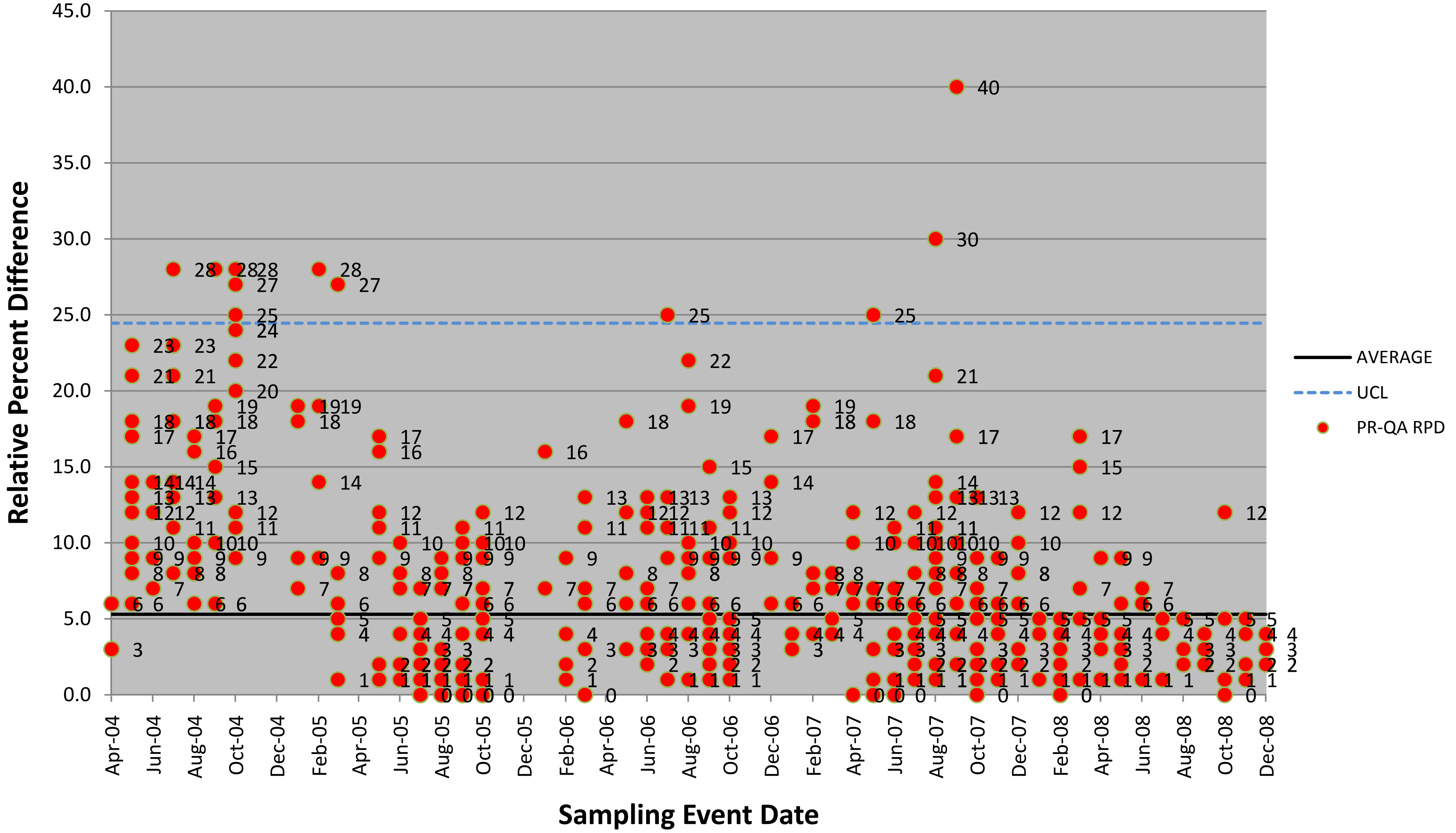


Chart A-25: Cadmium Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

Chart A-26: Calcium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)



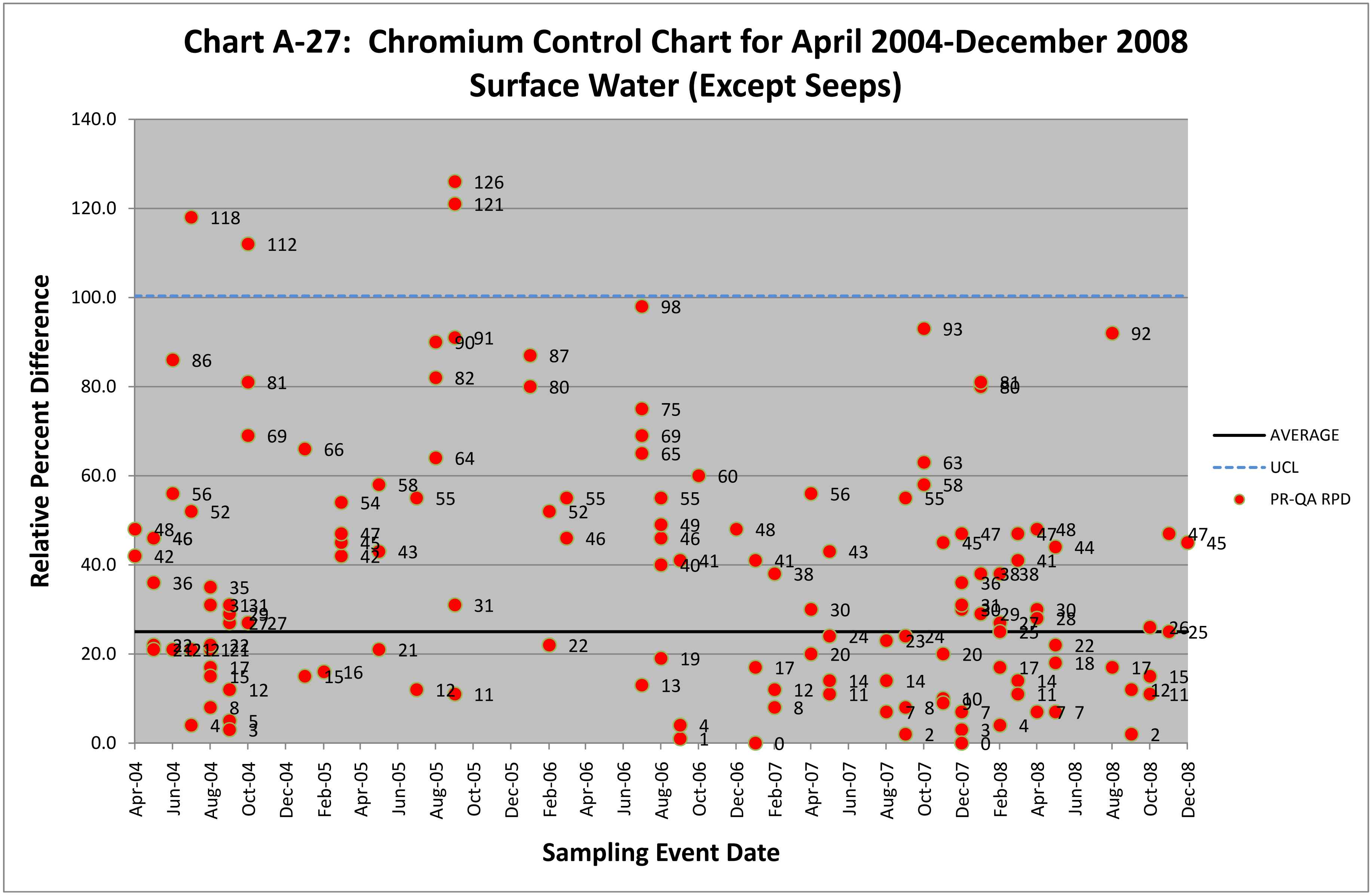


Chart A-27: Chromium Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

Chart A-28: Cobalt Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

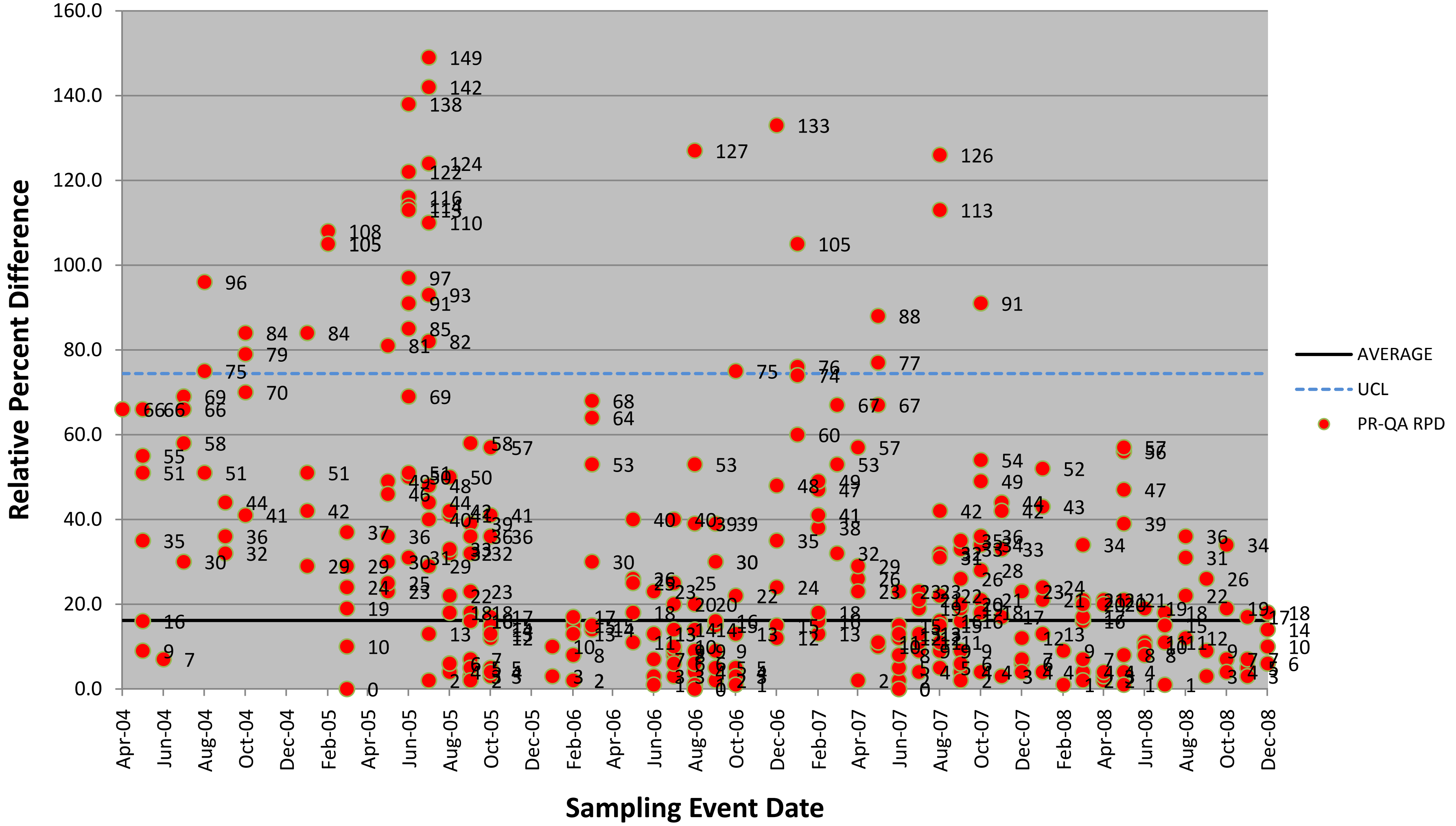


Chart A-29: Copper Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

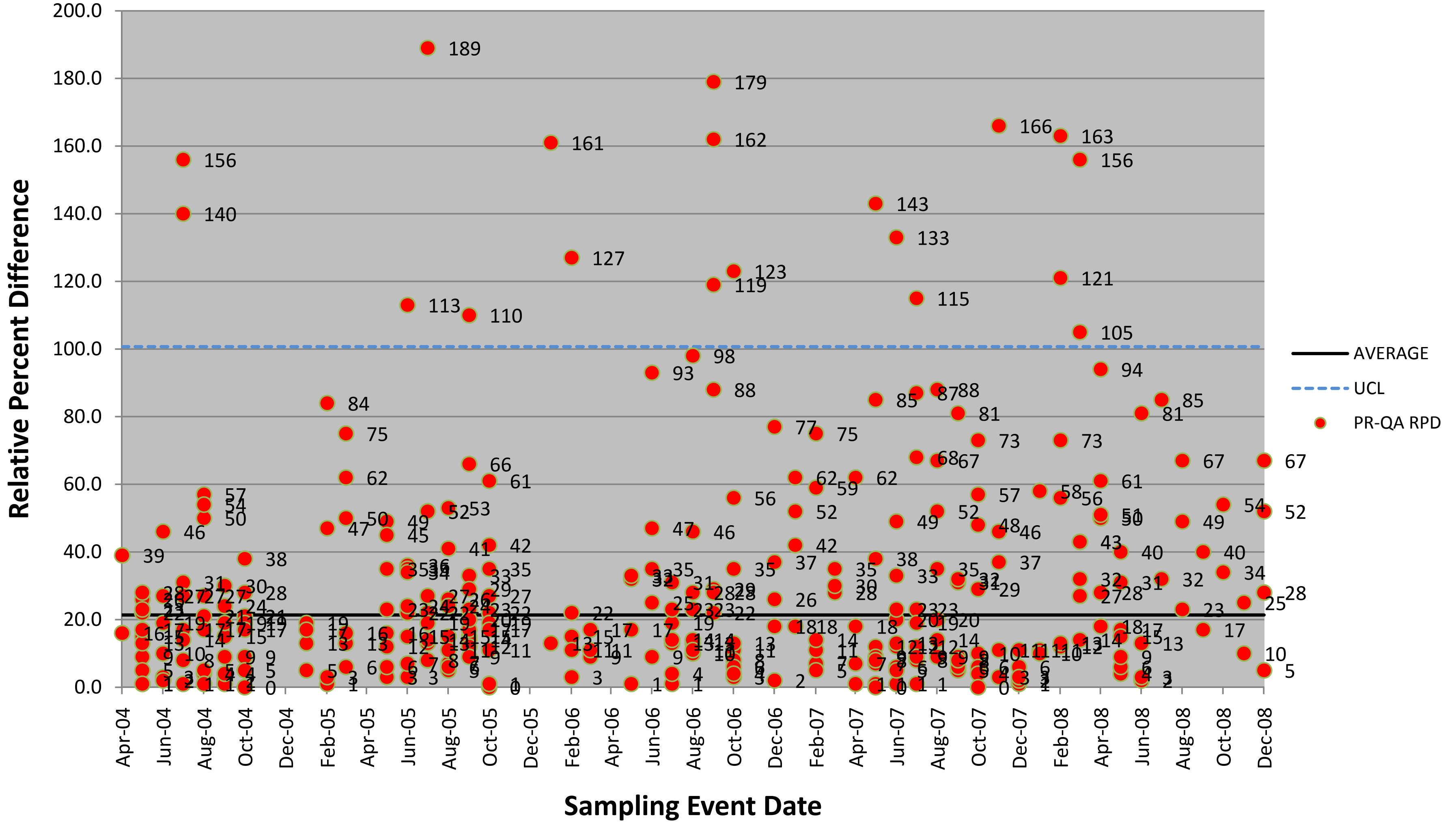


Chart A-30: Iron Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

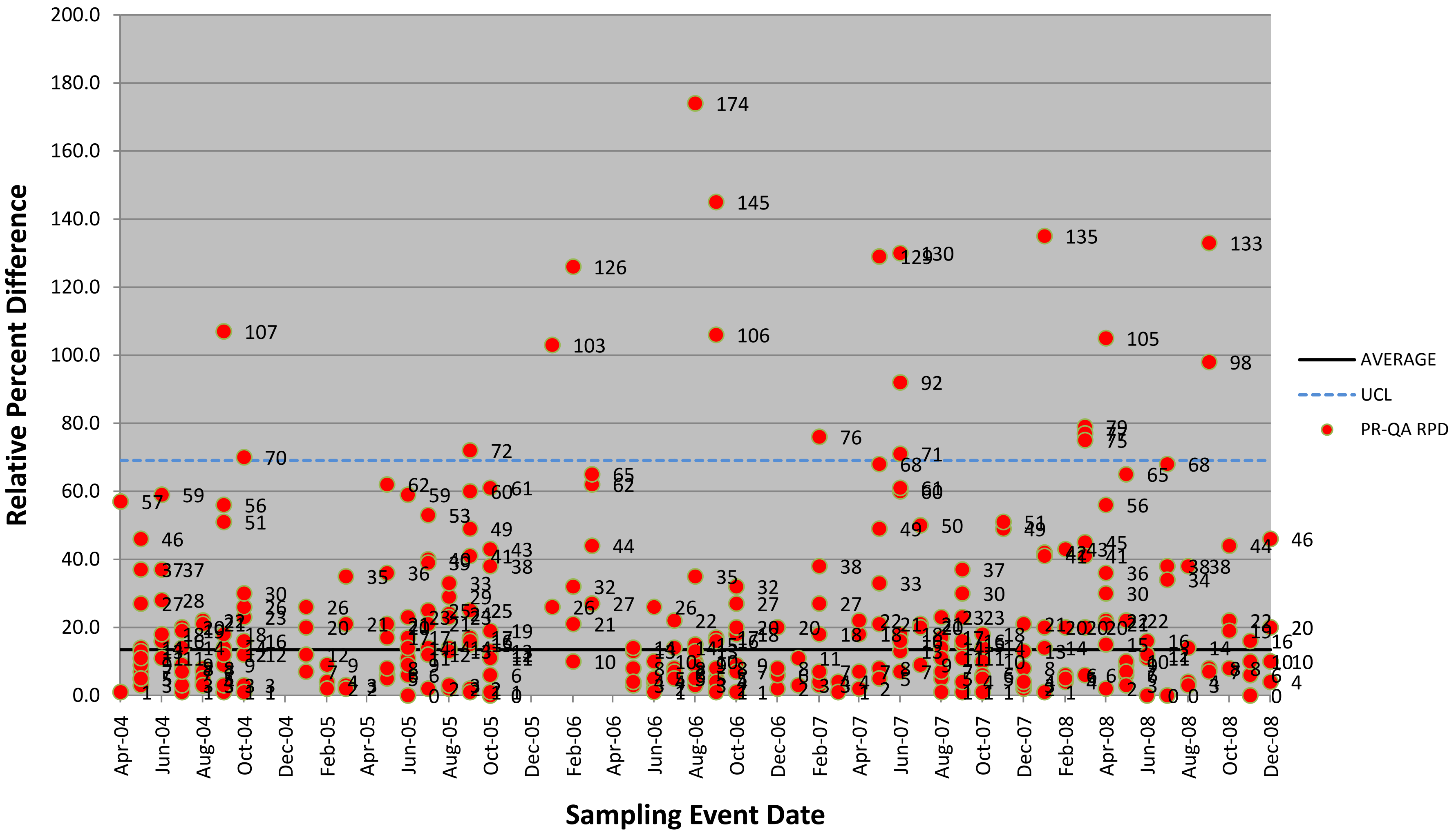


Chart A-31: Lead Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

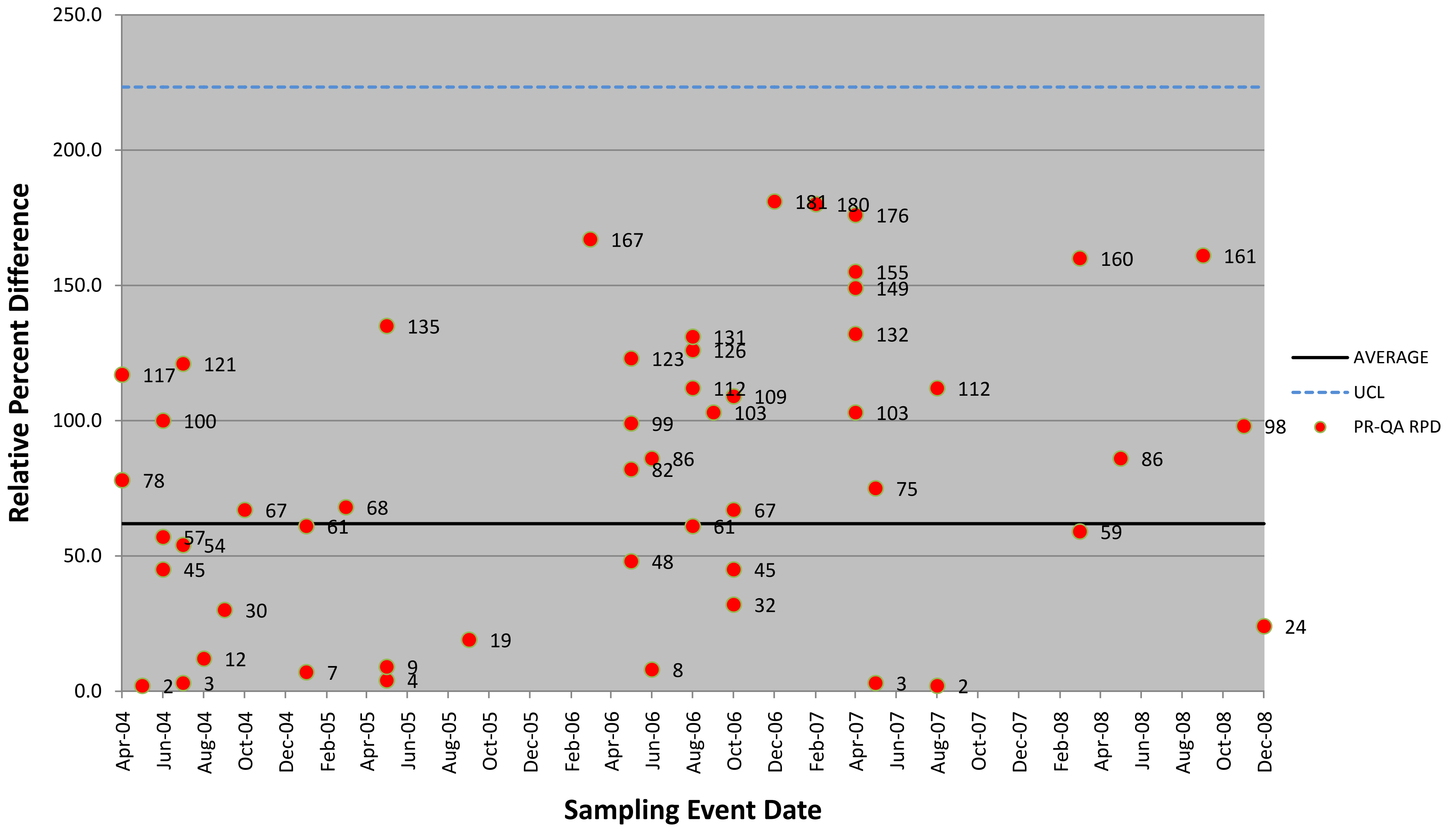


Chart A-32: Magnesium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

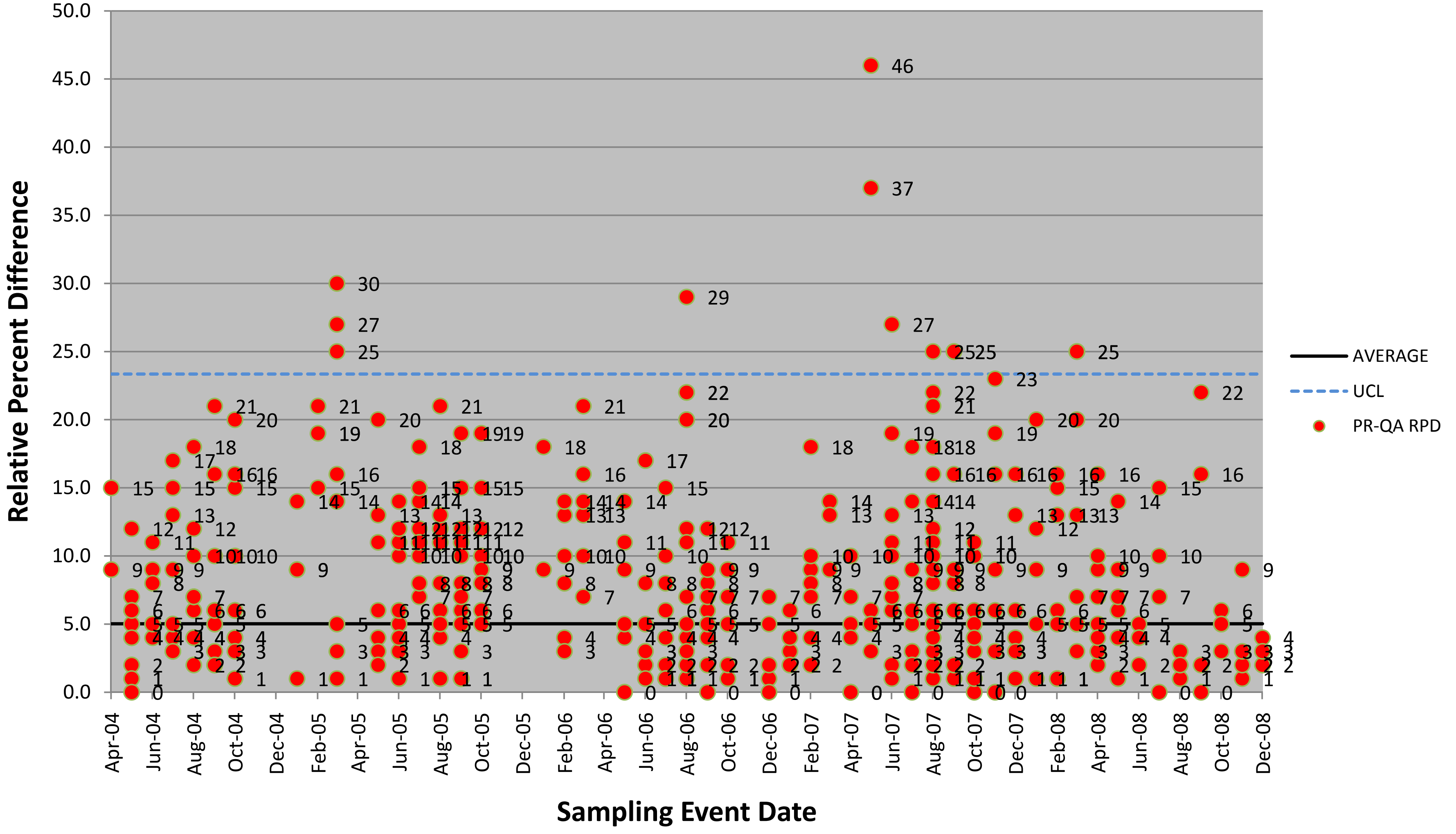
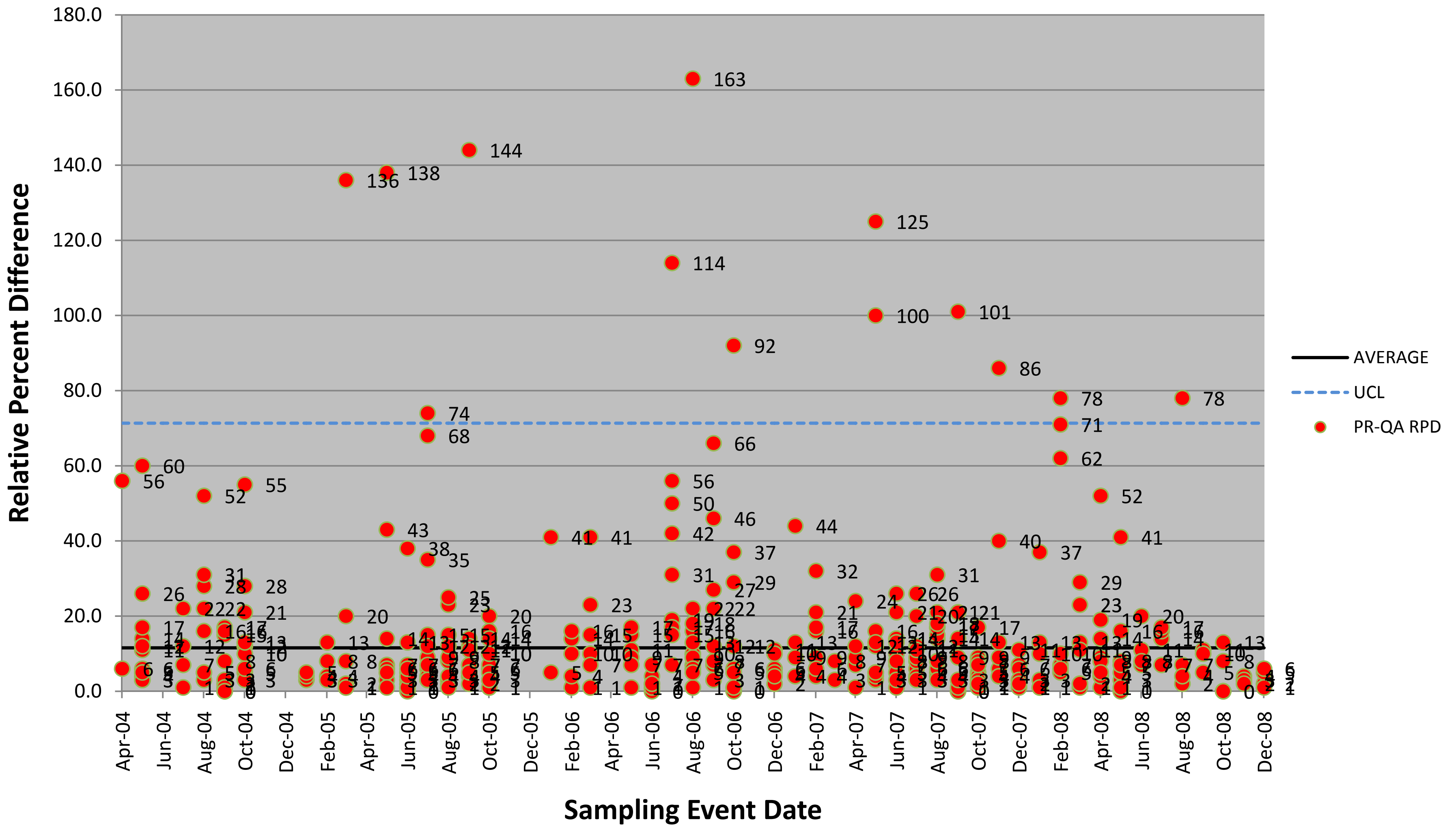


Chart A-33: Manganese Control Chart for April 2004-December 2008 Surface Water (Except Seeps)



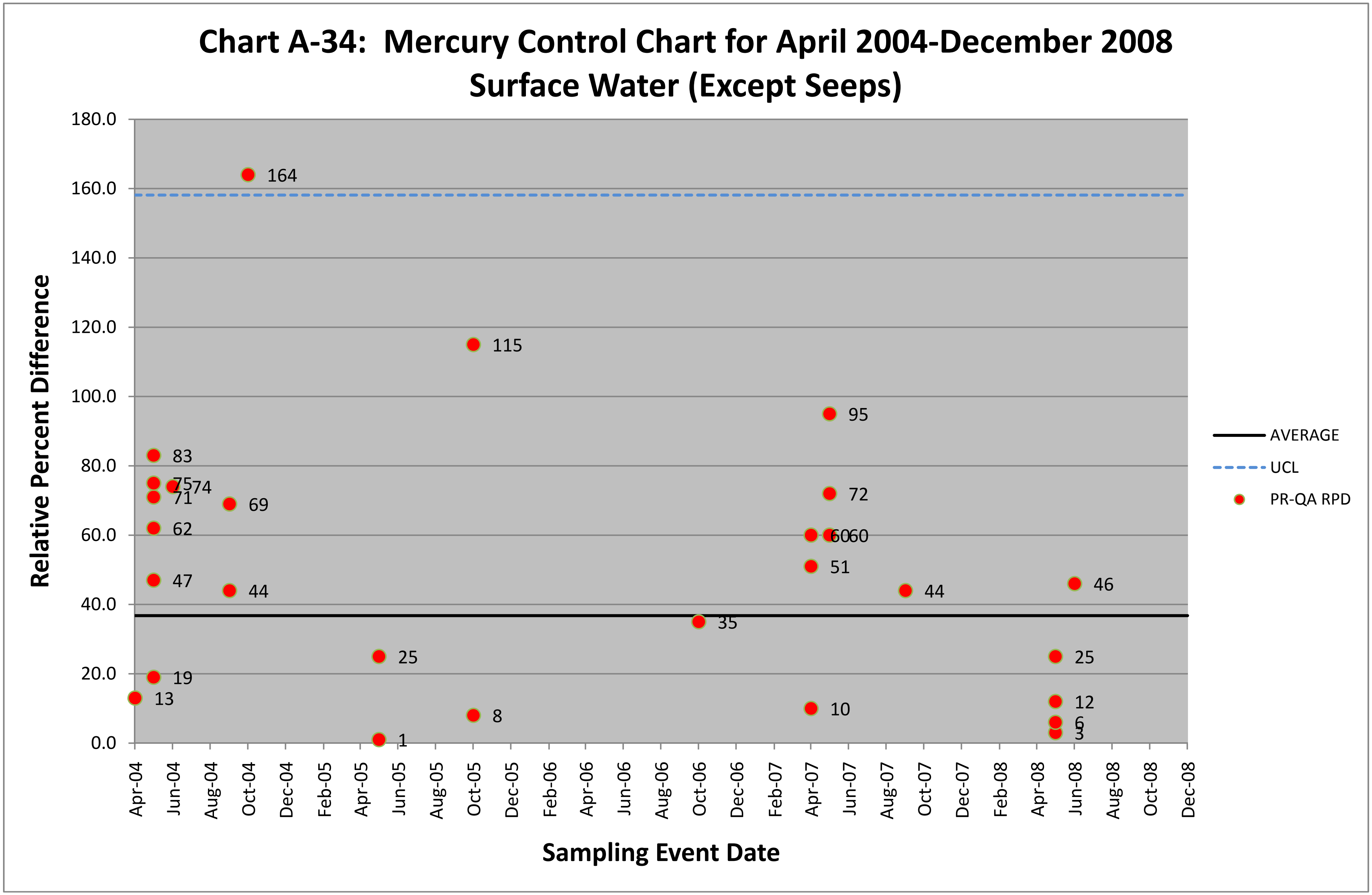


Chart A-34: Mercury Control Chart for April 2004-December 2008
Surface Water (Except Seeps)
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
164
115
95
83
75
74
71
69
72
62
60
60
47
44
51
44
46
35
25
25
19
13
10
12
8
1
6
3
Apr-04
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08
Jun-08
Aug-08
Oct-08
Dec-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

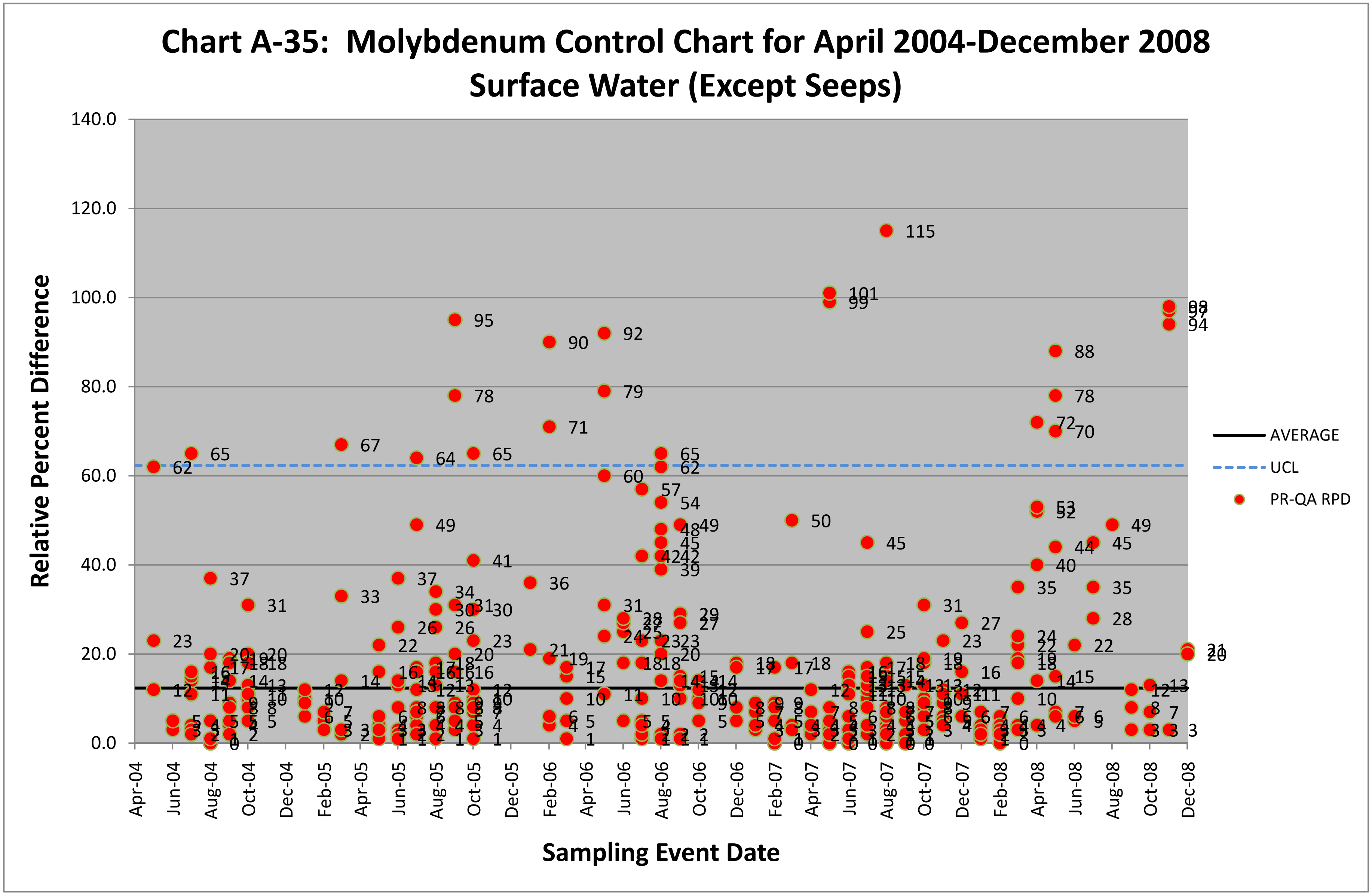


Chart A-35: Molybdenum Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

Chart A-36: Nickel Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

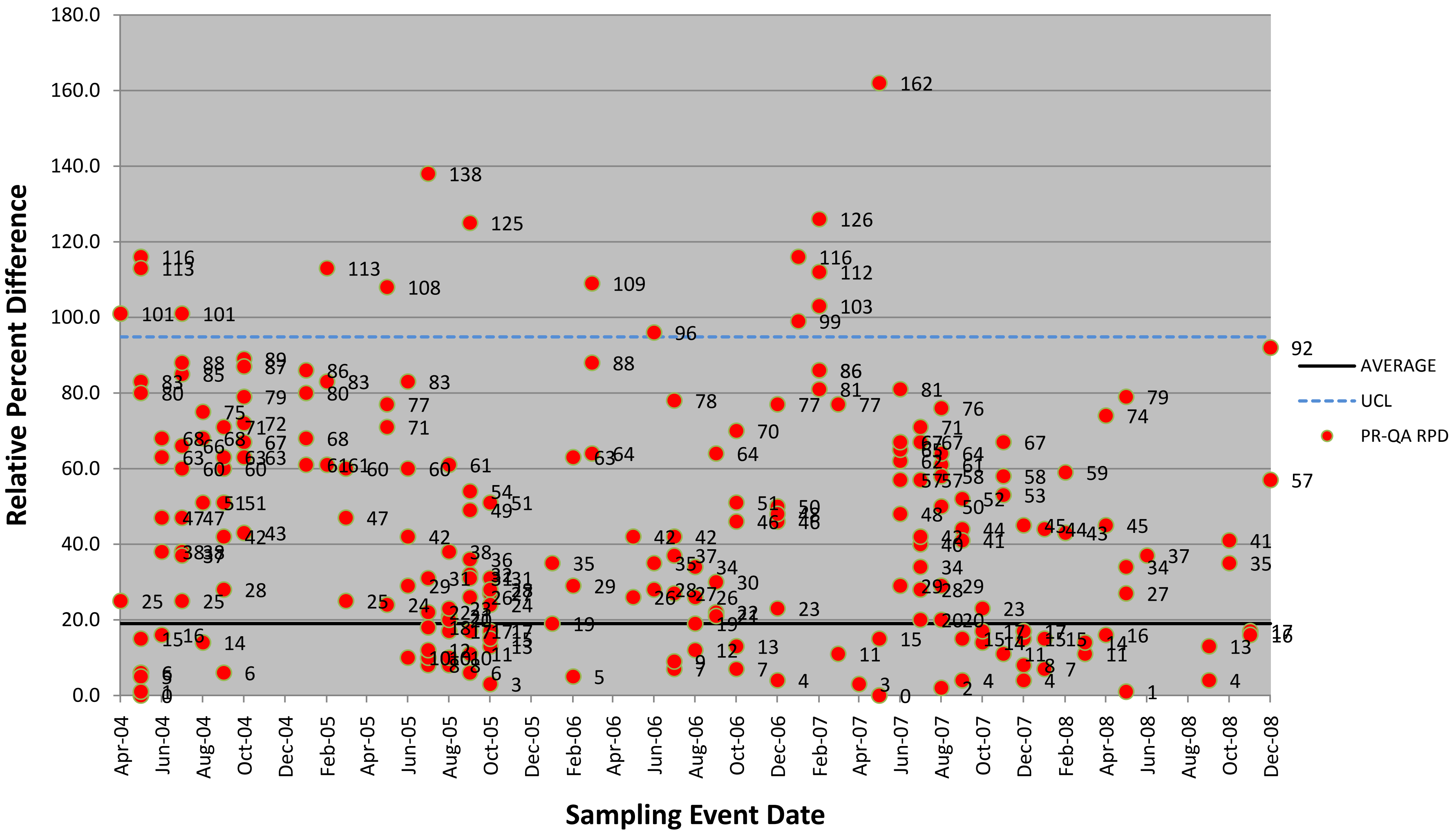


Chart A-37: Potassium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

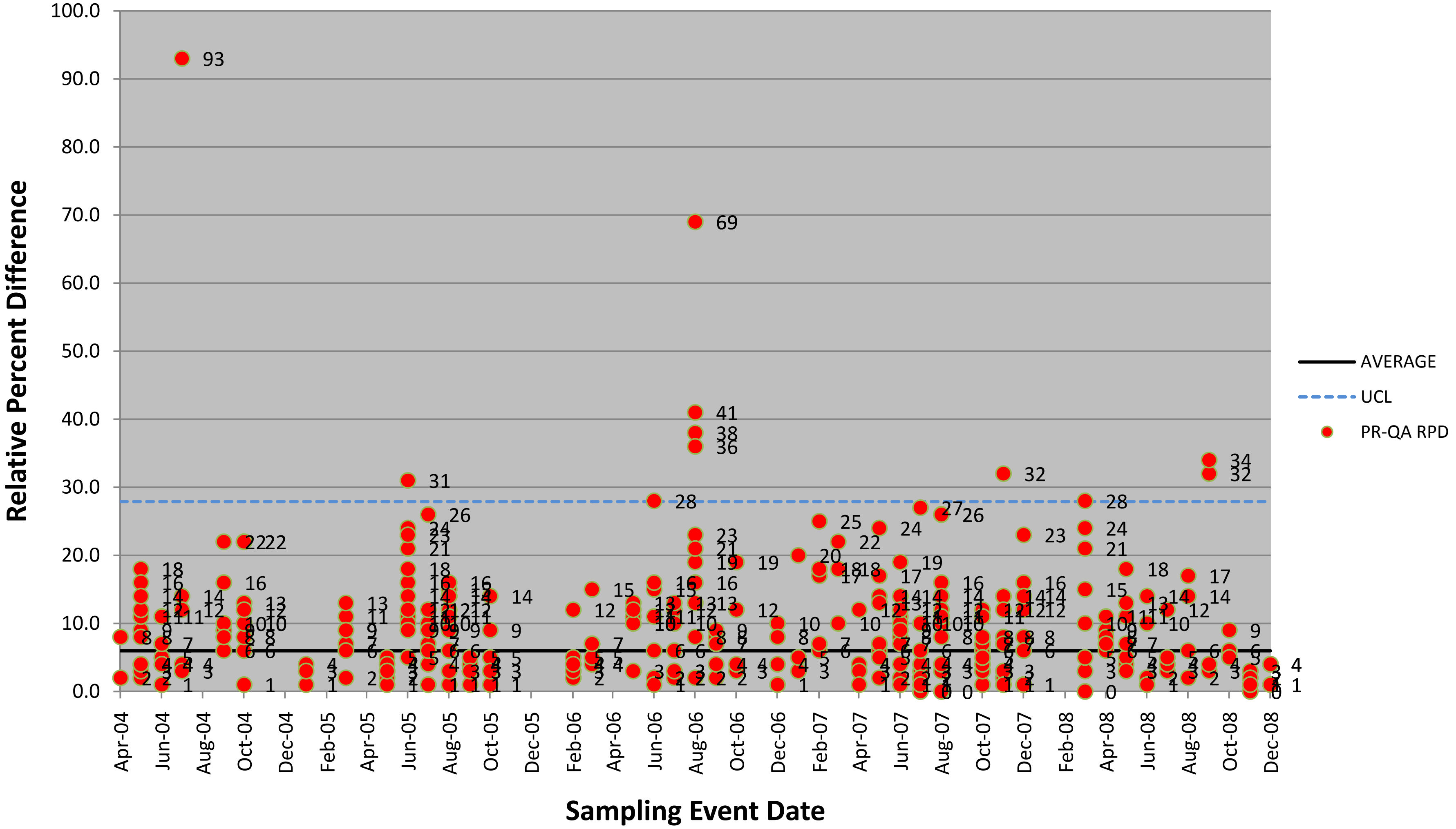
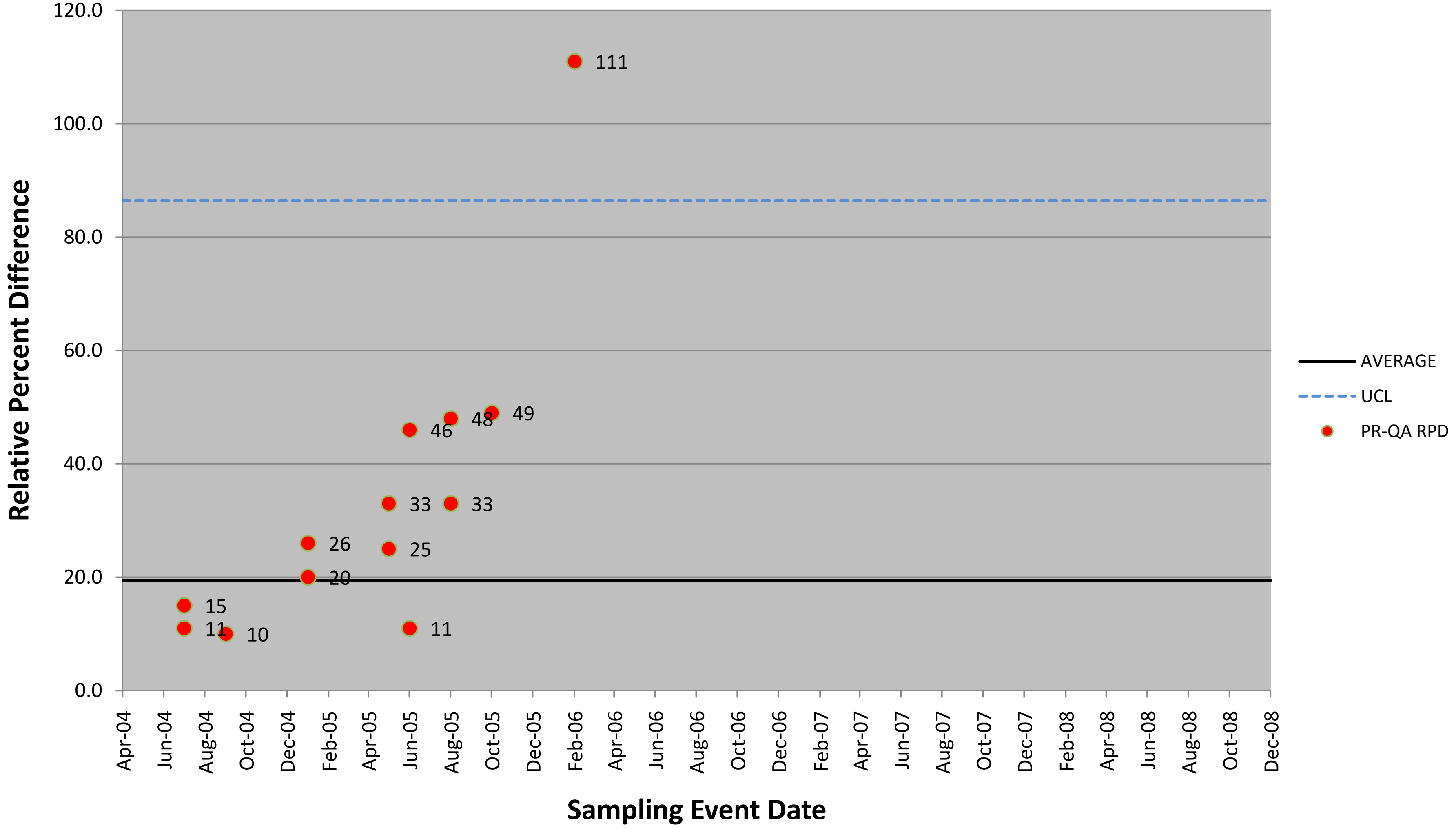


Chart A-38: Selenium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)



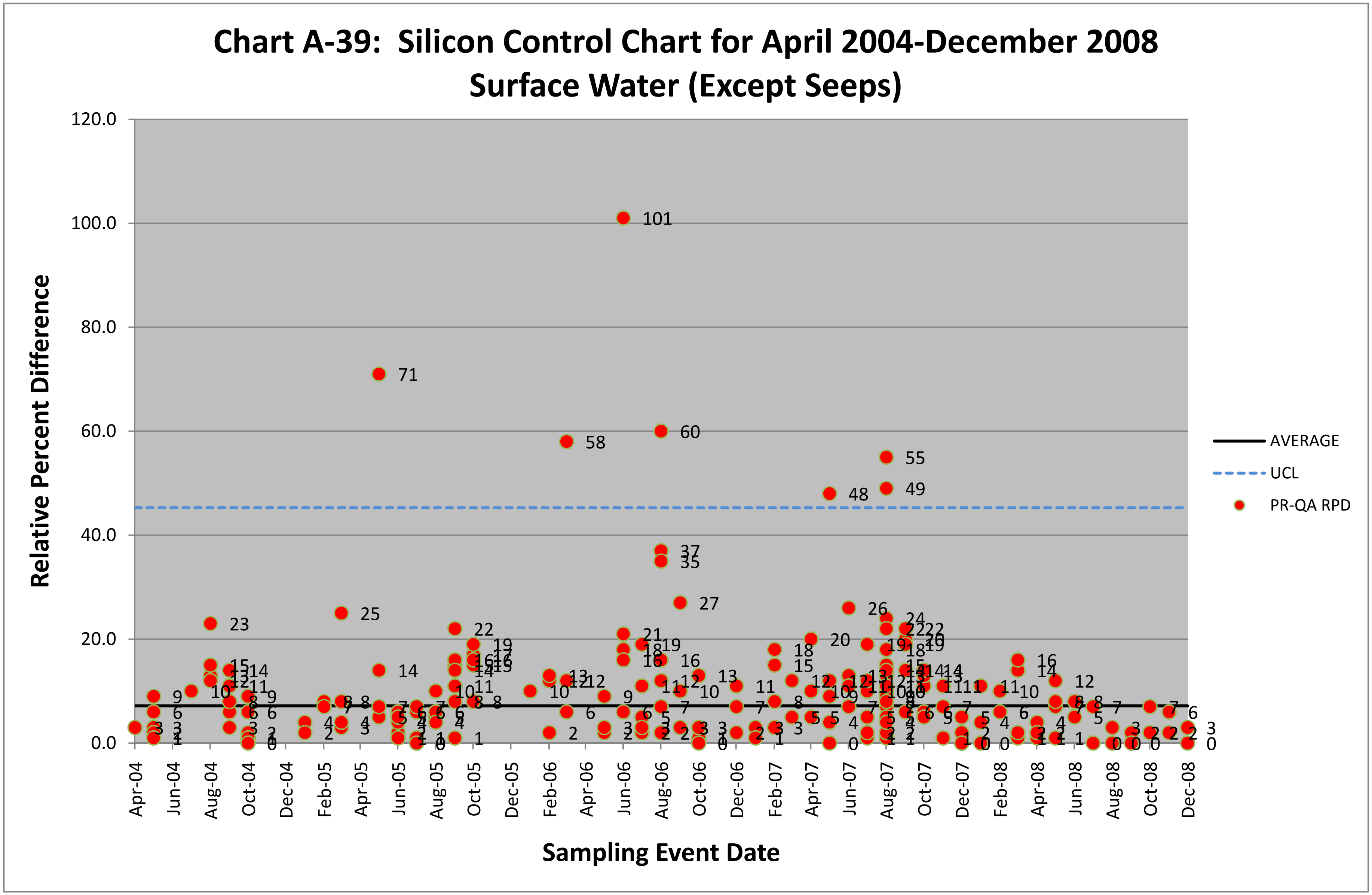


Chart A-39: Silicon Control Chart for April 2004-December 2008
Surface Water (Except Seeps)
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Sampling Event Date
Apr-04
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Oct-07
Dec-07
Feb-08
Apr-08
Jun-08
Aug-08
Oct-08
Dec-08
AVERAGE
UCL
PR-QA RPD
101
71
60
58
55
49
48
37
35
27
26
25
24
23

Chart A-40: Silver Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

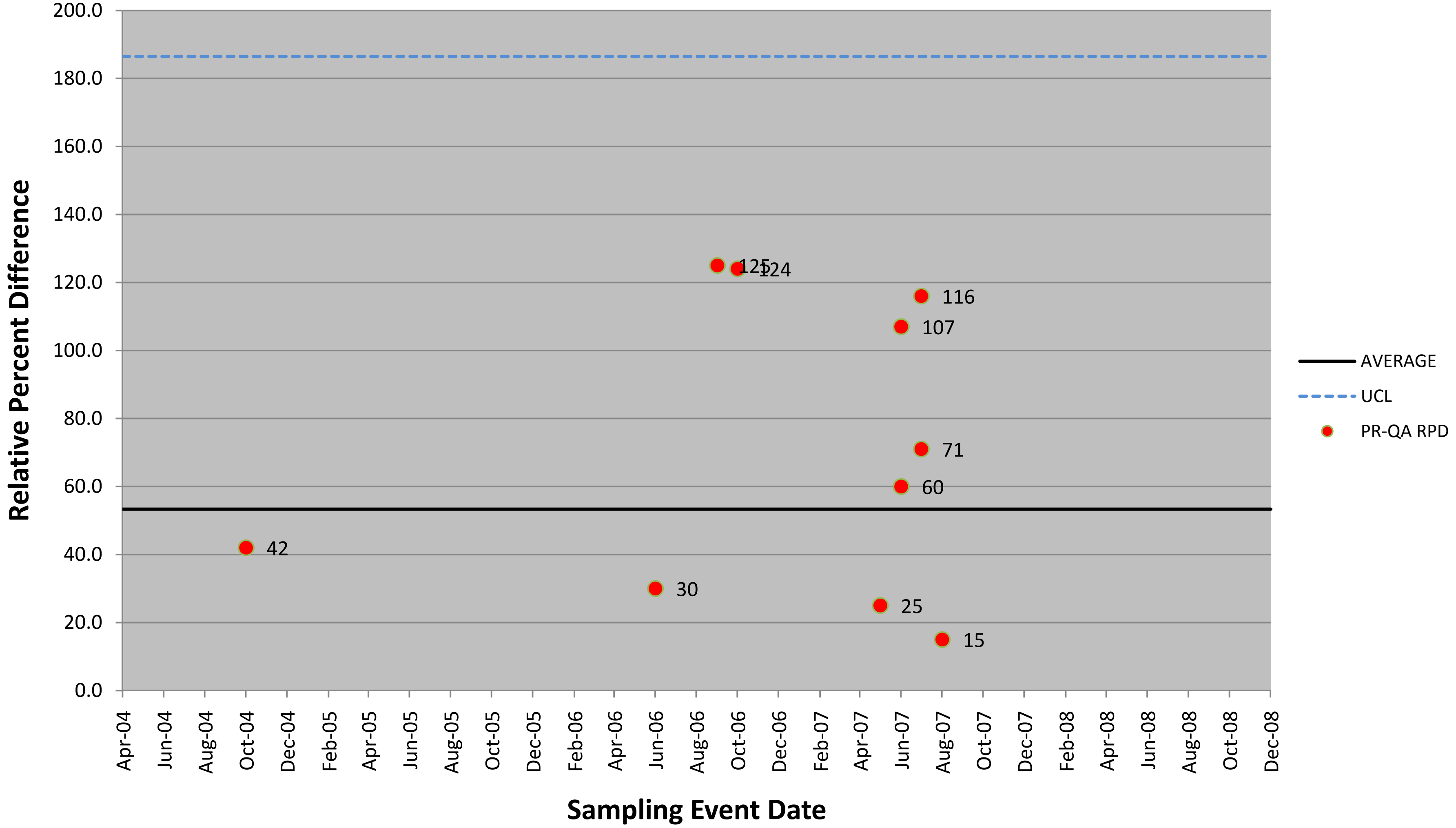


Chart A-41: Sodium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

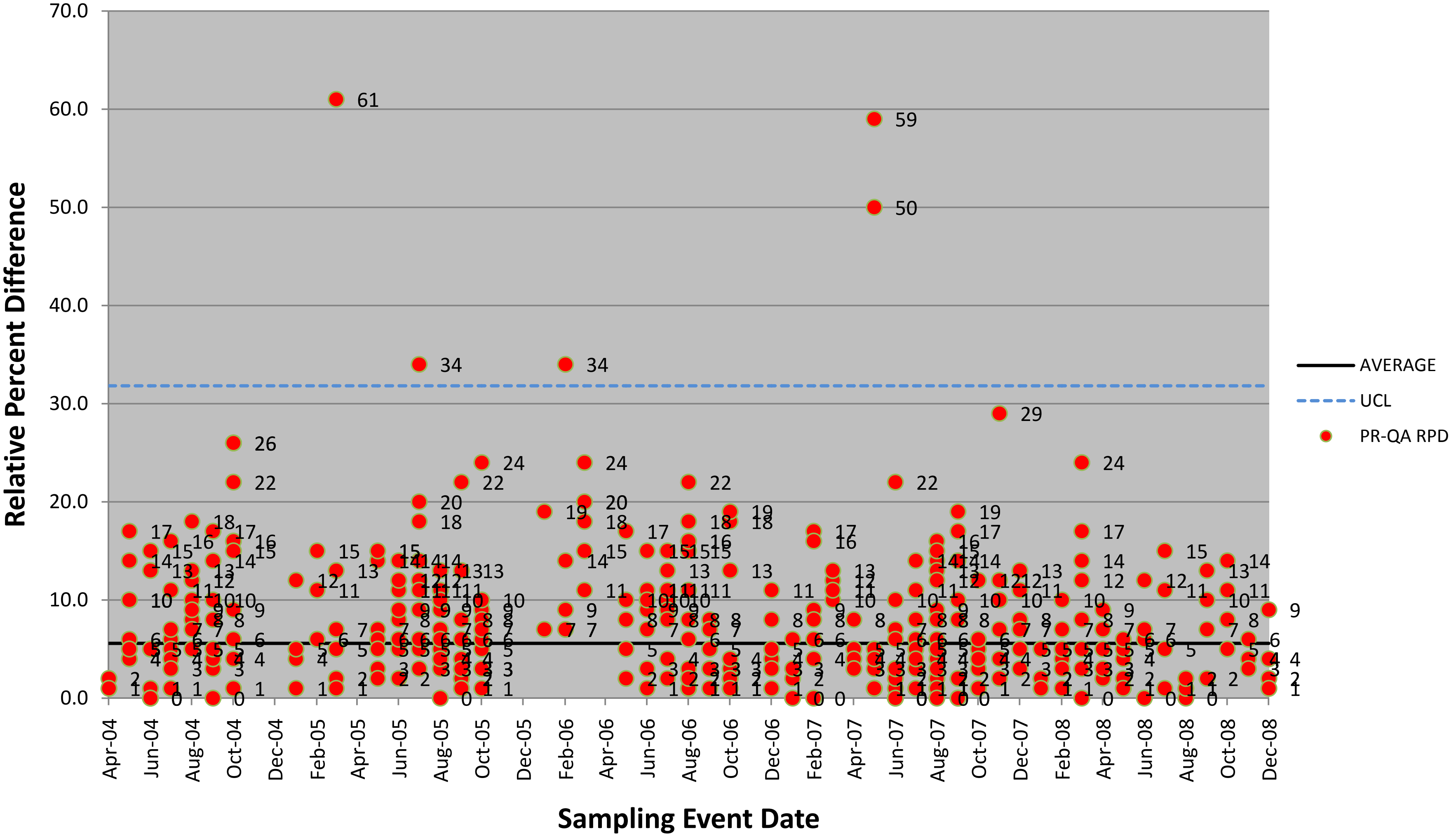


Chart A-42: Thallium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

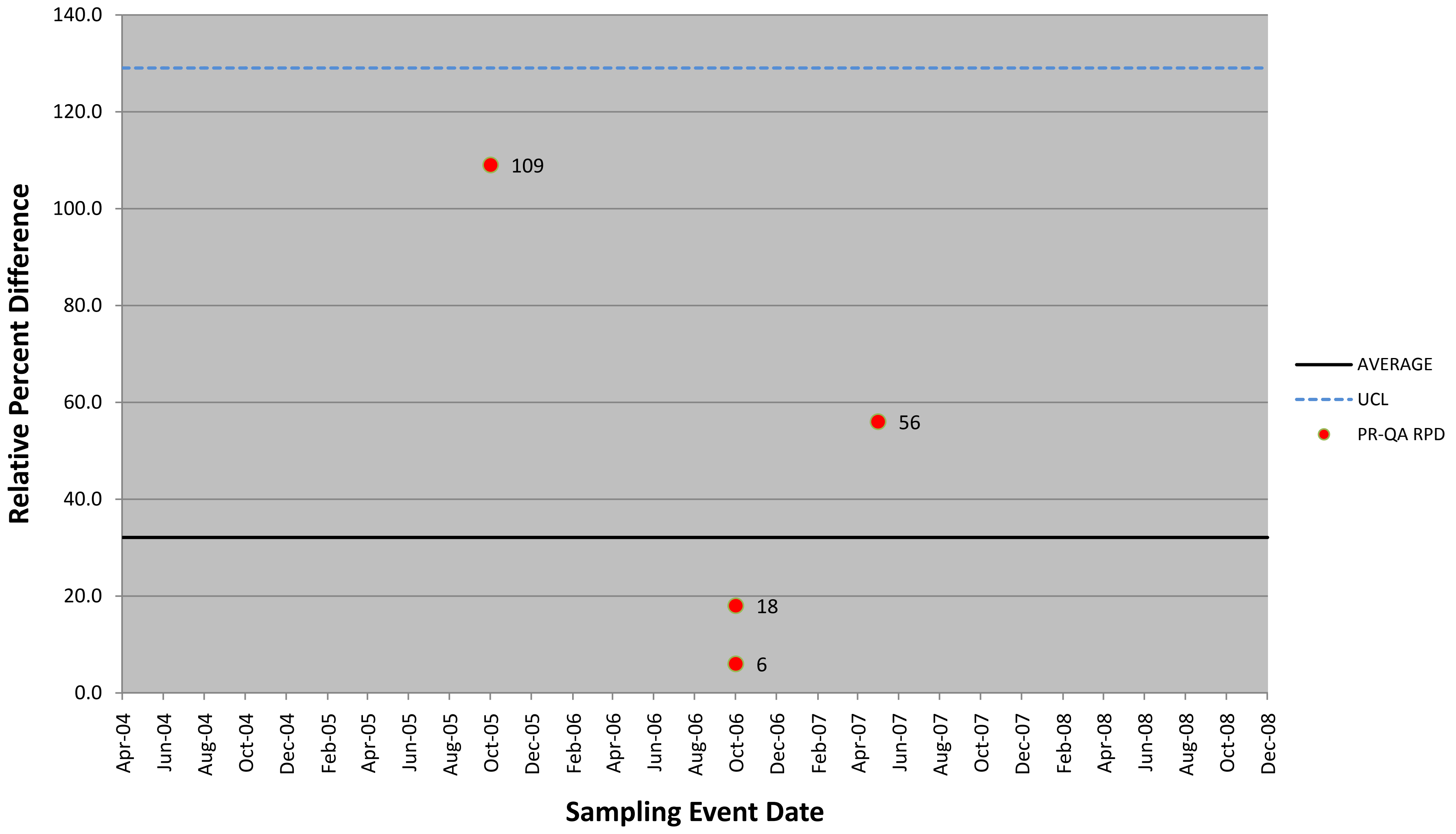


Chart A-43: Vanadium Control Chart for April 2004-December 2008 Surface Water (Except Seeps)

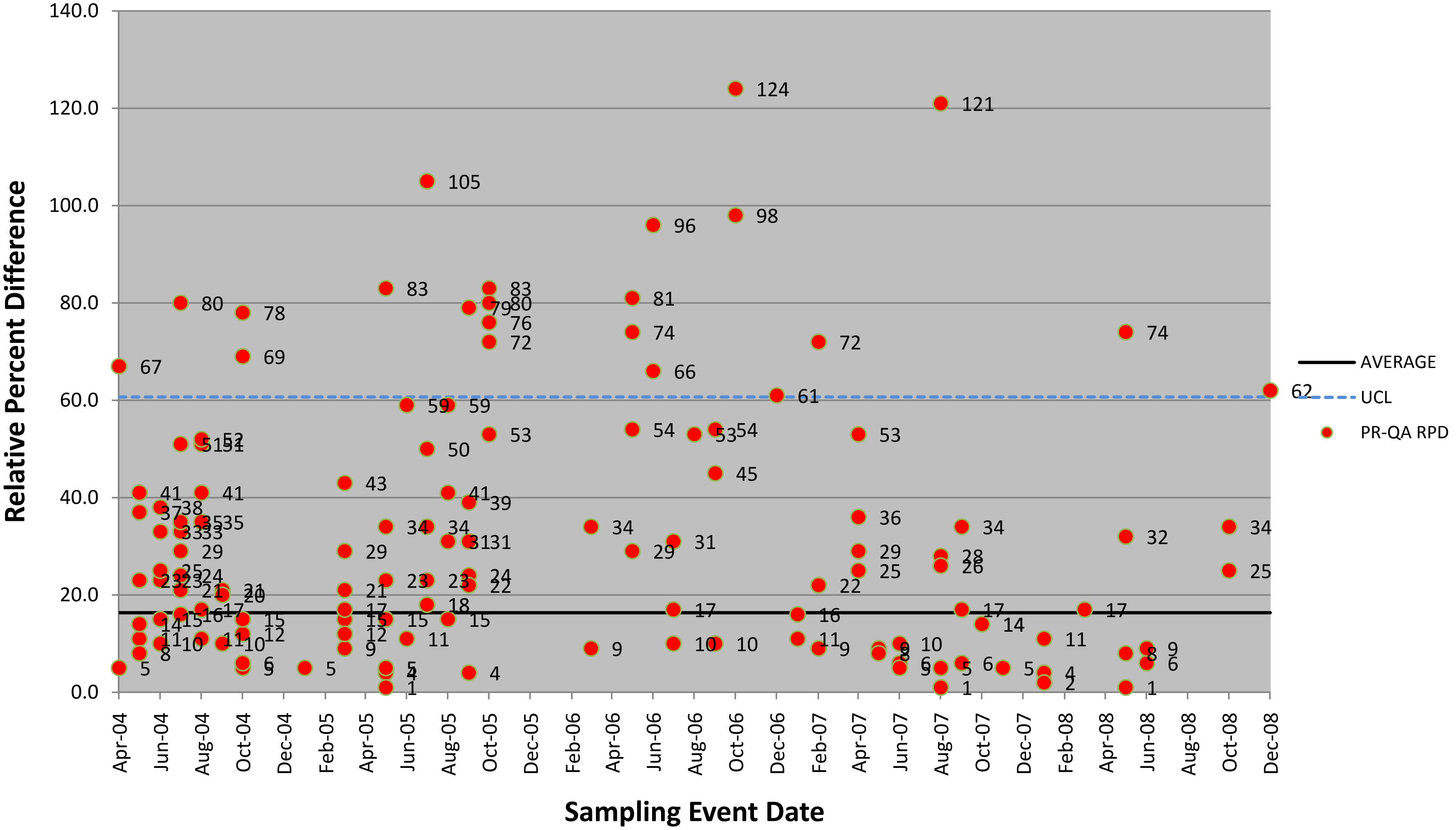


Chart A-44: Zinc Control Chart for April 2004-December 2008
Surface Water (Except Seeps)

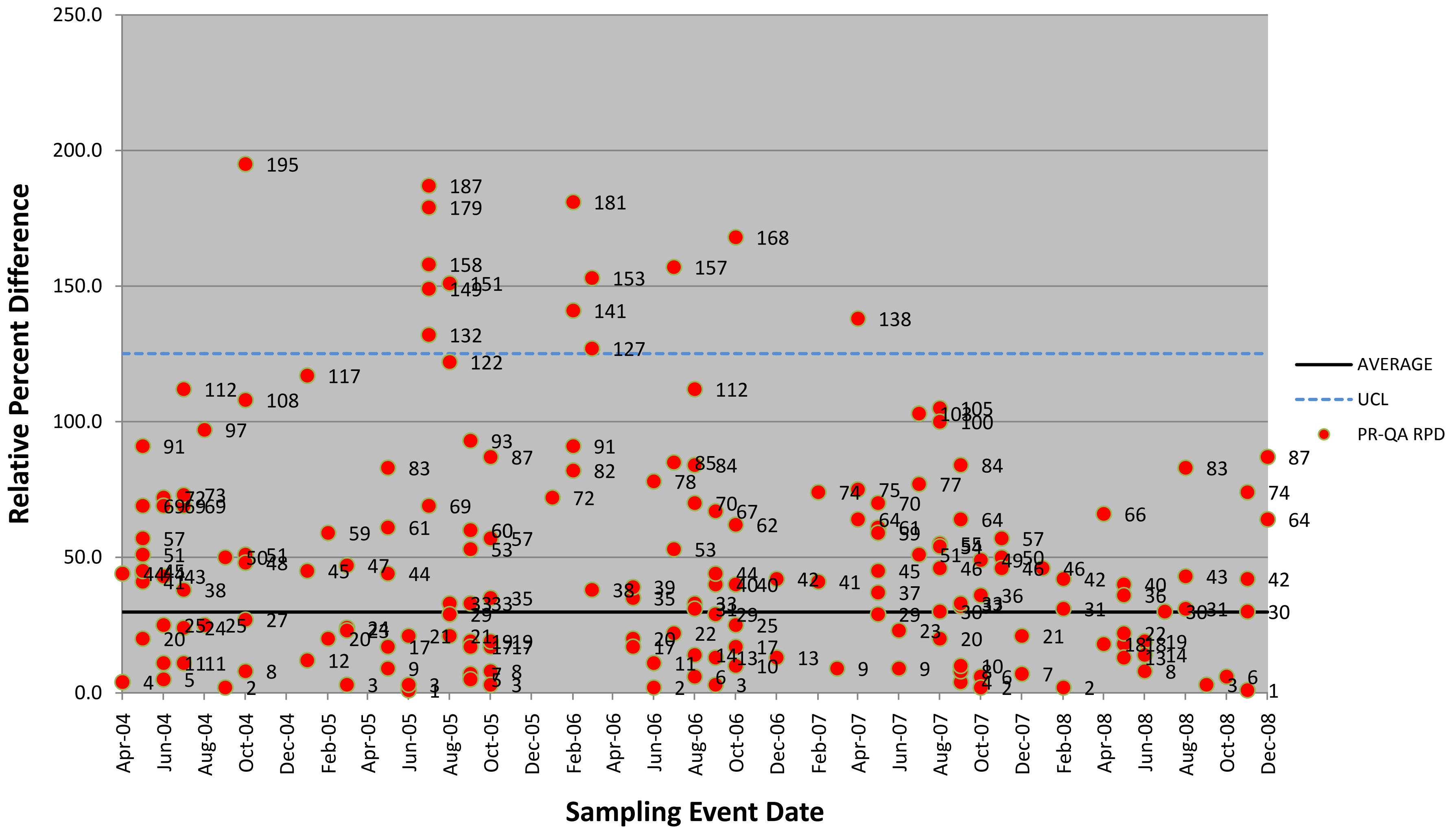


Chart A-45: Total Acidity Control Chart for May 2004-November 2008 Surface Water (Seeps)

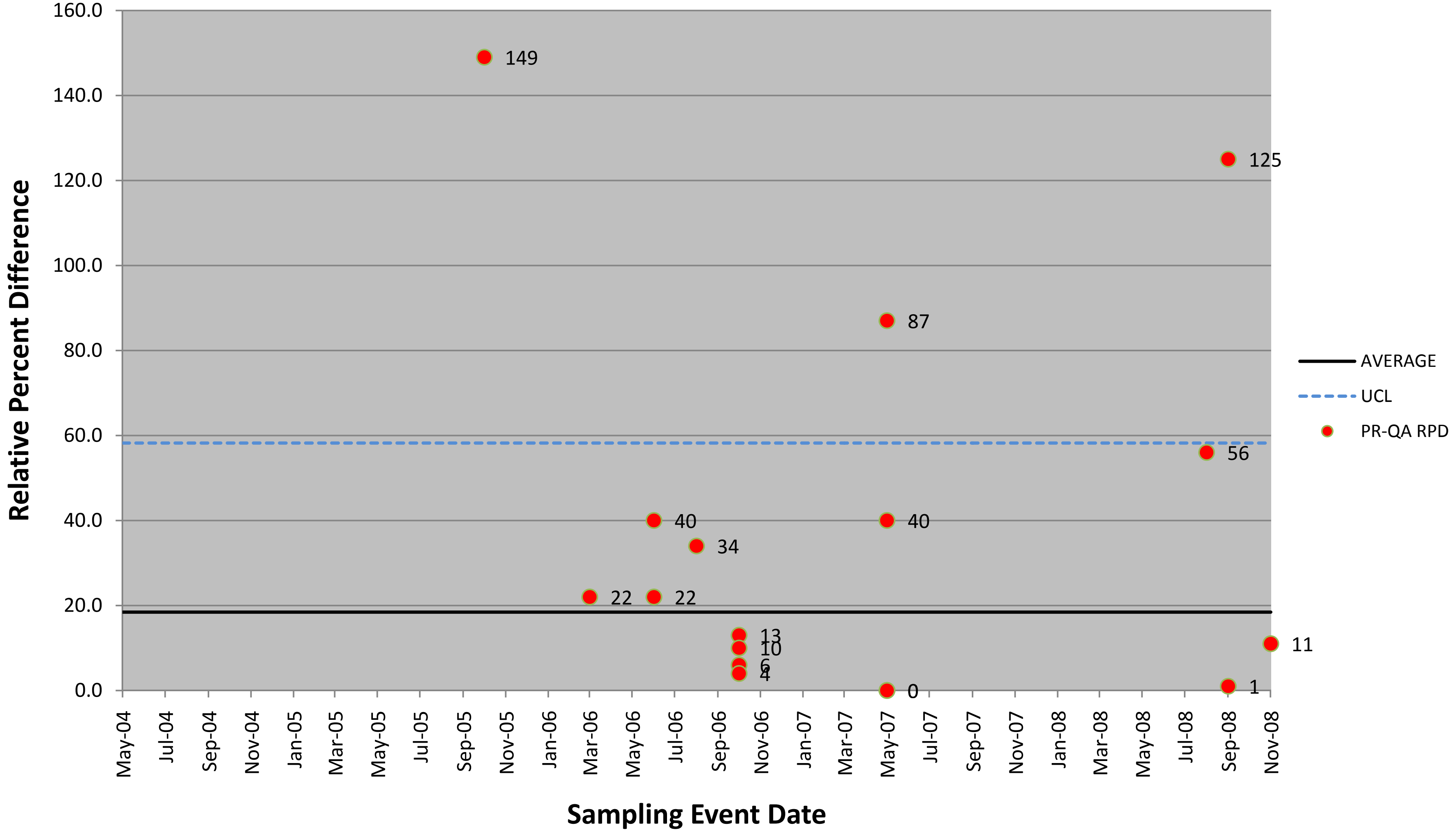


Chart A-46: Total Alkalinity Control Chart for May 2004-November 2008 Surface Water (Seeps)

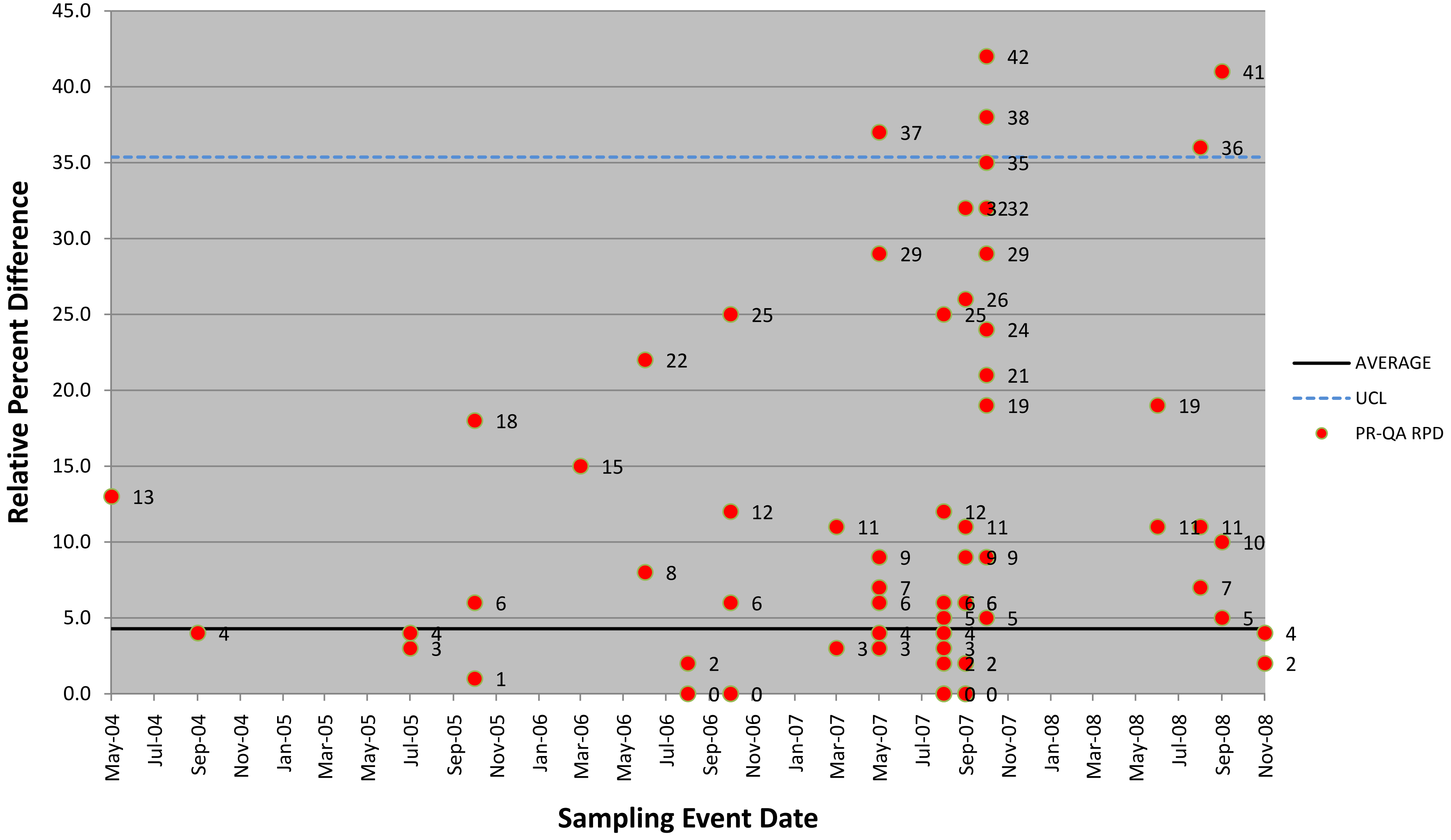


Chart A-47: Chloride Control Chart for May 2004-November 2008 Surface Water (Seeps)

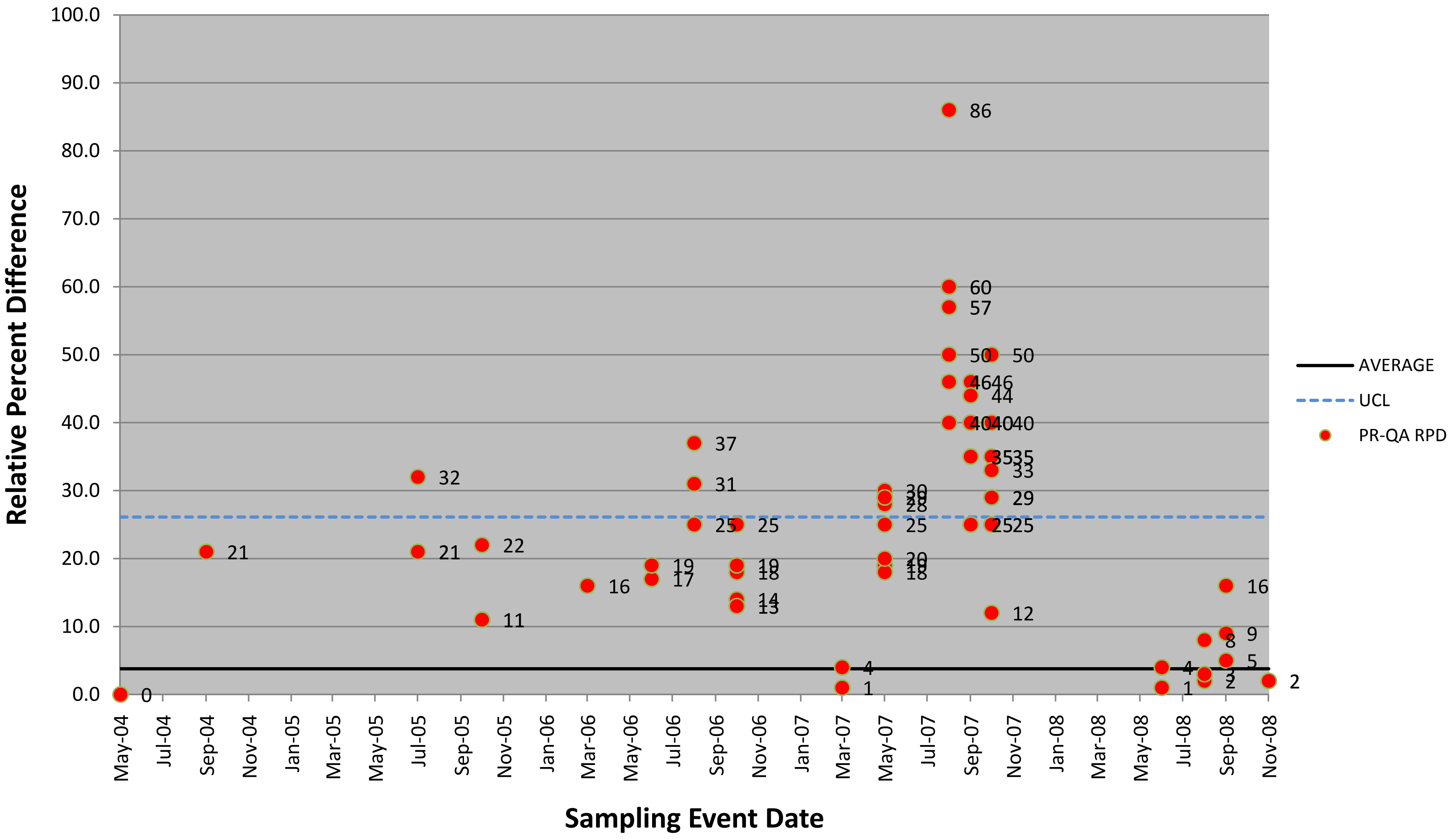
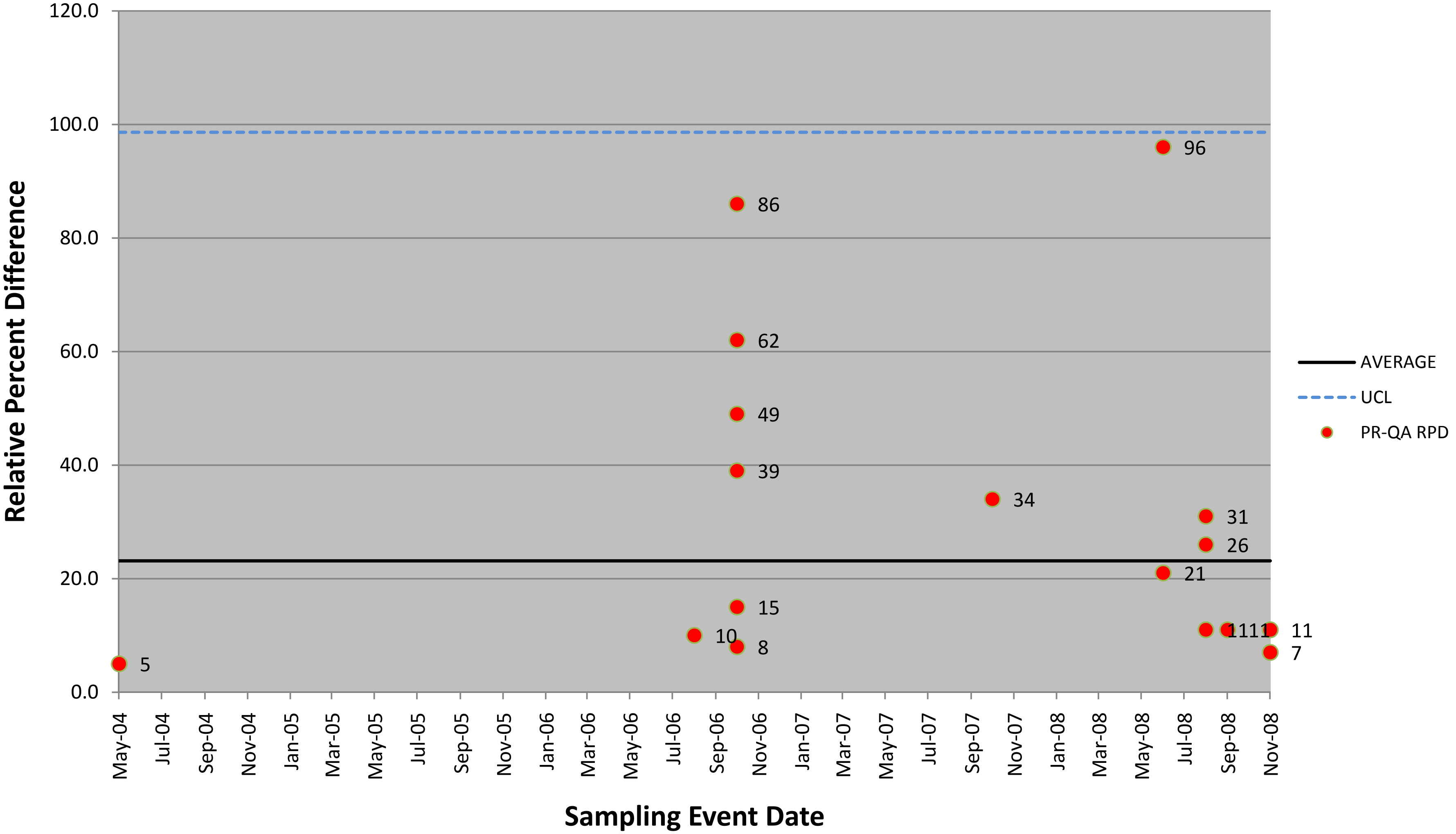


Chart A-48: Fluoride Control Chart for May 2004-November 2008 Surface Water (Seeps)



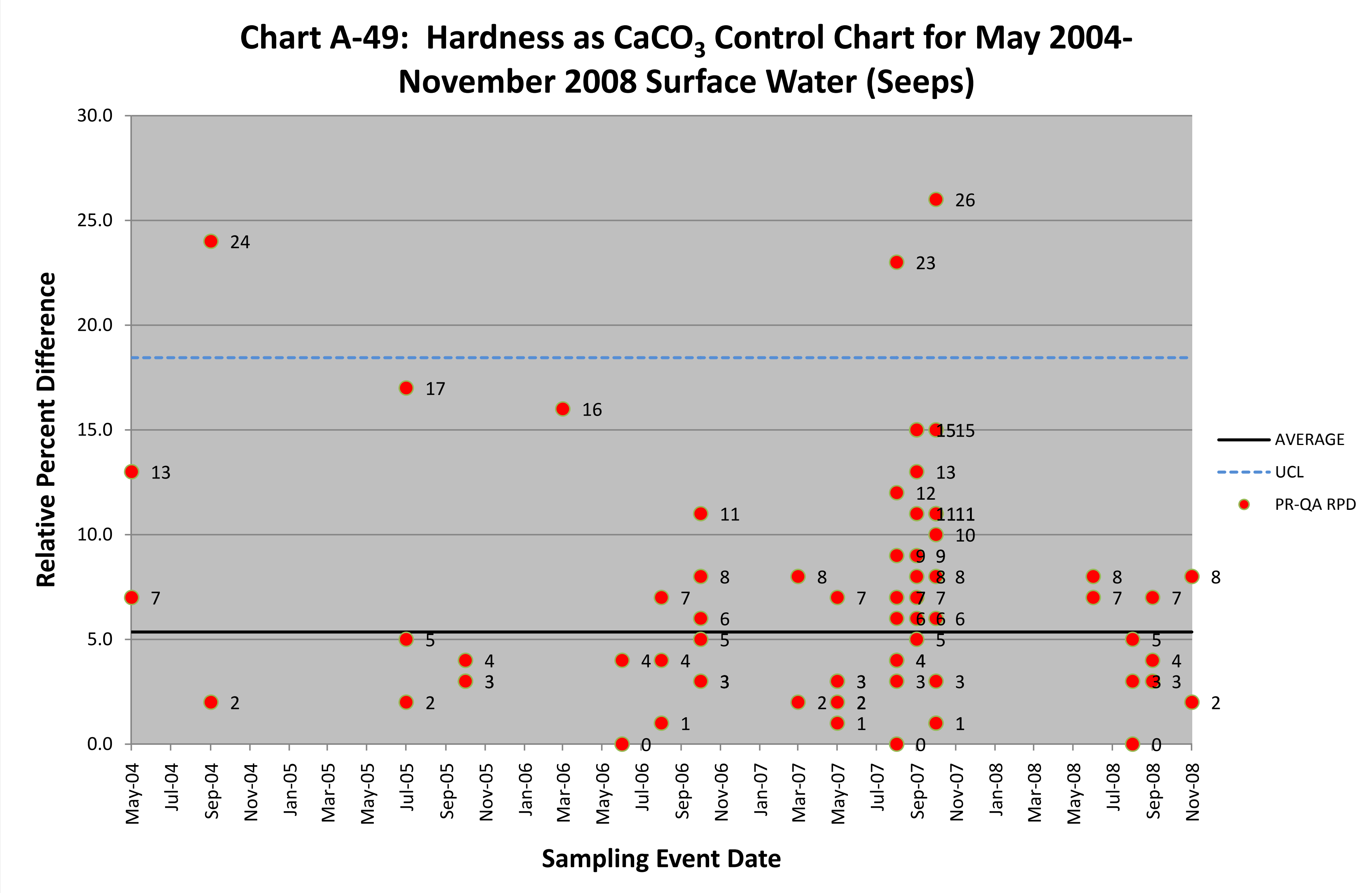
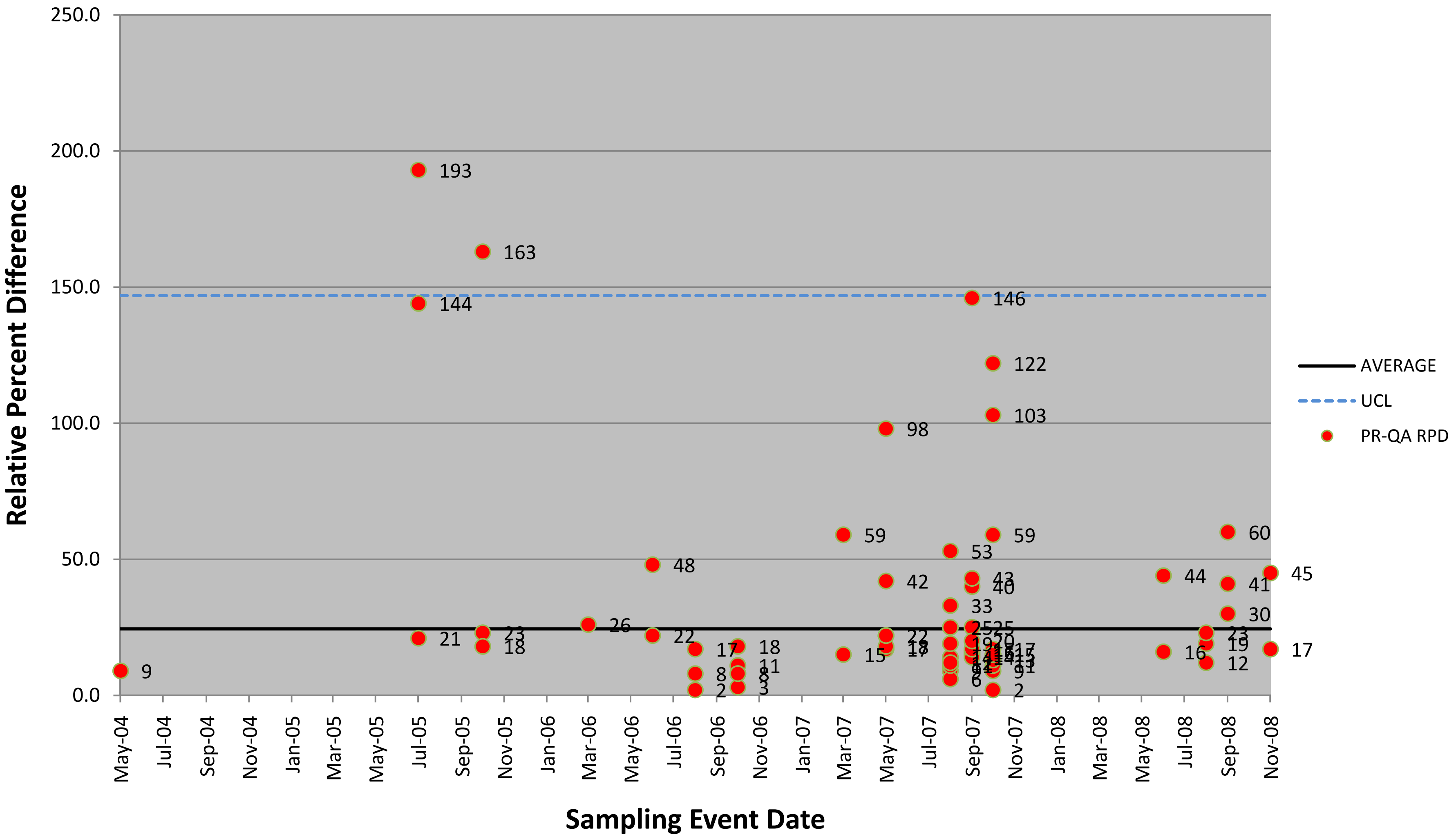


Chart A-49: Hardness as $CaCO_3$ Control Chart for May 2004-November 2008 Surface Water (Seeps)
Relative Percent Difference
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Sampling Event Date
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
AVERAGE
UCL
PR-QA RPD
13
7
24
2
17
5
2
4
3
16
4
0
7
4
1
11
8
6
5
3
8
2
7
3
2
1
26
23
15
15
13
12
11
11
10
9
9
8
8
7
7
6
6
5
4
3
3
0
1
8
7
5
3
0
7
4
3
8
2

Chart A-50: Nitrogen: Nitrate-Nitrite Control Chart for May 2004-November 2008 Surface Water (Seeps)



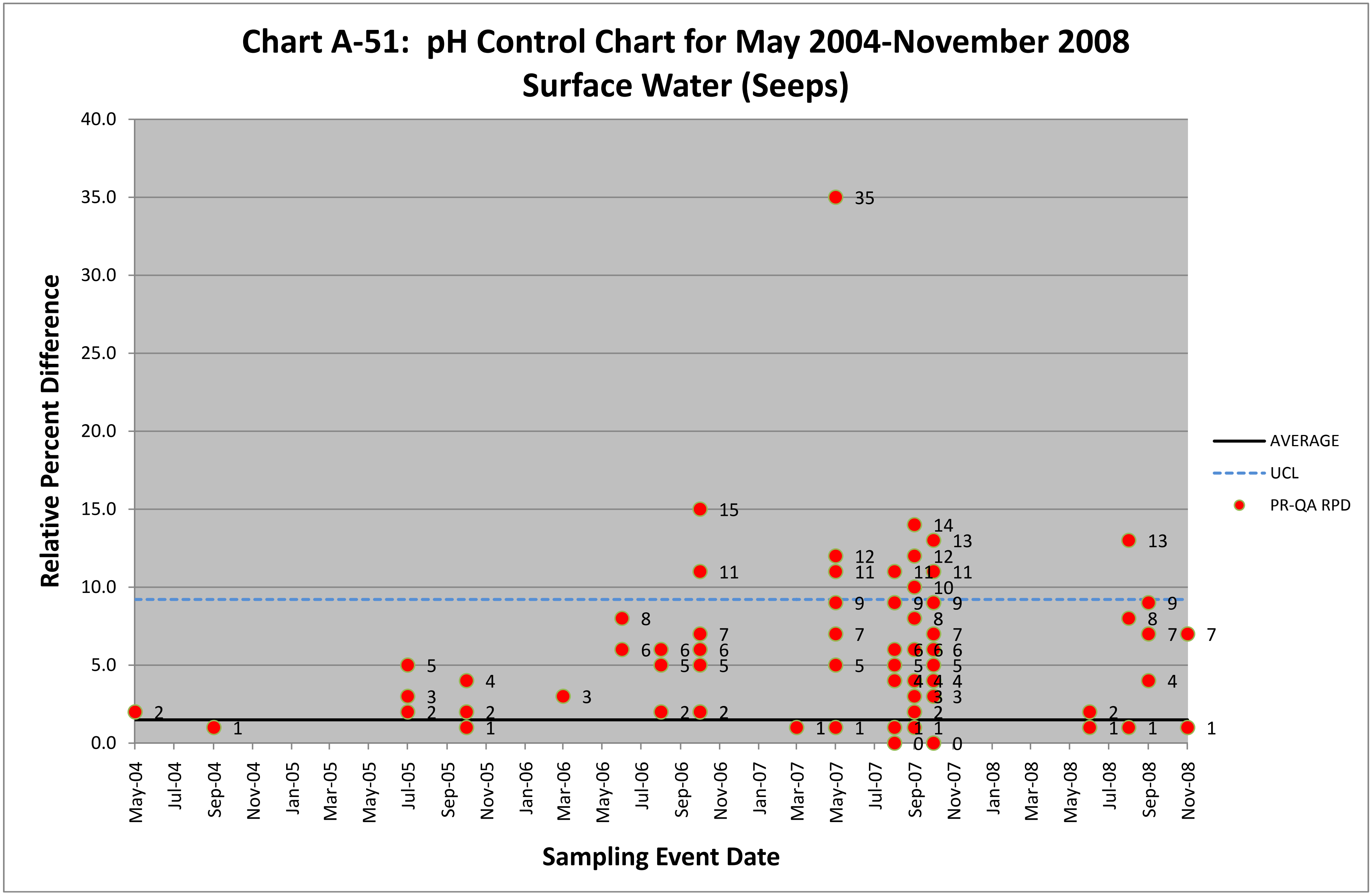


Chart A-51: pH Control Chart for May 2004-November 2008 Surface Water (Seeps)

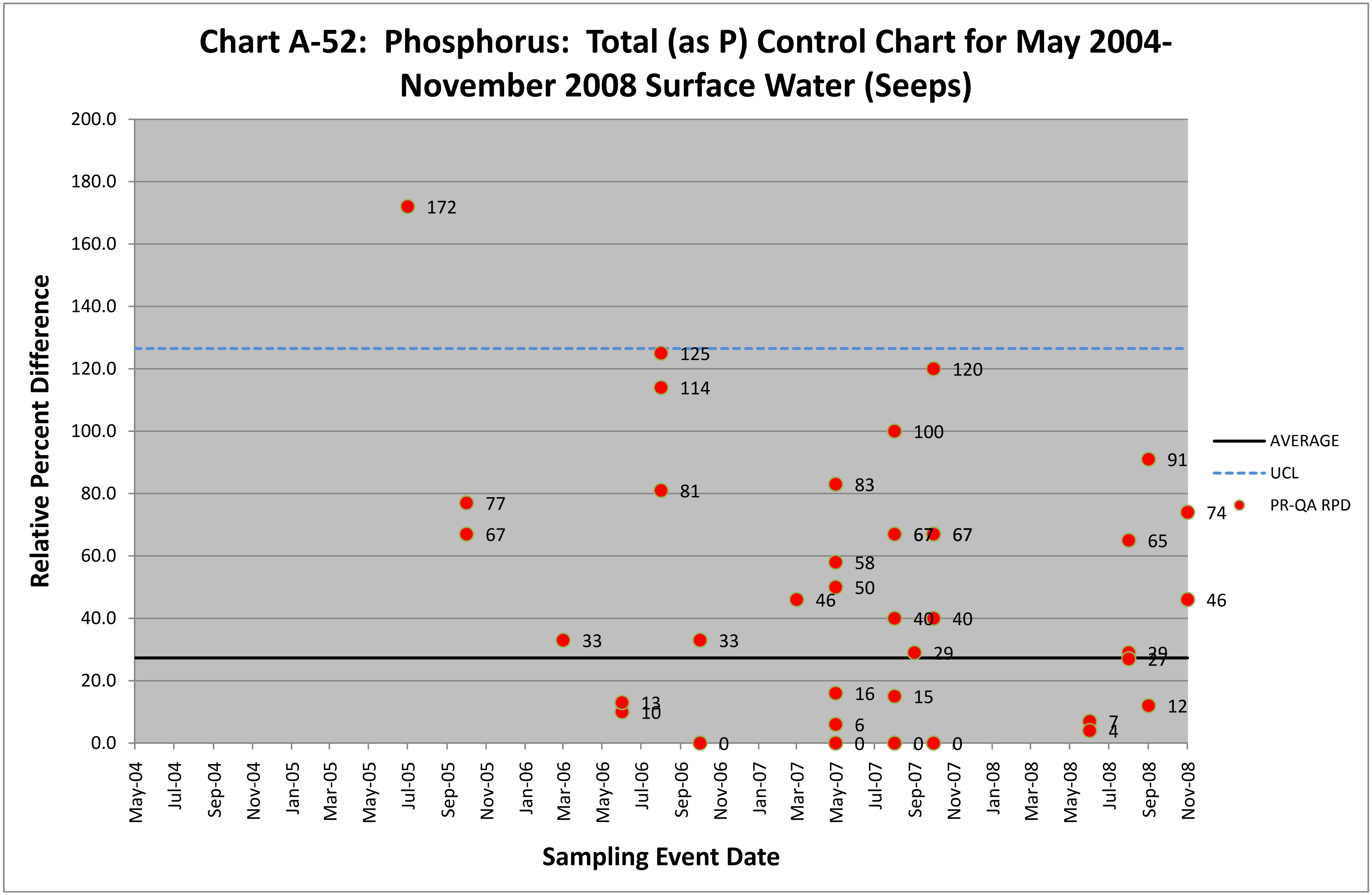


Chart A-52: Phosphorus: Total (as P) Control Chart for May 2004-November 2008 Surface Water (Seeps)

Chart A-53: Specific Conductance Control Chart for May 2004-November 2008 Surface Water (Seeps)

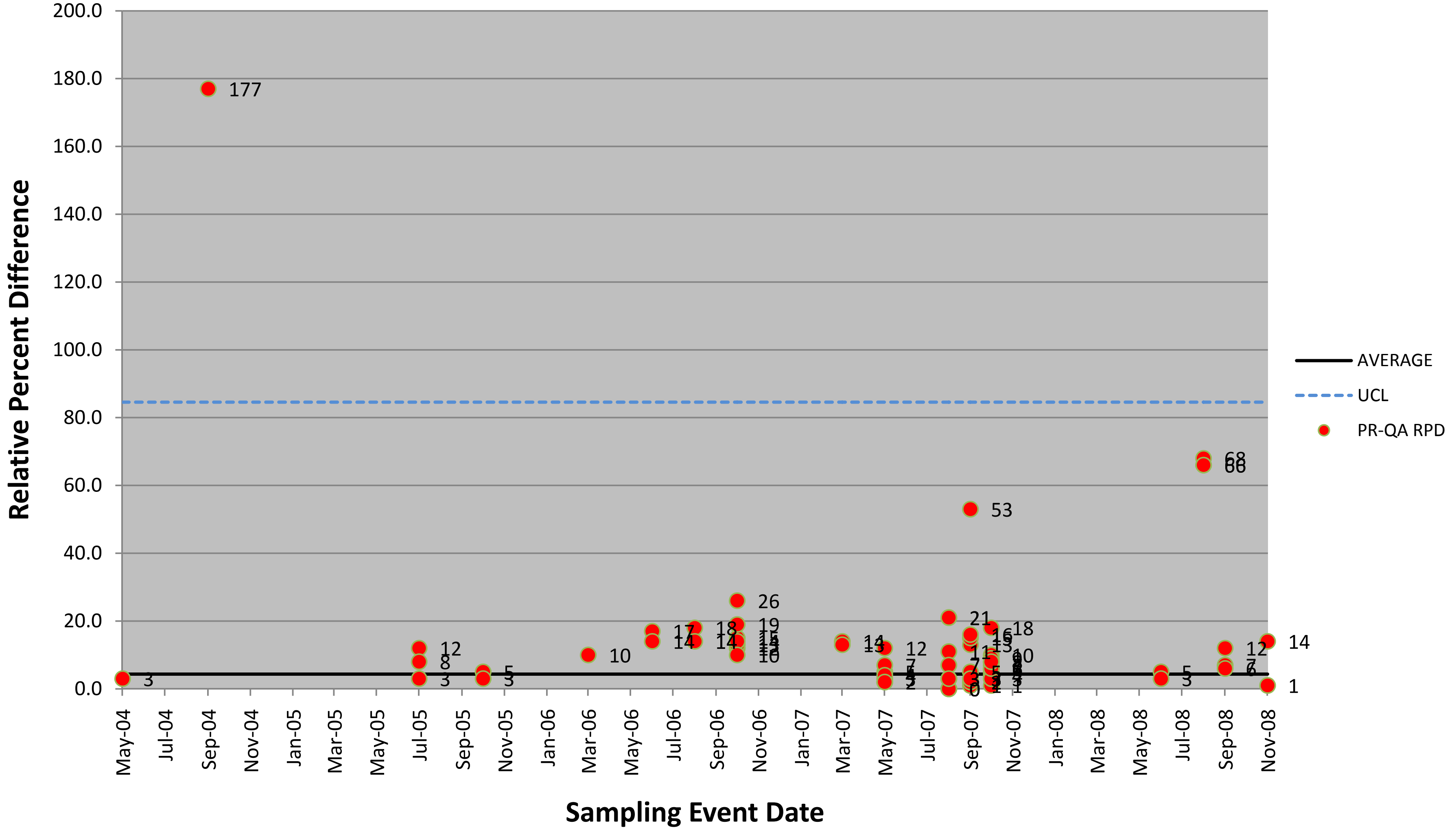


Chart A-54: Sulfate Control Chart for May 2004-November 2008 Surface Water (Seeps)

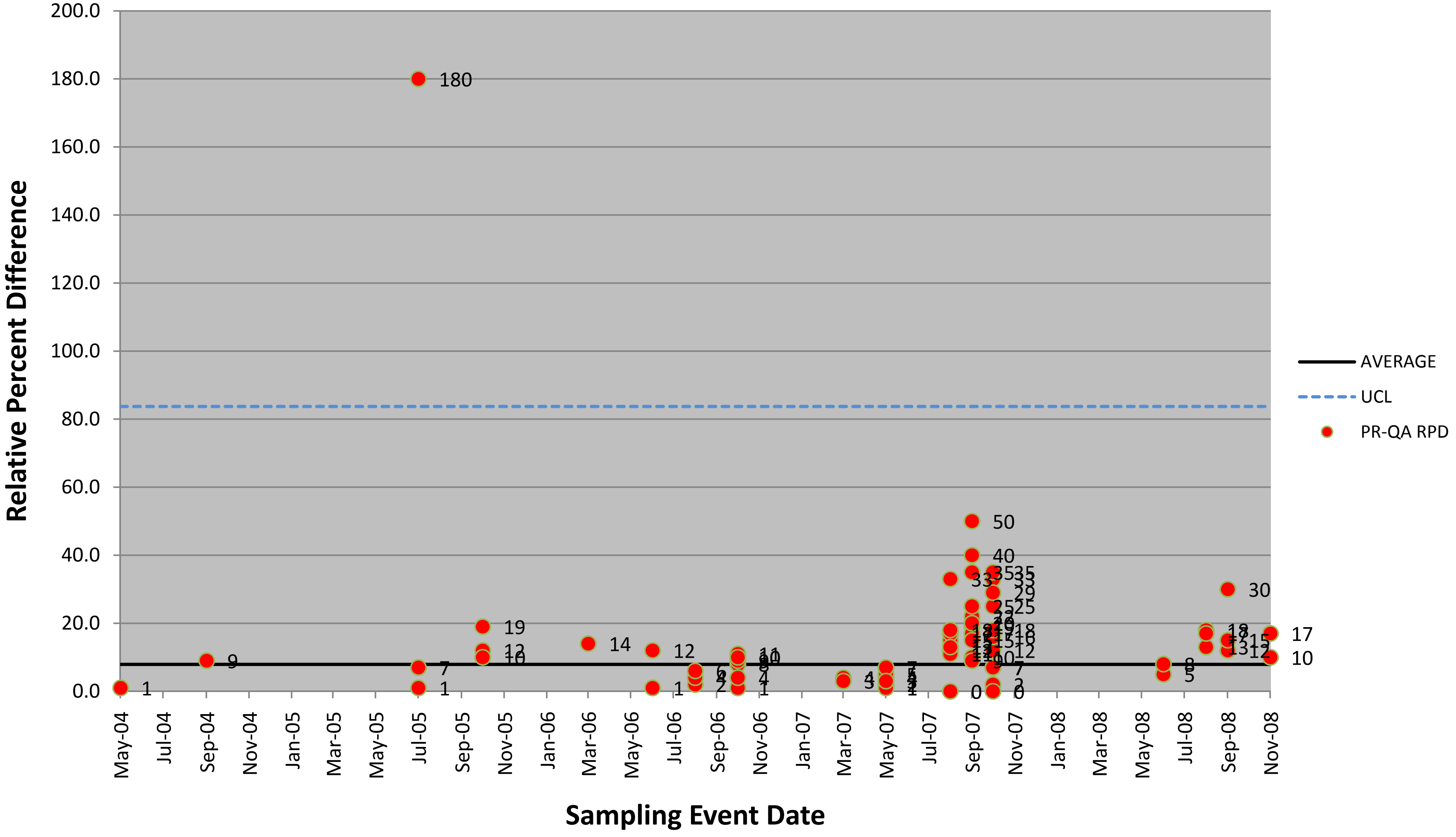


Chart A-55: Total Dissolved Solids Control Chart for May 2004-November 2008 Surface Water (Seeps)

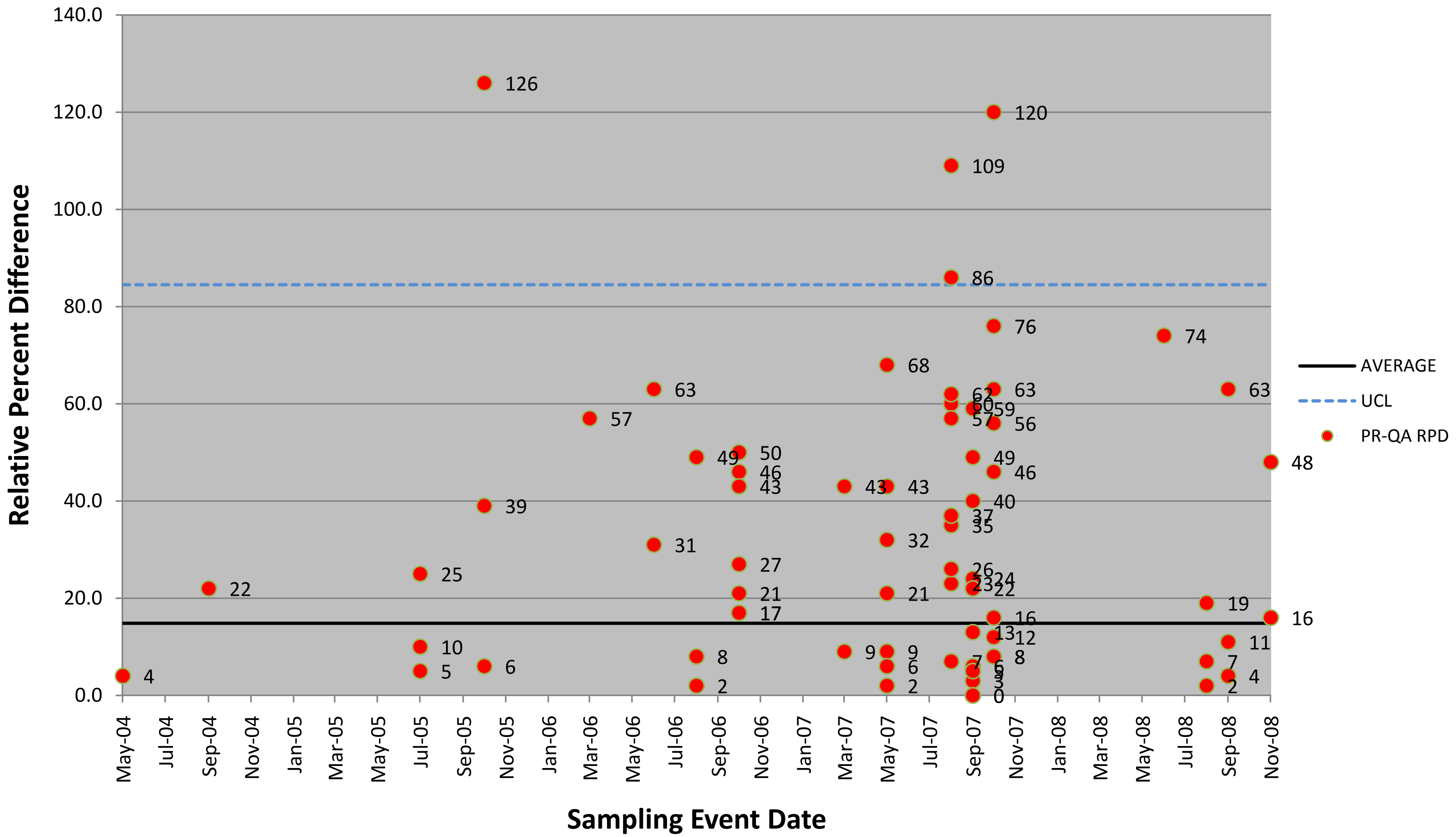
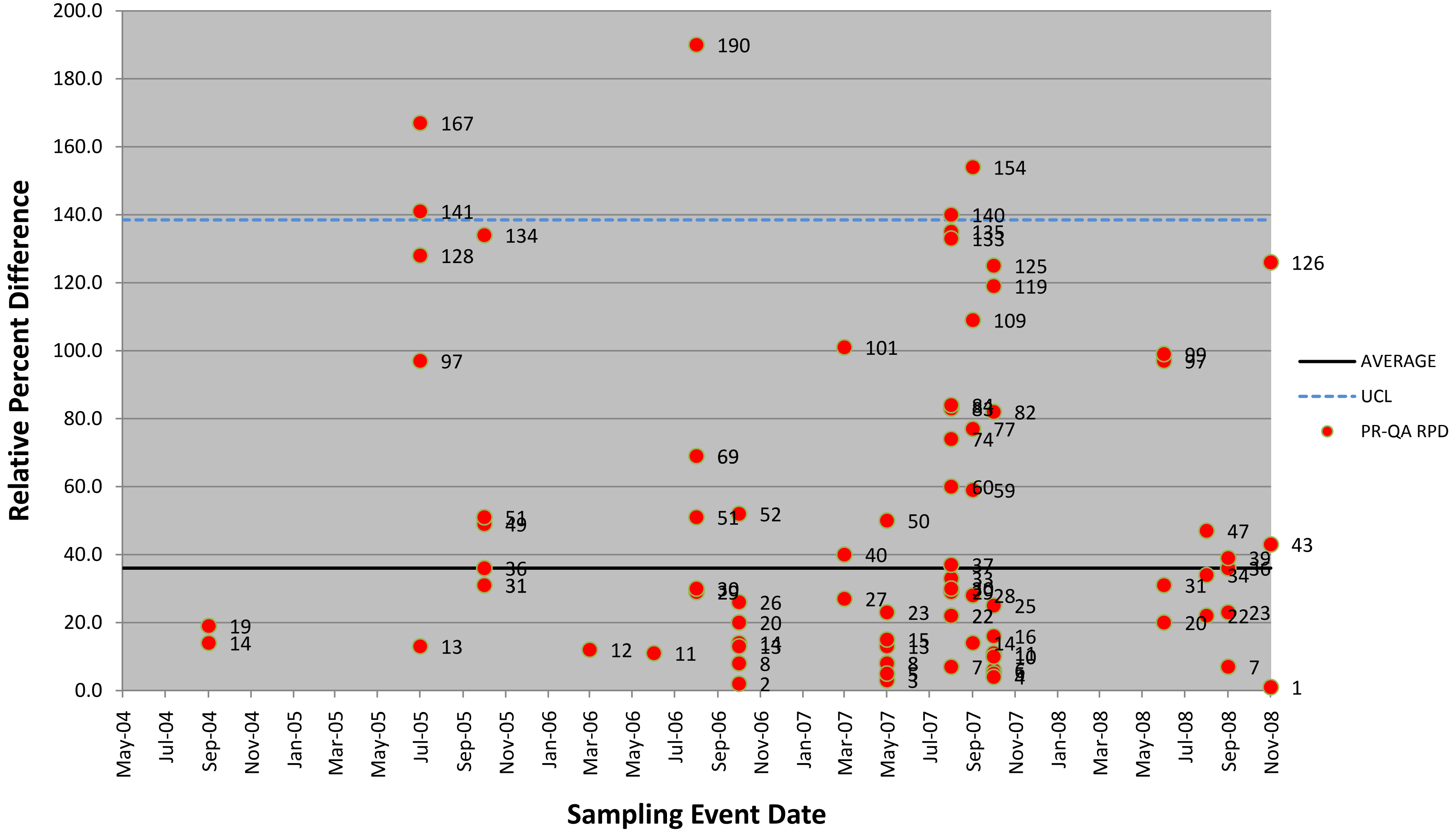


Chart A-56: Aluminum Control Chart for May 2004-November 2008 Surface Water (Seeps)



Sampling Event Date

Chart A-57: Antimony Control Chart for May 2004-November 2008
Surface Water (Seeps)

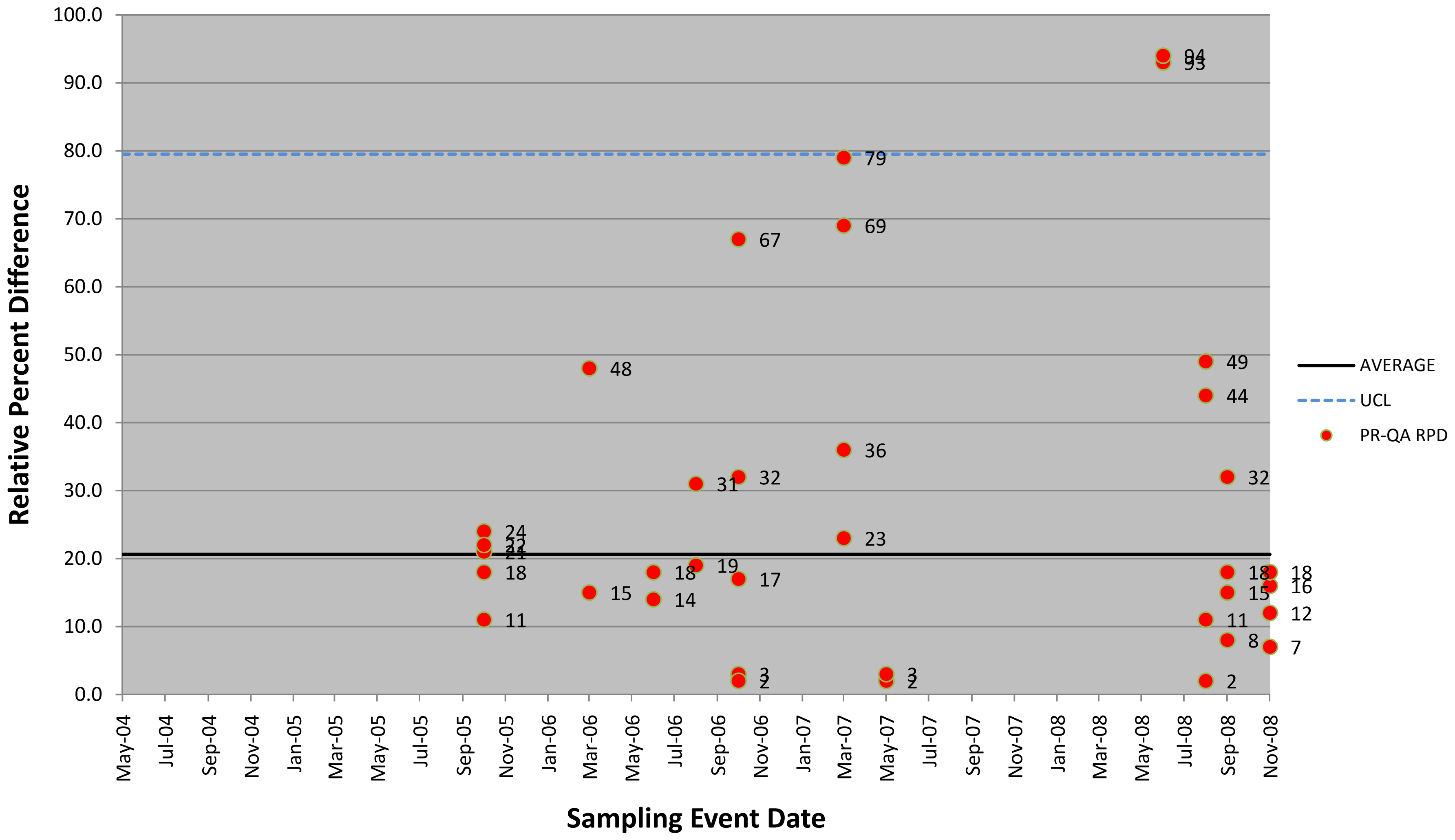


Chart A-58: Arsenic Control Chart for May 2004-November 2008 Surface Water (Seeps)

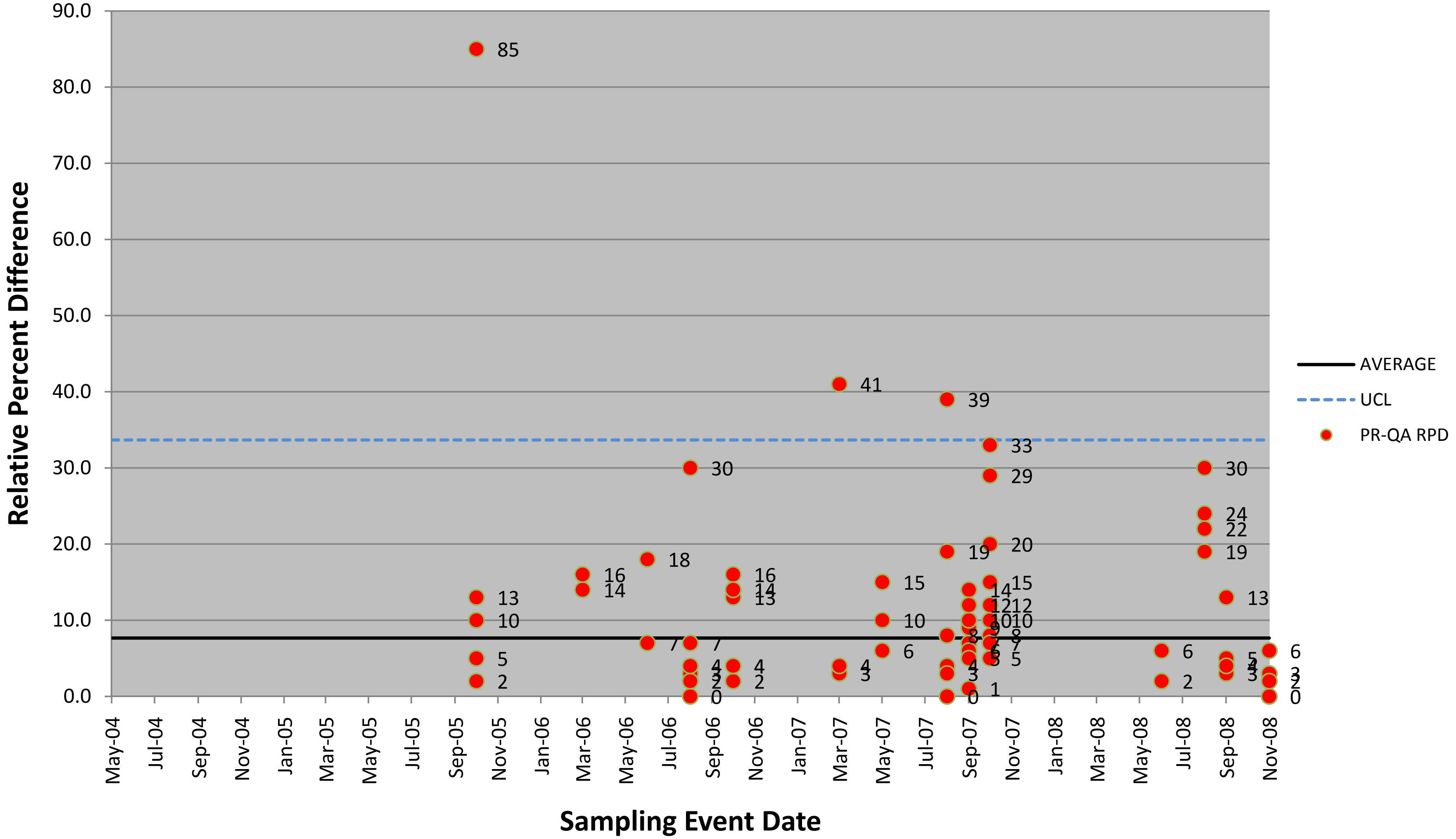
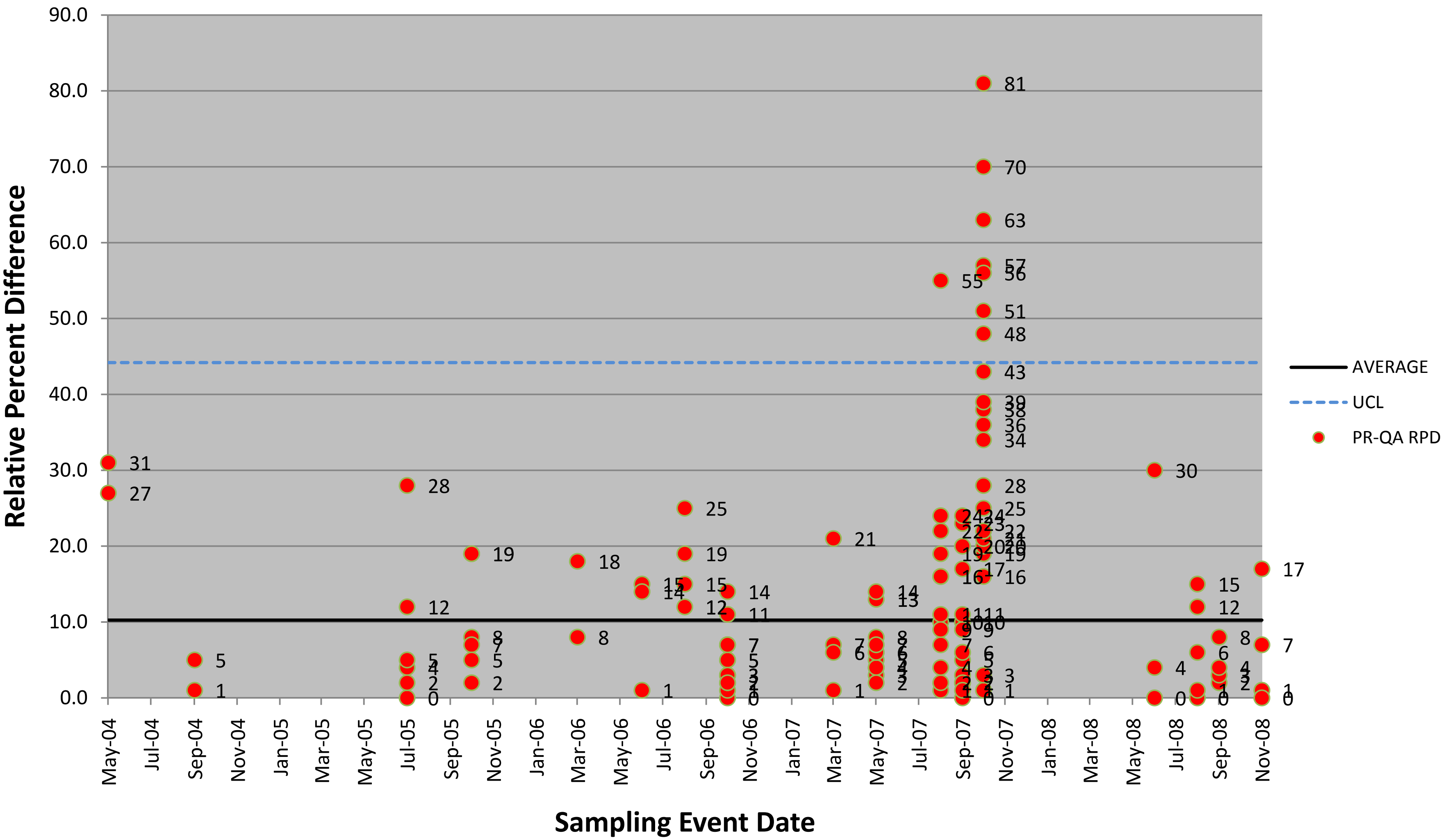


Chart A-59: Barium Control Chart for May 2004-November 2008 Surface Water (Seeps)



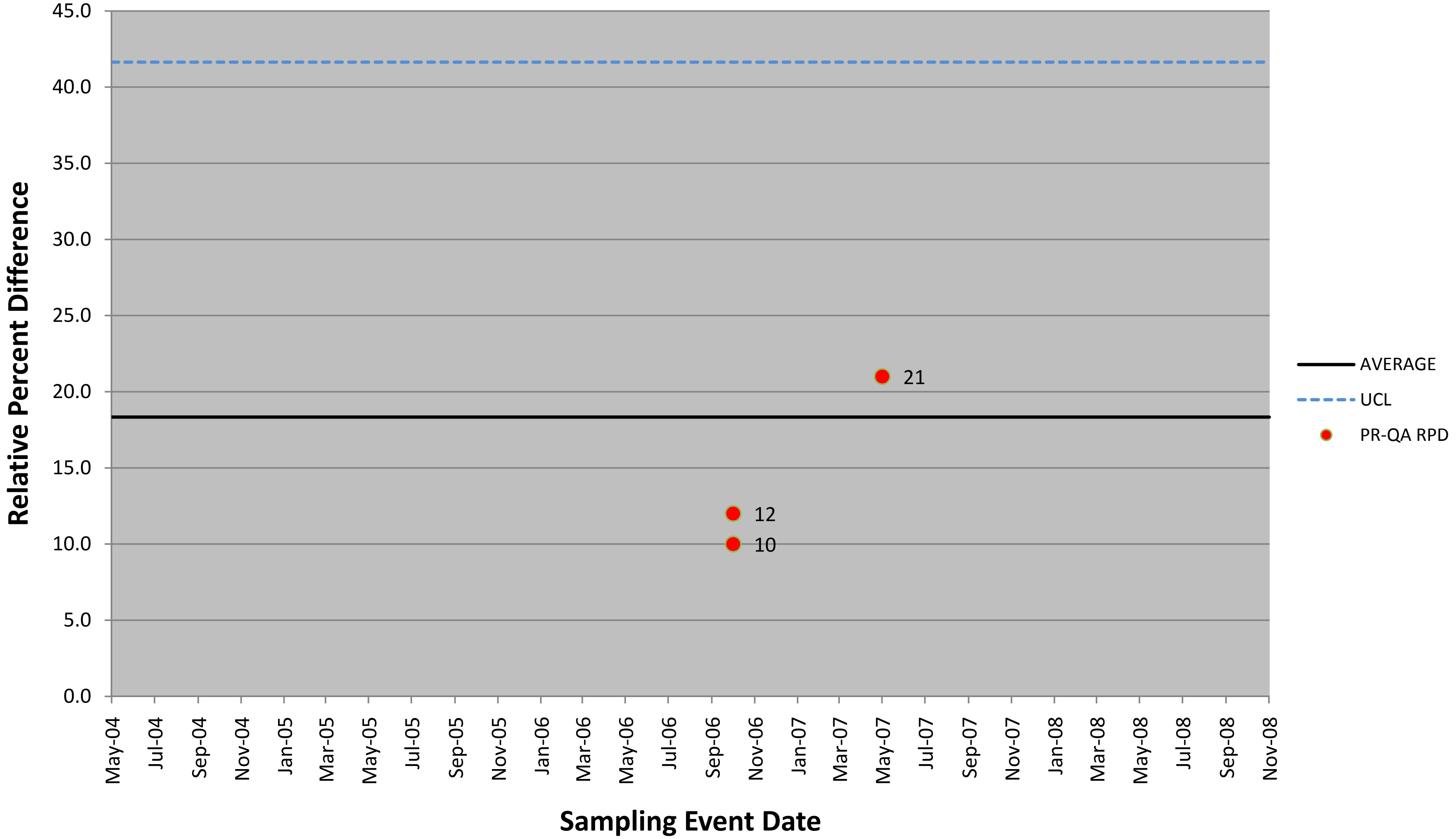


Chart A-60: Beryllium Control Chart for May 2004-November 2008
Surface Water (Seeps)

Chart A-61: Boron Control Chart for May 2004-November 2008 Surface Water (Seeps)

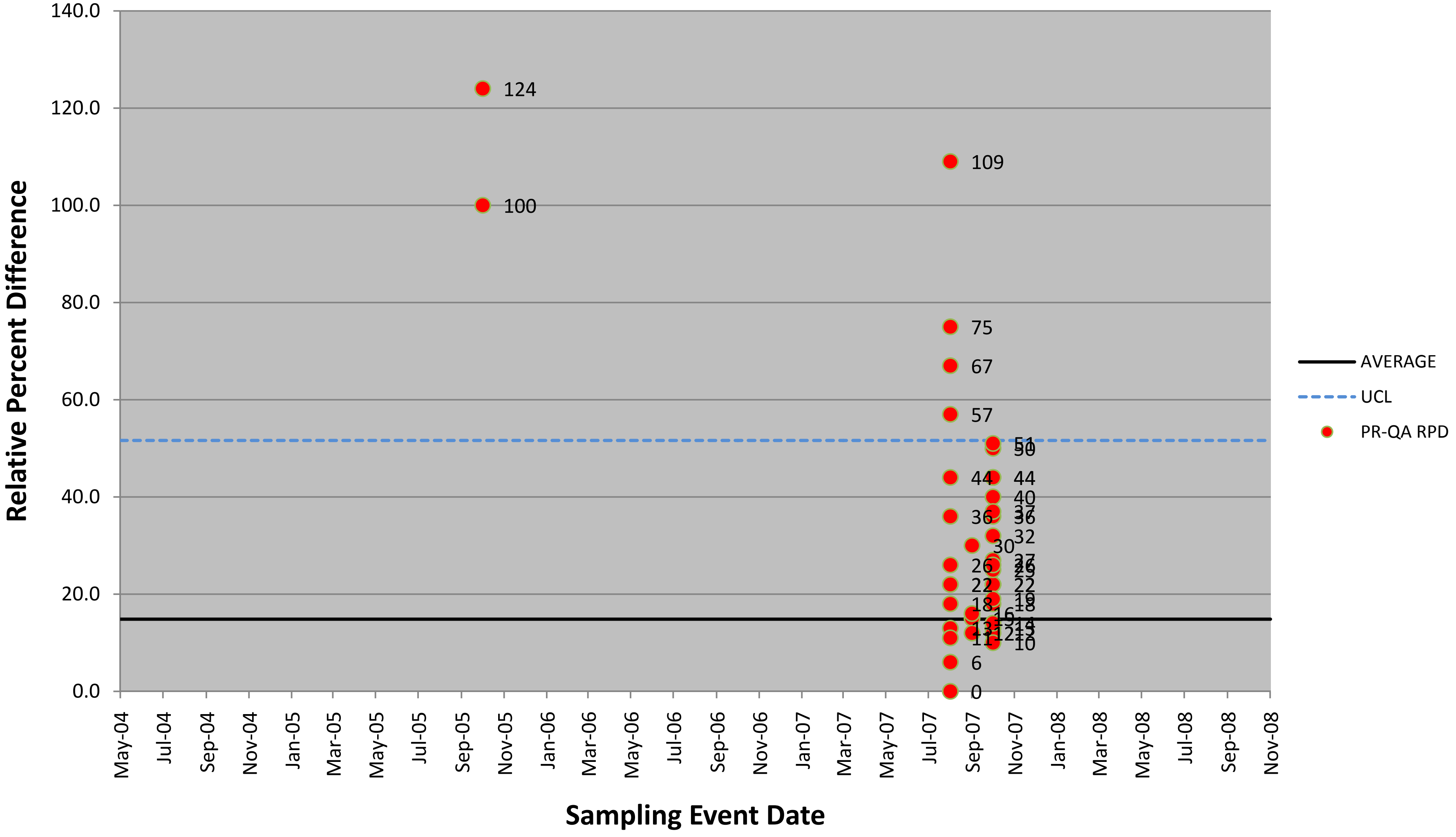
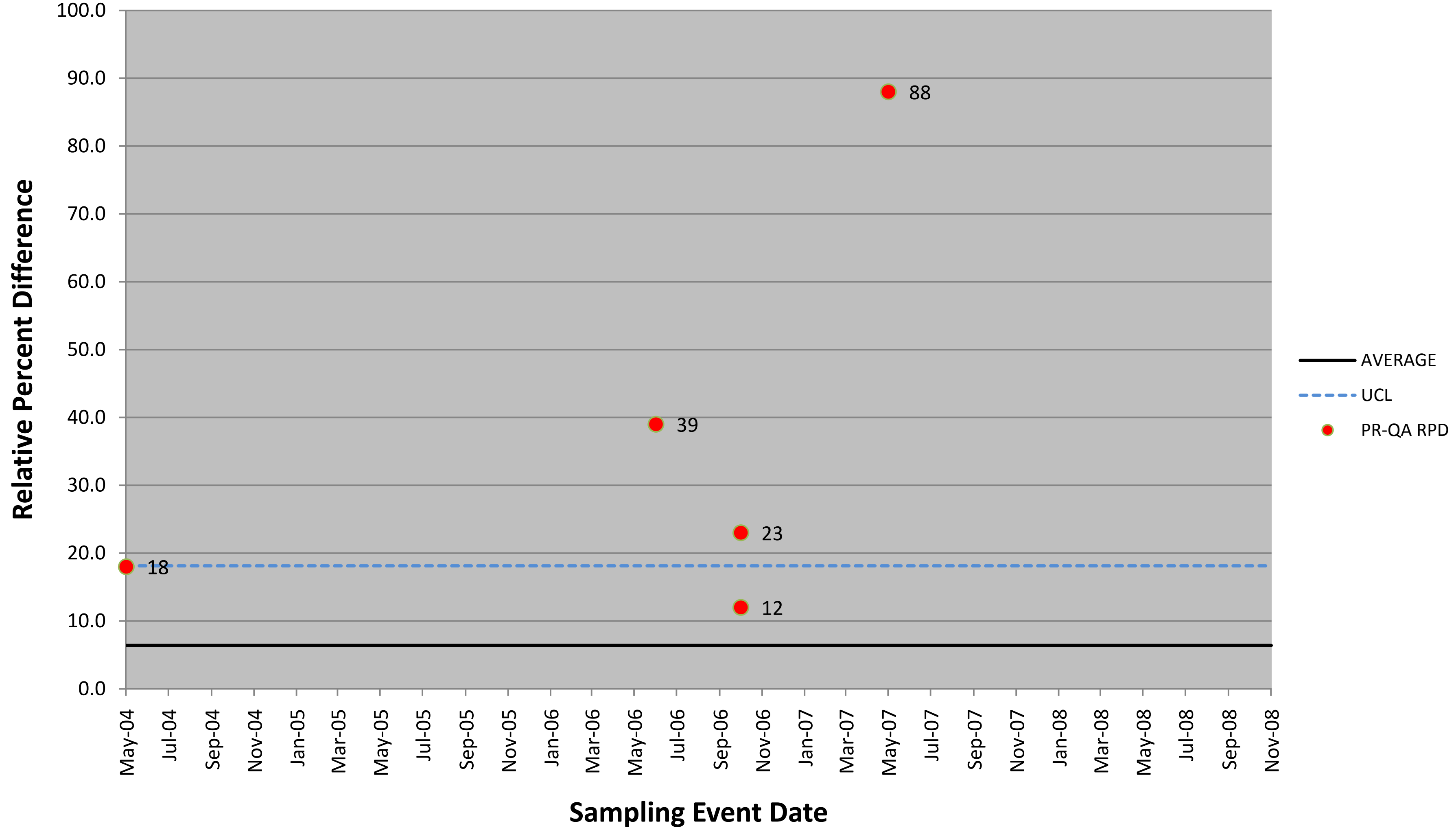


Chart A-62: Cadmium Control Chart for May 2004-November 2008 Surface Water (Seeps)



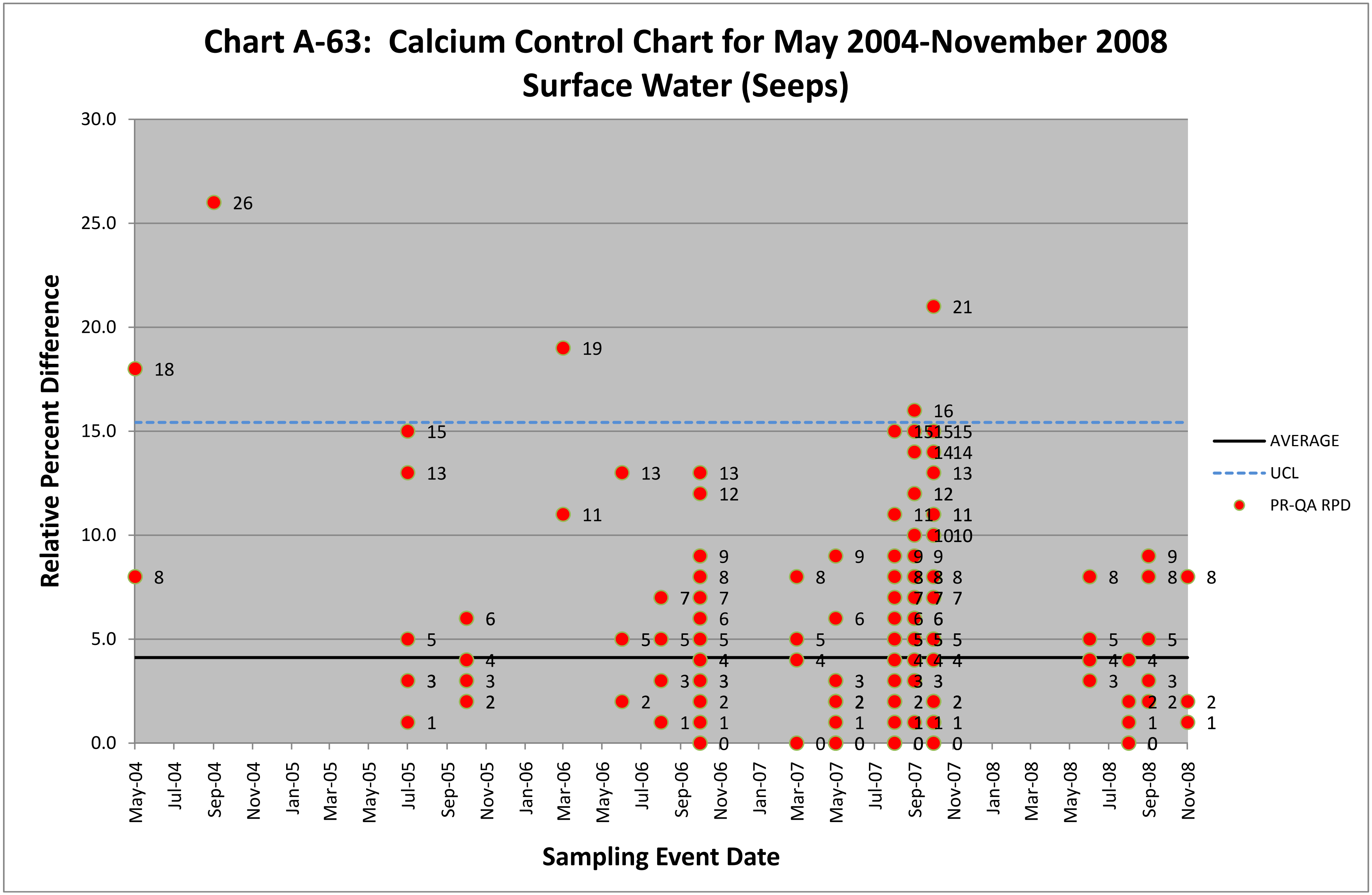


Chart A-63: Calcium Control Chart for May 2004-November 2008
Surface Water (Seeps)
Relative Percent Difference
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Sampling Event Date
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
AVERAGE
UCL
PR-QA RPD
18
8
26
15
13
5
3
1
6
4
3
2
19
11
13
5
2
7
5
3
1
13
12
9
8
7
6
5
4
3
2
1
0
8
5
4
0
9
6
3
2
1
0
21
16
15
14
12
11
10
8
5
4
3
9
8
5
4
2
1
0

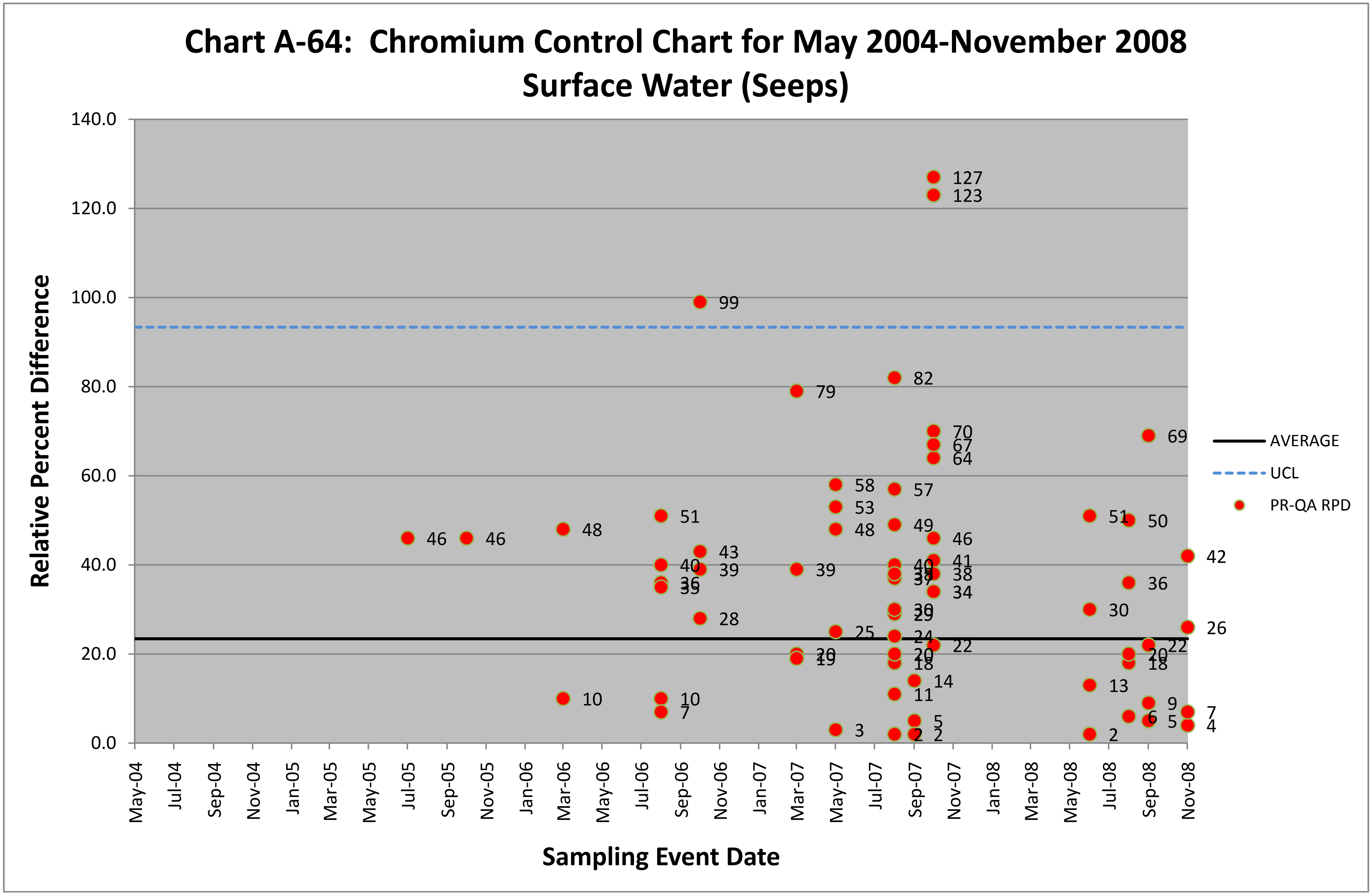


Chart A-64: Chromium Control Chart for May 2004-November 2008 Surface Water (Seeps)

Chart A-65: Cobalt Control Chart for May 2004-November 2008
Surface Water (Seeps)

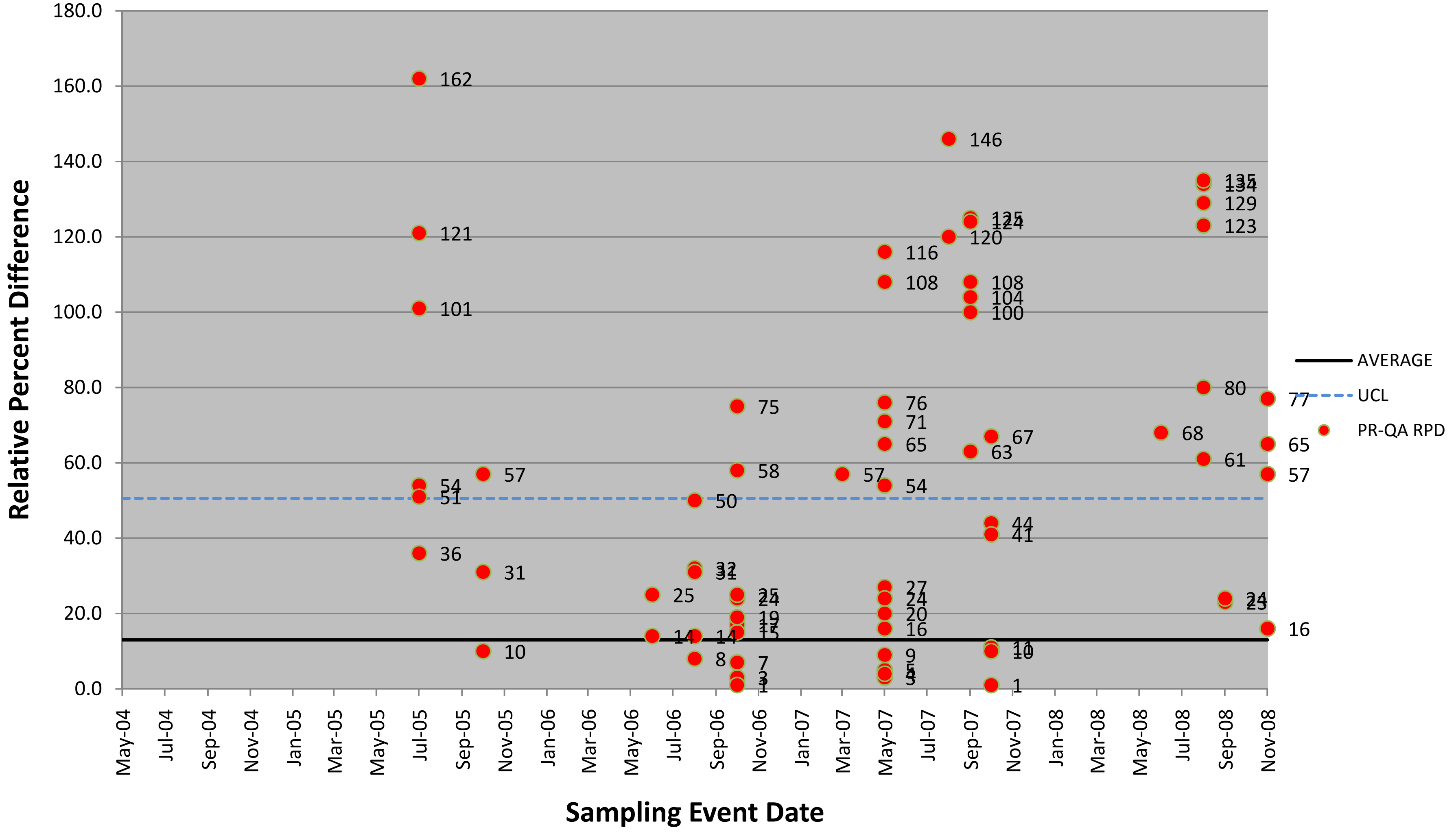
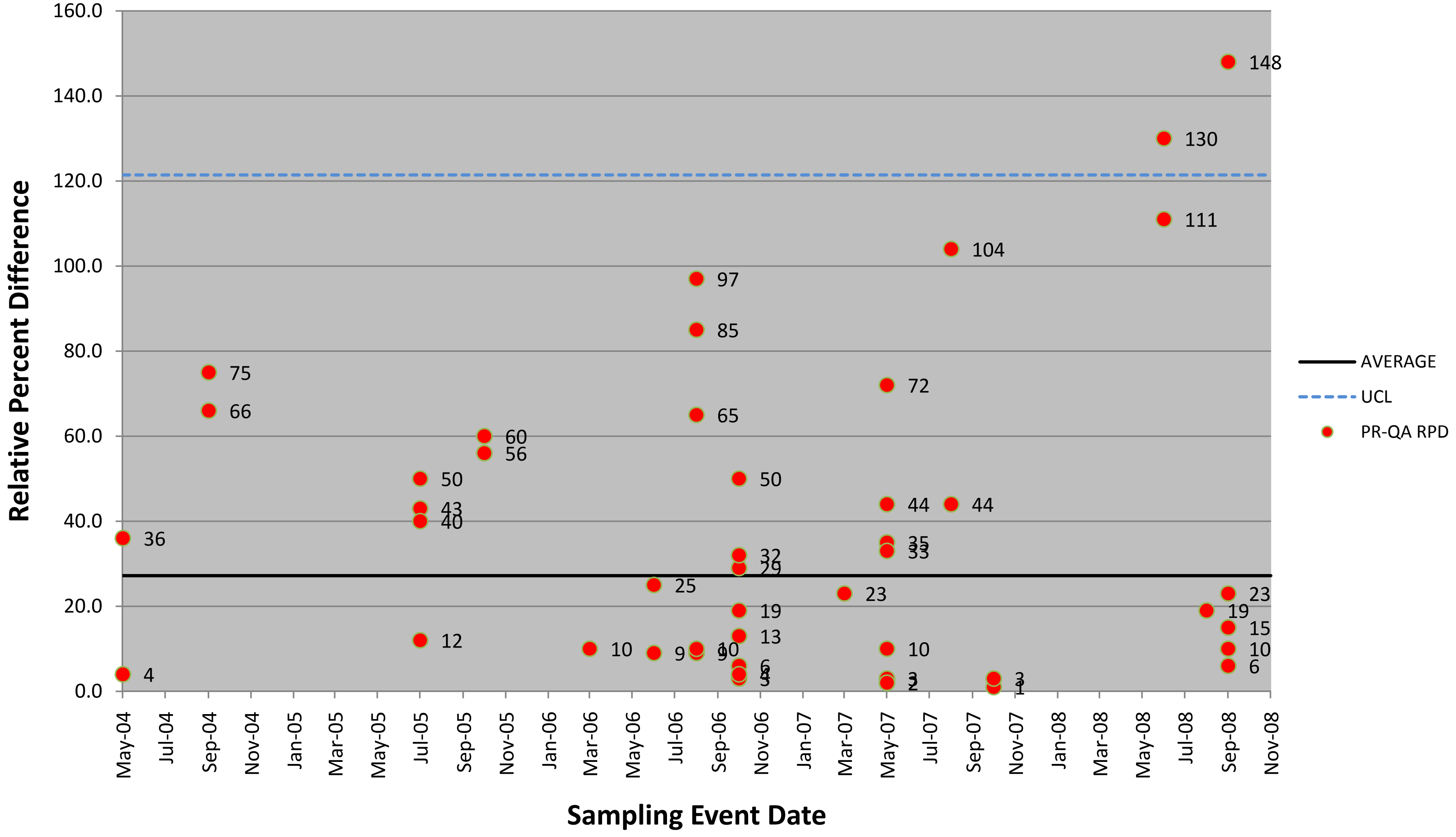


Chart A-66: Copper Control Chart for May 2004-November 2008 Surface Water (Seeps)



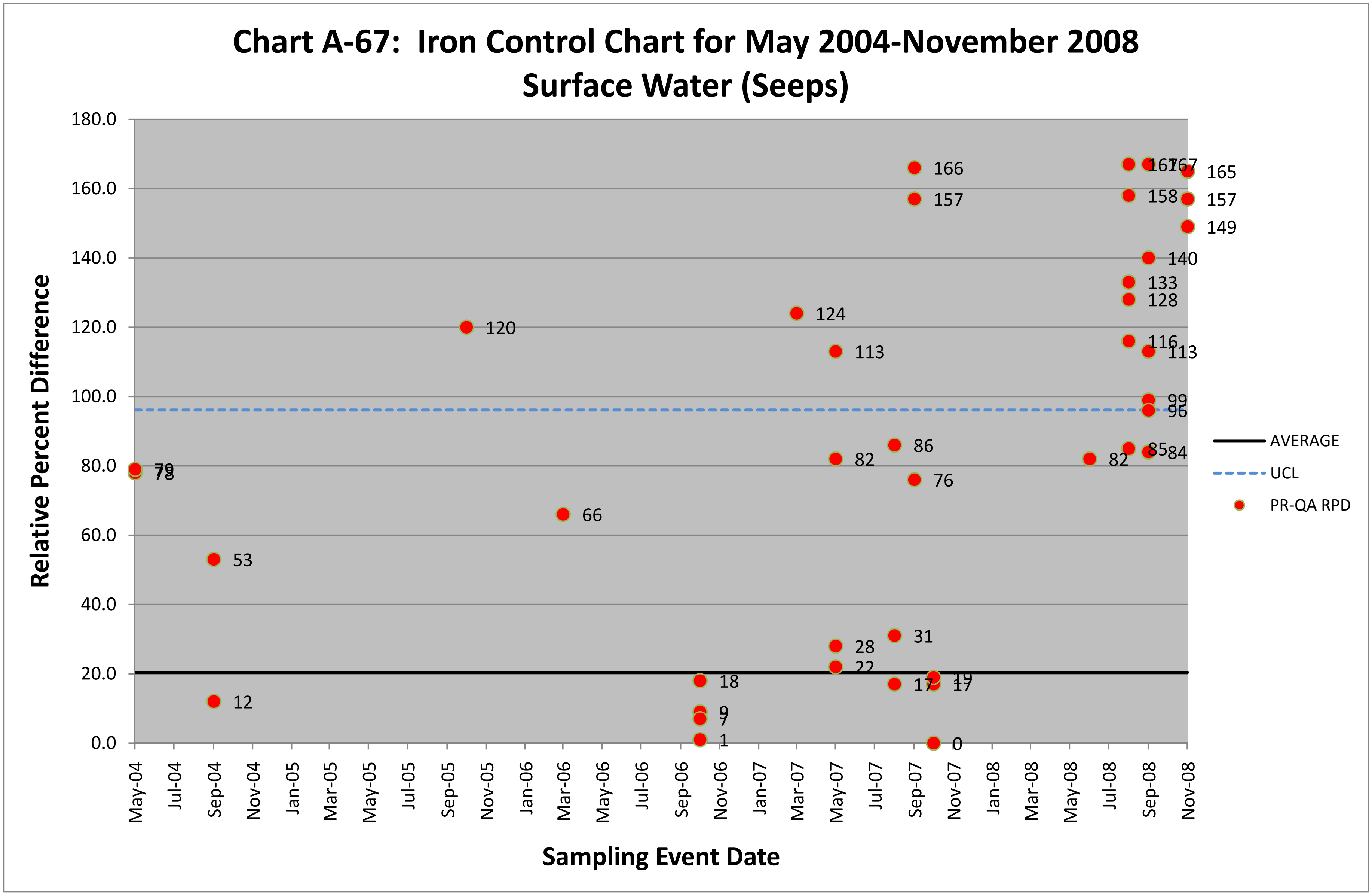


Chart A-67: Iron Control Chart for May 2004-November 2008
Surface Water (Seeps)
Relative Percent Difference
Sampling Event Date
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
79
78
53
12
120
66
18
9
7
1
124
113
82
28
22
86
31
17
166
157
76
19
17
0
82
167
158
133
128
116
85
167
140
113
99
96
84
165
157
149
AVERAGE
UCL
PR-QA RPD

Chart A-68: Lead Control Chart for May 2004-November 2008 Surface Water (Seeps)

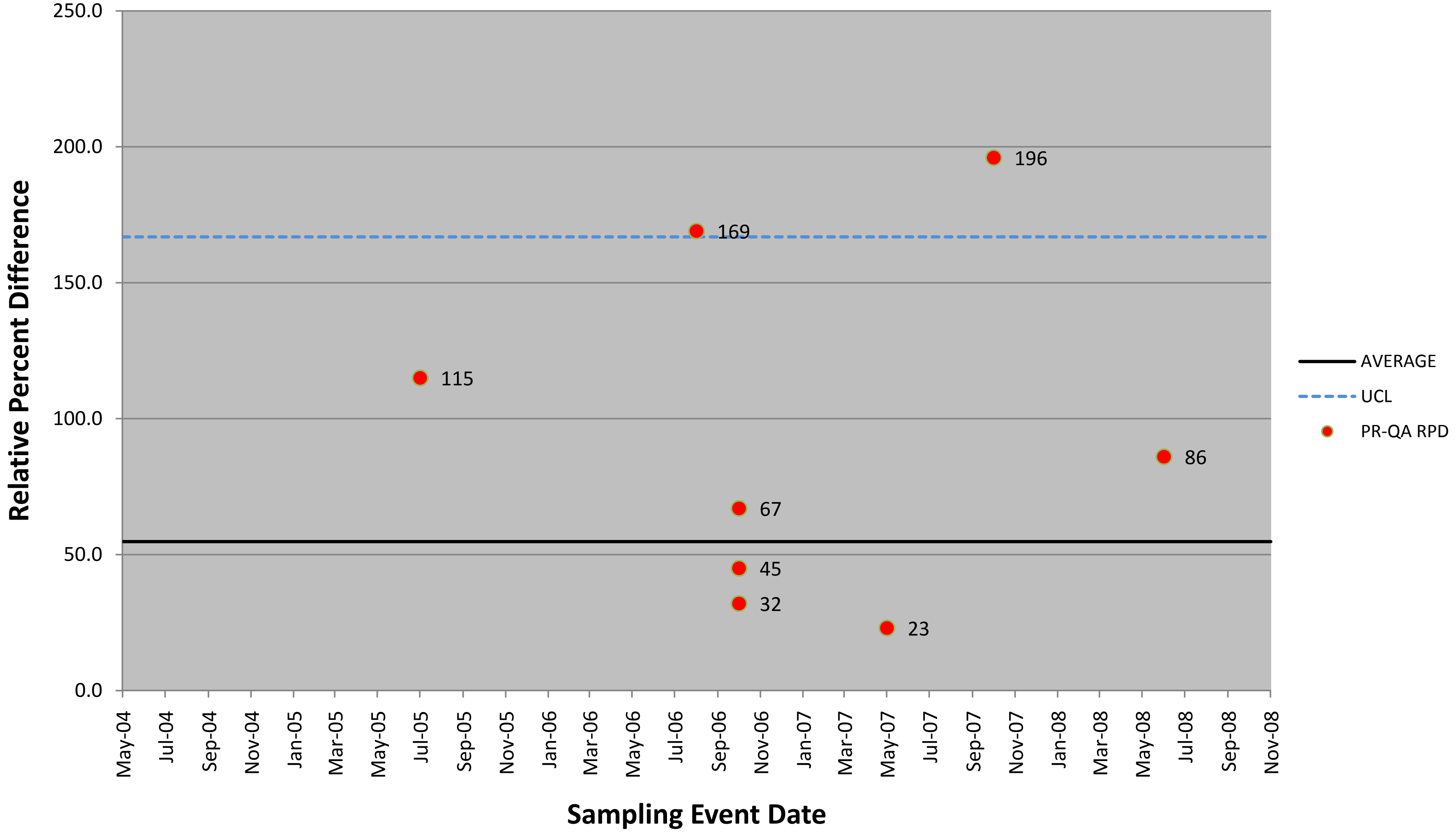


Chart A-69: Magnesium Control Chart for May 2004-November 2008 Surface Water (Seeps)

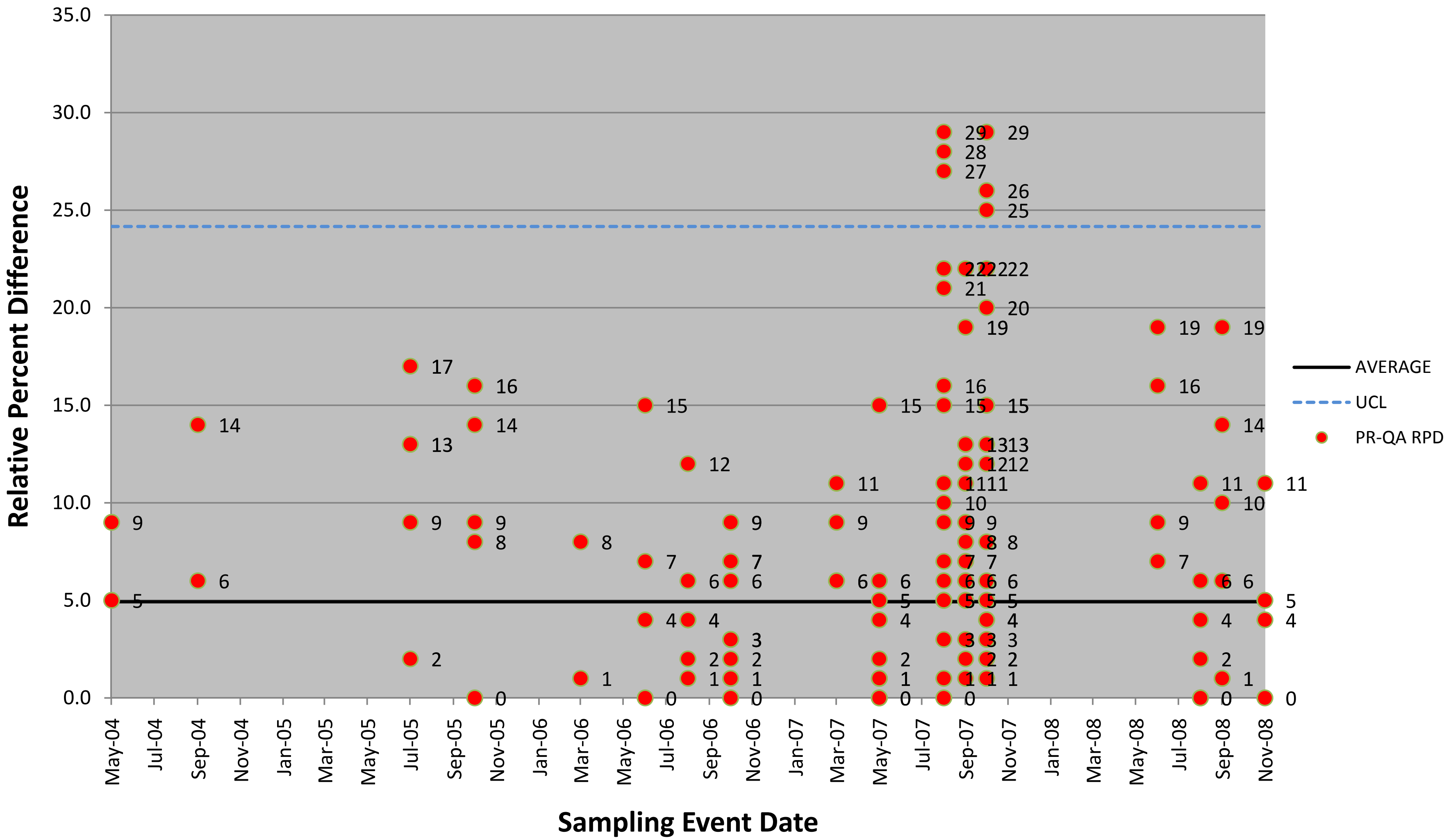
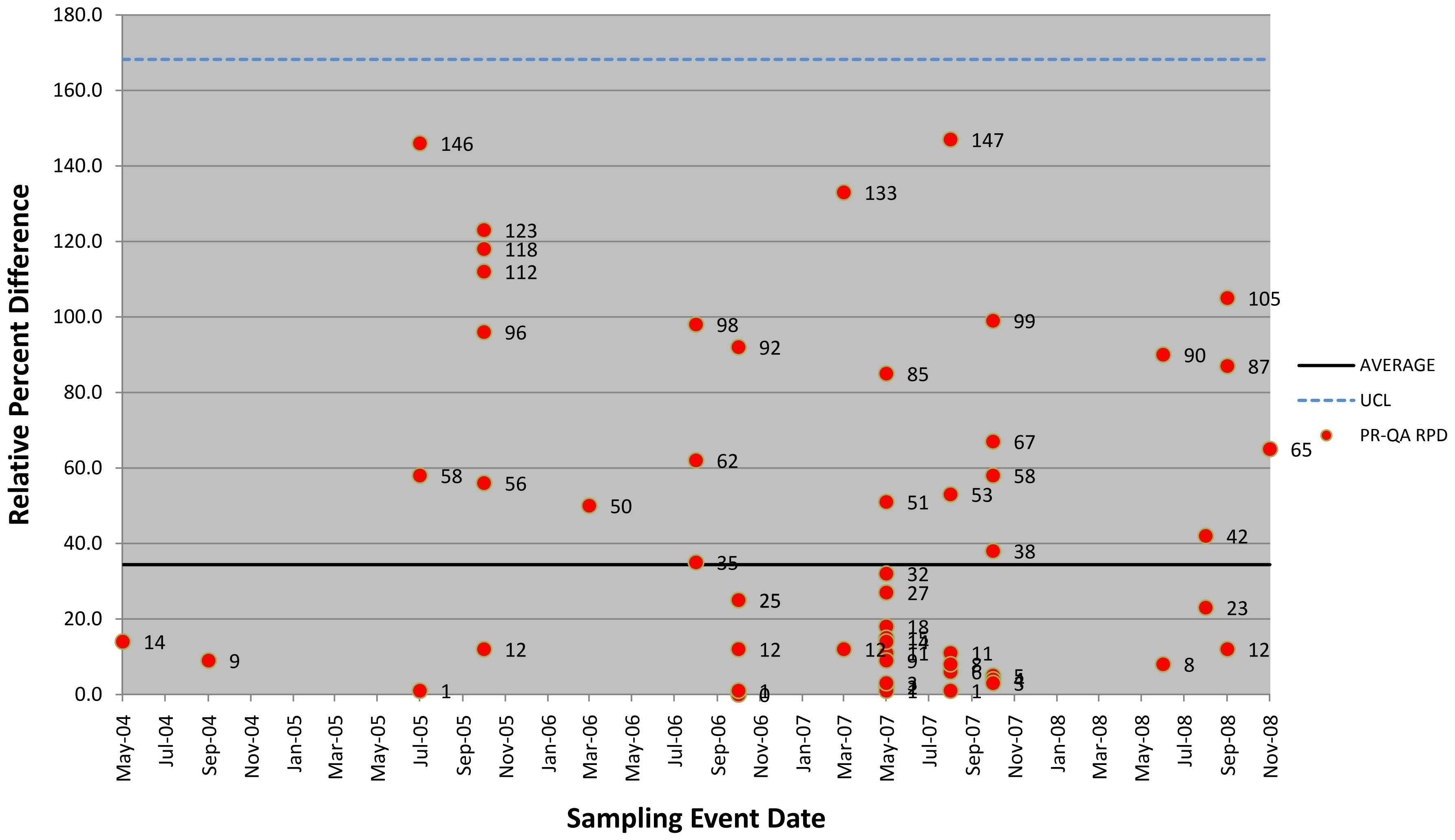


Chart A-70: Manganese Control Chart for May 2004-November 2008 Surface Water (Seeps)



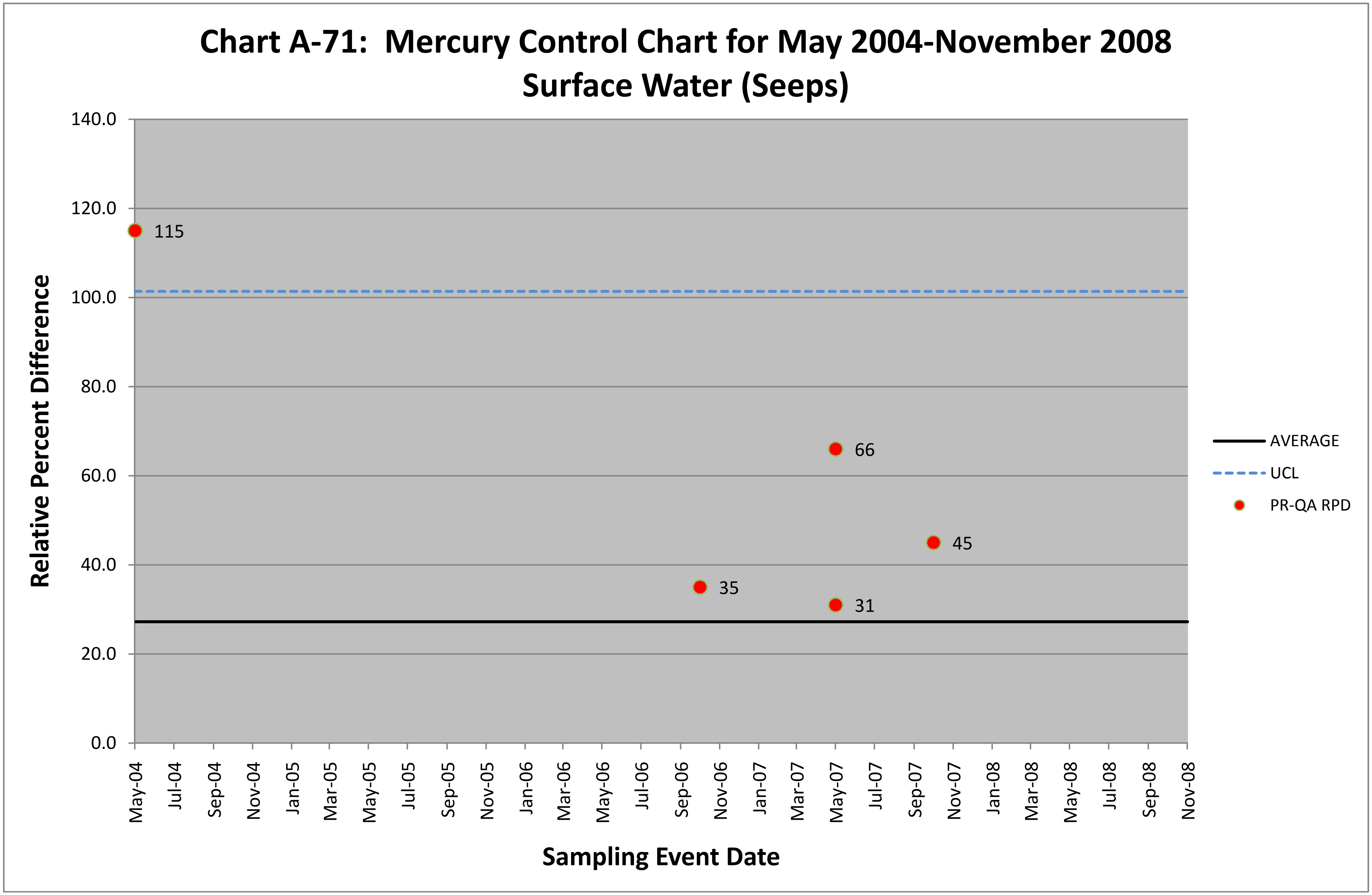


Chart A-71: Mercury Control Chart for May 2004-November 2008
Surface Water (Seeps)
Relative Percent Difference
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
115
66
45
35
31
AVERAGE
UCL
PR-QA RPD
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Sampling Event Date

Chart A-72: Molybdenum Control Chart for May 2004-November 2008
Surface Water (Seeps)

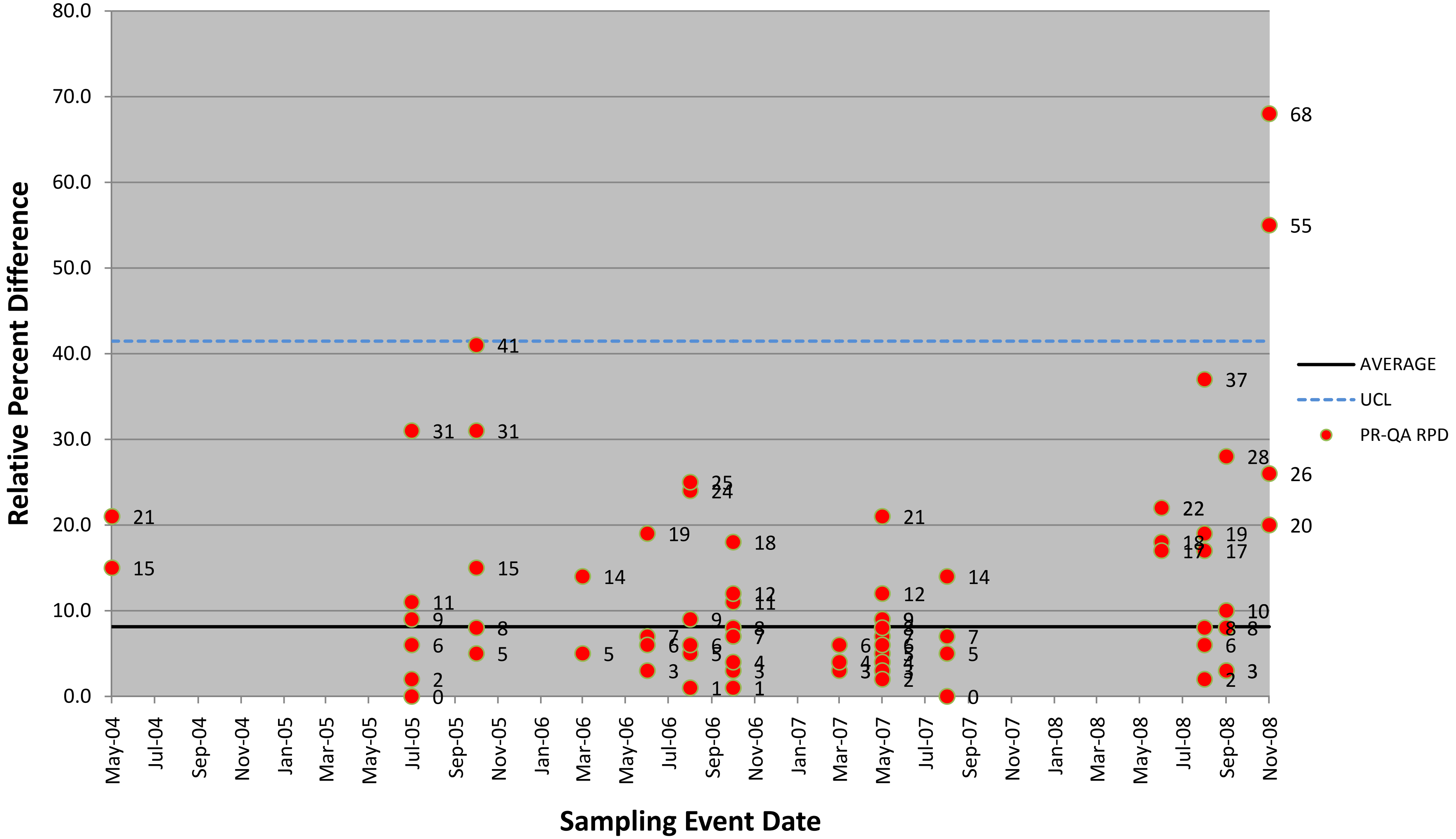


Chart A-73: Nickel Control Chart for May 2004-November 2008 Surface Water (Seeps)

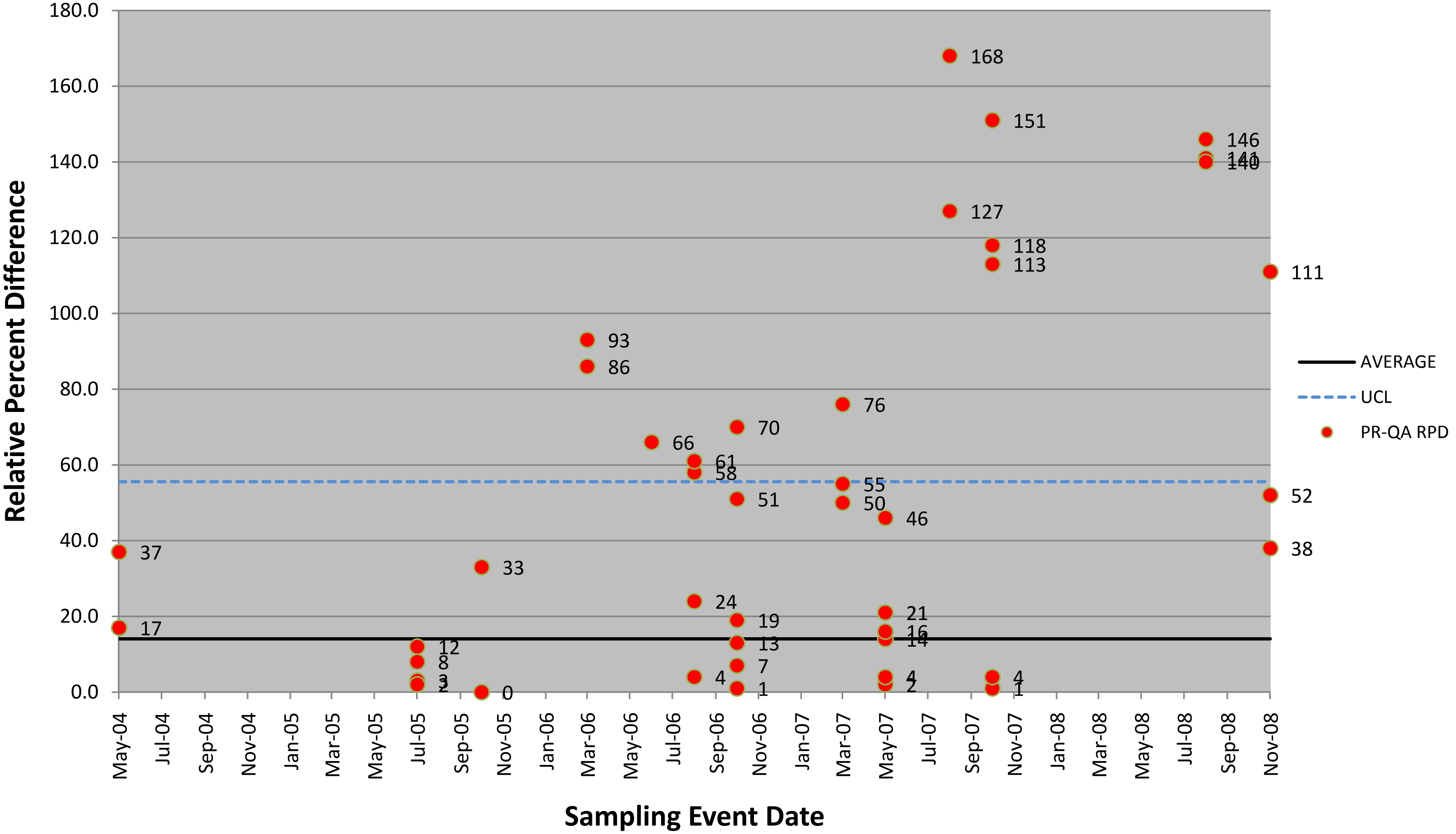
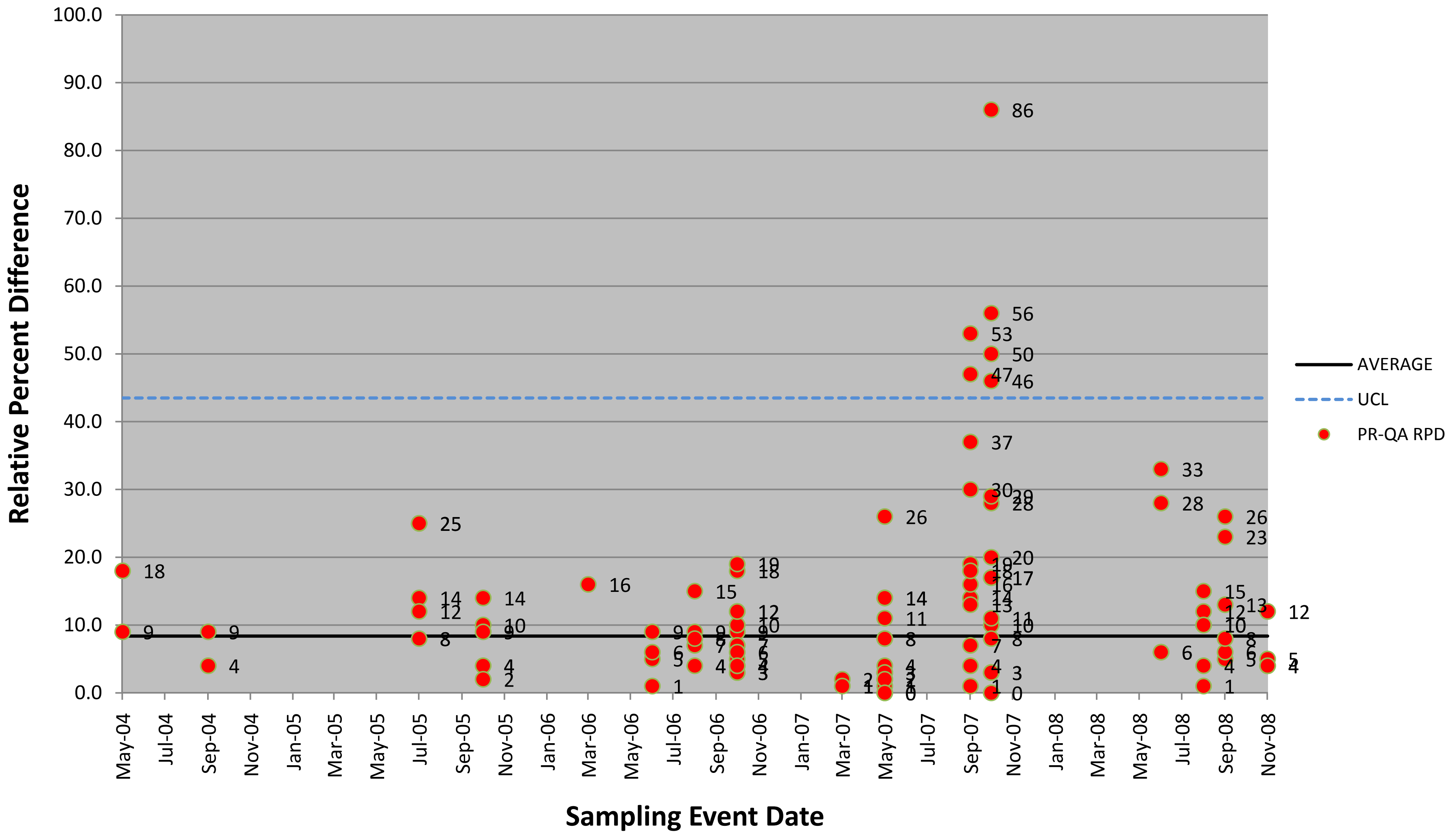


Chart A-74: Potassium Control Chart for May 2004-November 2008 Surface Water (Seeps)



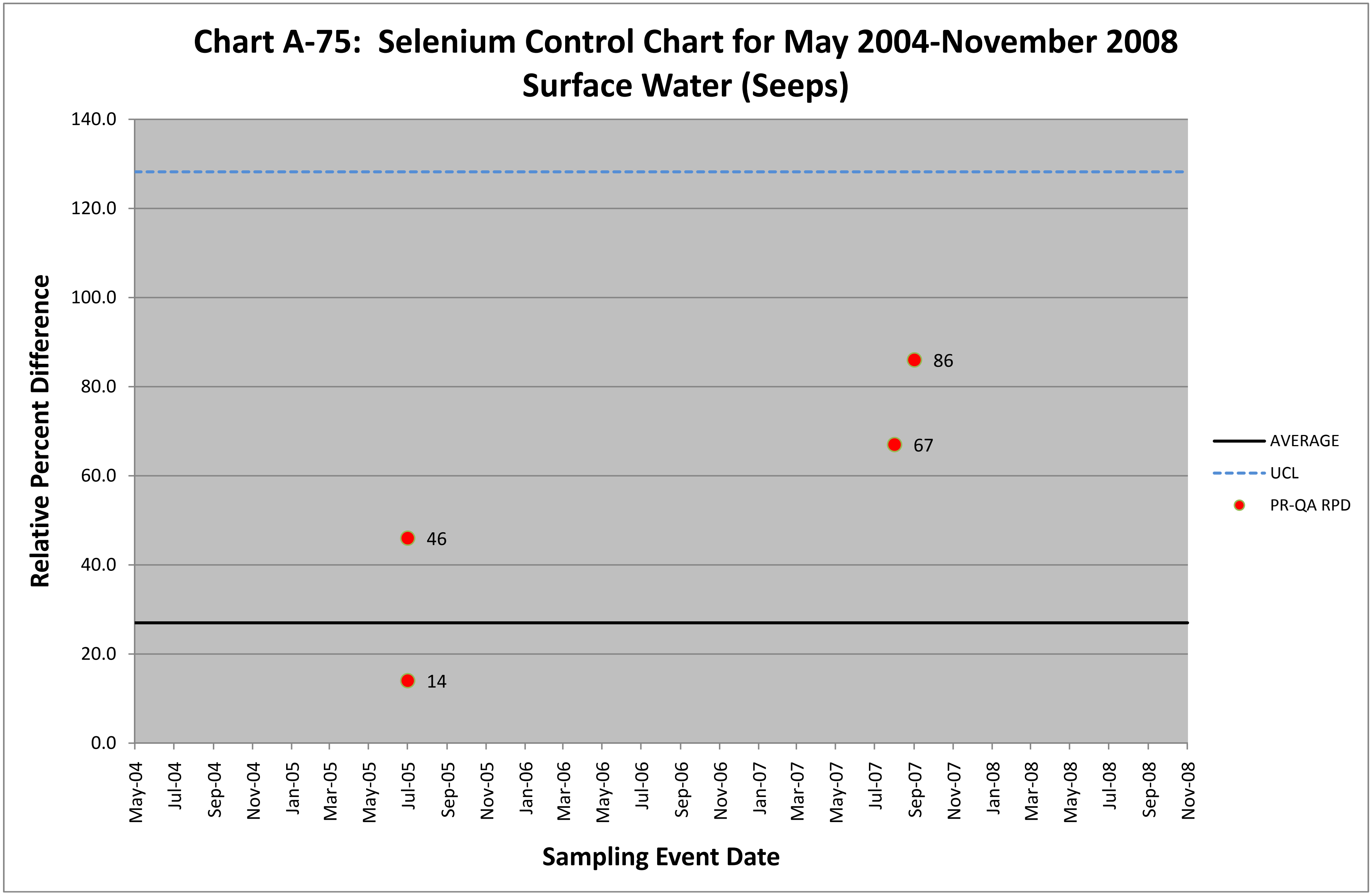
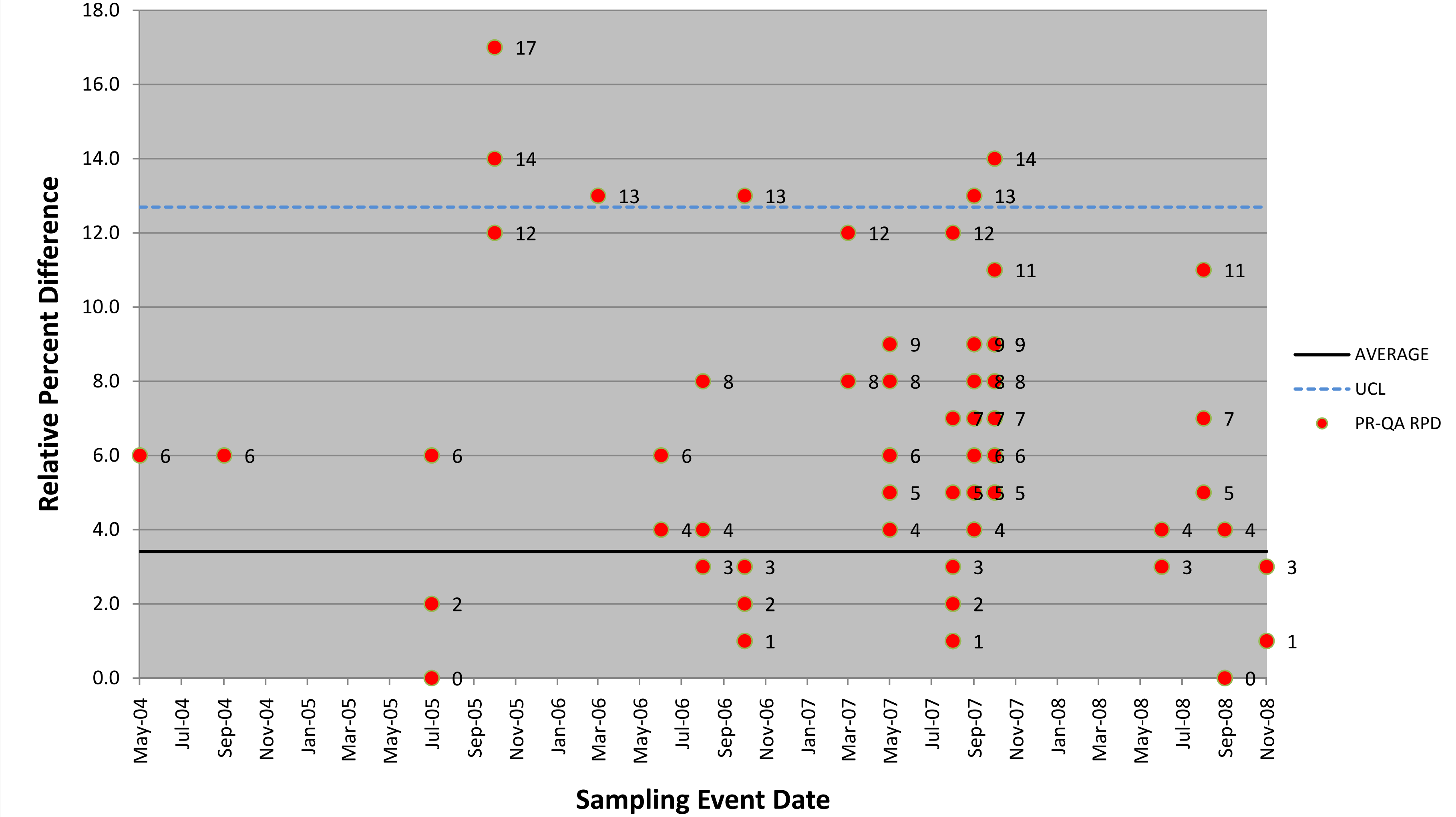


Chart A-75: Selenium Control Chart for May 2004-November 2008
Surface Water (Seeps)
Relative Percent Difference
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
86
67
46
14
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-76: Silicon Control Chart for May 2004-November 2008 Surface Water (Seeps)



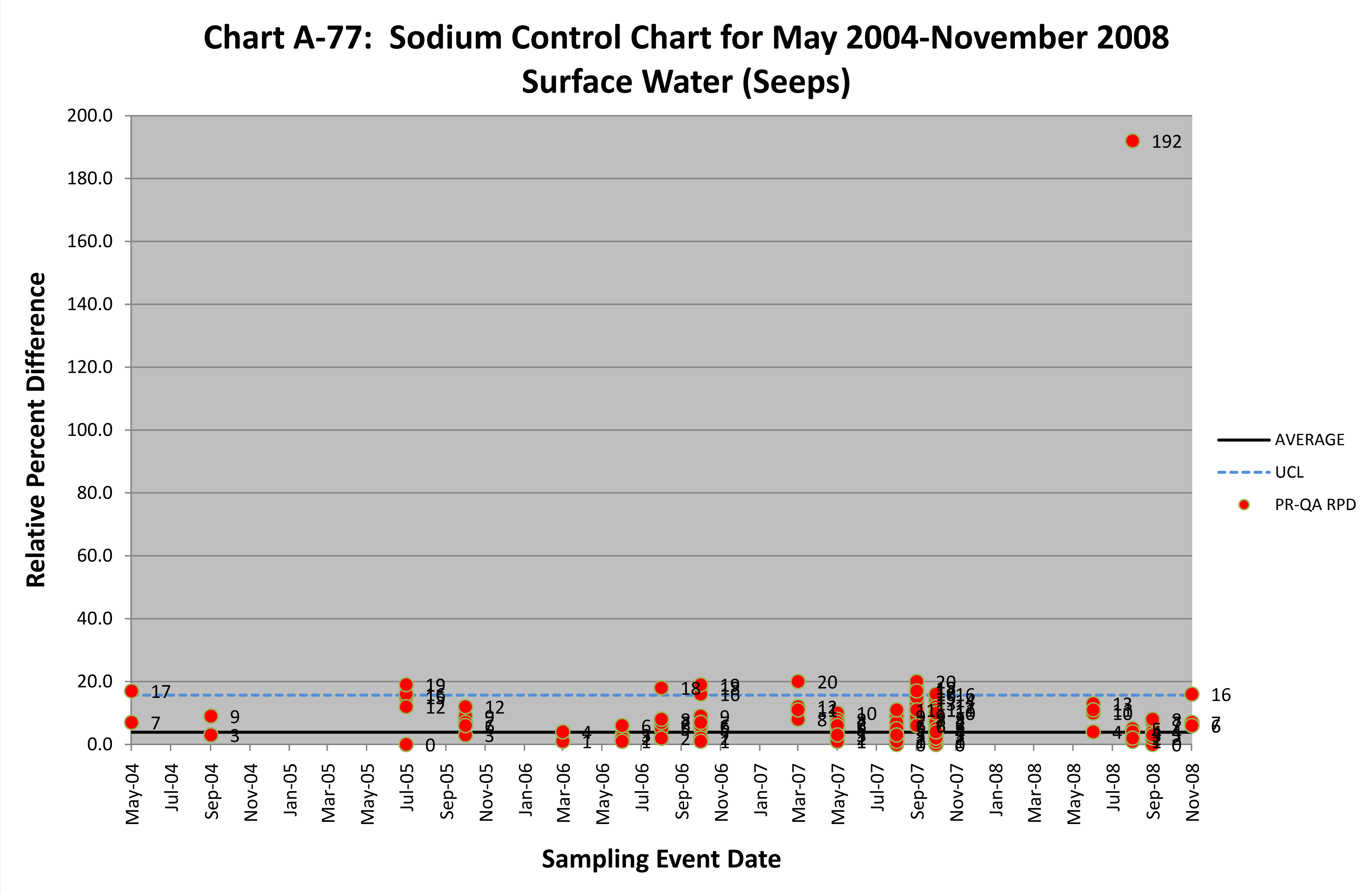


Chart A-77: Sodium Control Chart for May 2004-November 2008
Surface Water (Seeps)
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Sampling Event Date
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Nov-08
192
17
7
9
3
19
12
0
12
3
4
1
18
20
10
13
10
4
16
7
6
AVERAGE
UCL
PR-QA RPD

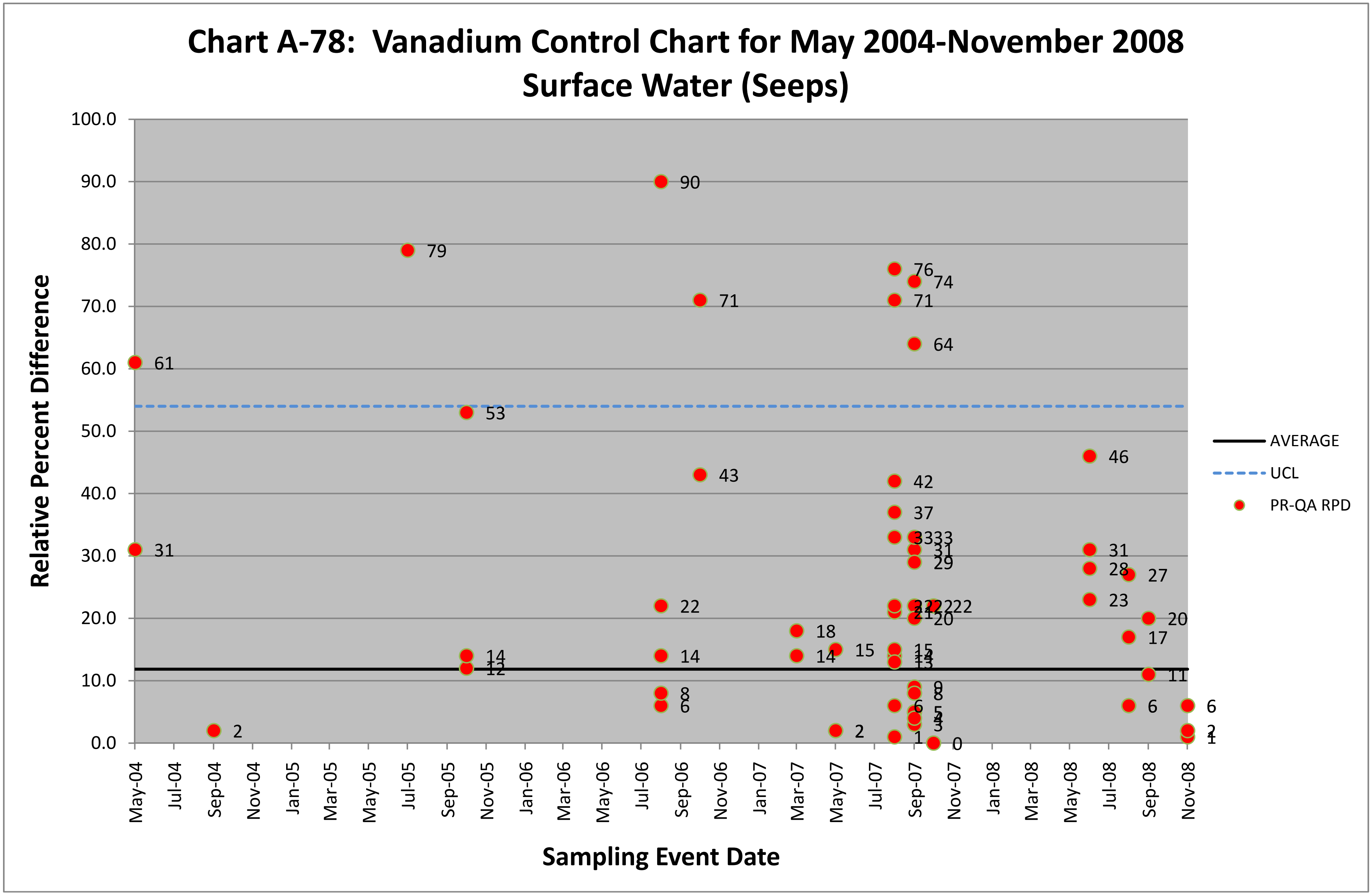
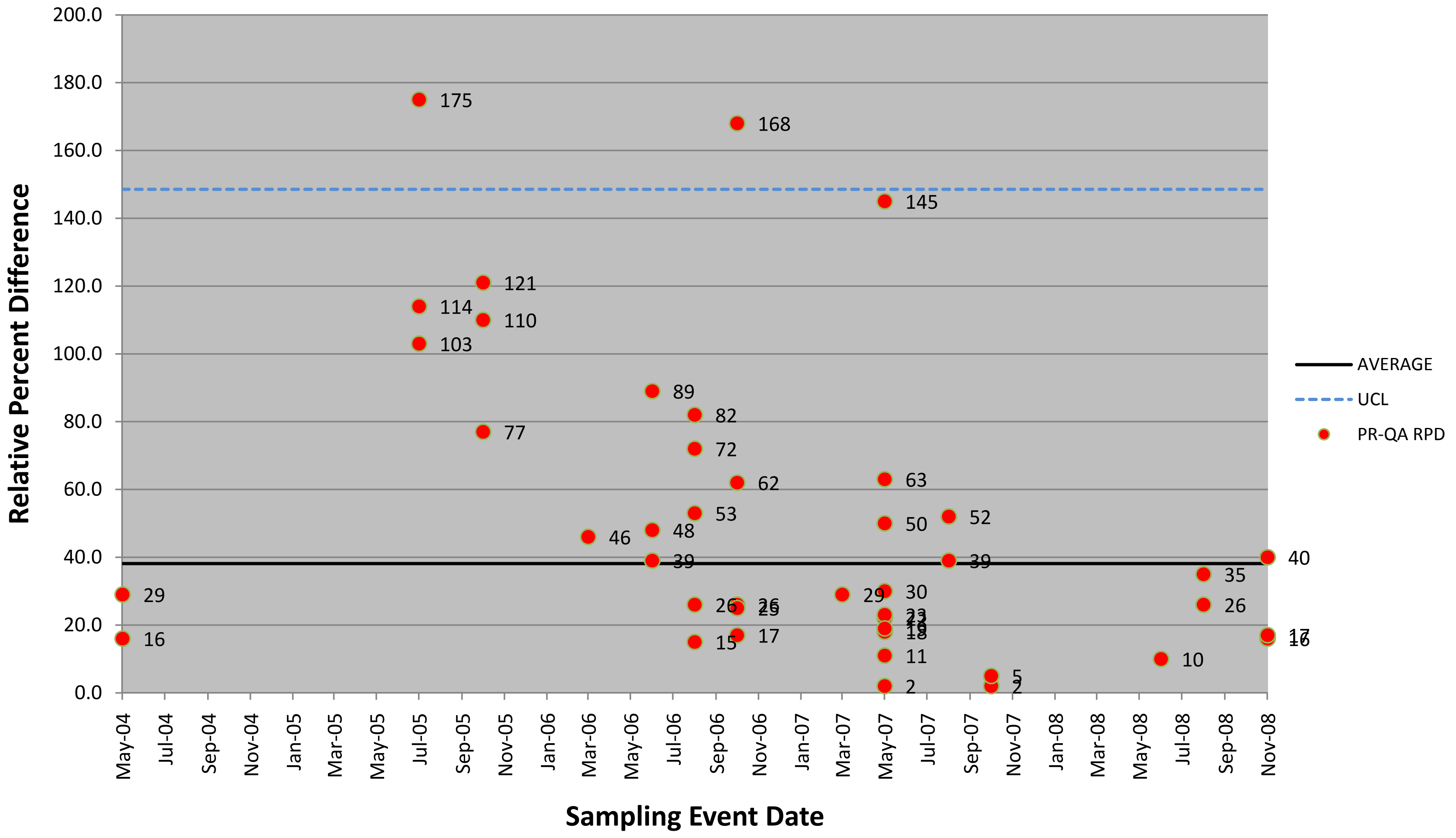


Chart A-78: Vanadium Control Chart for May 2004-November 2008 Surface Water (Seeps)

Chart A-79: Zinc Control Chart for May 2004-November 2008 Surface Water (Seeps)



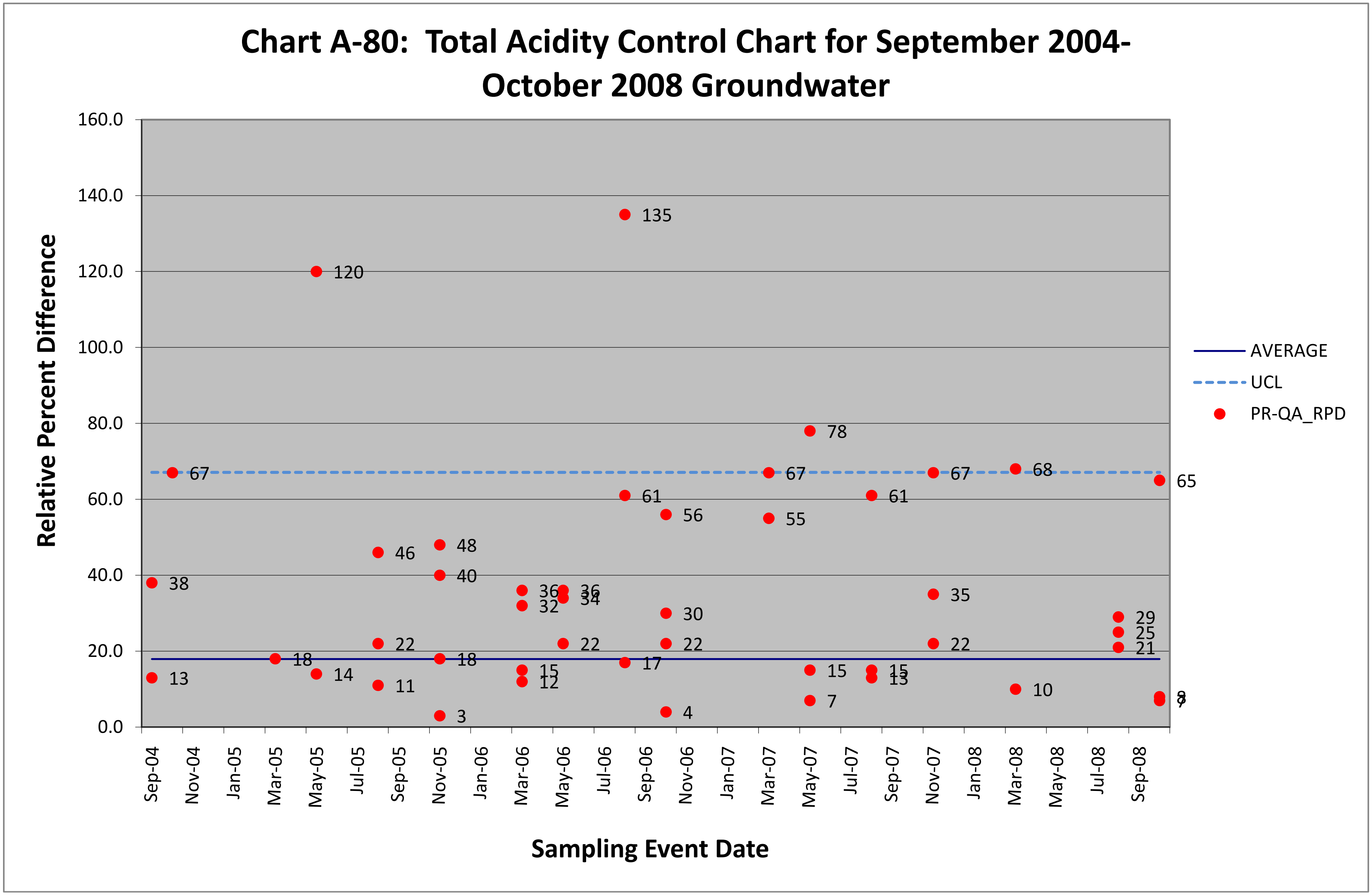


Chart A-80: Total Acidity Control Chart for September 2004-October 2008 Groundwater

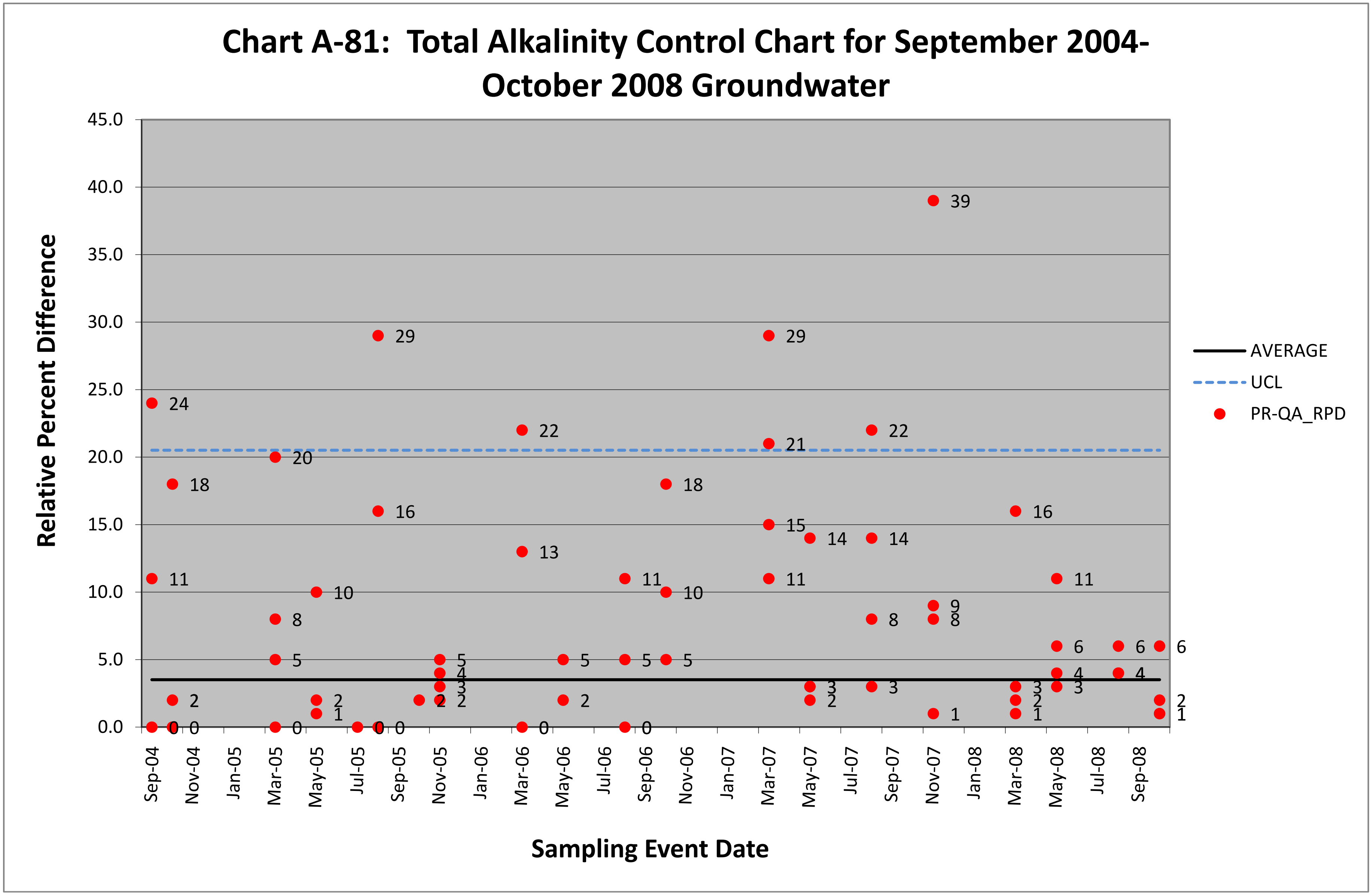


Chart A-81: Total Alkalinity Control Chart for September 2004-October 2008 Groundwater
Relative Percent Difference
45.0
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
Sampling Event Date
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
AVERAGE
UCL
PR-QA_RPD
24
11
0
18
2
0
0
20
8
5
0
10
2
1
0
29
16
0
0
2
5
4
3
2
2
22
13
0
5
2
11
5
0
18
10
5
29
21
15
11
14
3
2
22
14
8
3
39
9
8
1
16
3
2
1
11
6
4
3
6
4
6
2
1

Chart A-82: Chloride Control Chart for September 2004-October 2008 Groundwater

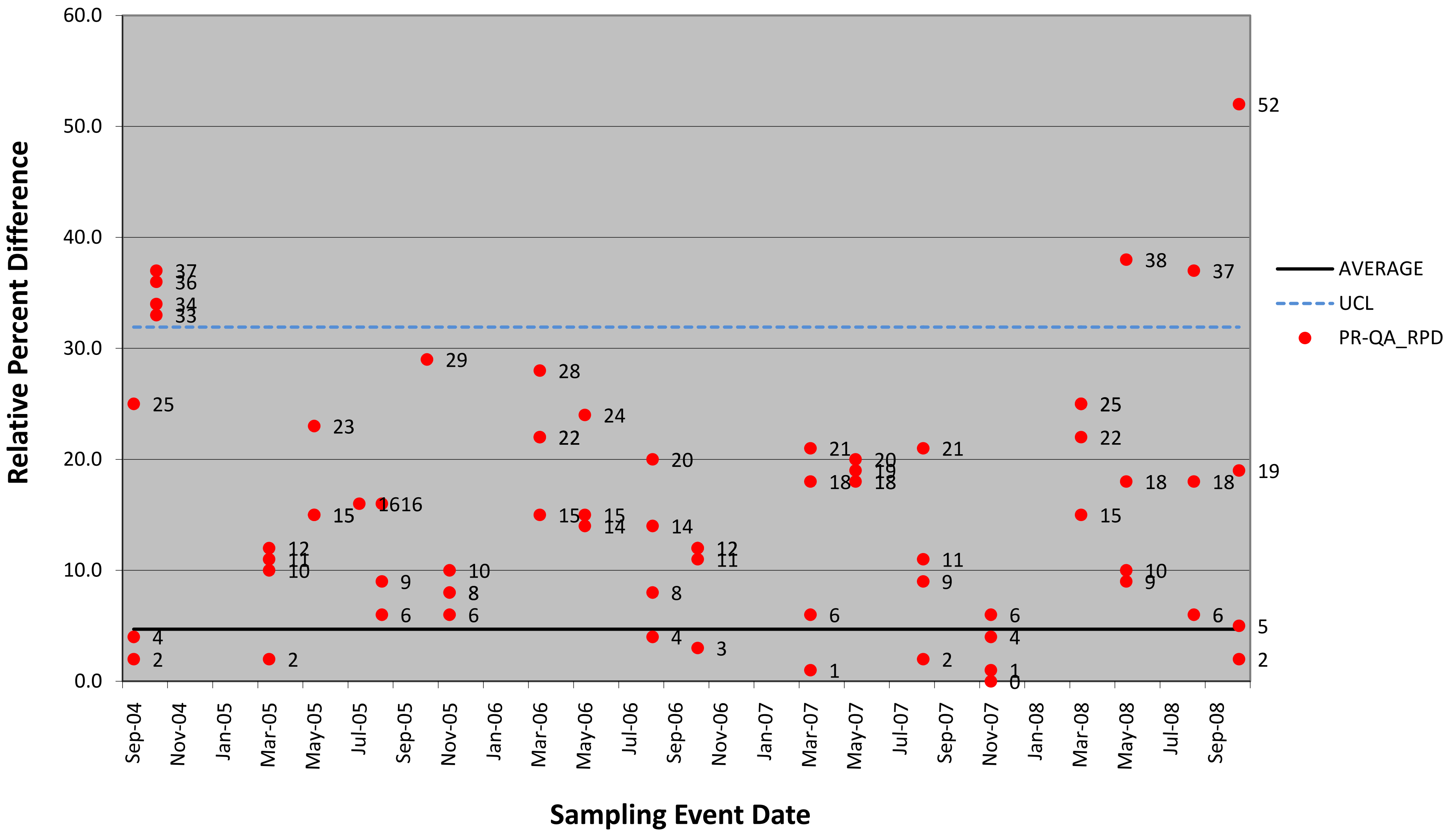


Chart A-83: Fluoride Control Chart for September 2004-October 2008 Groundwater

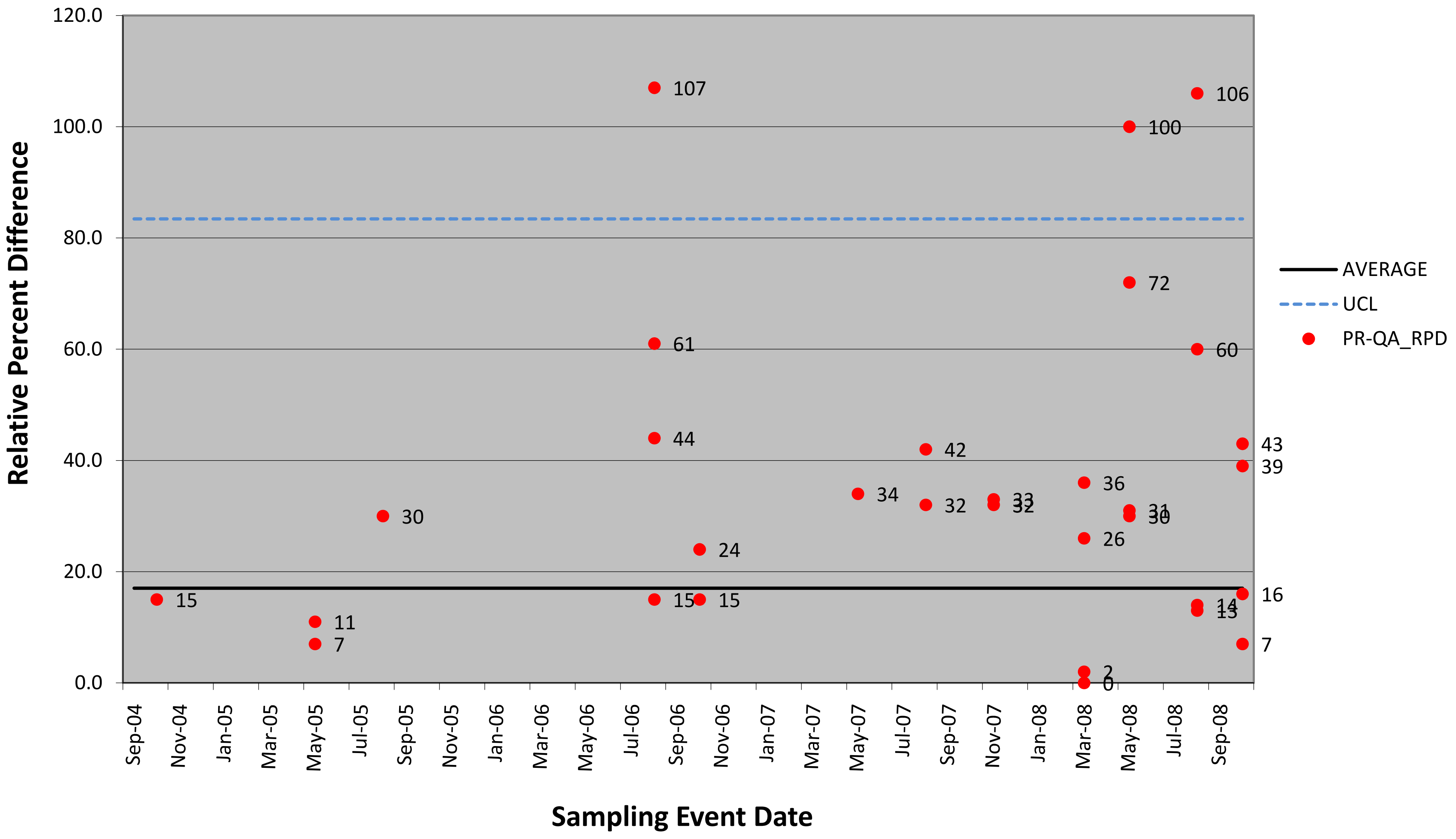


Chart A-84: Hardness as $CaCO_3$ Control Chart for September 2004-October 2008 Groundwater

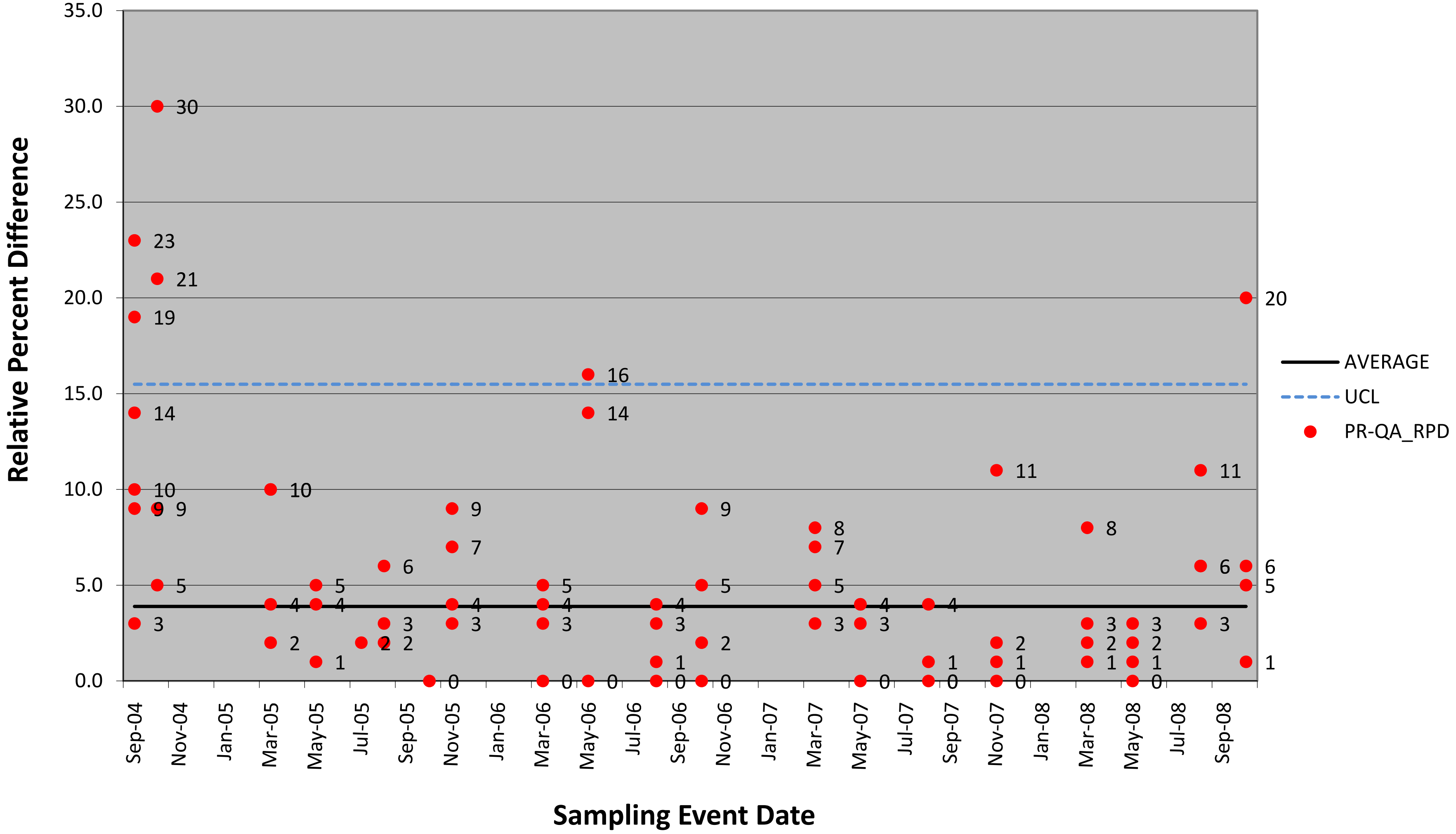
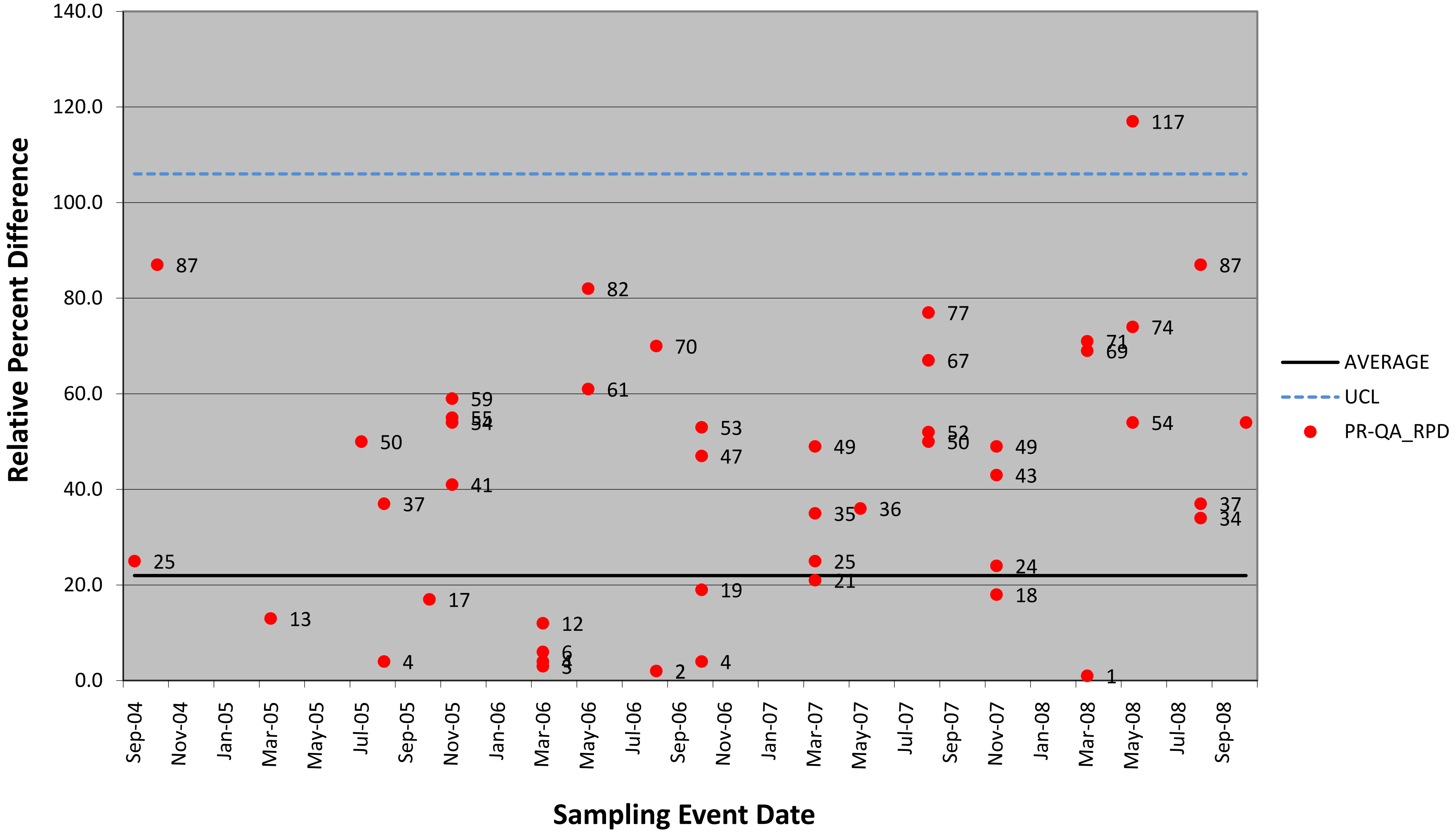


Chart A-85: Nitrogen: Nitrate-Nitrite Control Chart for September 2004-October 2008 Groundwater



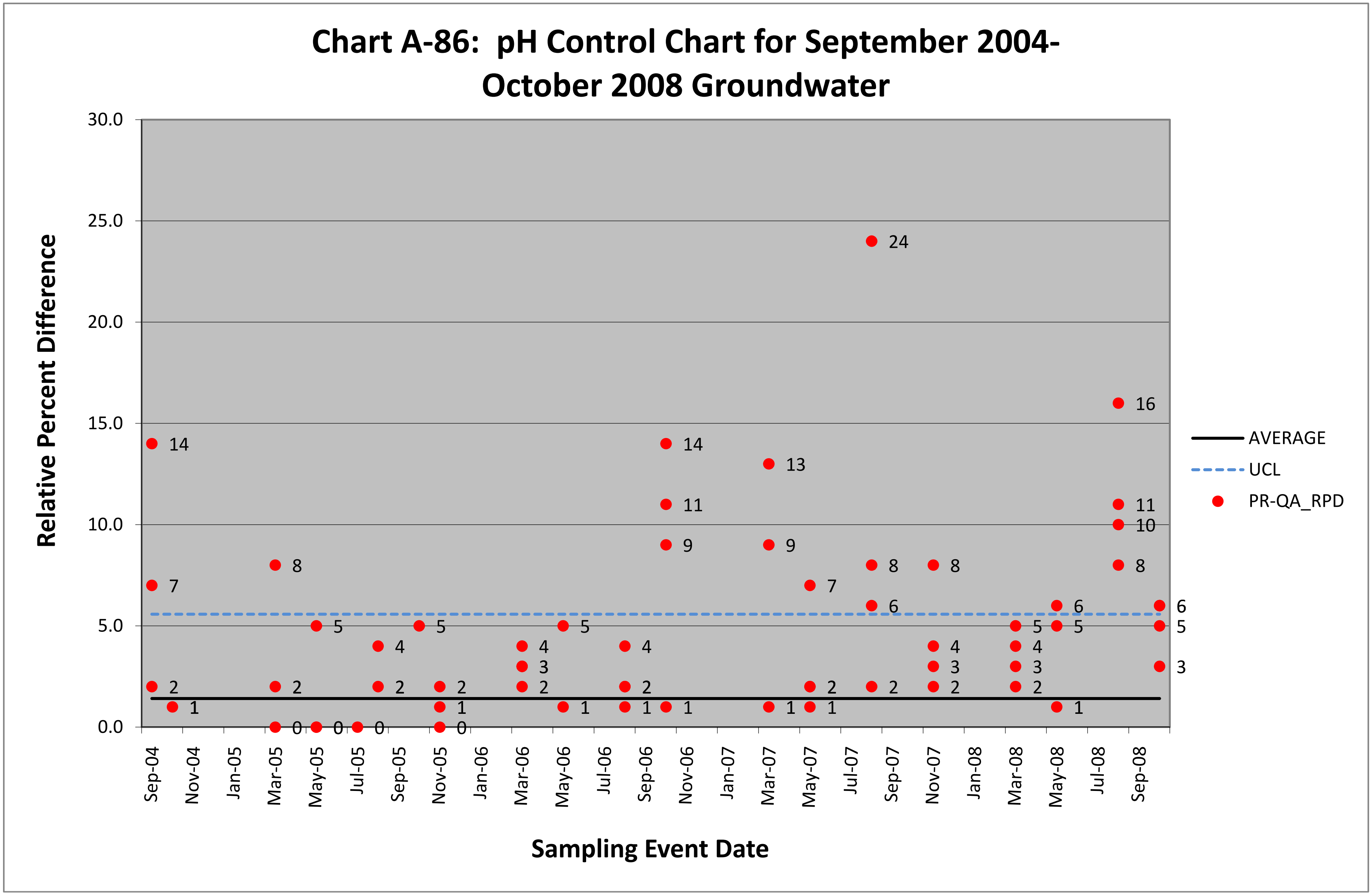


Chart A-86: pH Control Chart for September 2004-October 2008 Groundwater

Chart A-87: Total Phosphorus (as P) Control Chart for September 2004-October 2008 Groundwater

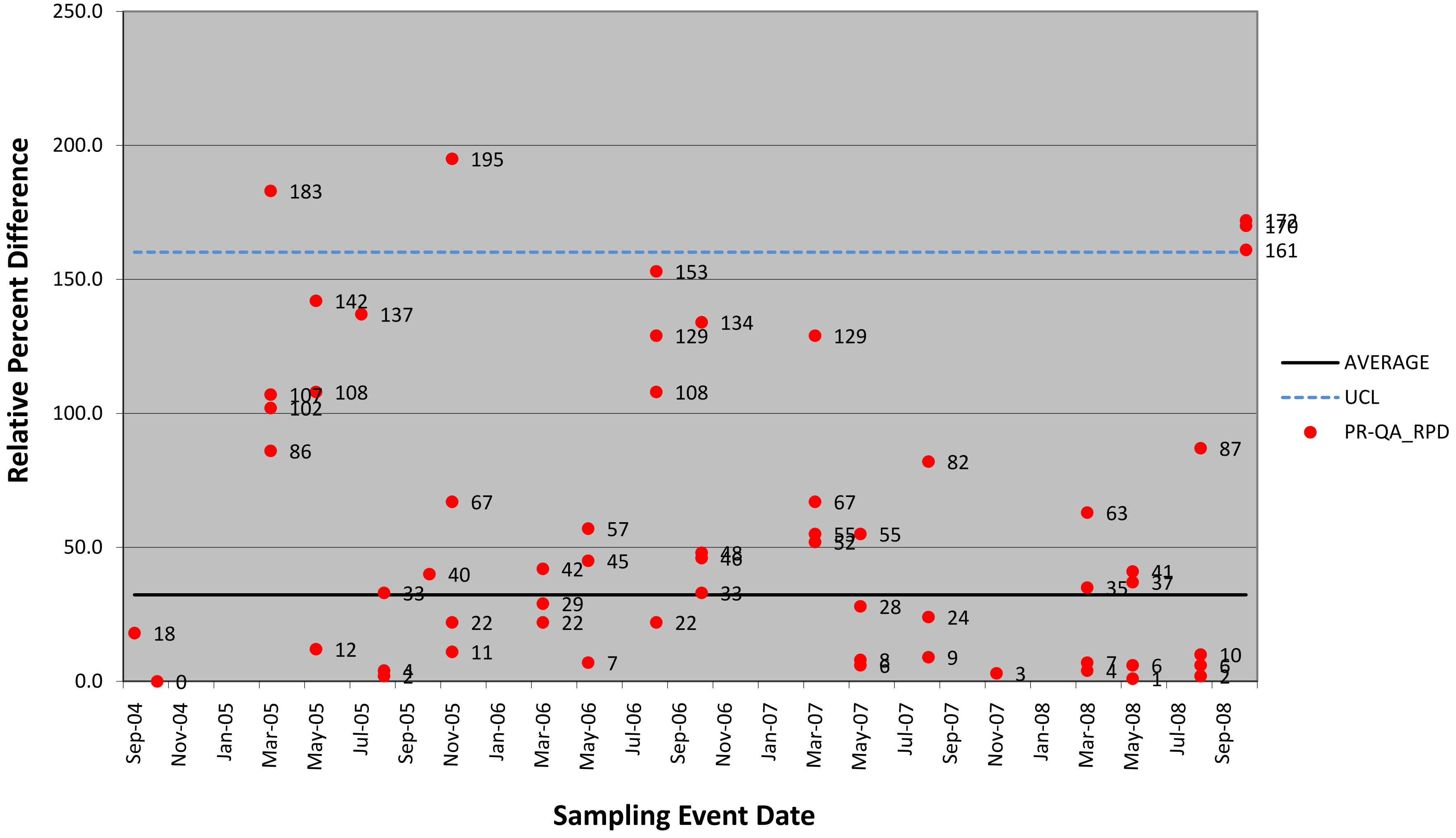
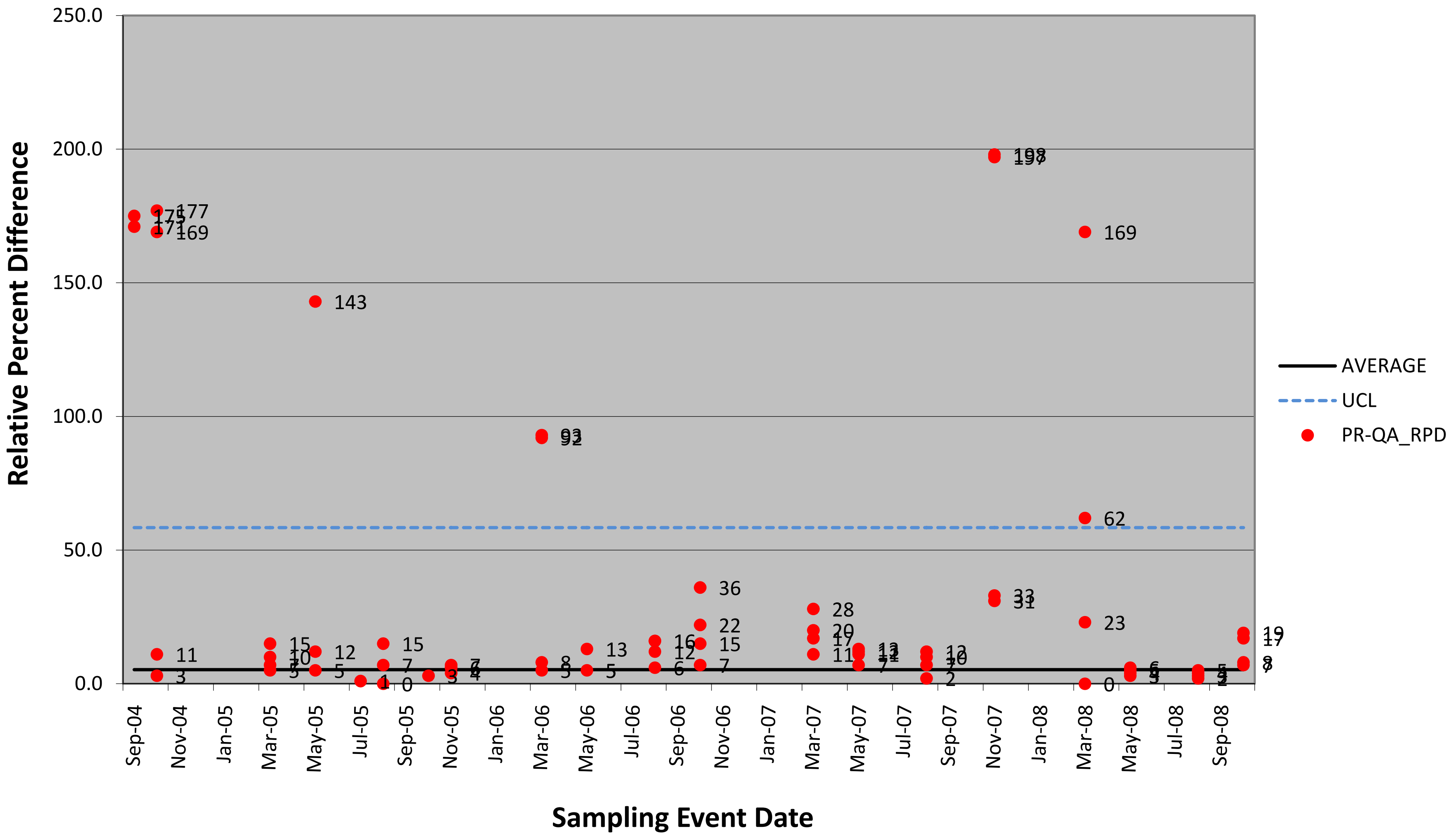


Chart A-88: Specific Conductance Control Chart for September 2004-October 2008 Groundwater



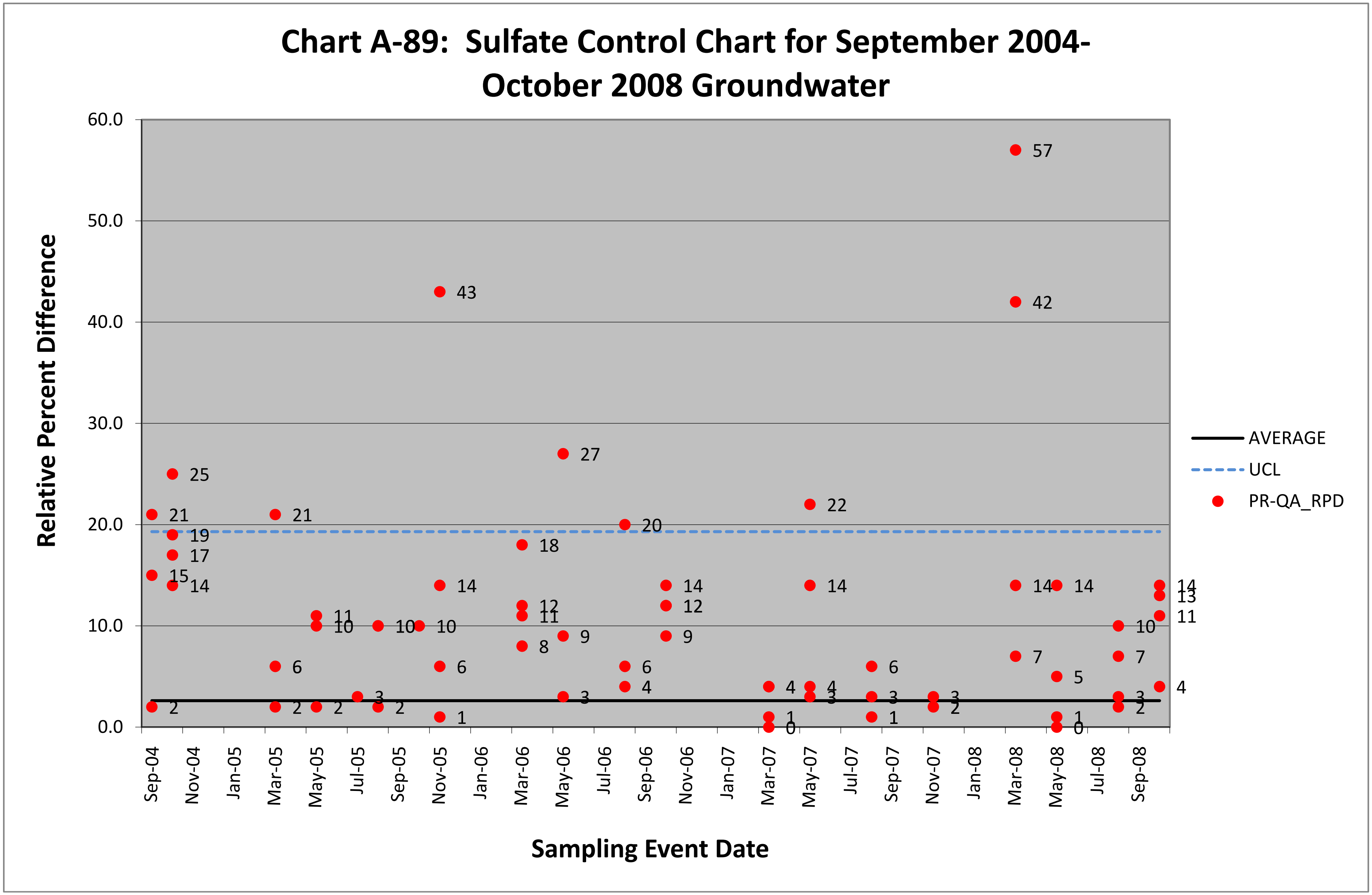


Chart A-89: Sulfate Control Chart for September 2004-October 2008 Groundwater

Chart A-90: Thiocyanate Control Chart for September 2004-October 2008 Groundwater

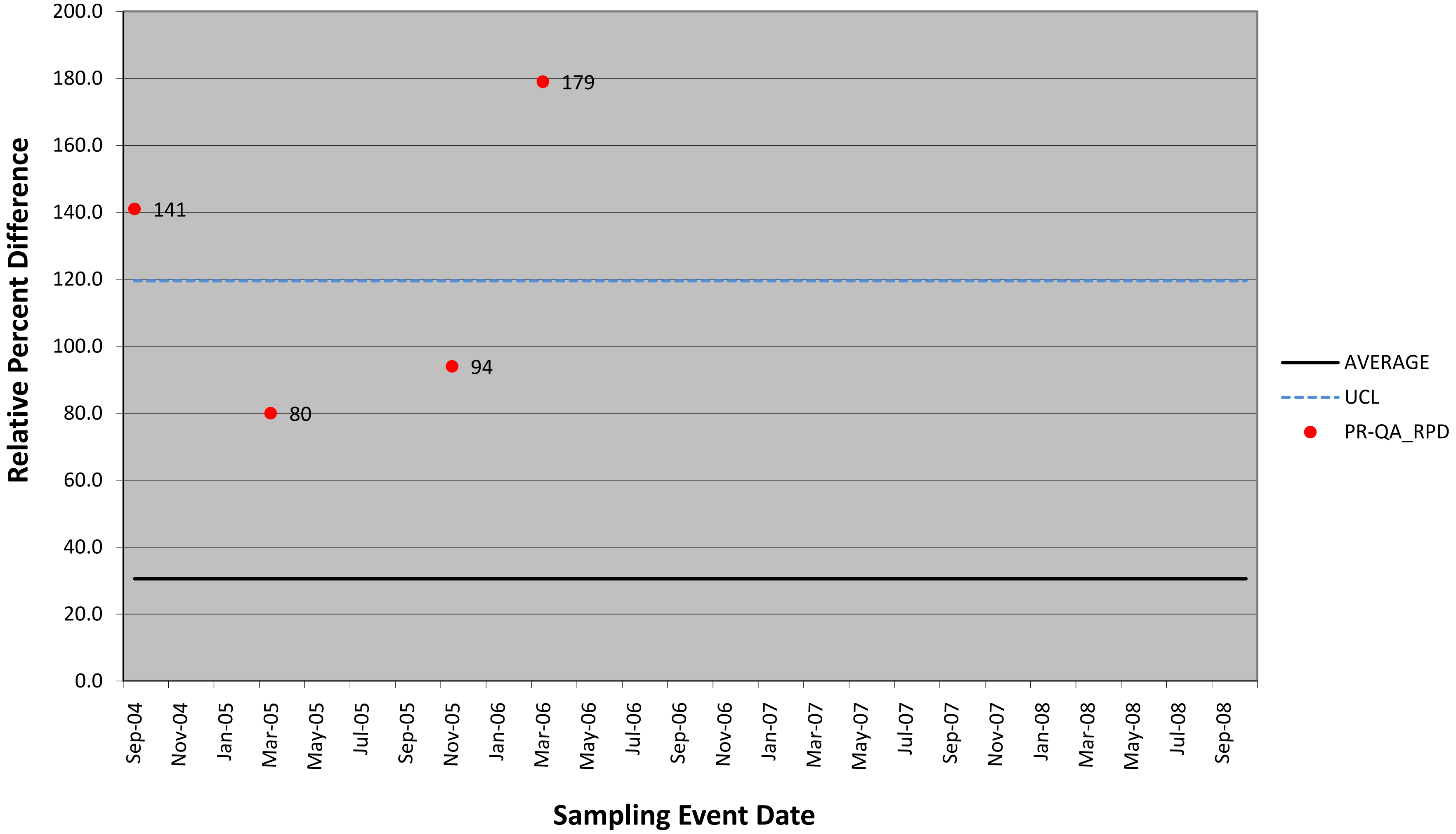


Chart A-91: Total Dissolved Solids Control Chart for September 2004-October 2008 Groundwater

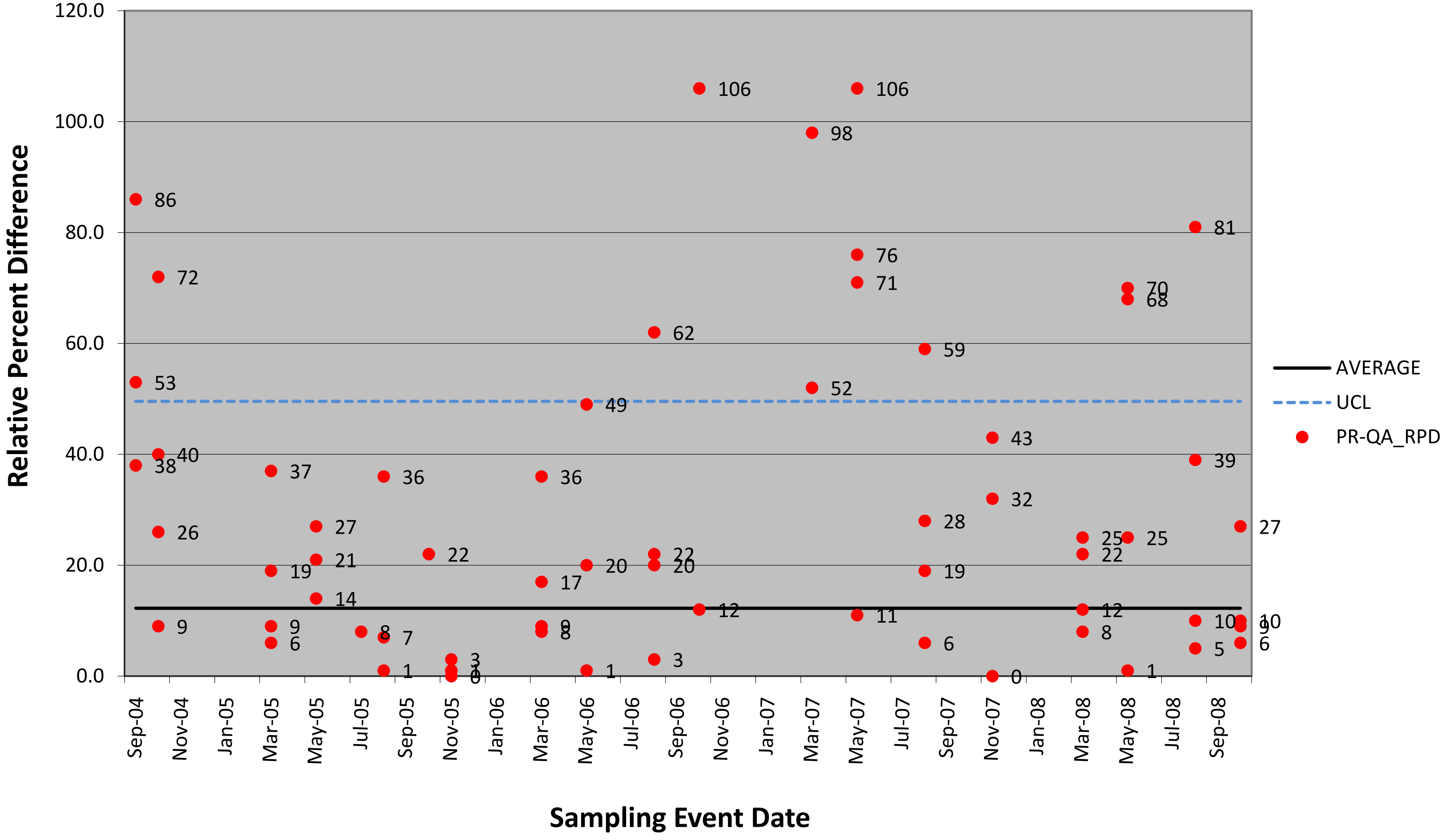
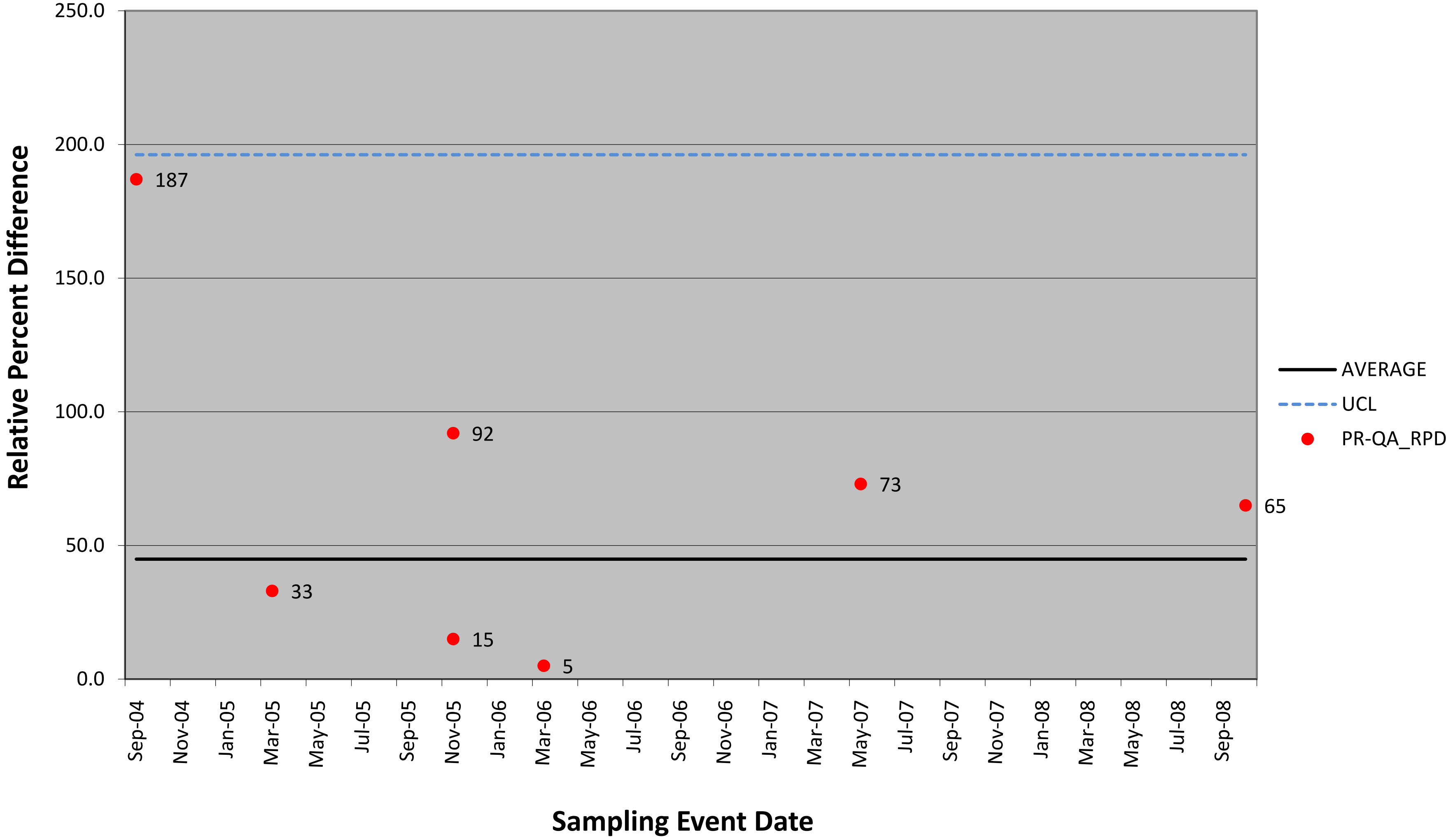


Chart A-92: Total Suspended Solids Control Chart for September 2004-October 2008 Groundwater



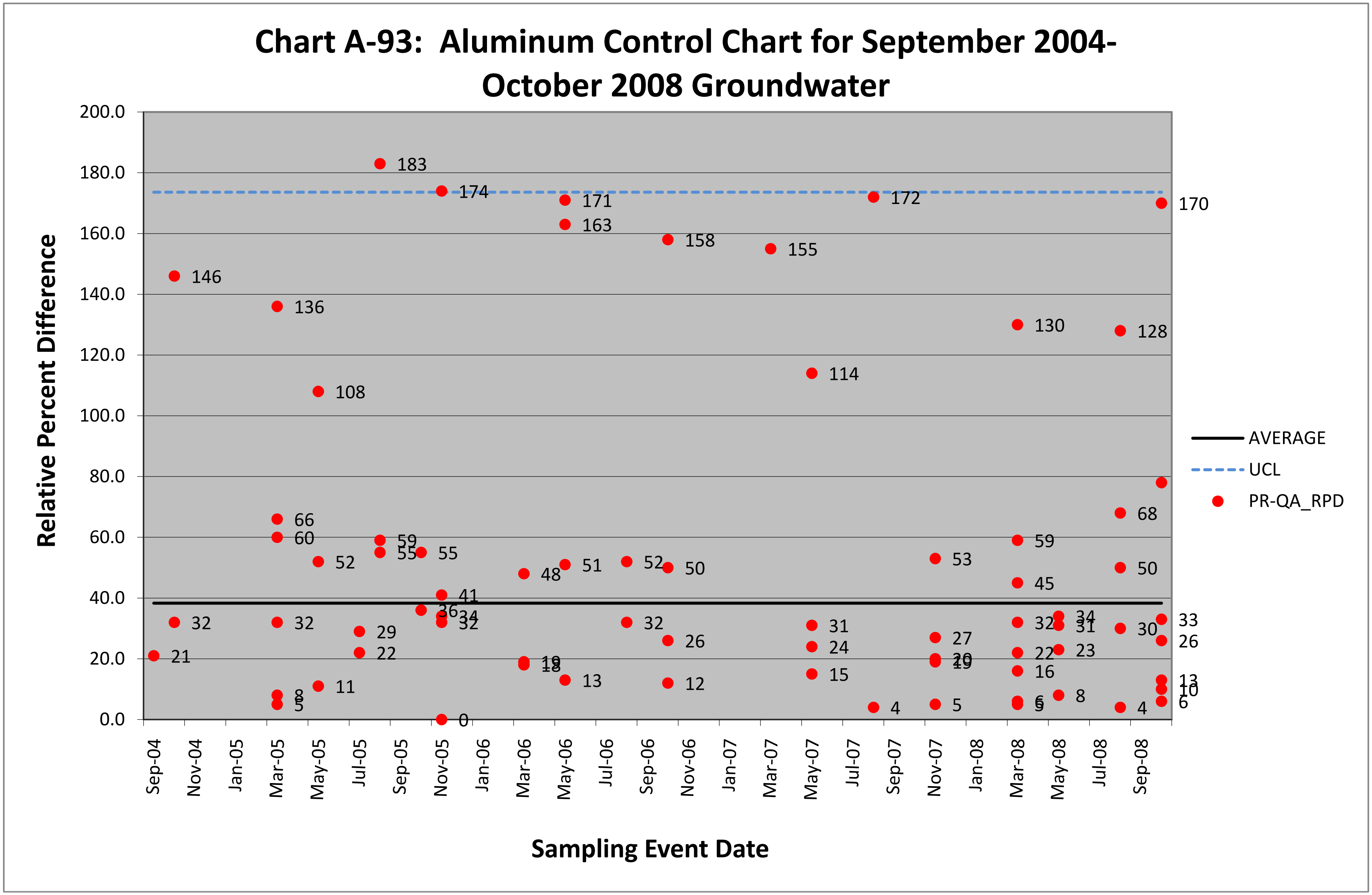


Chart A-93: Aluminum Control Chart for September 2004-October 2008 Groundwater

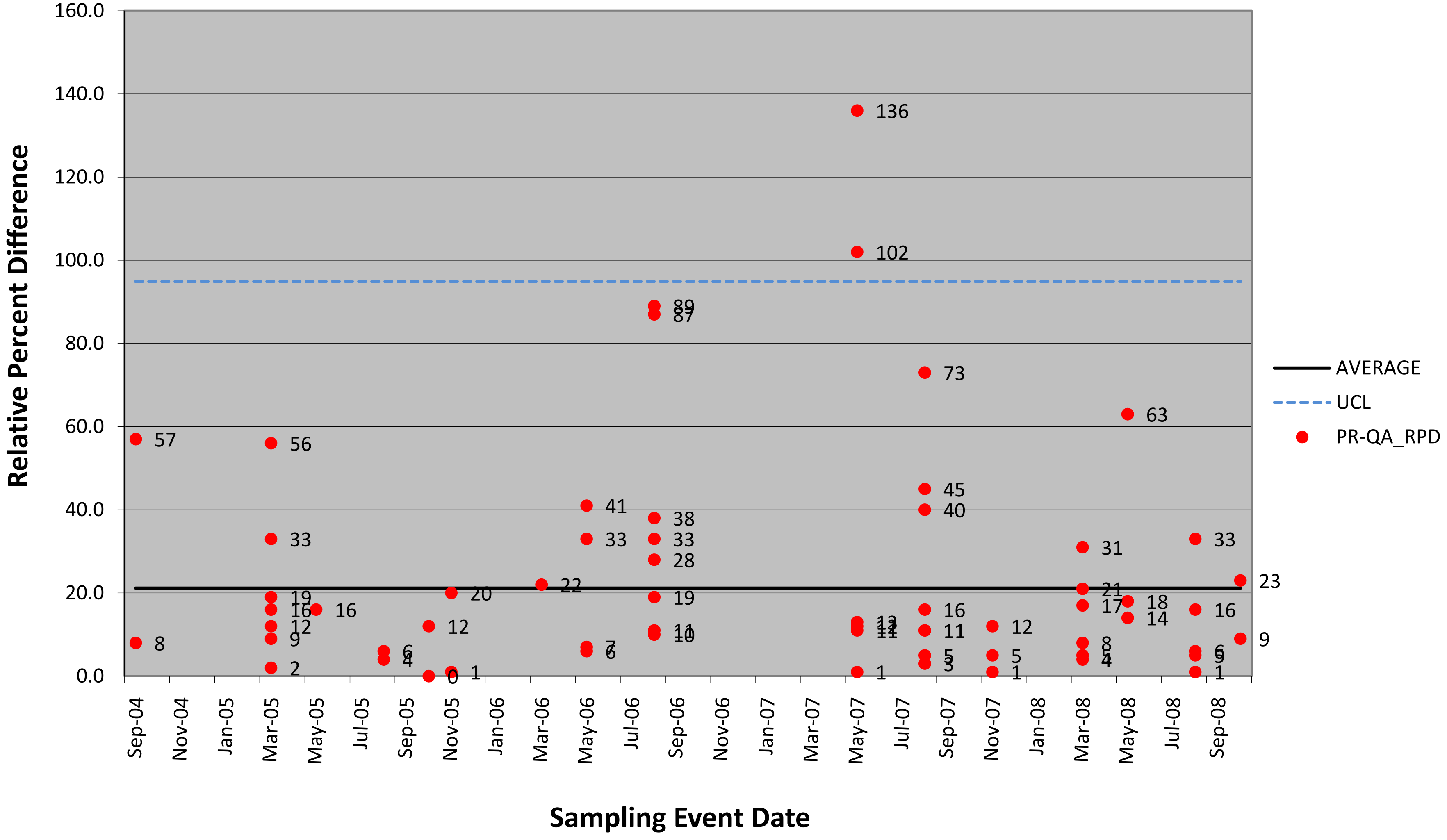


Chart A-94: Antimony Control Chart for September 2004-October 2008 Groundwater

Chart A-95: Arsenic Control Chart for September 2004-October 2008 Groundwater

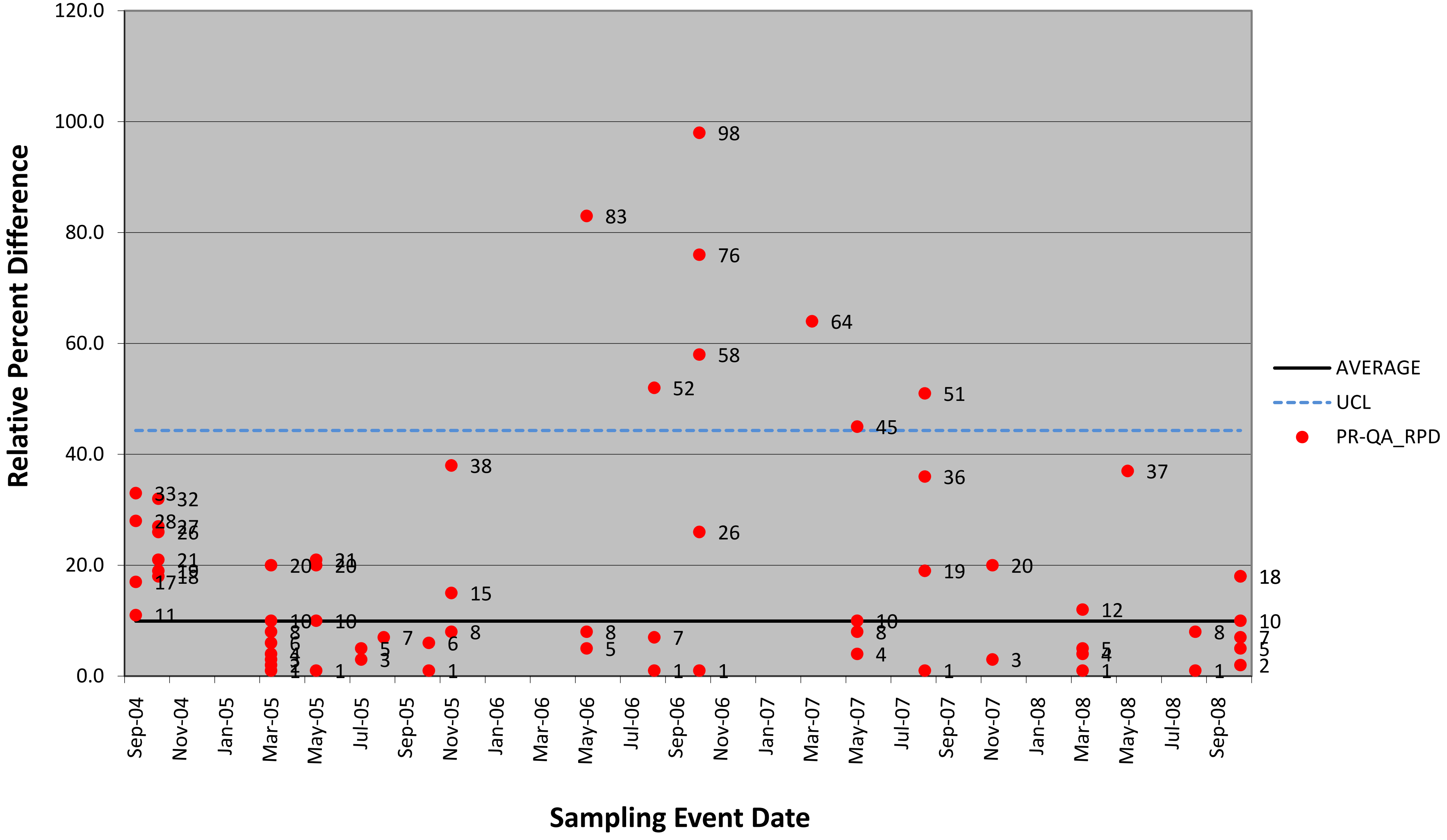


Chart A-96: Barium Control Chart for September 2004-October 2008 Groundwater

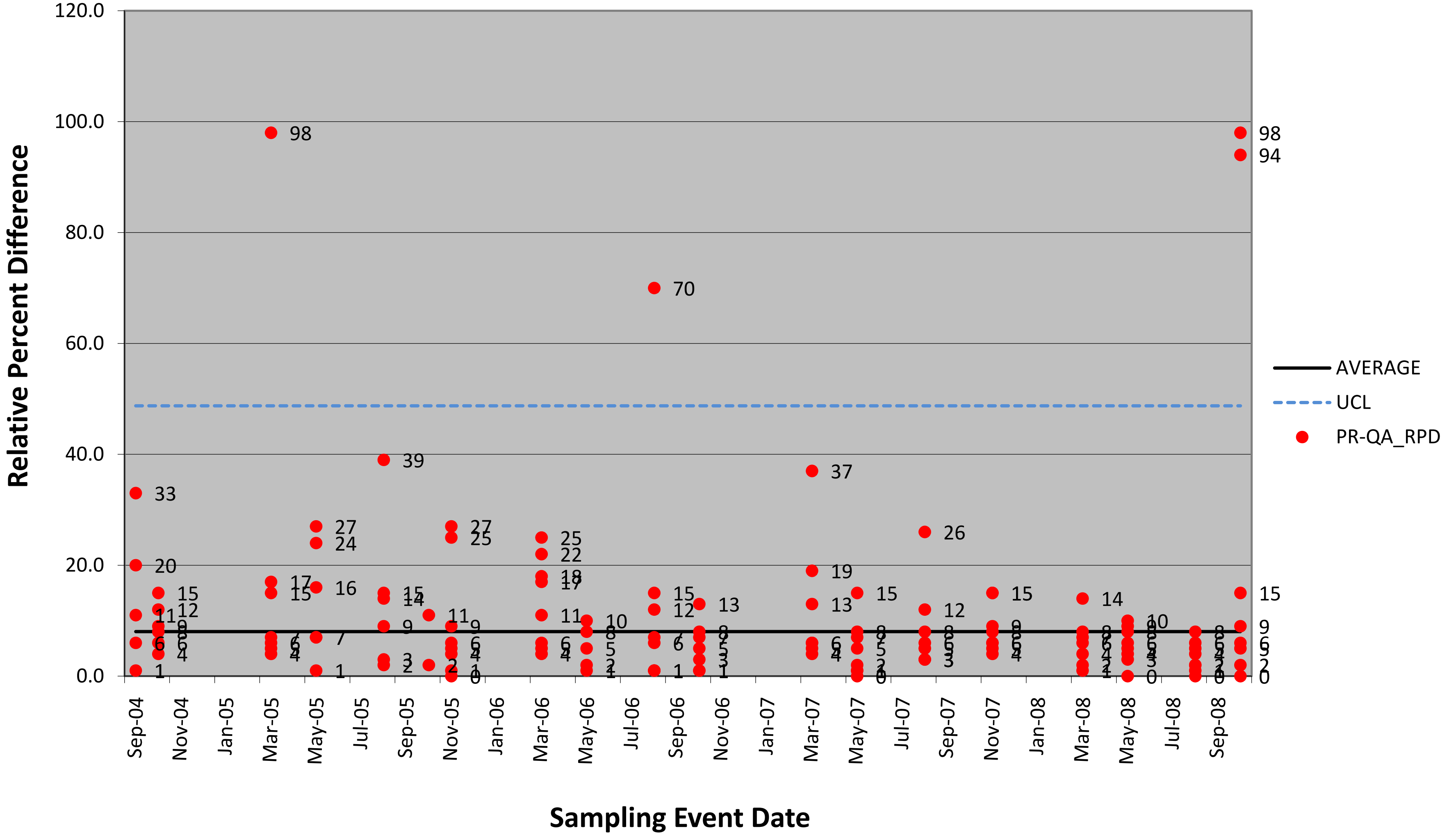


Chart A-97: Beryllium Control Chart for September 2004-October 2008 Groundwater

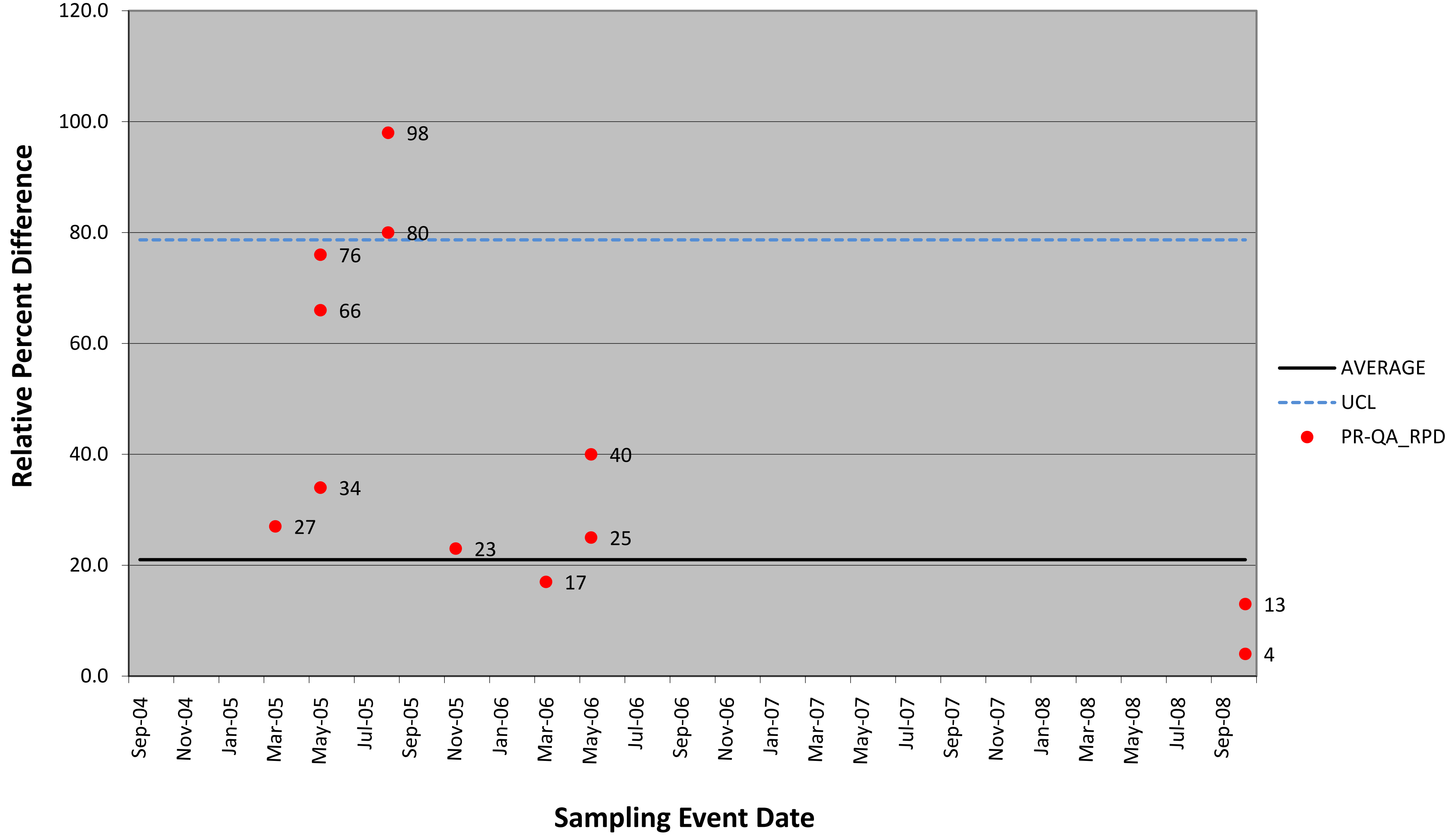
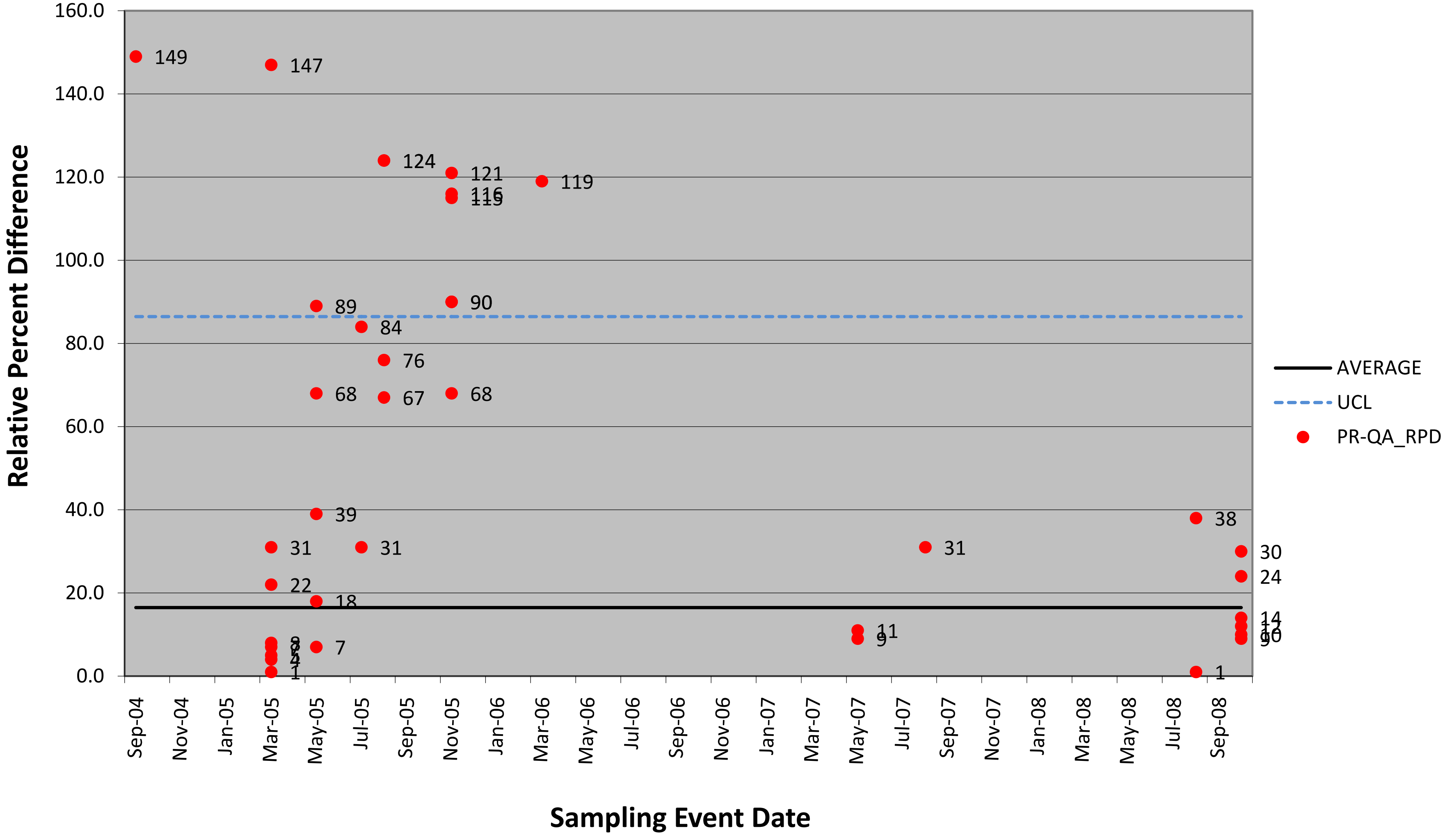


Chart A-98: Boron Control Chart for September 2004-October 2008 Groundwater



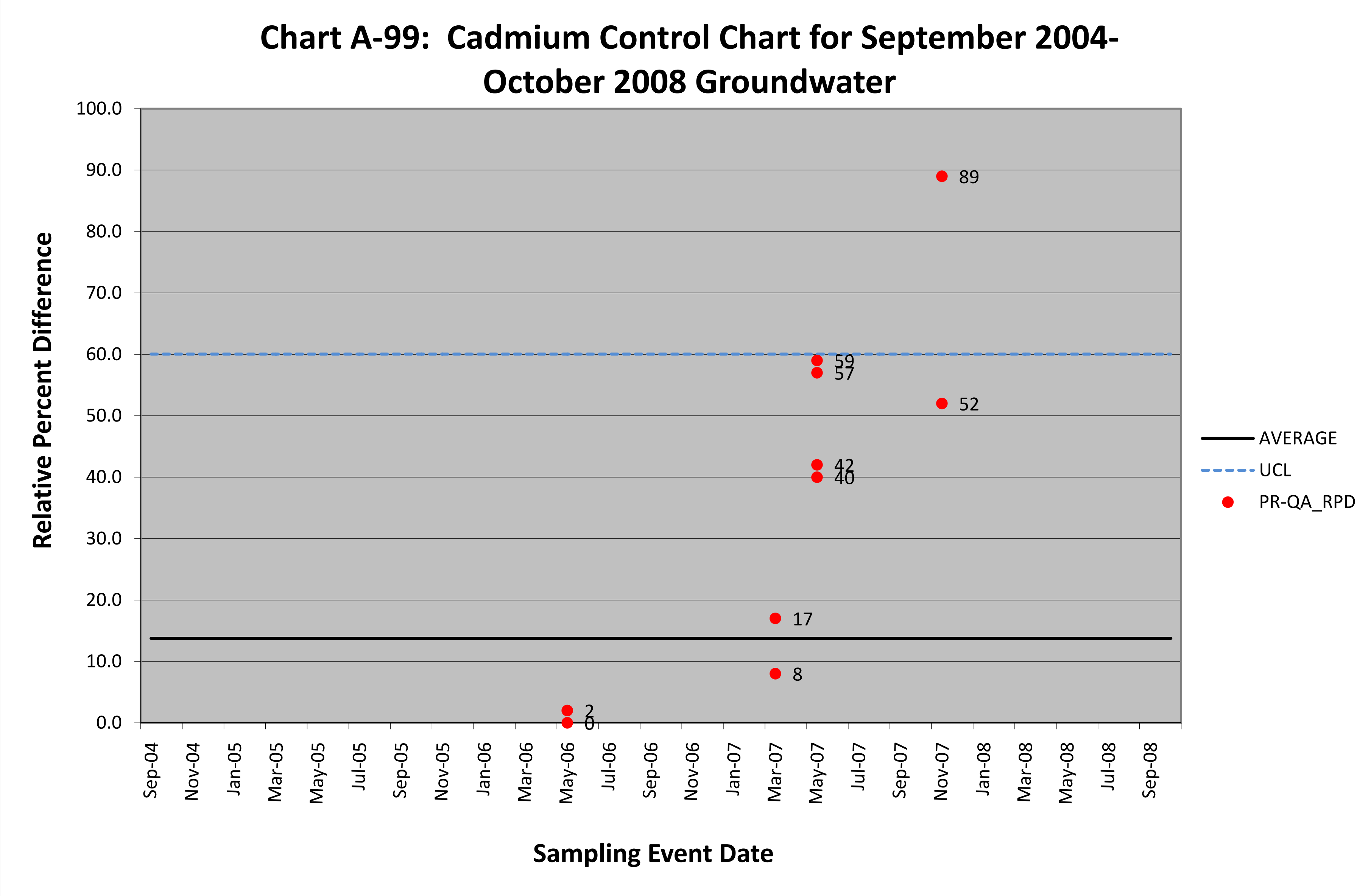


Chart A-99: Cadmium Control Chart for September 2004-October 2008 Groundwater
Relative Percent Difference
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
89
59
57
52
42
40
17
8
2
0
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
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Jan-08
Mar-08
May-08
Jul-08
Sep-08
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD

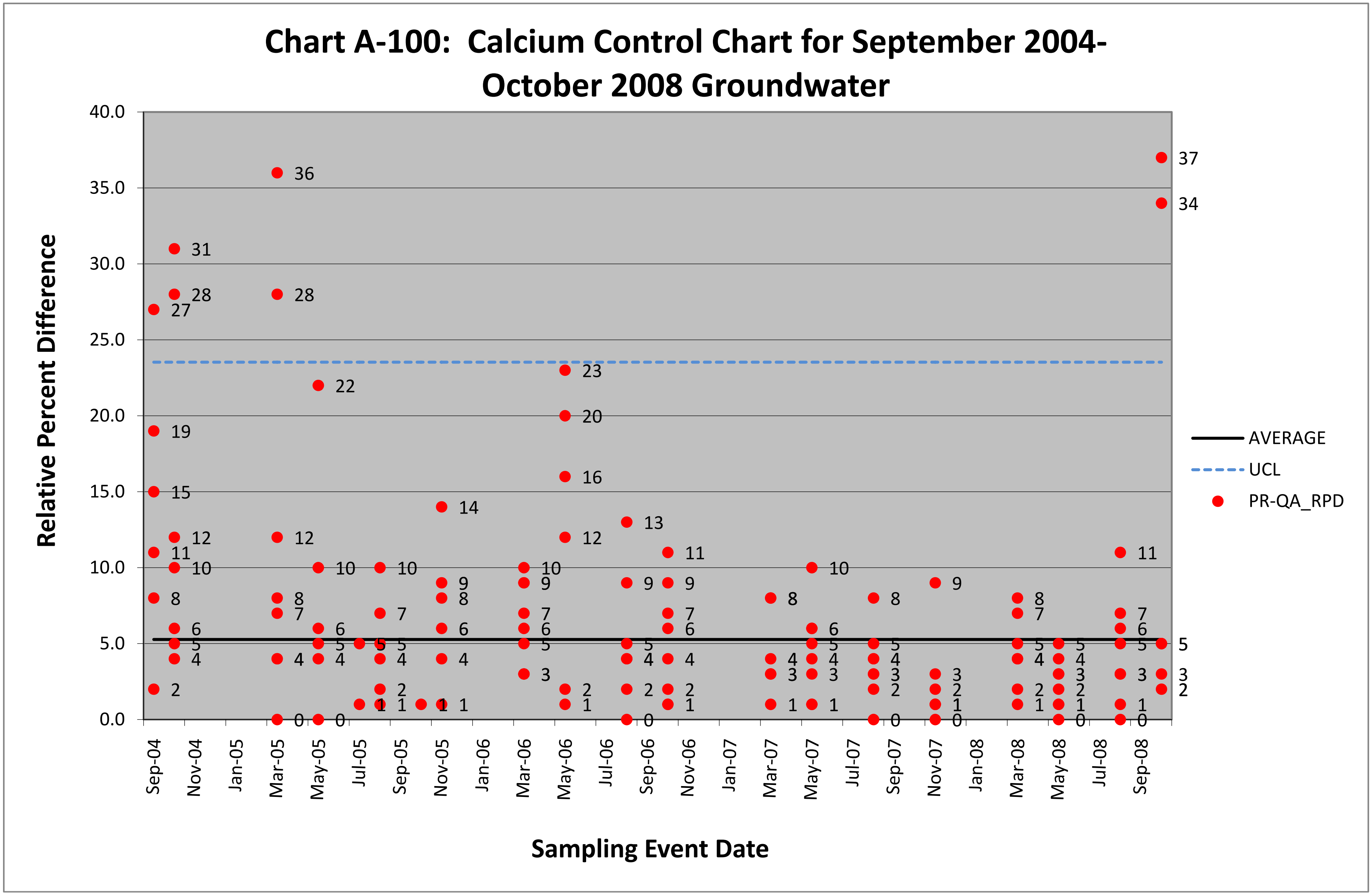


Chart A-100: Calcium Control Chart for September 2004-October 2008 Groundwater

Chart A-101: Chromium Control Chart for September 2004-October 2008 Groundwater

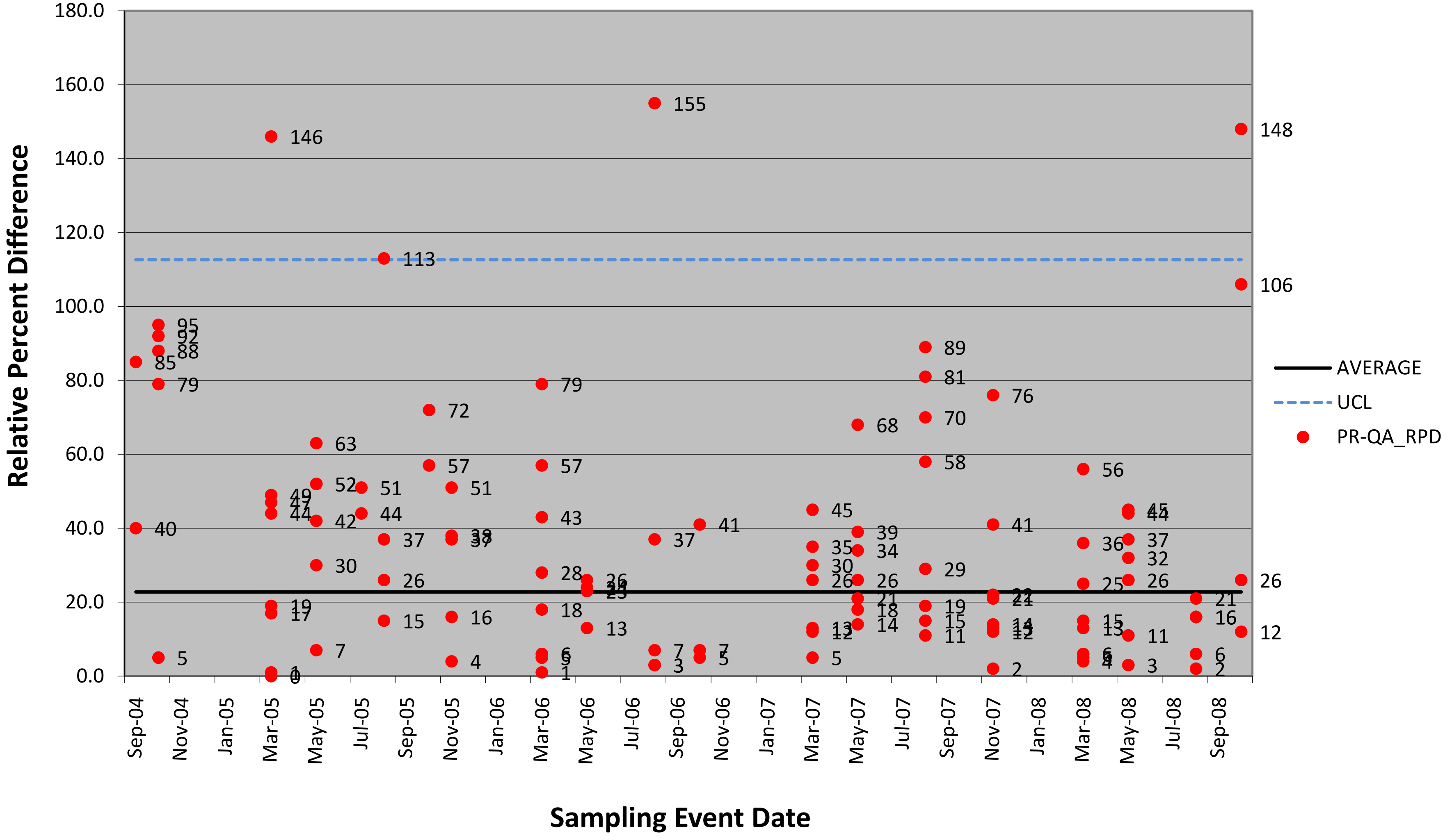


Chart A-102: Cobalt Control Chart for September 2004-October 2008 Groundwater

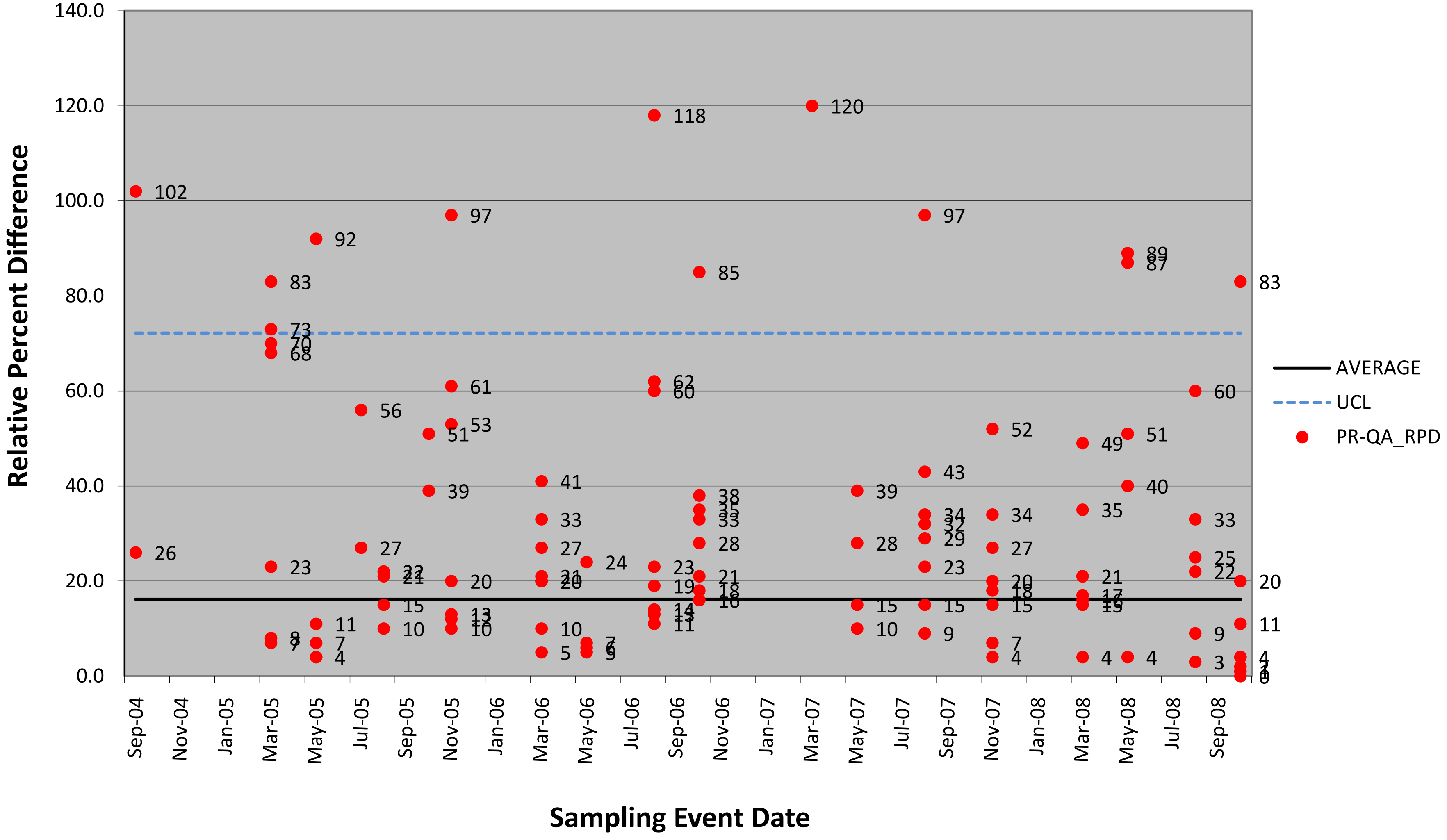
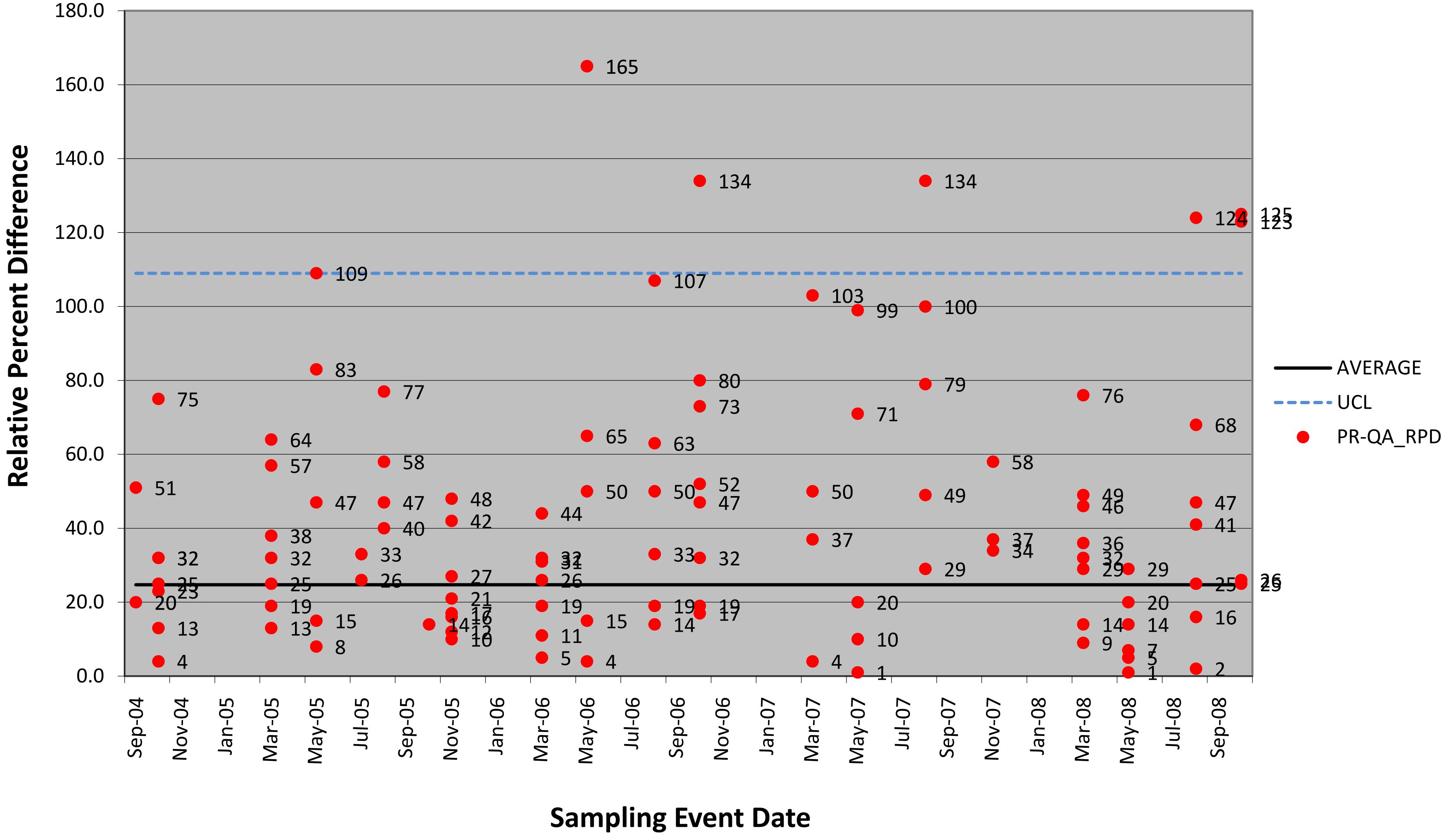


Chart A-103: Copper Control Chart for September 2004-October 2008 Groundwater



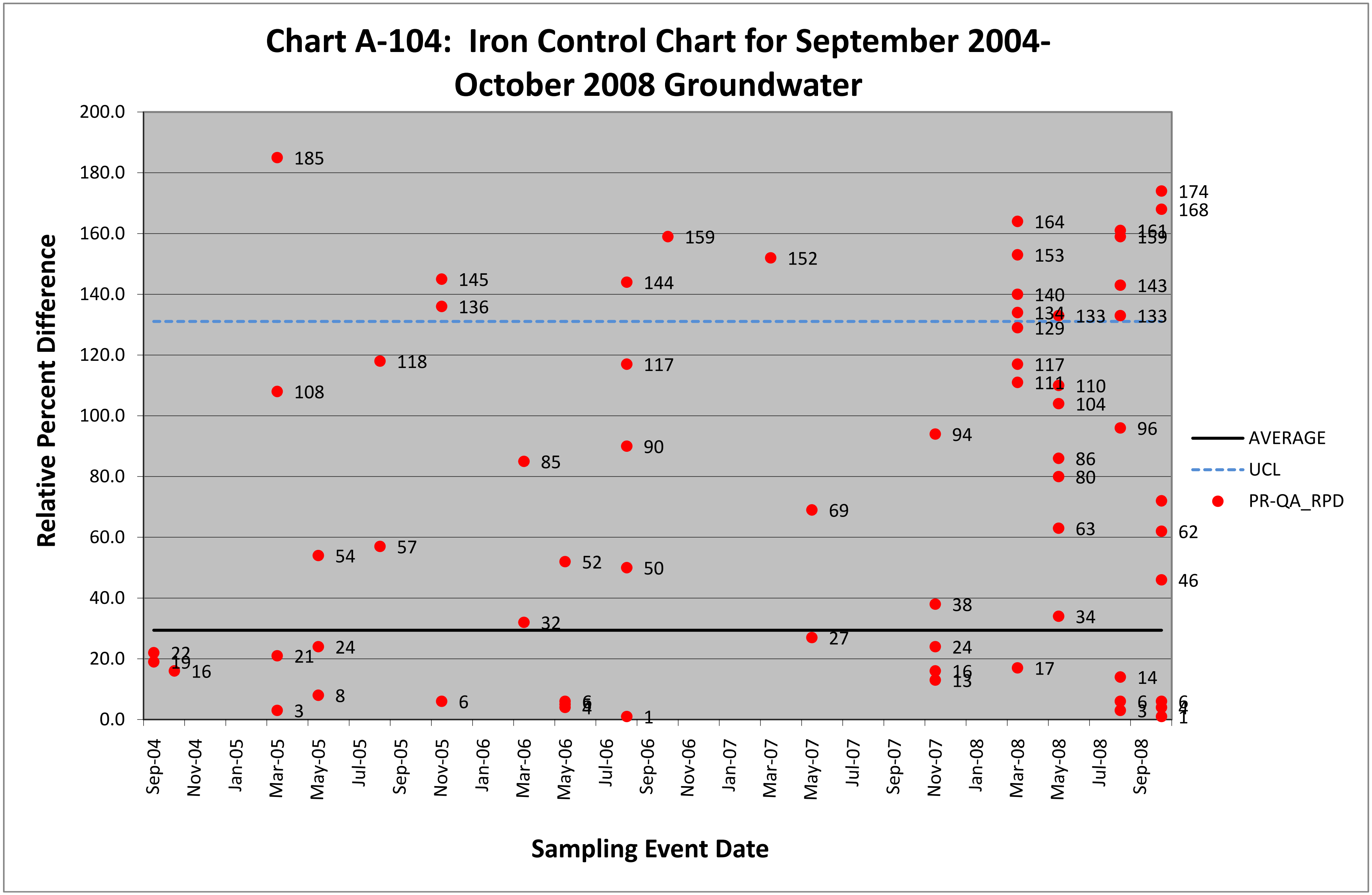


Chart A-104: Iron Control Chart for September 2004-October 2008 Groundwater

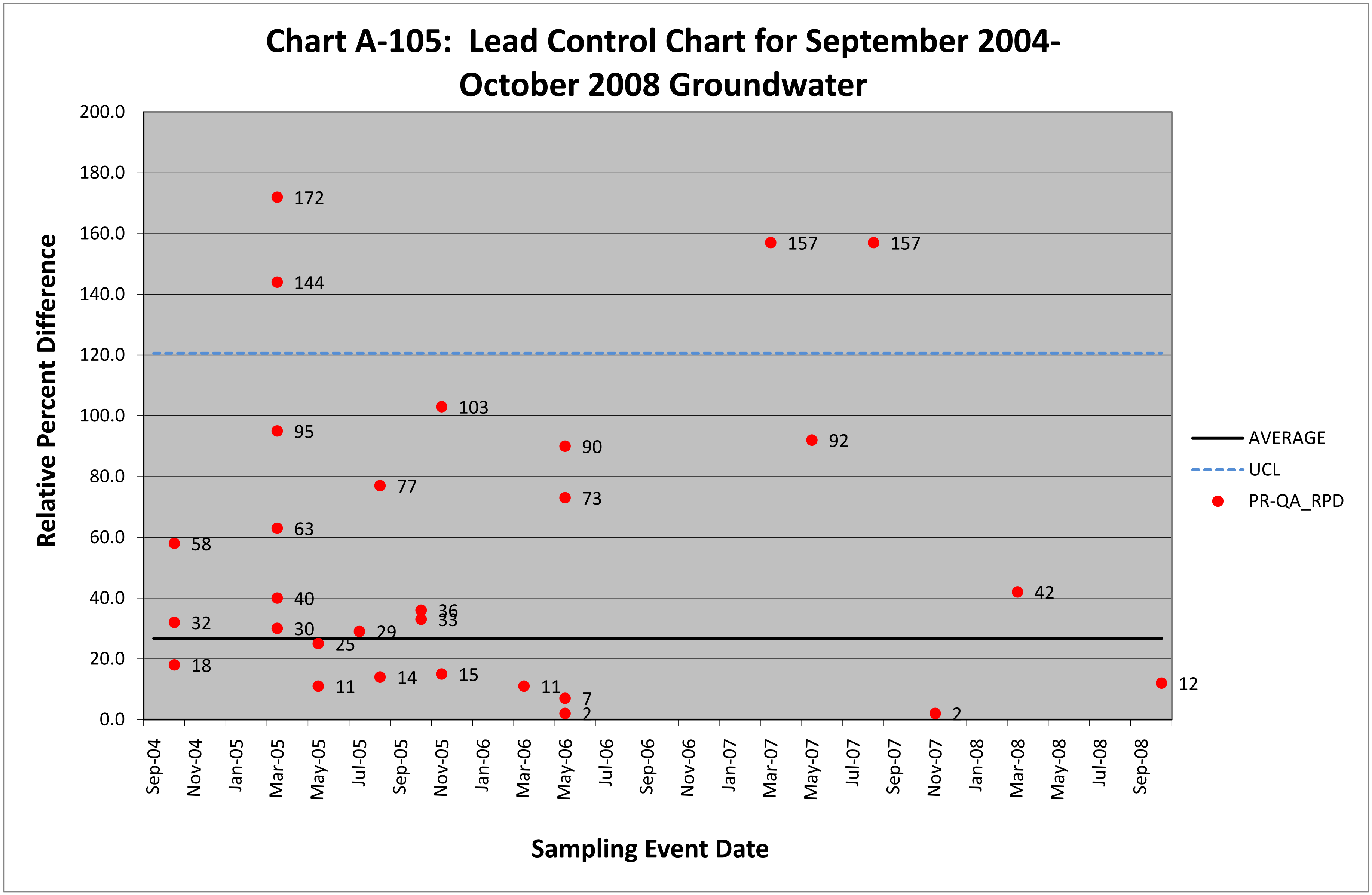
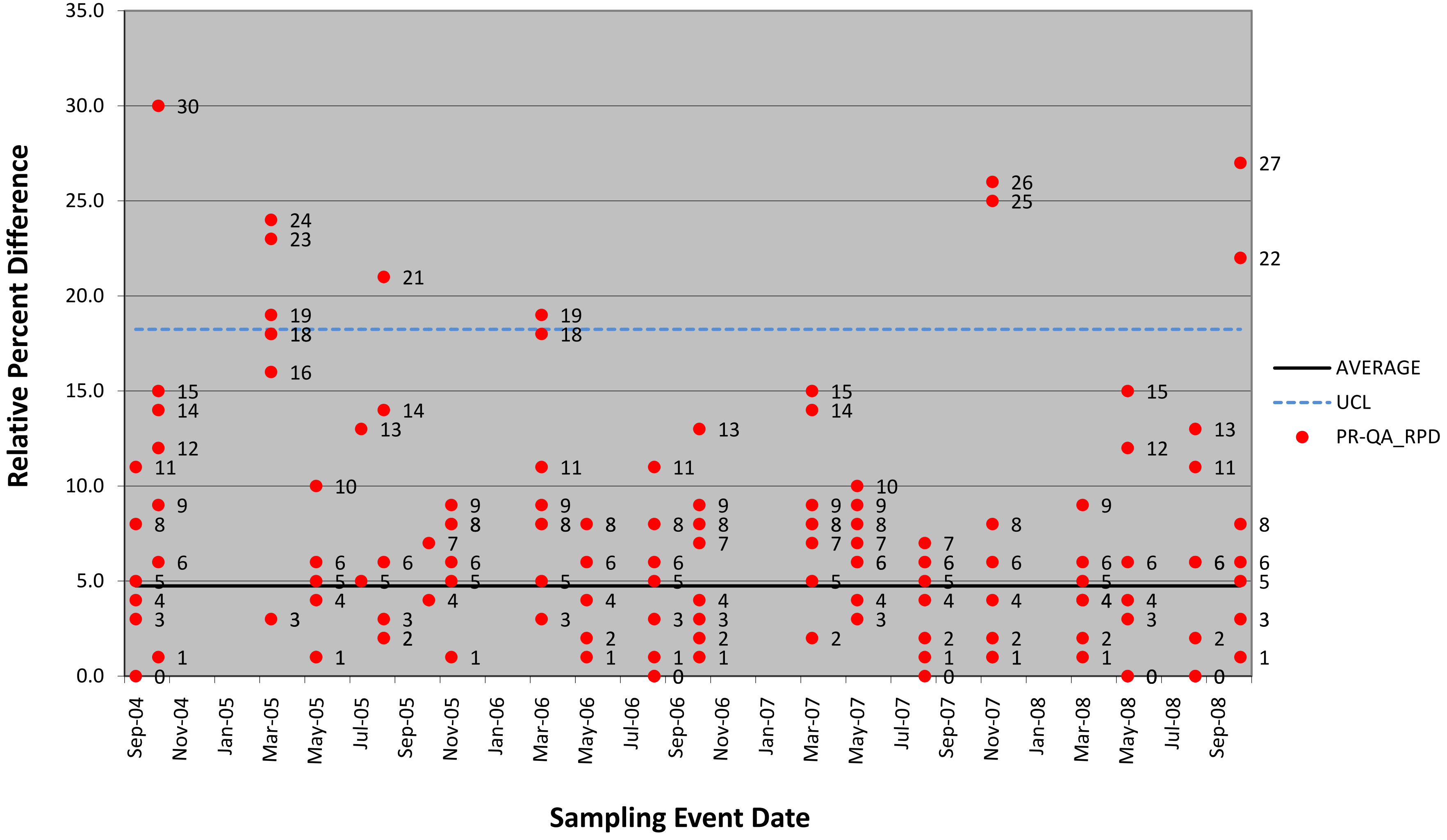


Chart A-105: Lead Control Chart for September 2004-October 2008 Groundwater

Chart A-106: Magnesium Control Chart for September 2004-October 2008 Groundwater



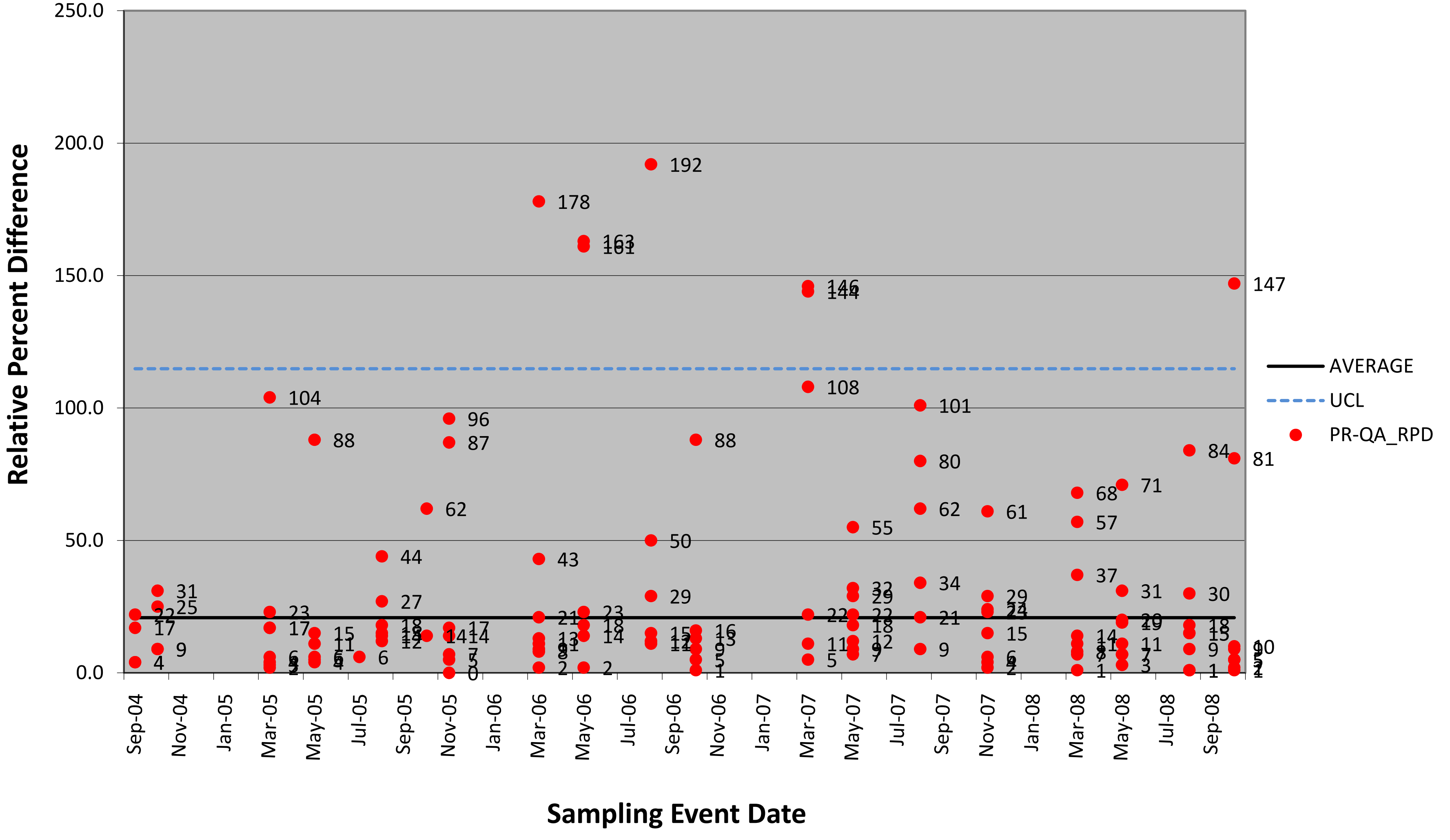


Chart A-107: Manganese Control Chart for September 2004-October 2008 Groundwater

Chart A-108: Molybdenum Control Chart for September 2004-October 2008 Groundwater

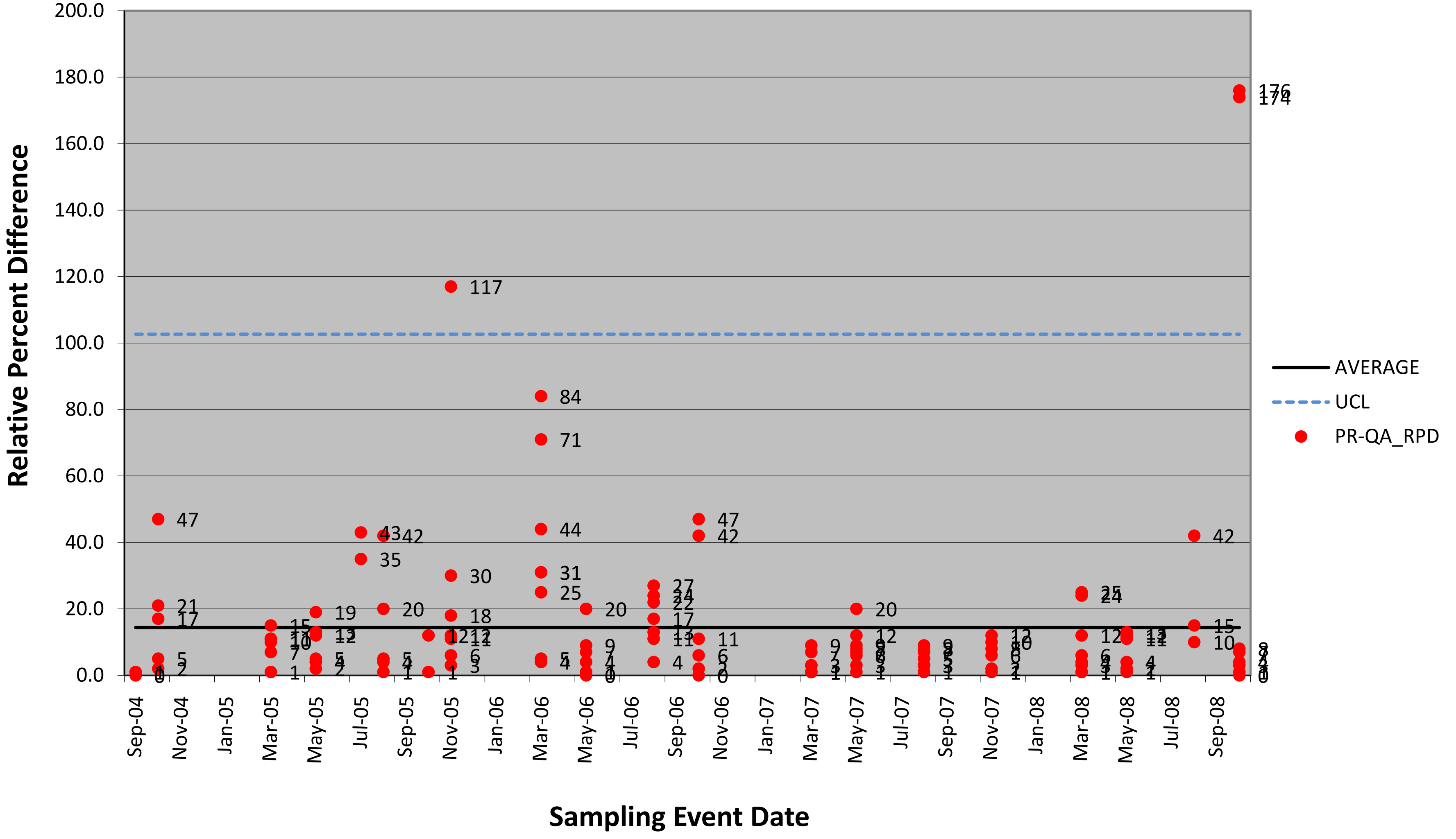


Chart A-109: Nickel Control Chart for September 2004-October 2008 Groundwater

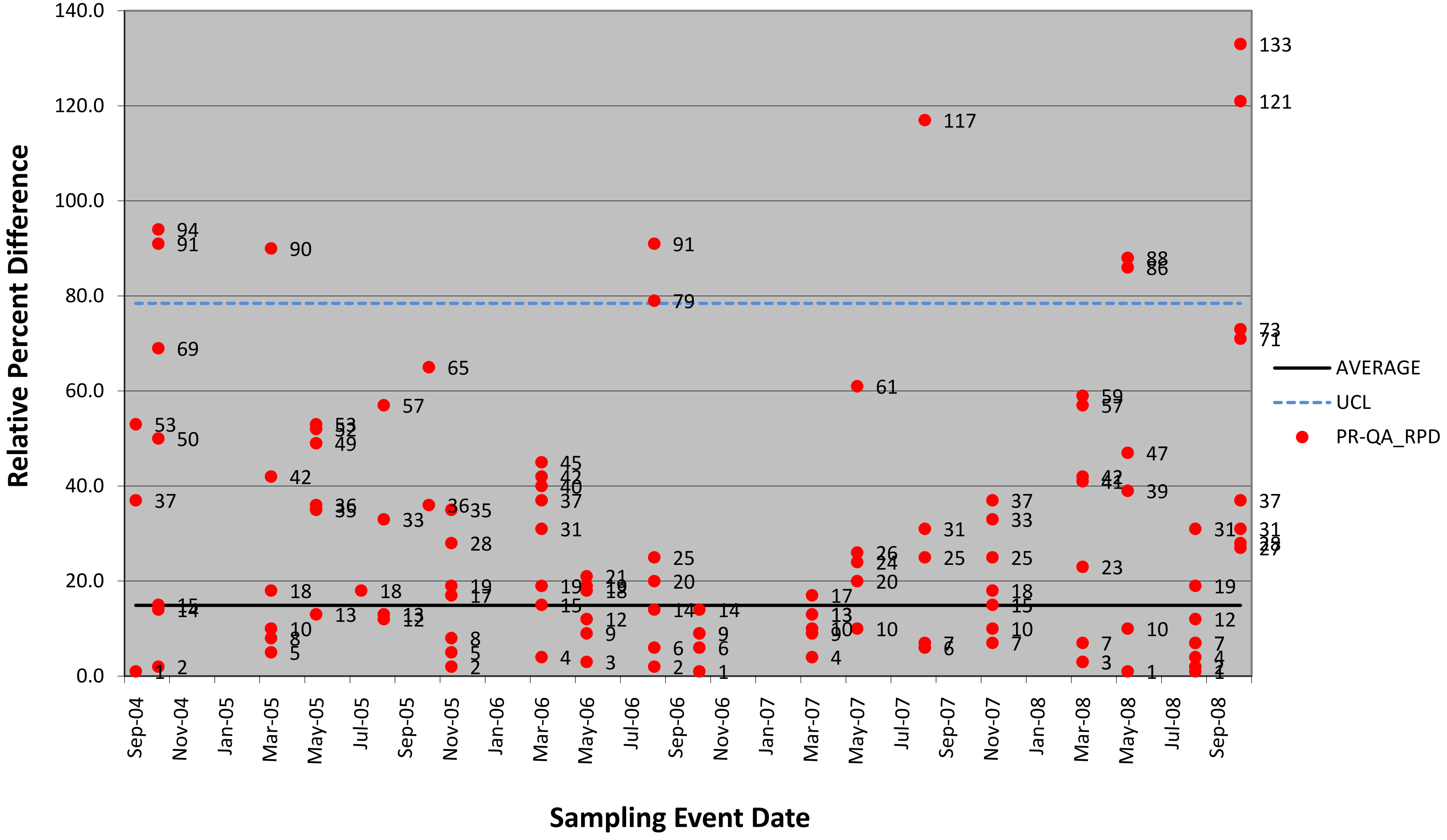


Chart A-110: Potassium Control Chart for September 2004-October 2008 Groundwater

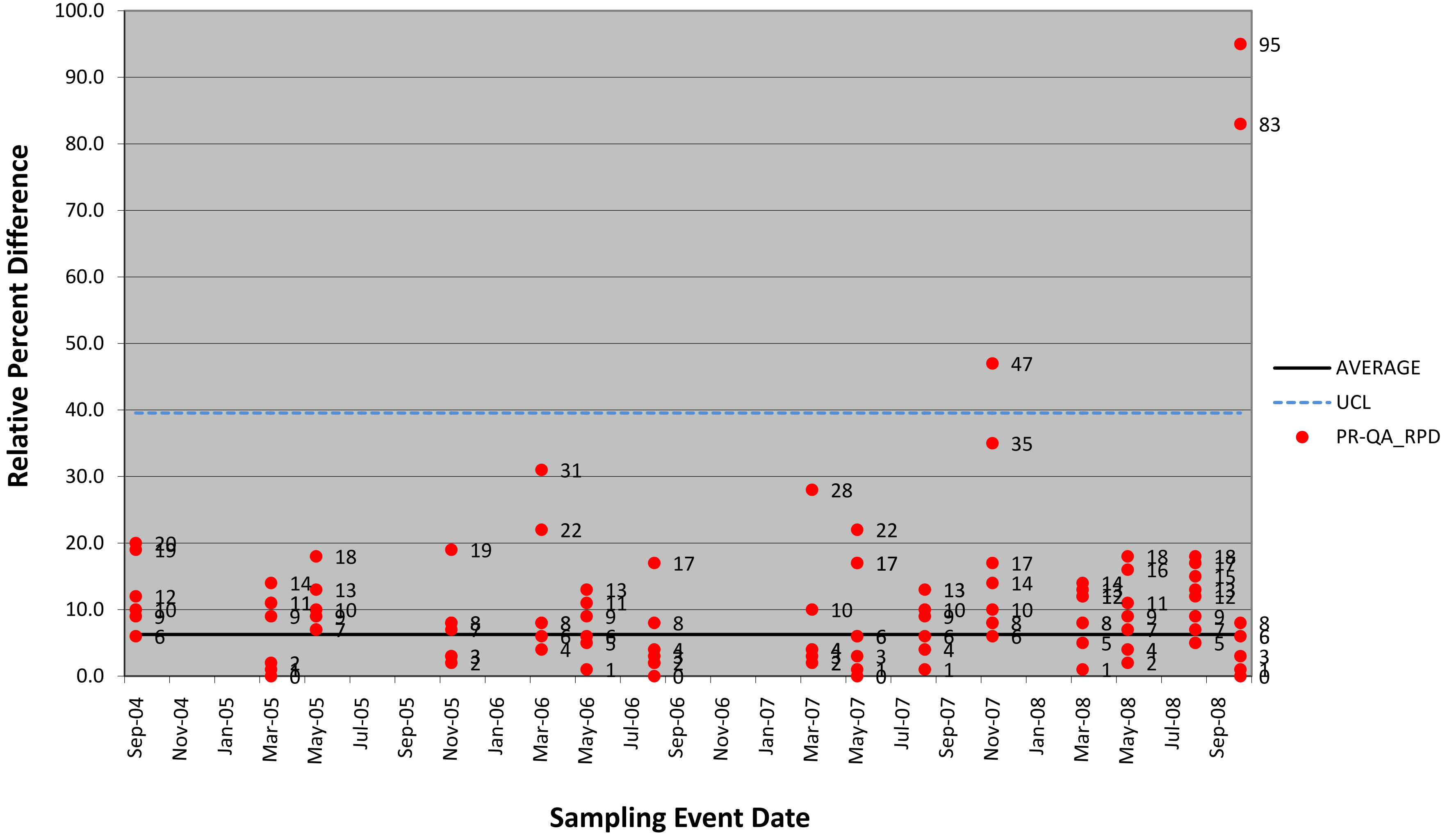


Chart A-111: Selenium Control Chart for September 2004-October 2008 Groundwater

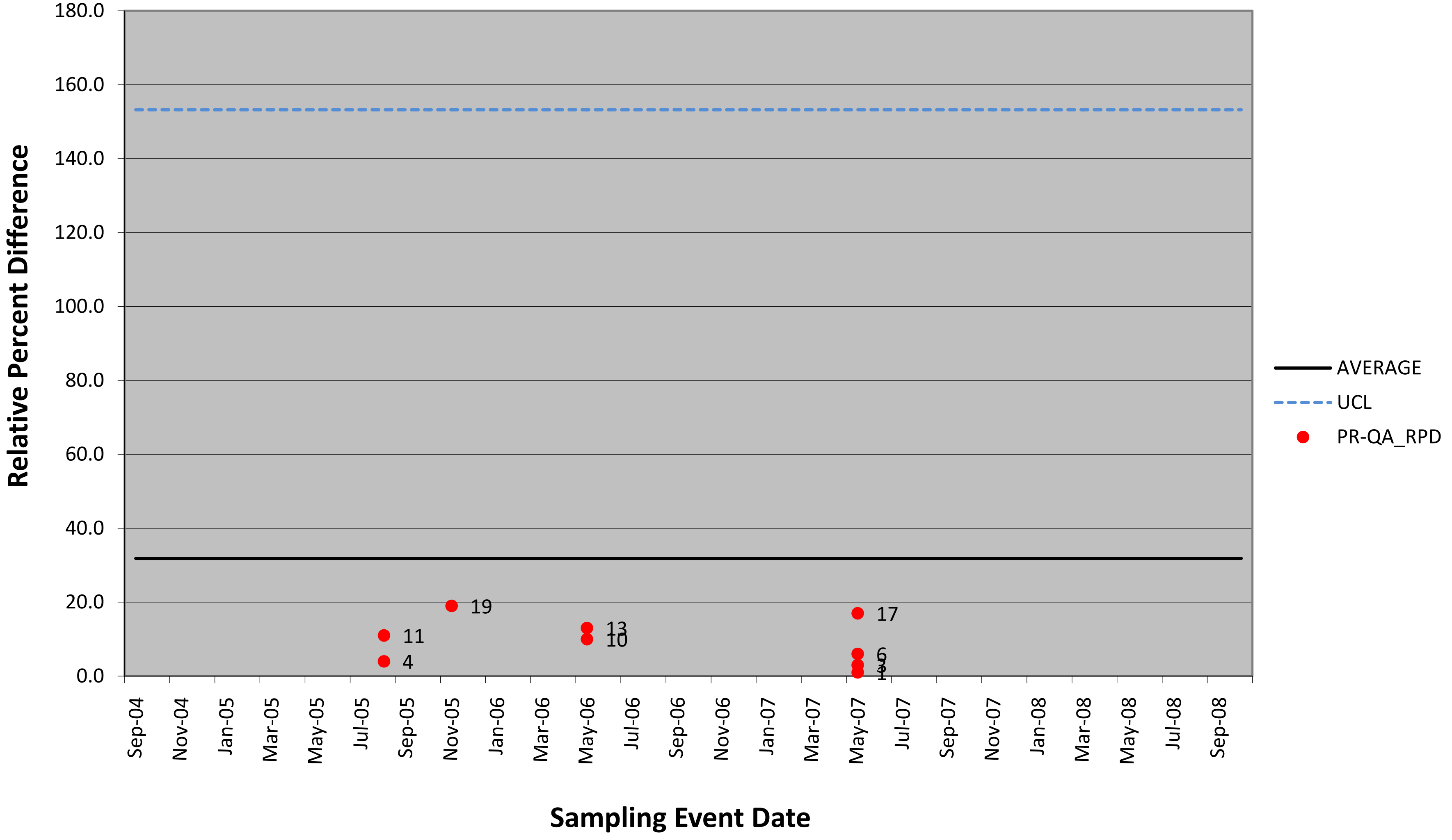
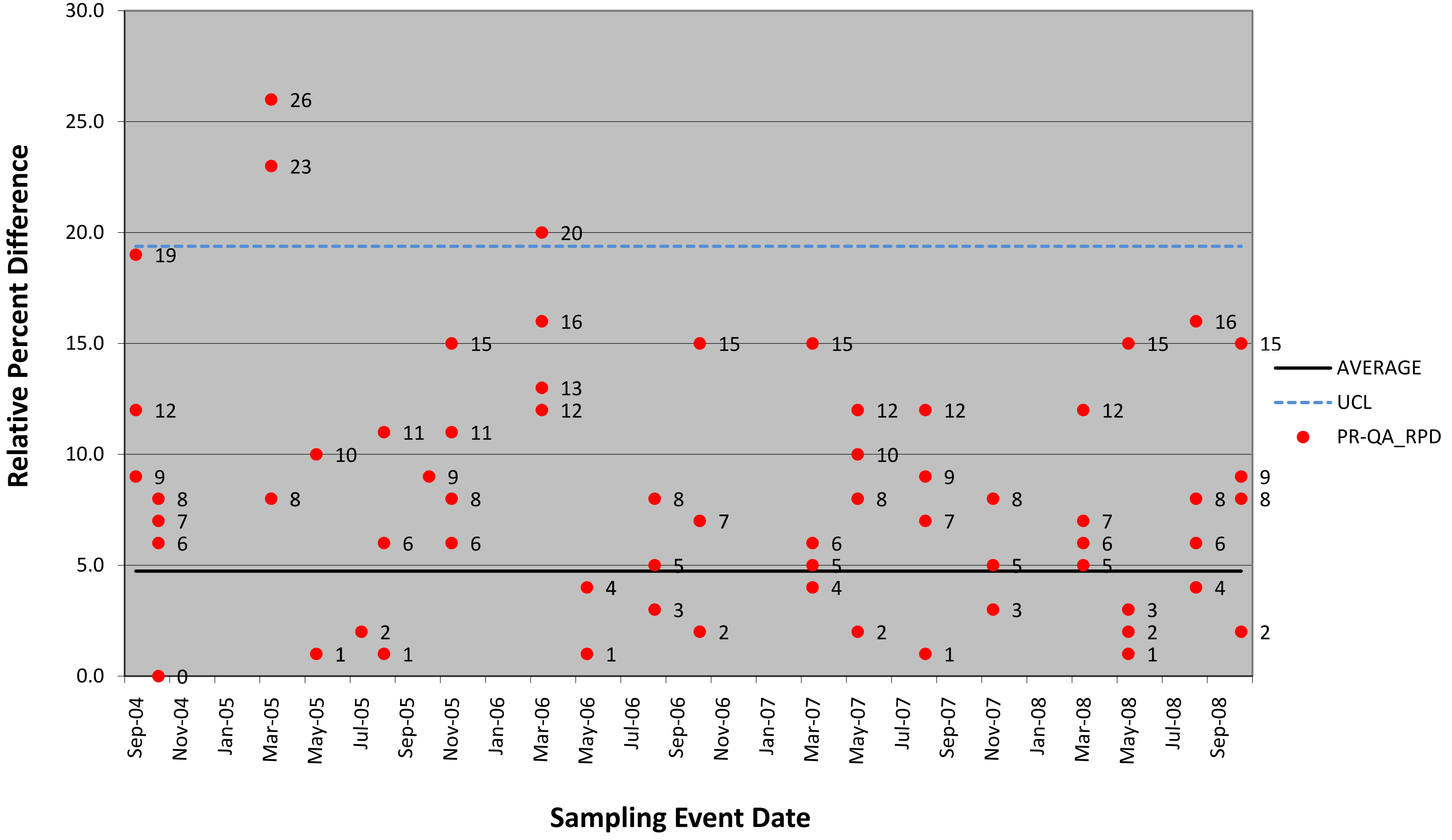


Chart A-112: Silicon Control Chart for September 2004-October 2008 Groundwater



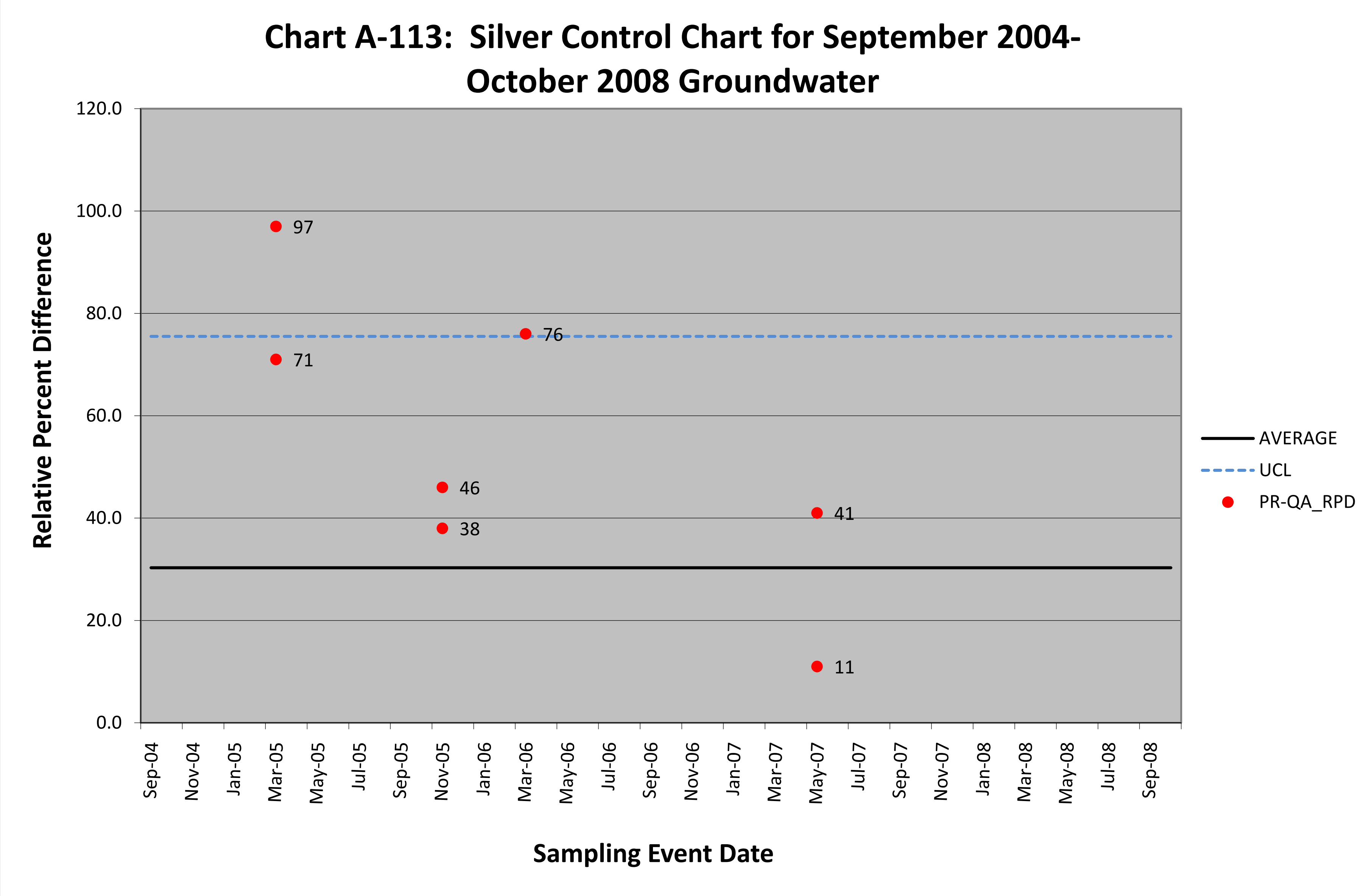


Chart A-113: Silver Control Chart for September 2004-October 2008 Groundwater
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
97
71
76
46
38
41
11
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD

Chart A-114: Sodium Control Chart for September 2004-October 2008 Groundwater

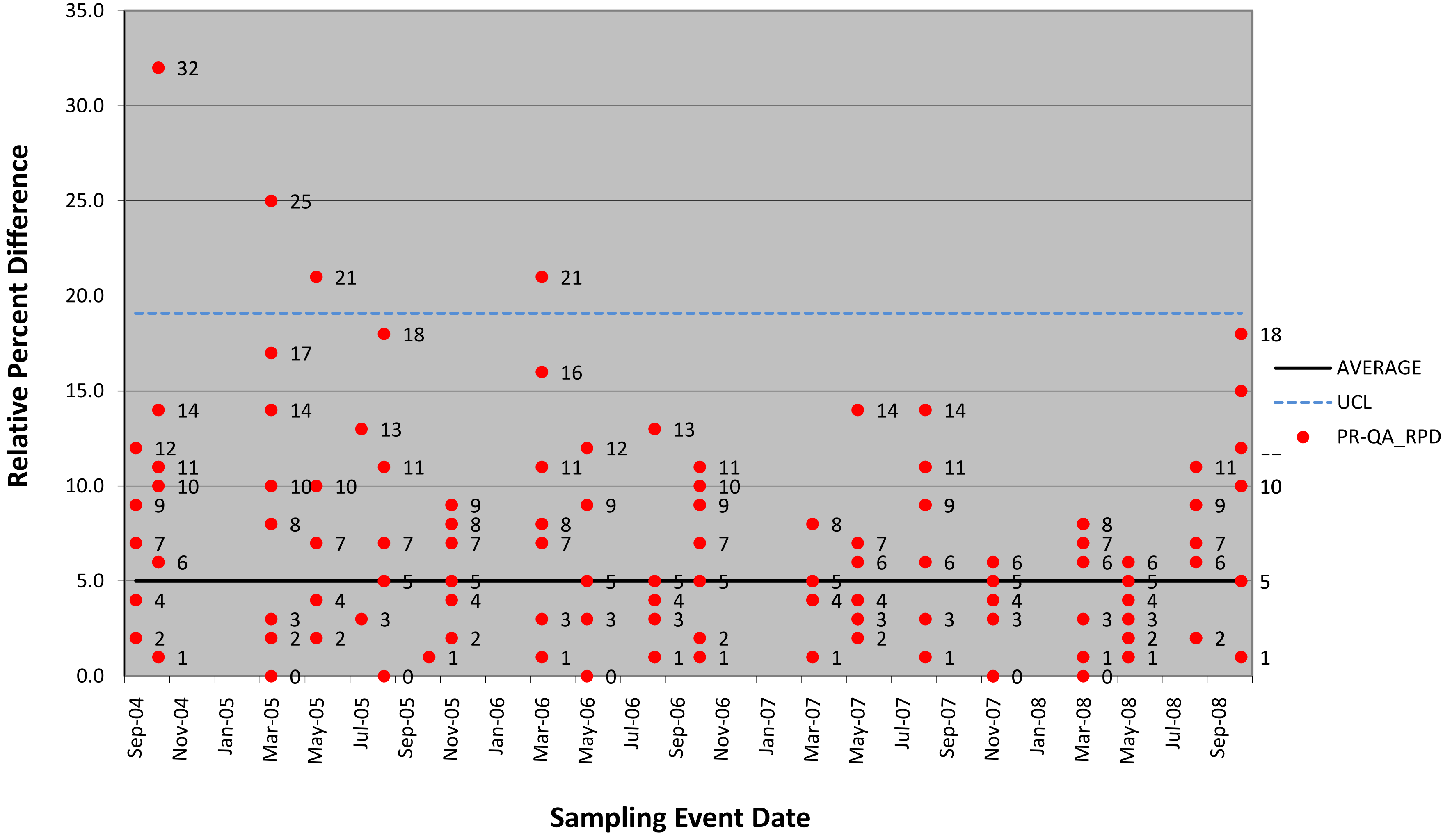
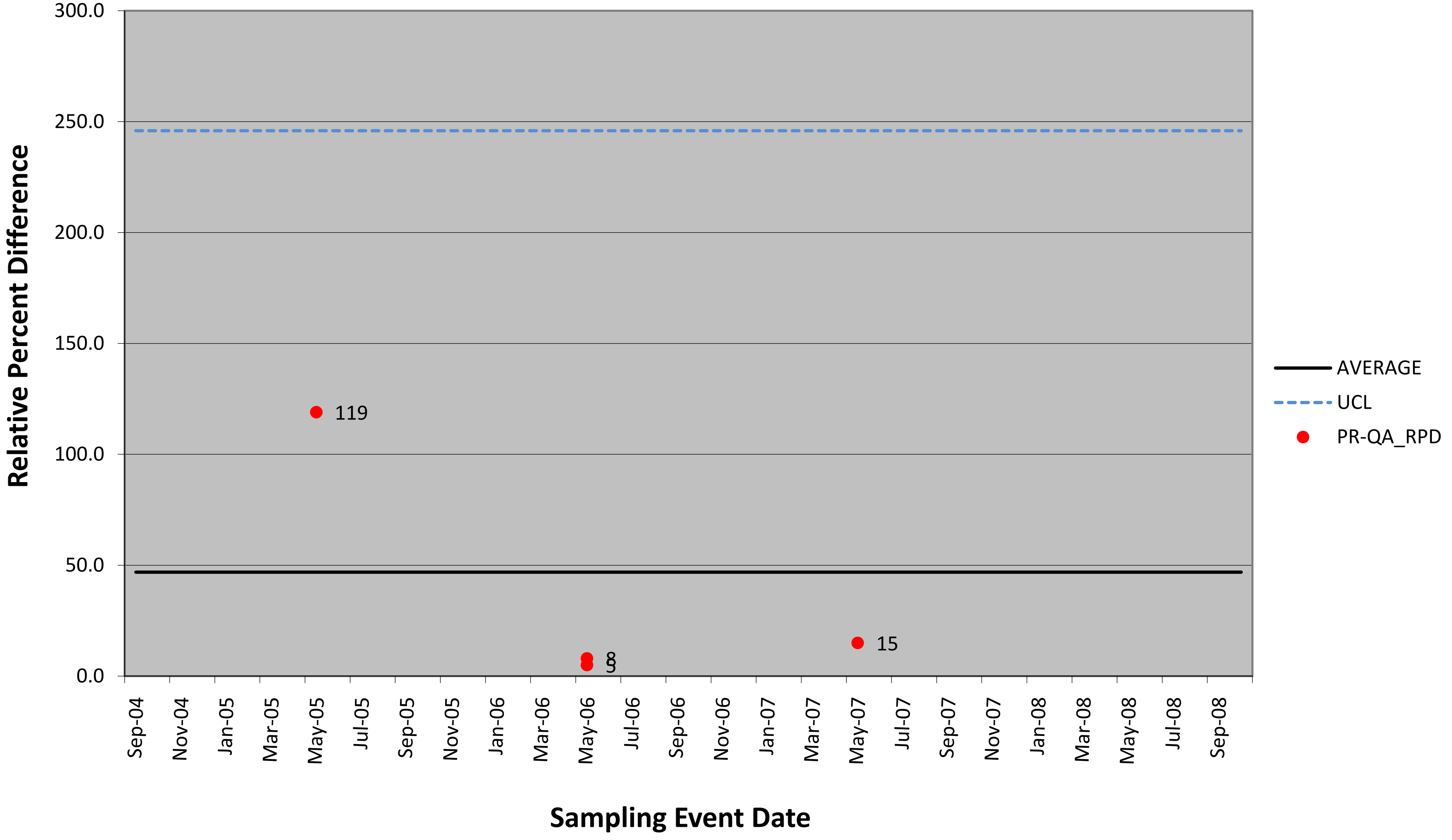


Chart A-115: Thallium Control Chart for September 2004-October 2008 Groundwater



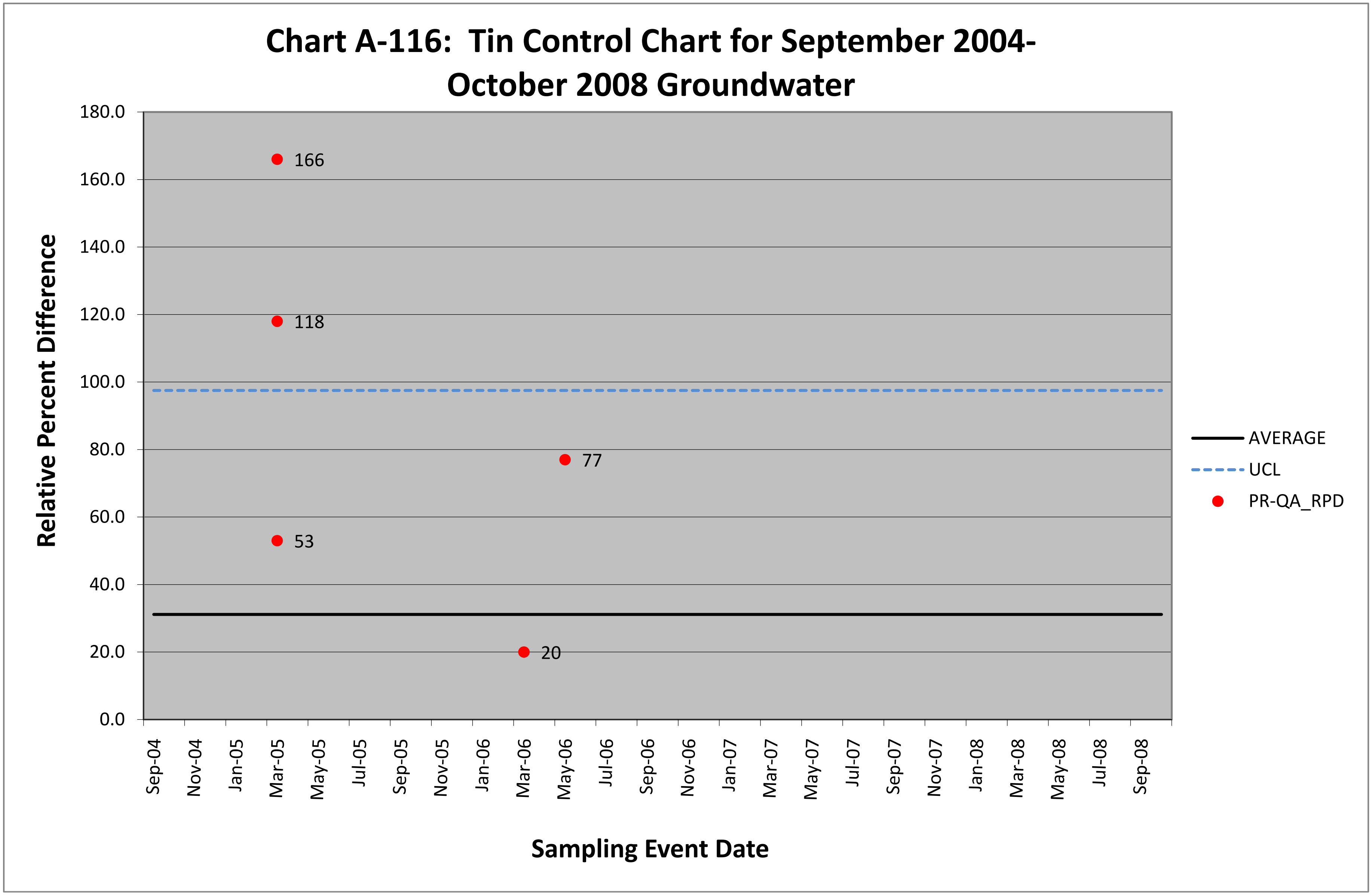


Chart A-116: Tin Control Chart for September 2004-October 2008 Groundwater
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
166
118
77
53
20
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Jul-07
Sep-07
Nov-07
Jan-08
Mar-08
May-08
Jul-08
Sep-08
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD

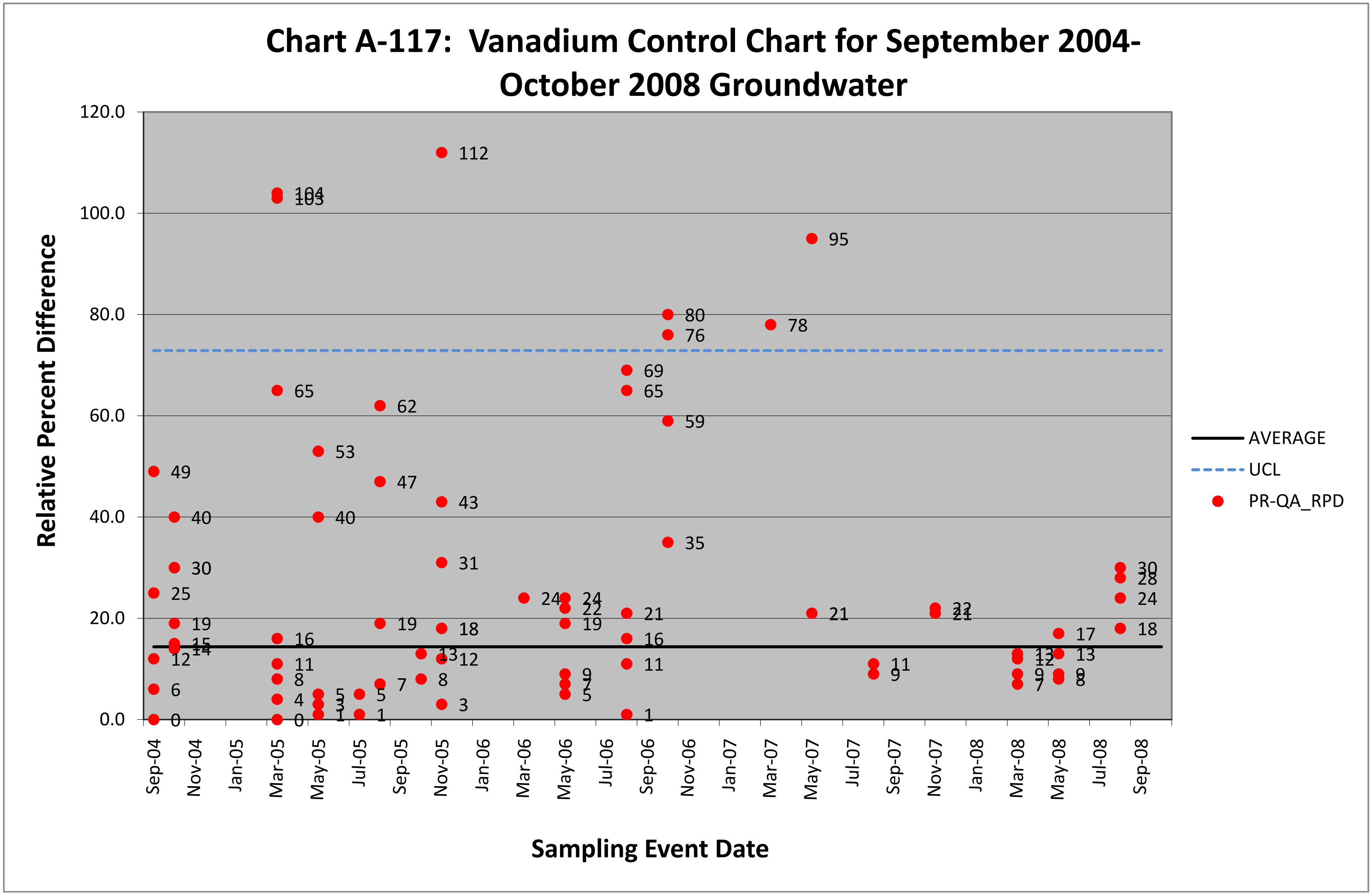
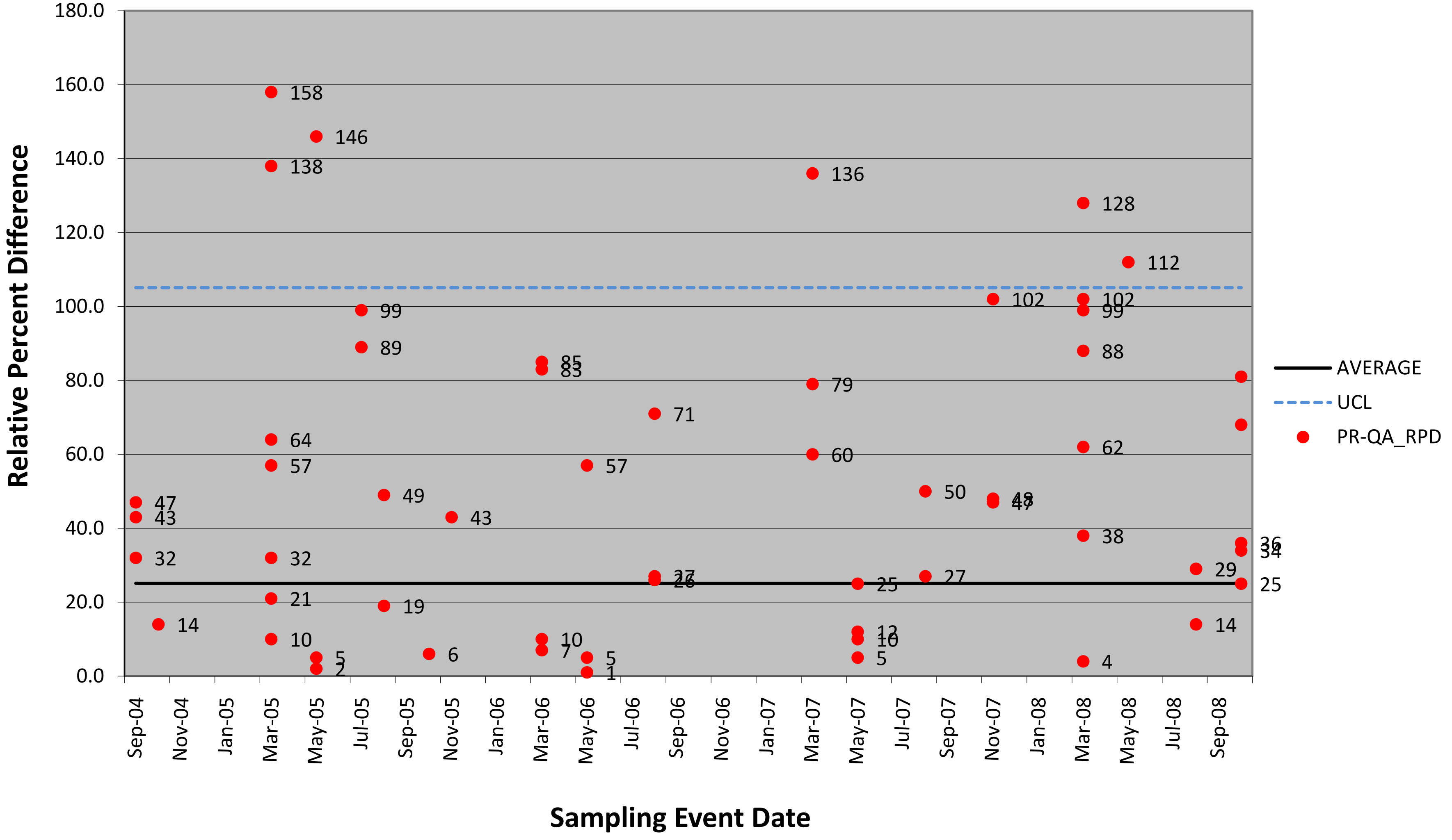


Chart A-117: Vanadium Control Chart for September 2004-October 2008 Groundwater

Chart A-118: Zinc Control Chart for September 2004-October 2008 Groundwater



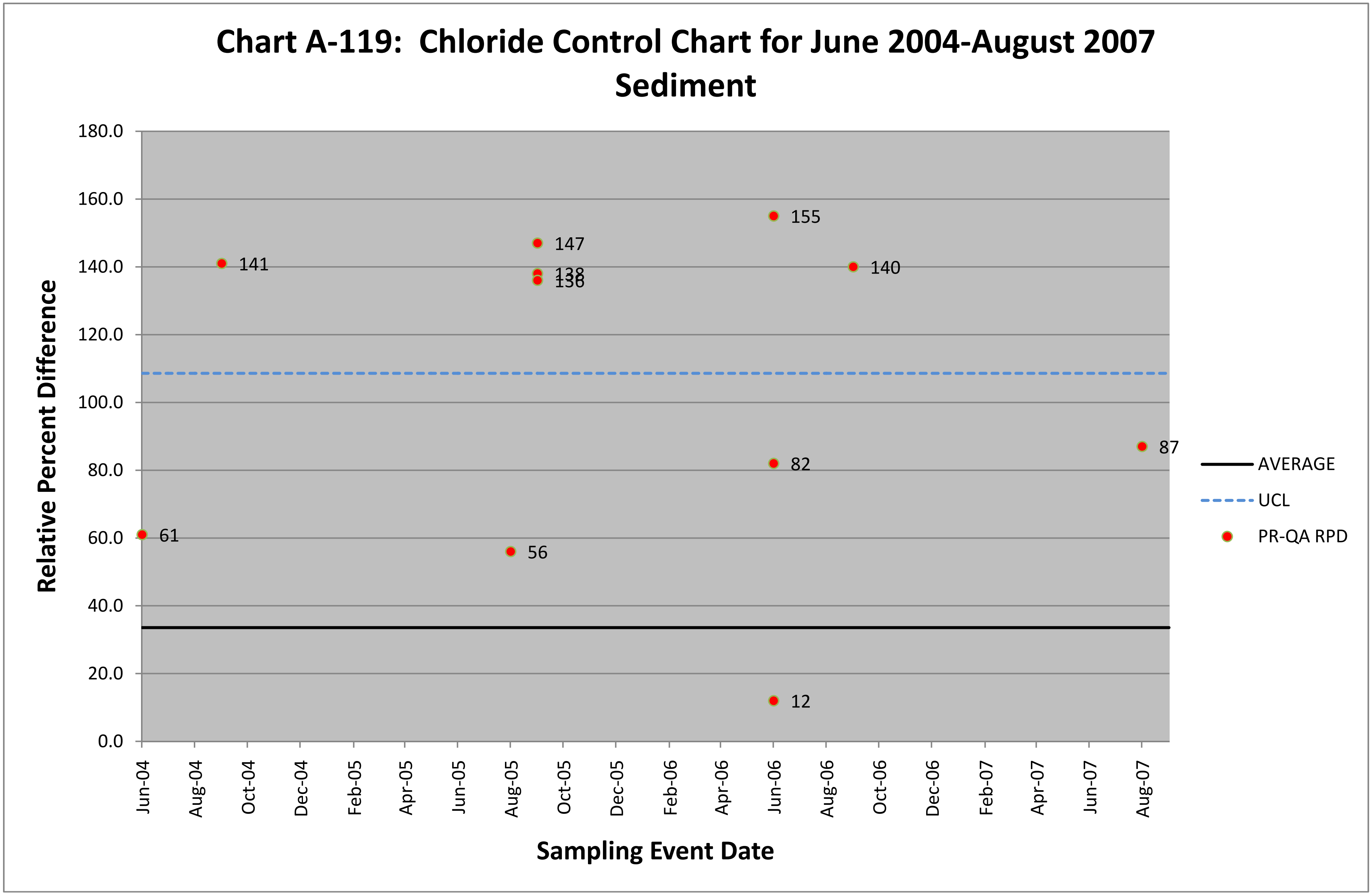


Chart A-119: Chloride Control Chart for June 2004-August 2007
Sediment
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
61
141
56
147
138
136
155
82
12
140
87
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
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Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

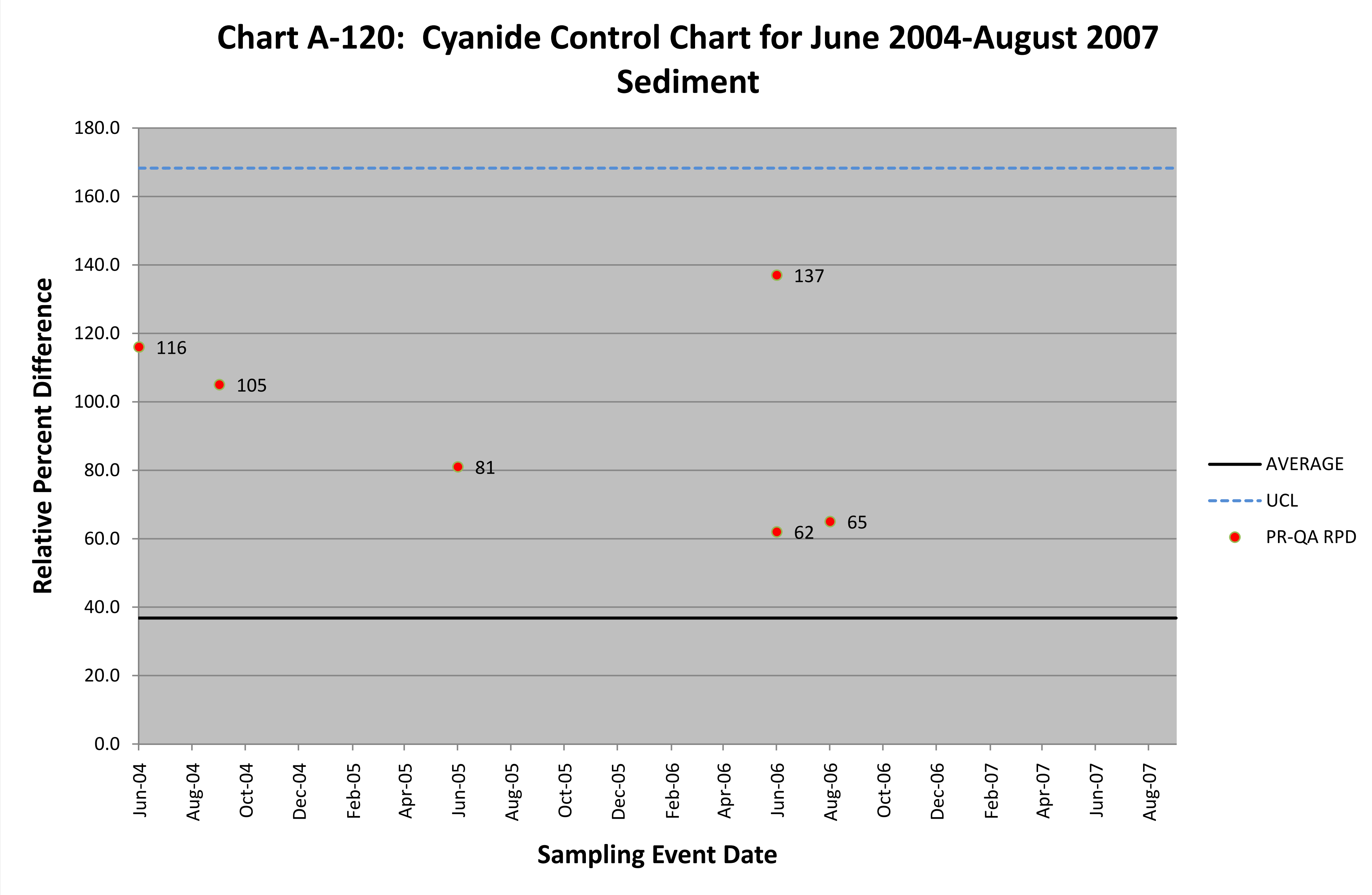


Chart A-120: Cyanide Control Chart for June 2004-August 2007
Sediment
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
137
116
105
81
62
65
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-121: Nitrogen: Ammonia (as N) Control Chart for June 2004-August 2007 Sediment

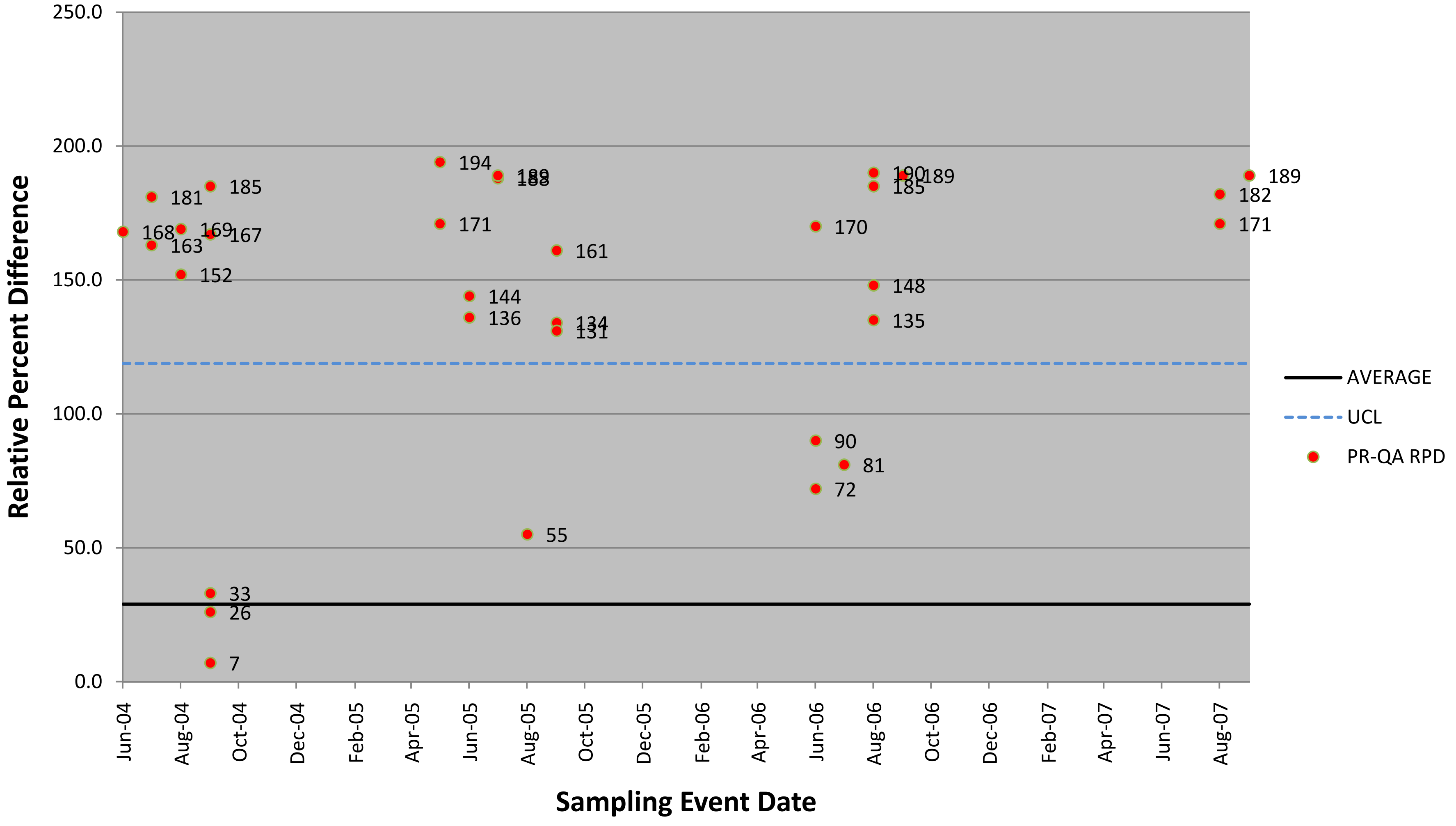


Chart A-122: Sulfate Control Chart for June 2004-August 2007 Sediment

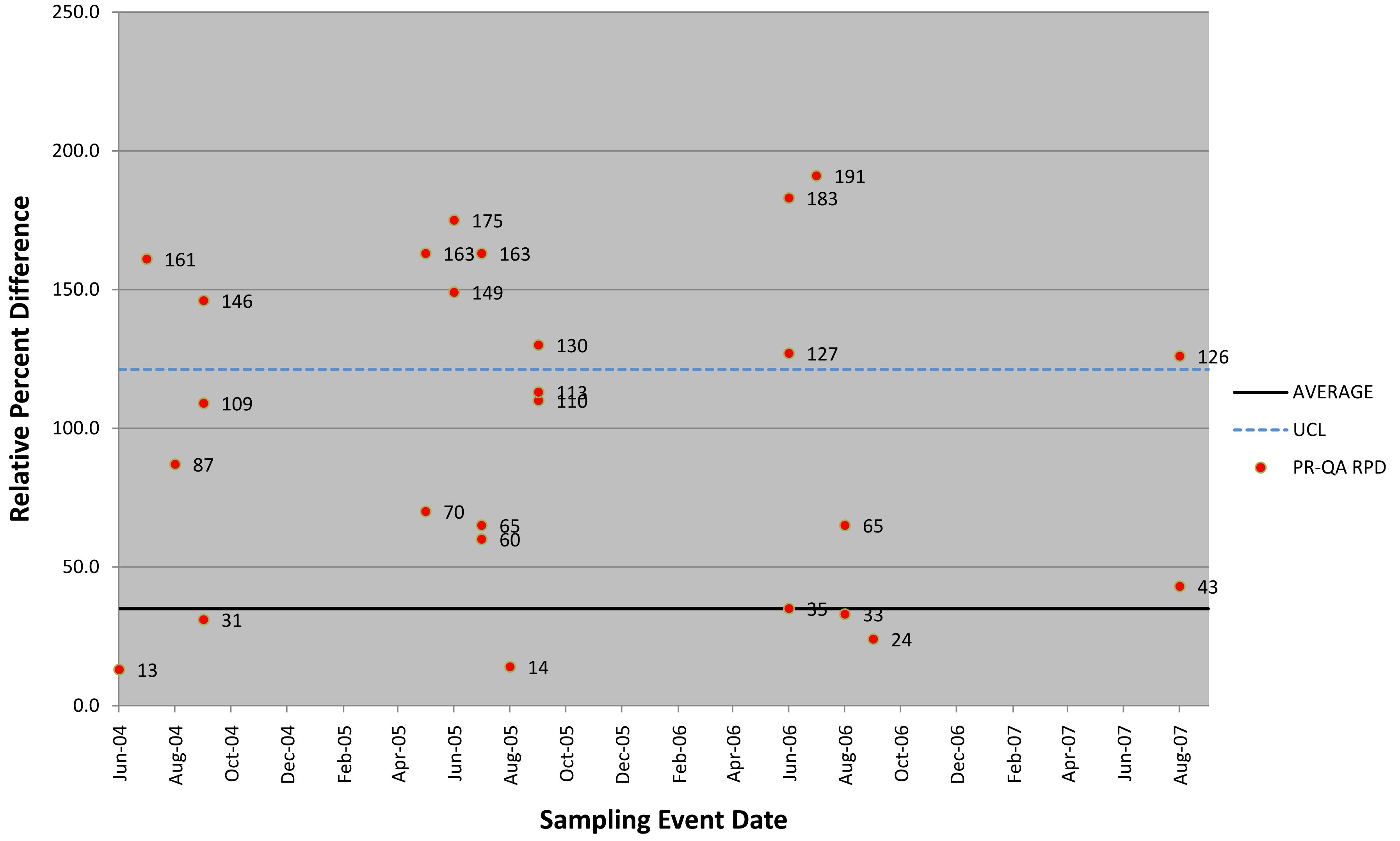


Chart A-123: Total Solids Control Chart for June 2004-August 2007 Sediment

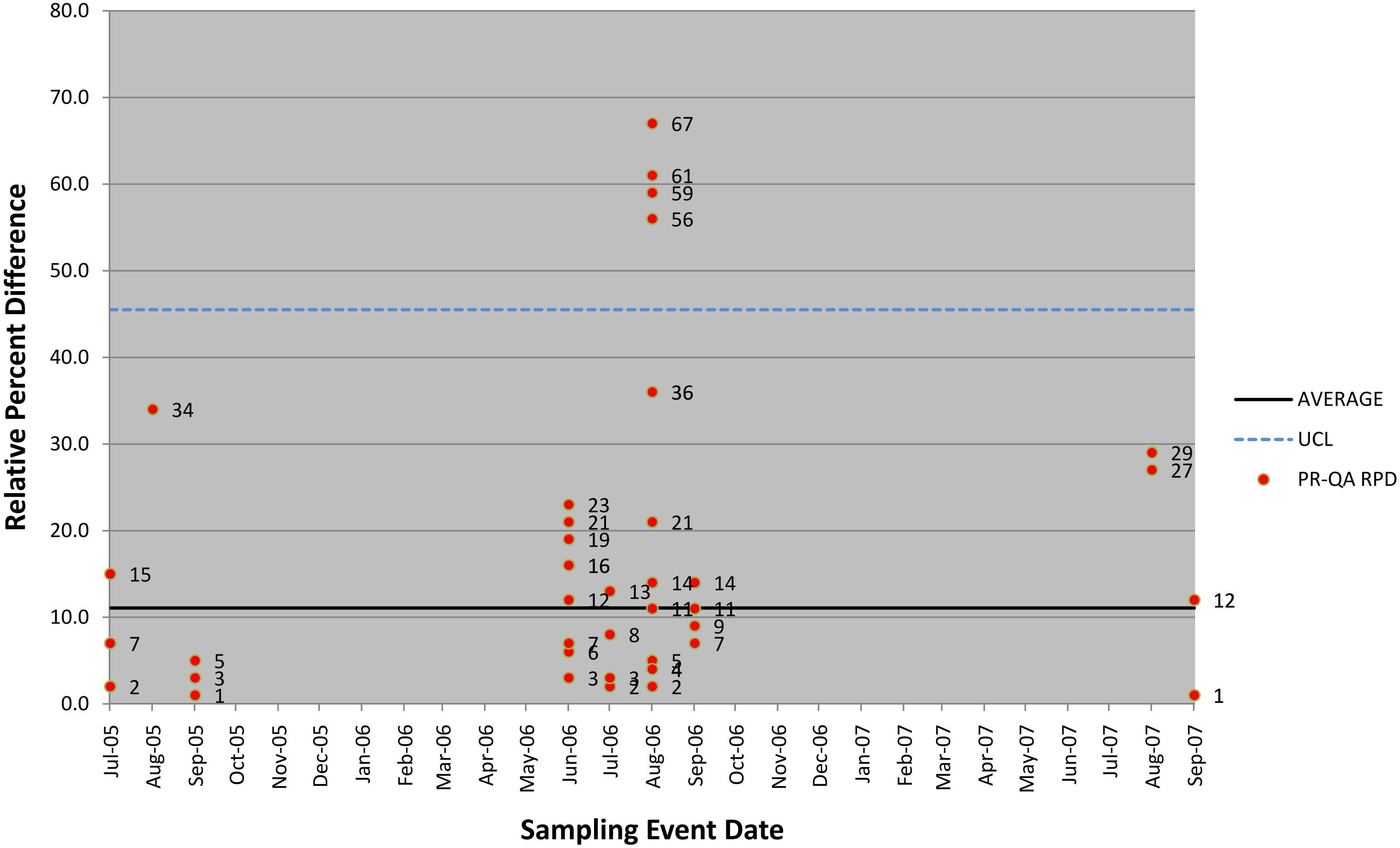


Chart A-124: Aluminum Control Chart for June 2004-August 2007 Sediment

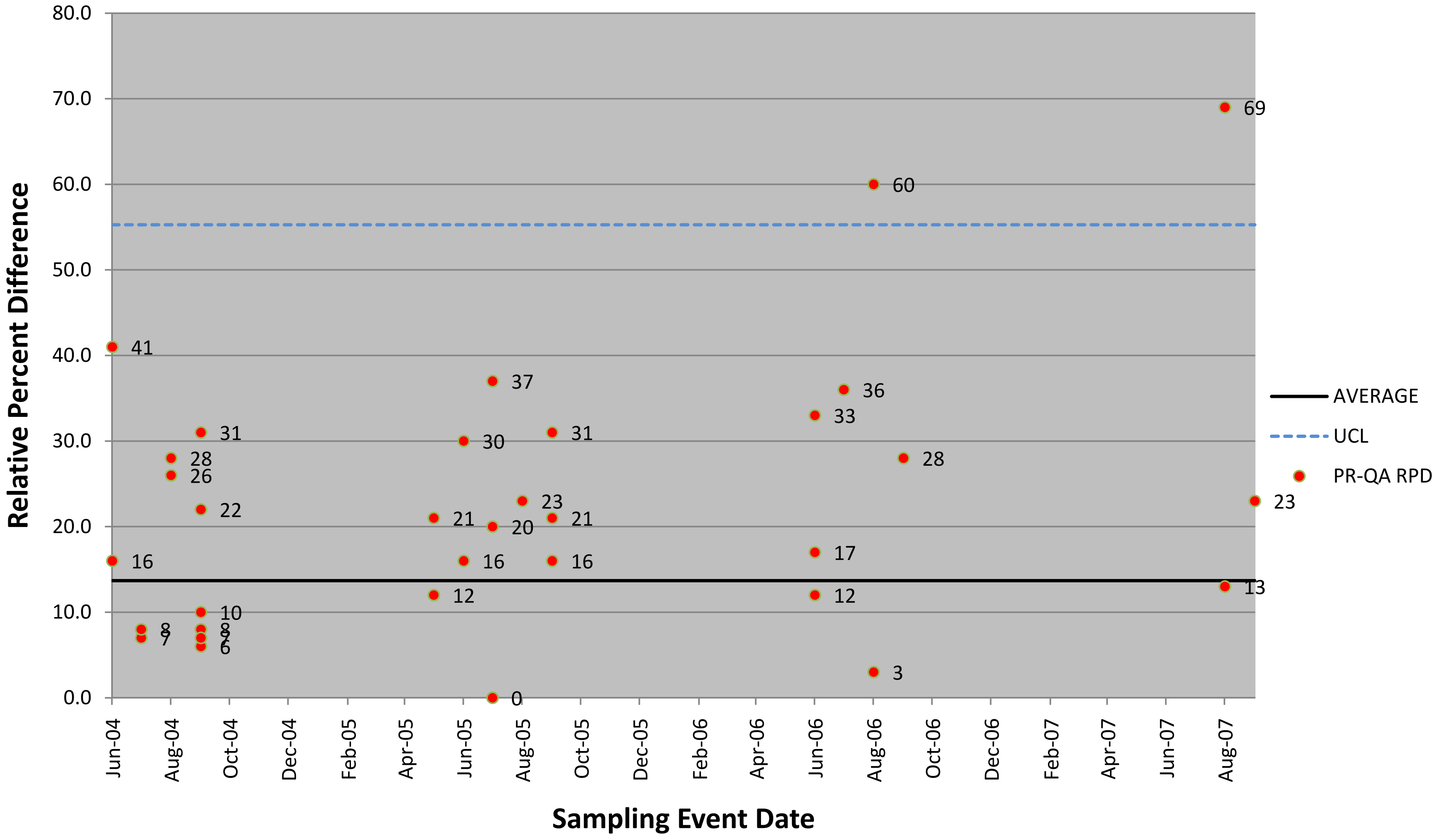
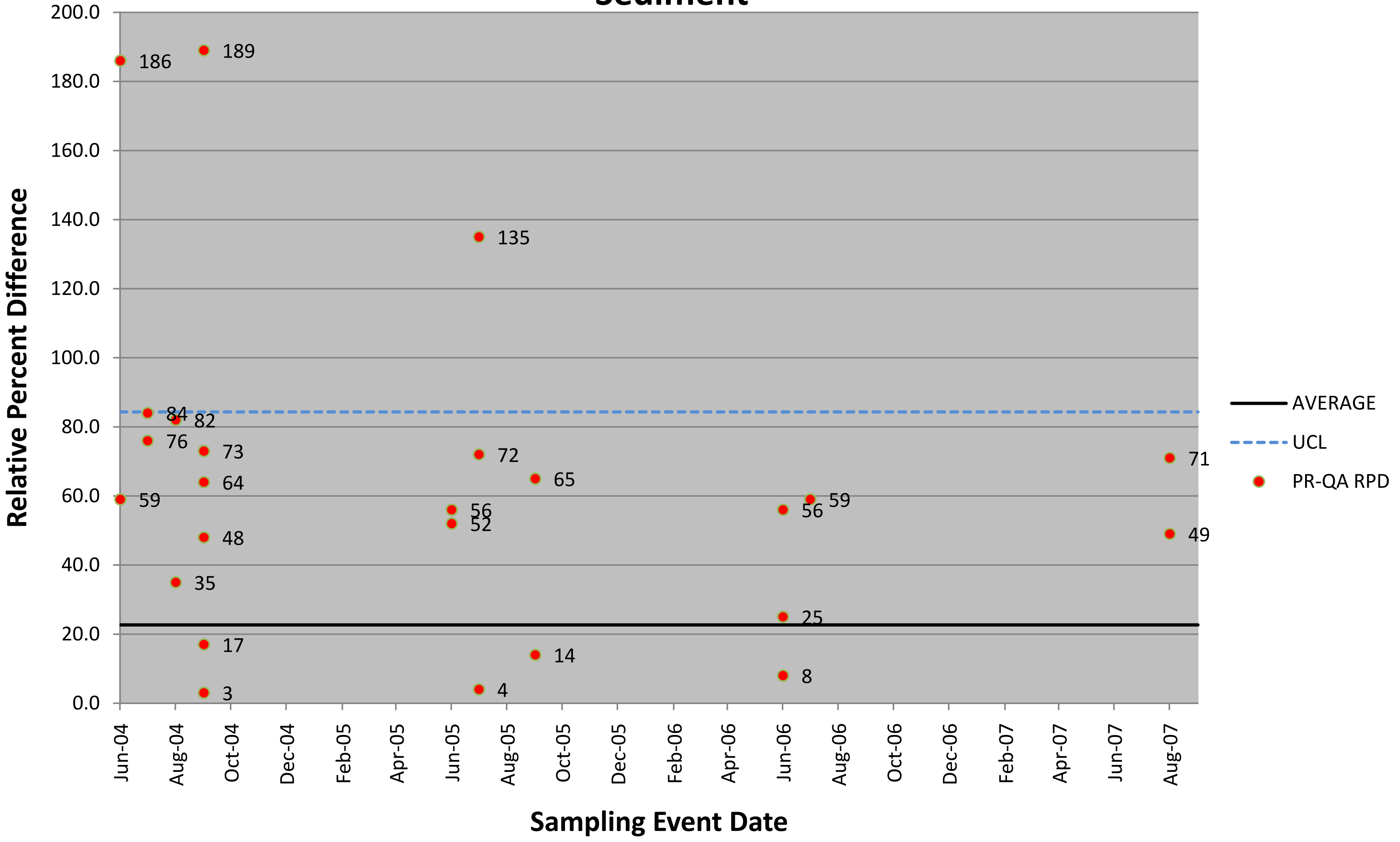


Chart A-125: Antimony Control Chart for June 2004-August 2007 Sediment



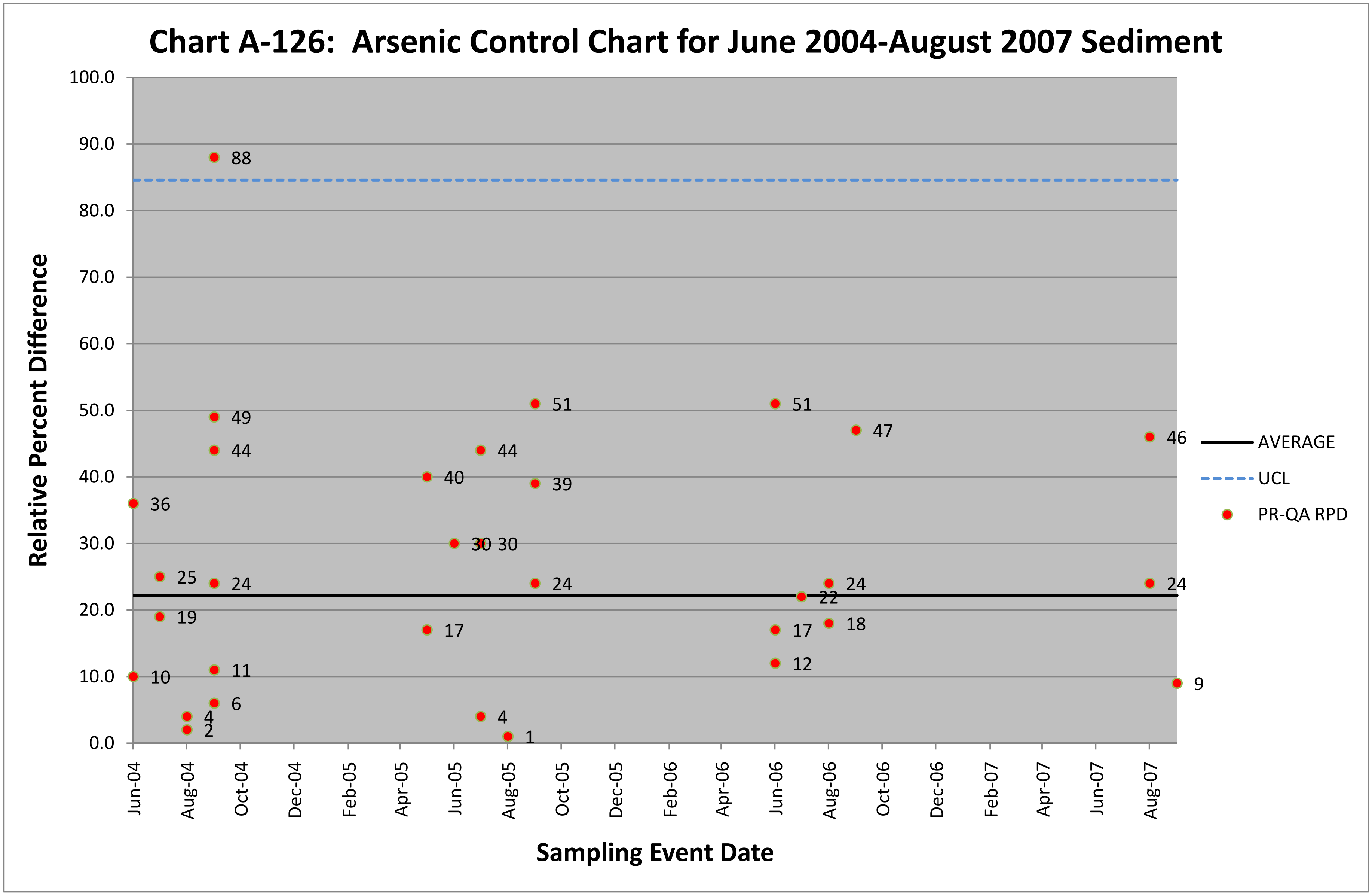


Chart A-126: Arsenic Control Chart for June 2004-August 2007 Sediment
Relative Percent Difference
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
88
49
44
36
25
24
19
10
11
6
4
2
40
17
30
30
44
4
1
51
39
24
51
17
12
22
24
18
47
46
24
9
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-127: Barium Control Chart for June 2004-August 2007 Sediment

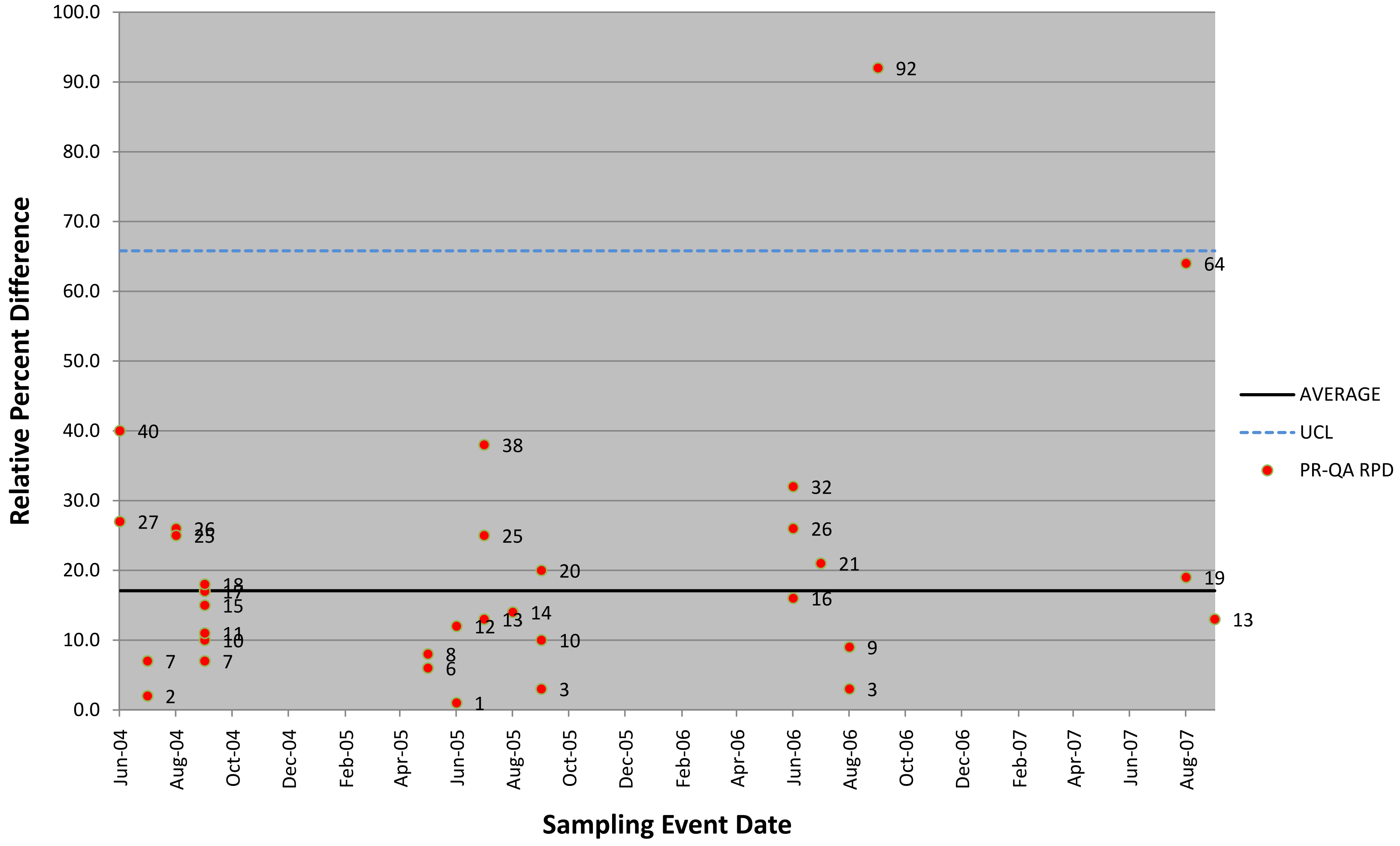


Chart A-128: Beryllium Control Chart for June 2004-August 2007 Sediment

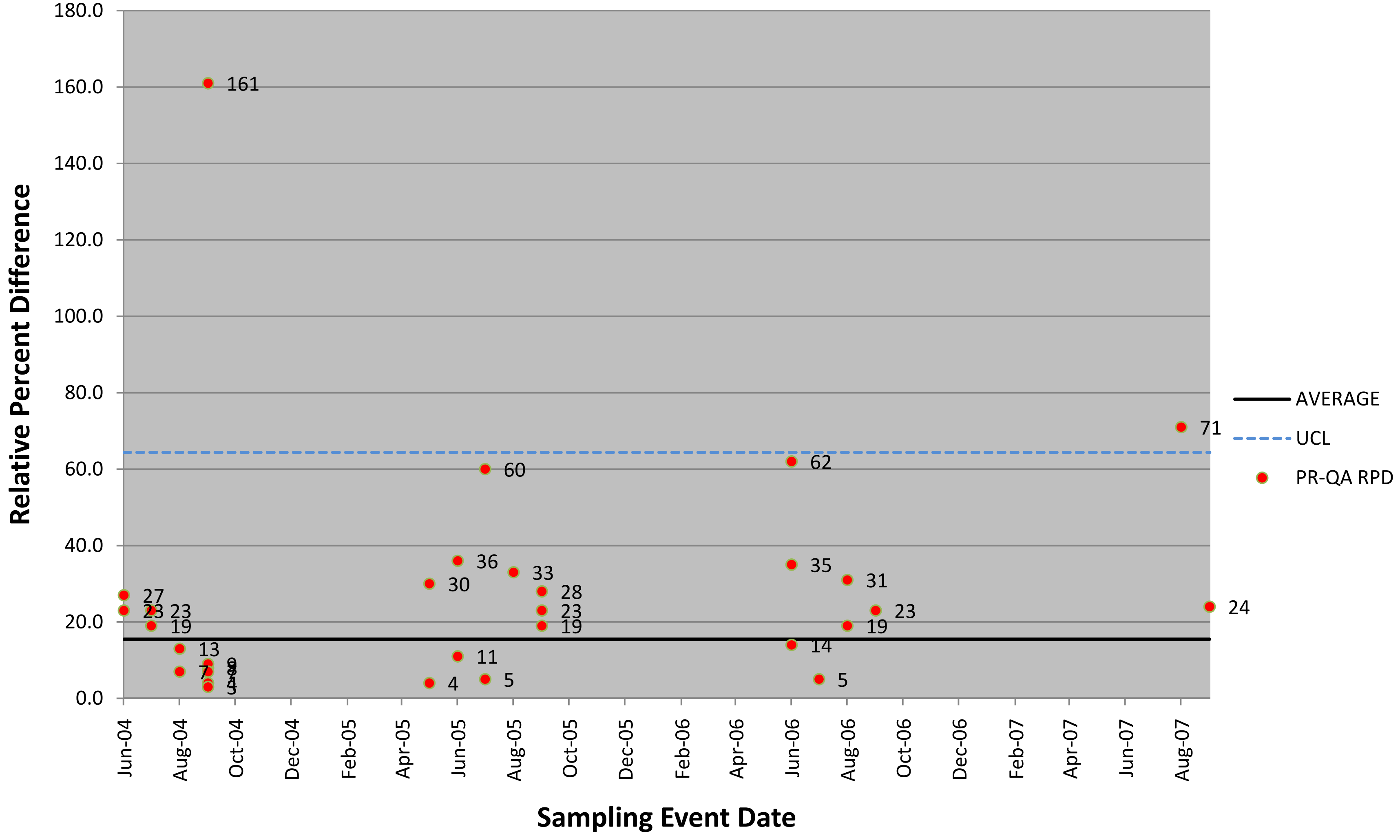
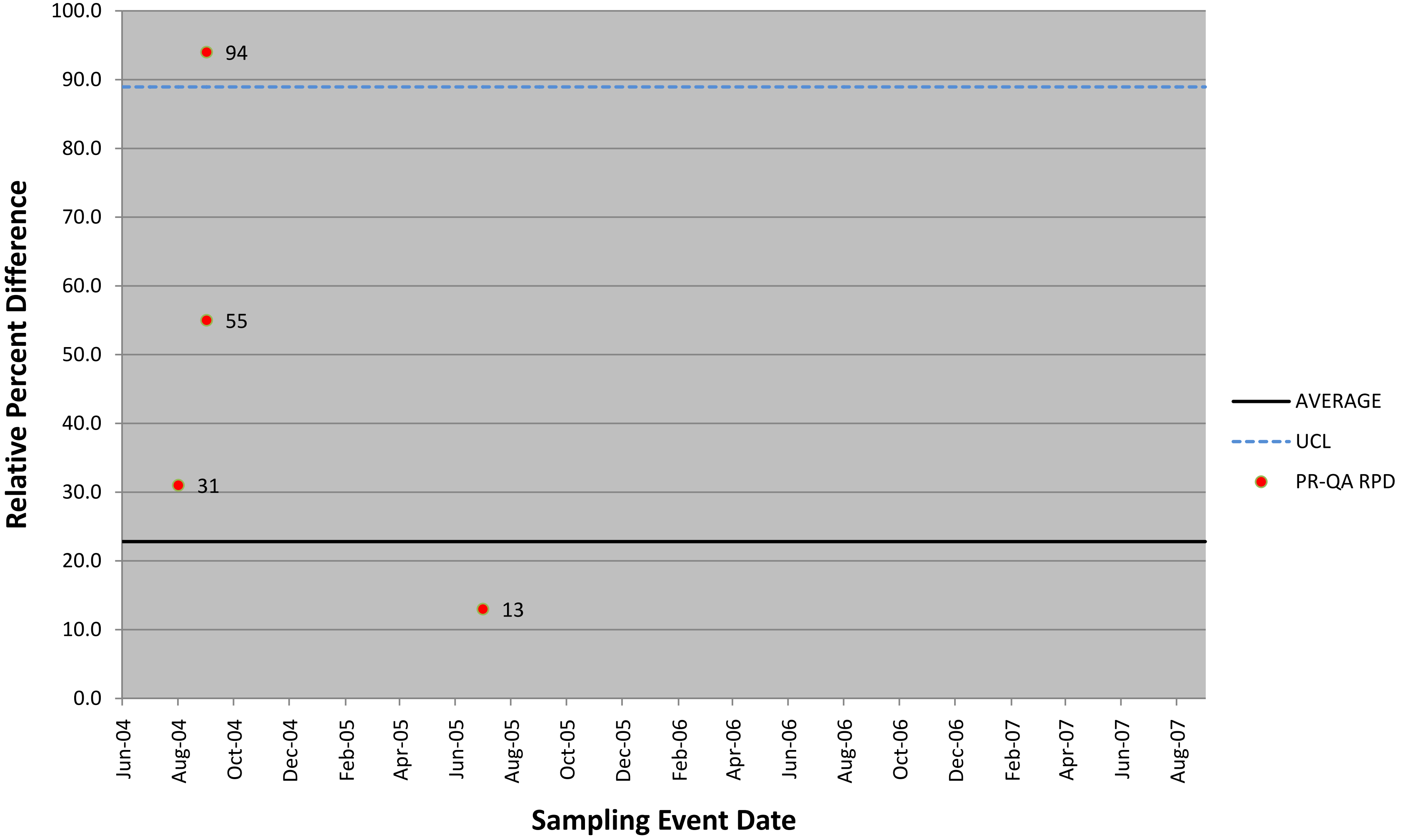


Chart A-129: Bismuth Control Chart for June 2004-August 2007 Sediment



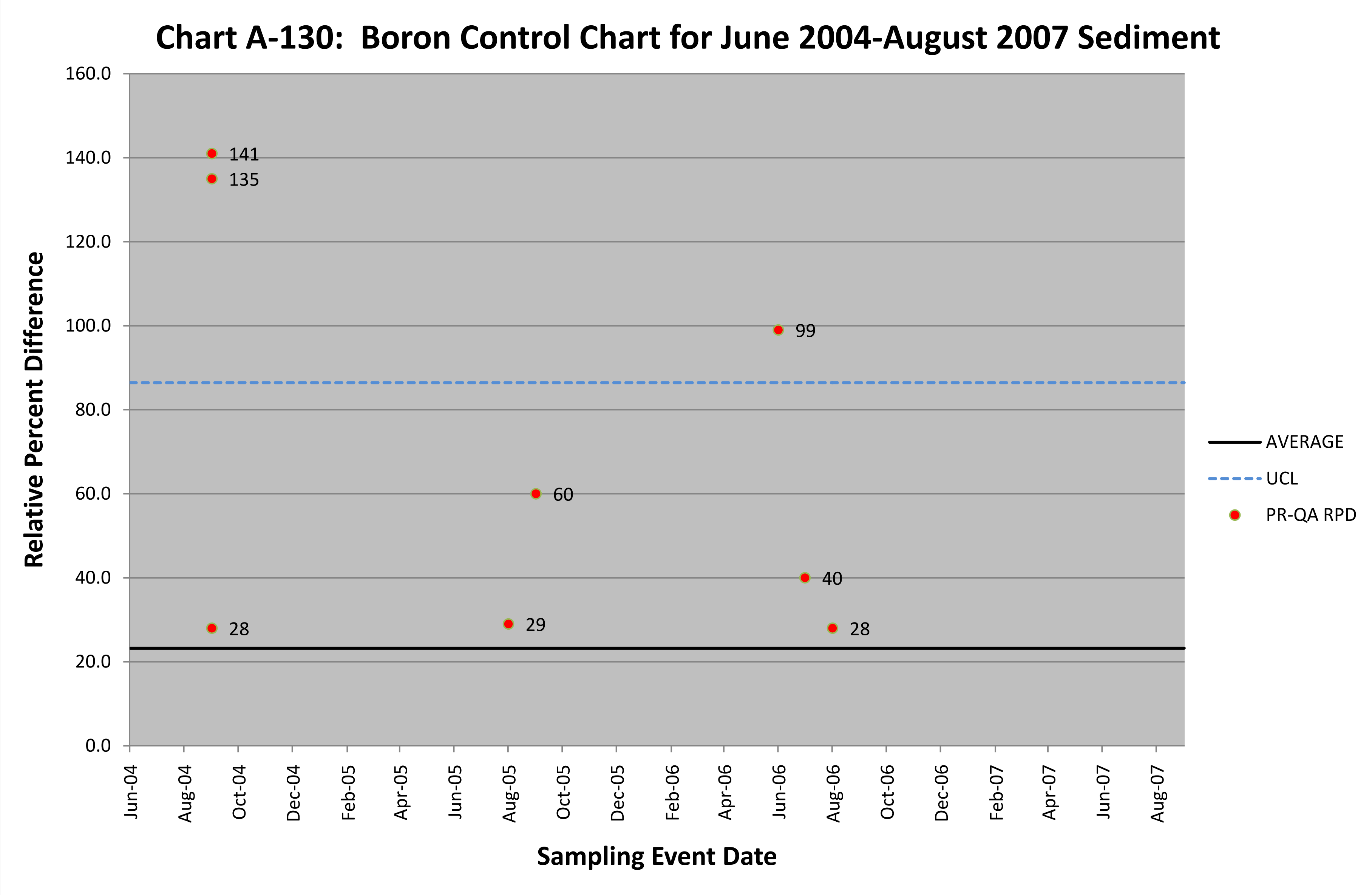


Chart A-130: Boron Control Chart for June 2004-August 2007 Sediment
Relative Percent Difference
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
141
135
99
60
40
28
29
28
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-131: Cadmium Control Chart for June 2004-August 2007 Sediment

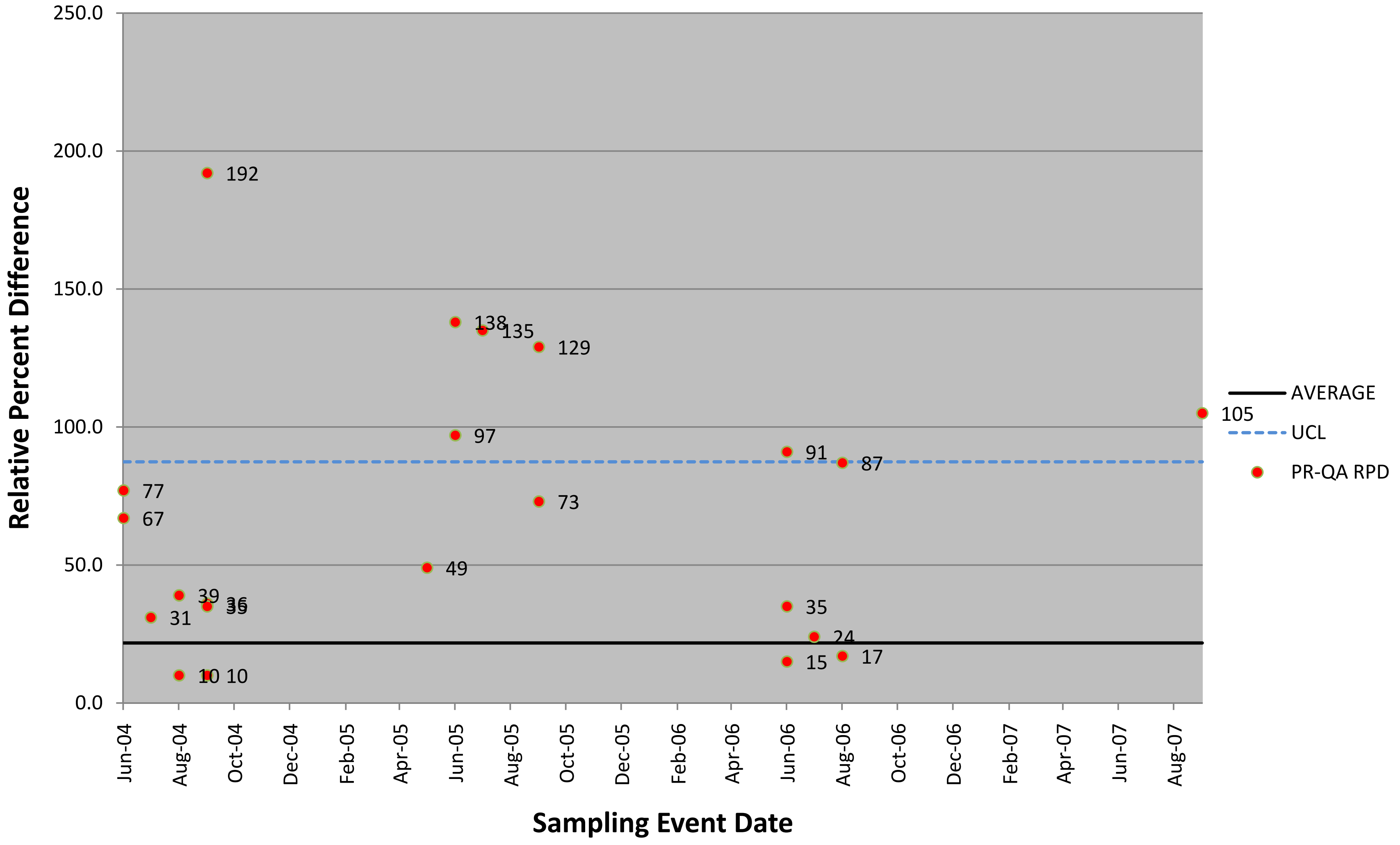


Chart A-132: Calcium Control Chart for June 2004-August 2007 Sediment

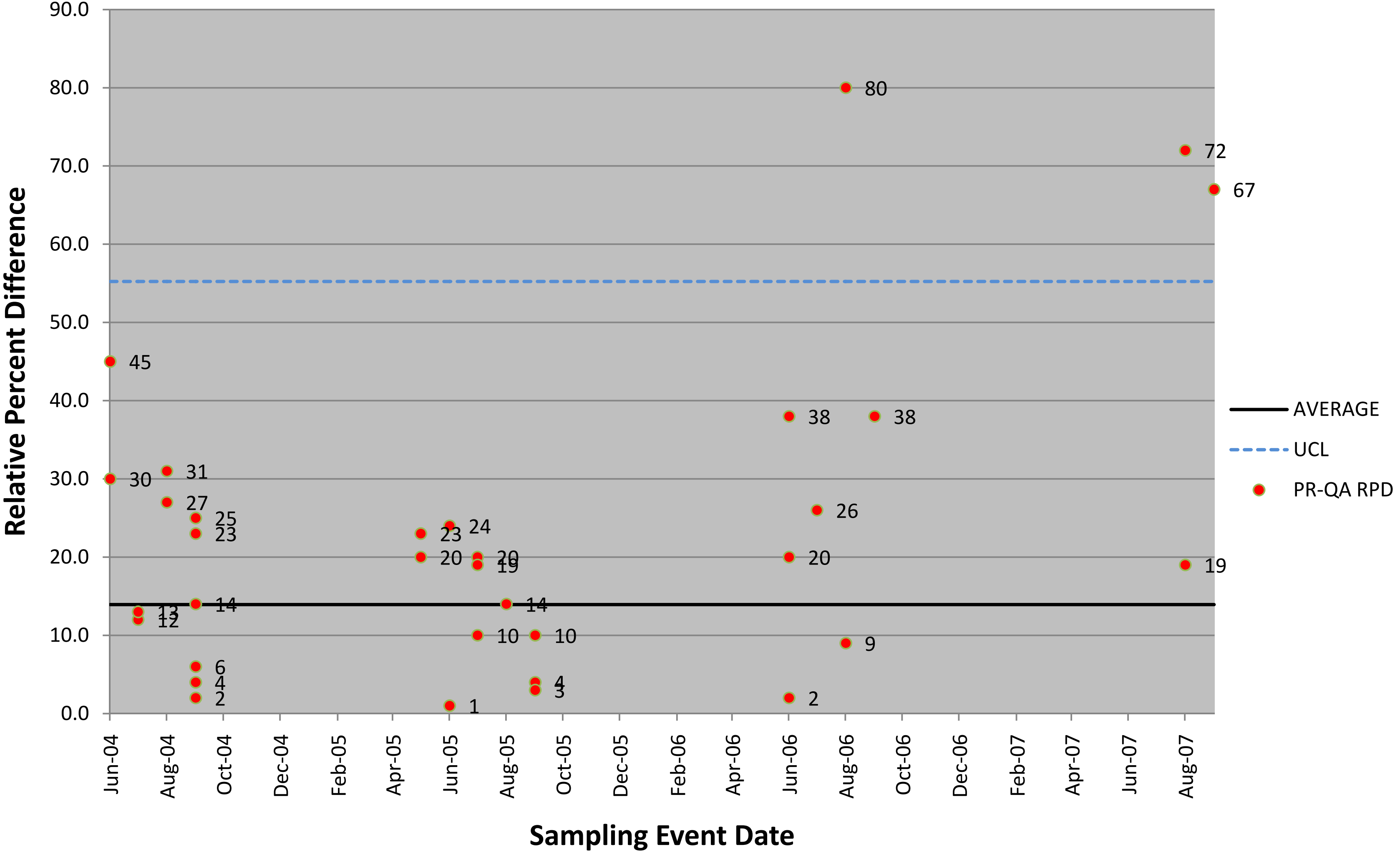
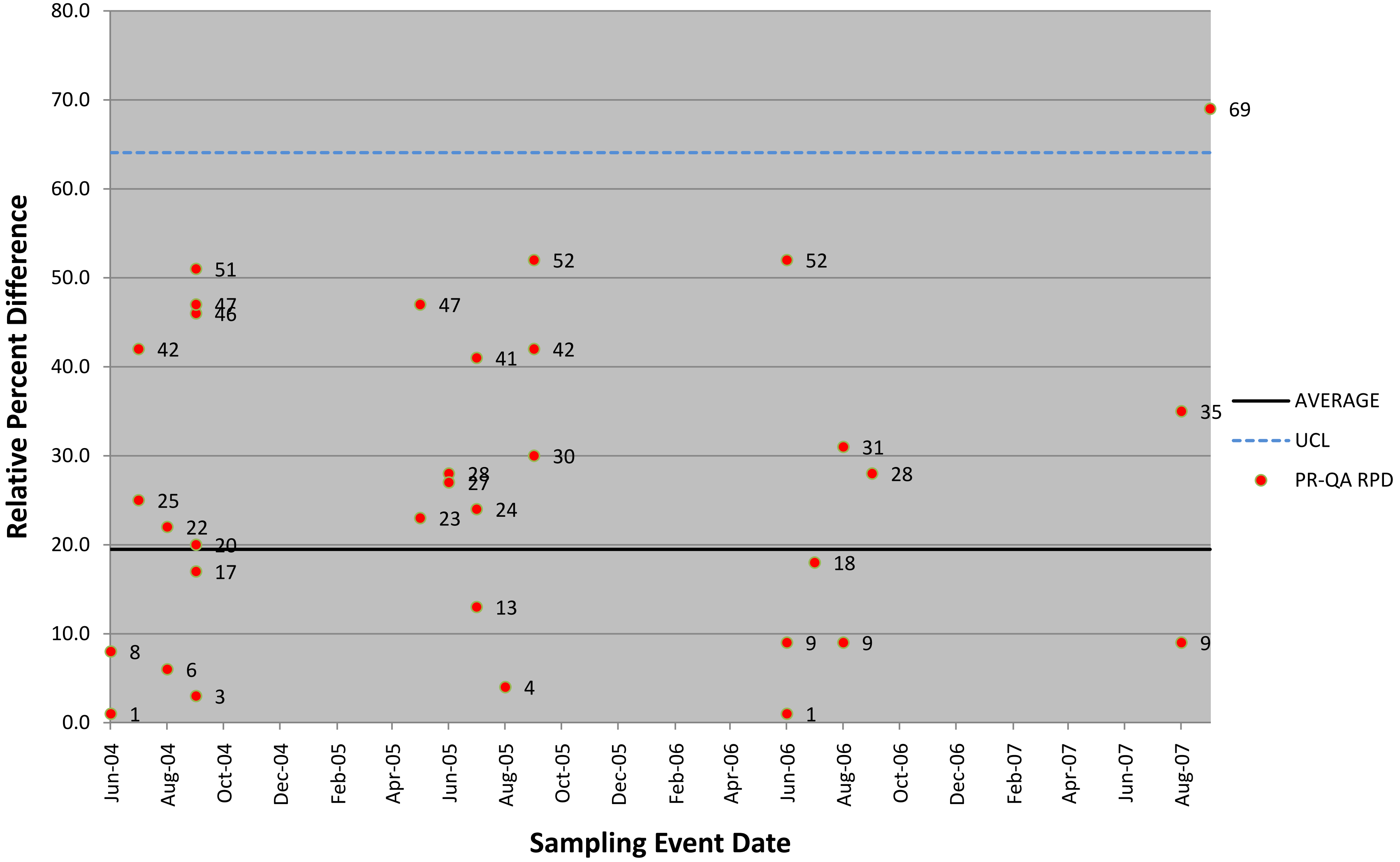


Chart A-133: Chromium Control Chart for June 2004-August 2007 Sediment



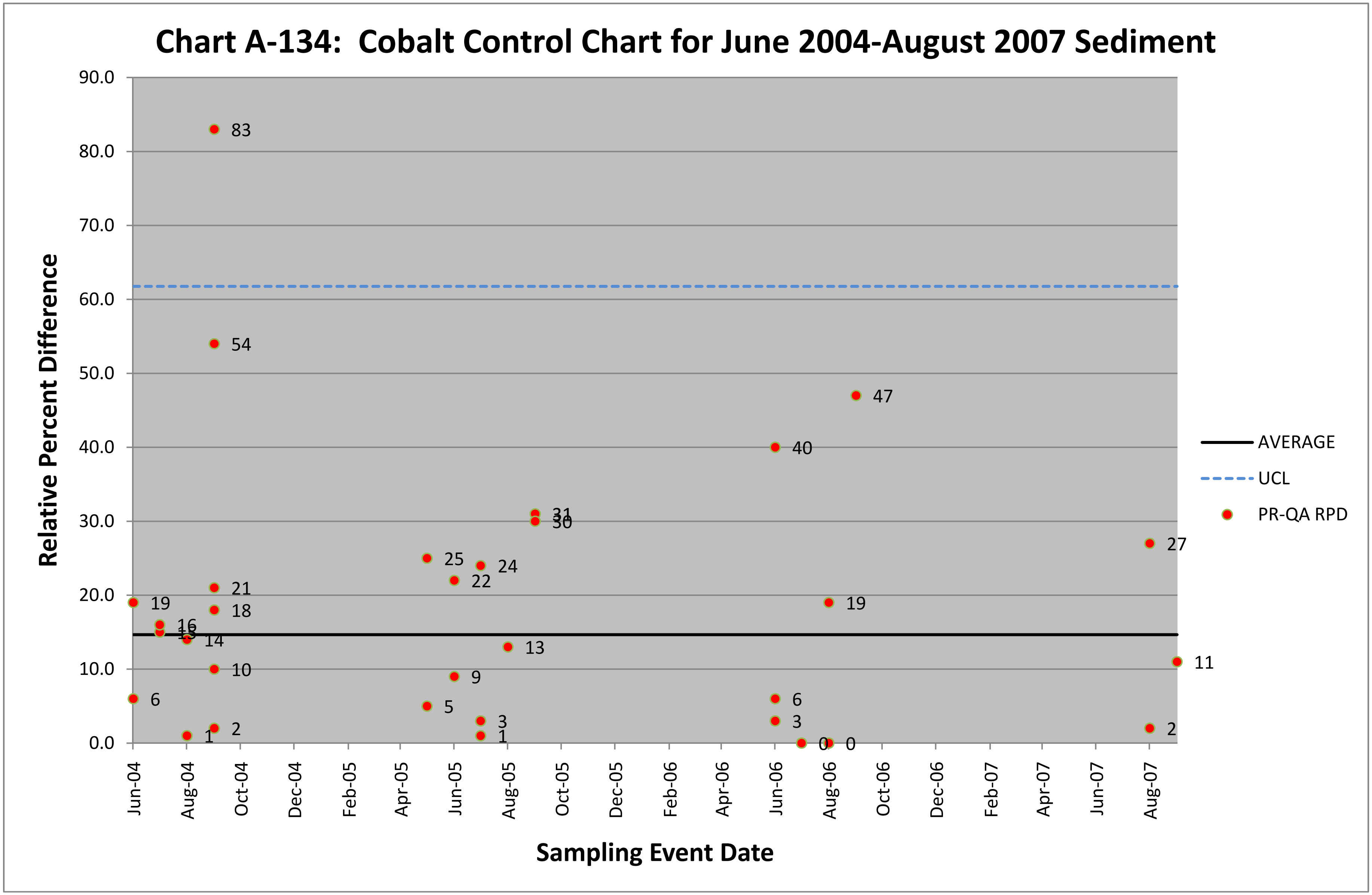


Chart A-134: Cobalt Control Chart for June 2004-August 2007 Sediment

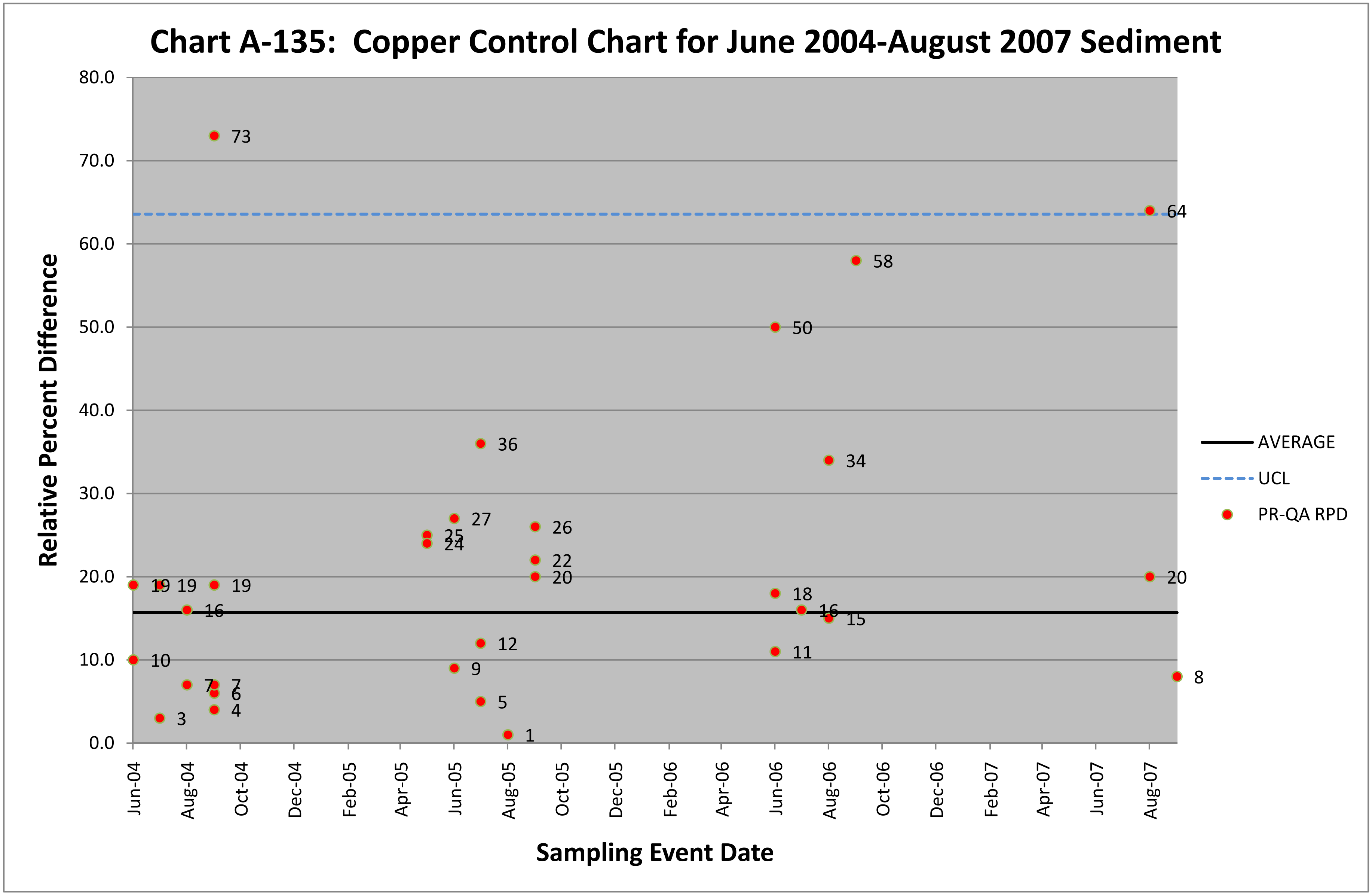


Chart A-135: Copper Control Chart for June 2004-August 2007 Sediment
Relative Percent Difference
Sampling Event Date
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
73
64
58
50
36
34
27
25
24
26
22
20
19
19
19
19
16
10
7
7
6
4
3
12
9
5
1
18
16
15
11
20
8
AVERAGE
UCL
PR-QA RPD

Chart A-136: Iron Control Chart for June 2004-August 2007 Sediment

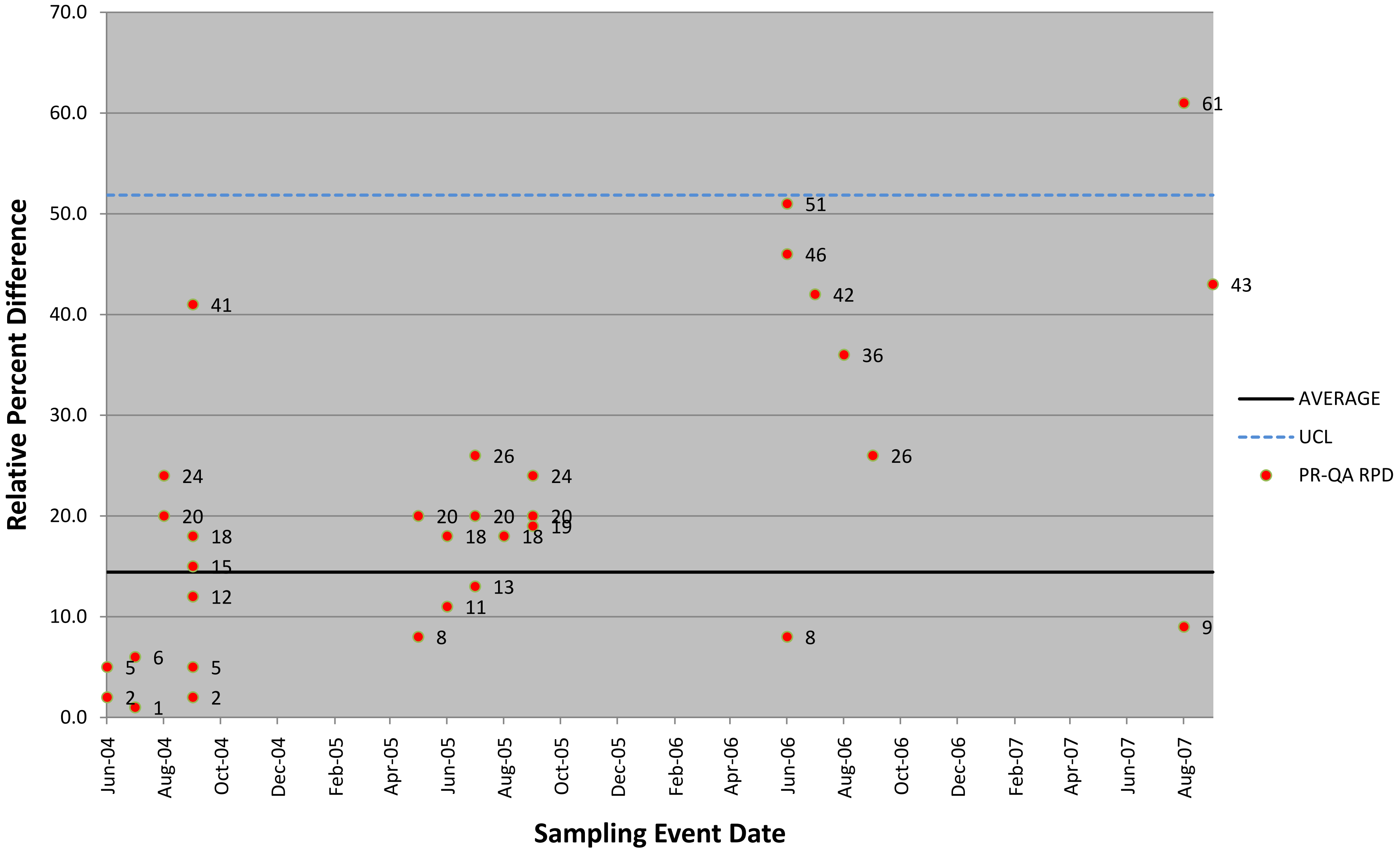
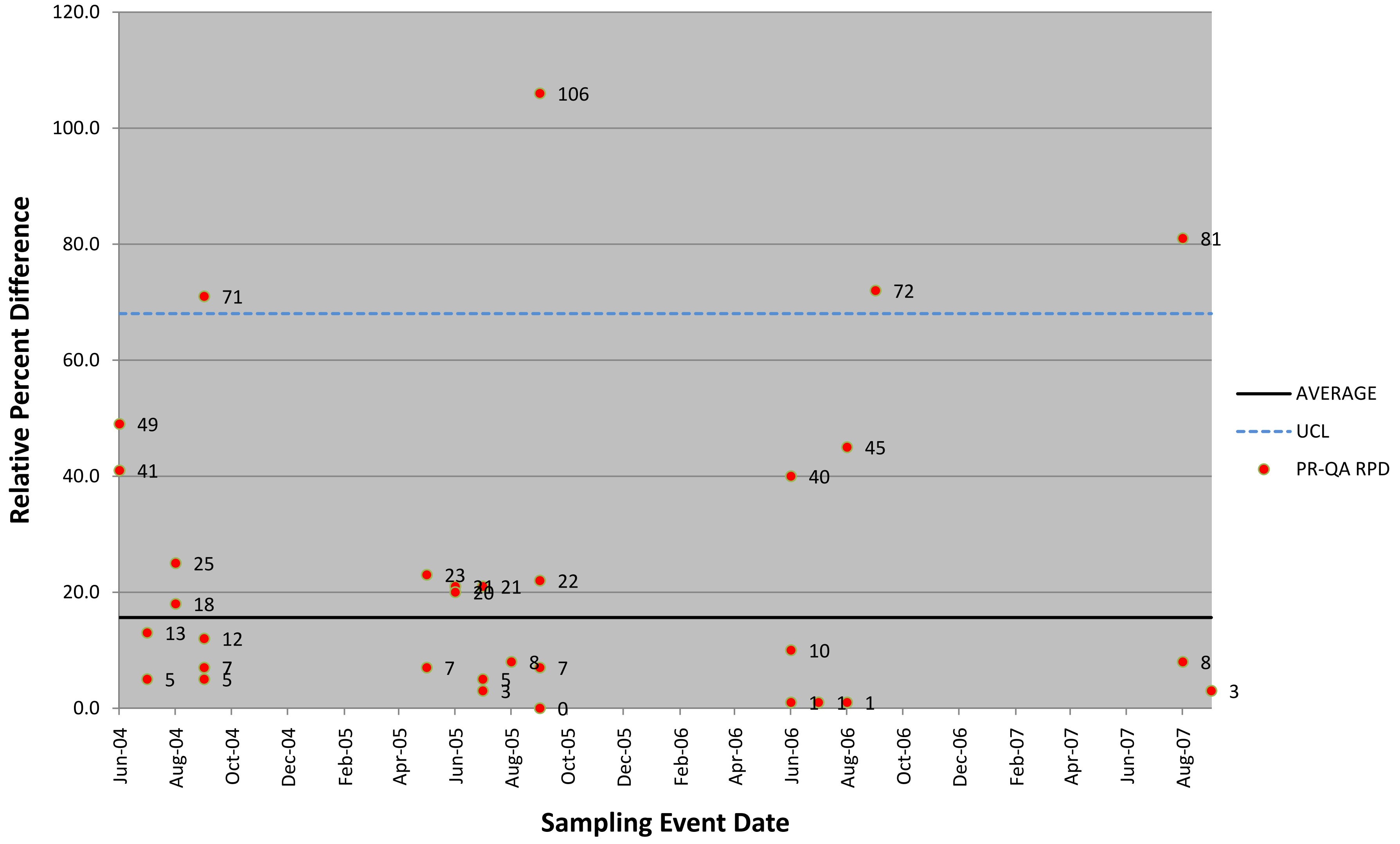


Chart A-137: Lead Control Chart for June 2004-August 2007 Sediment



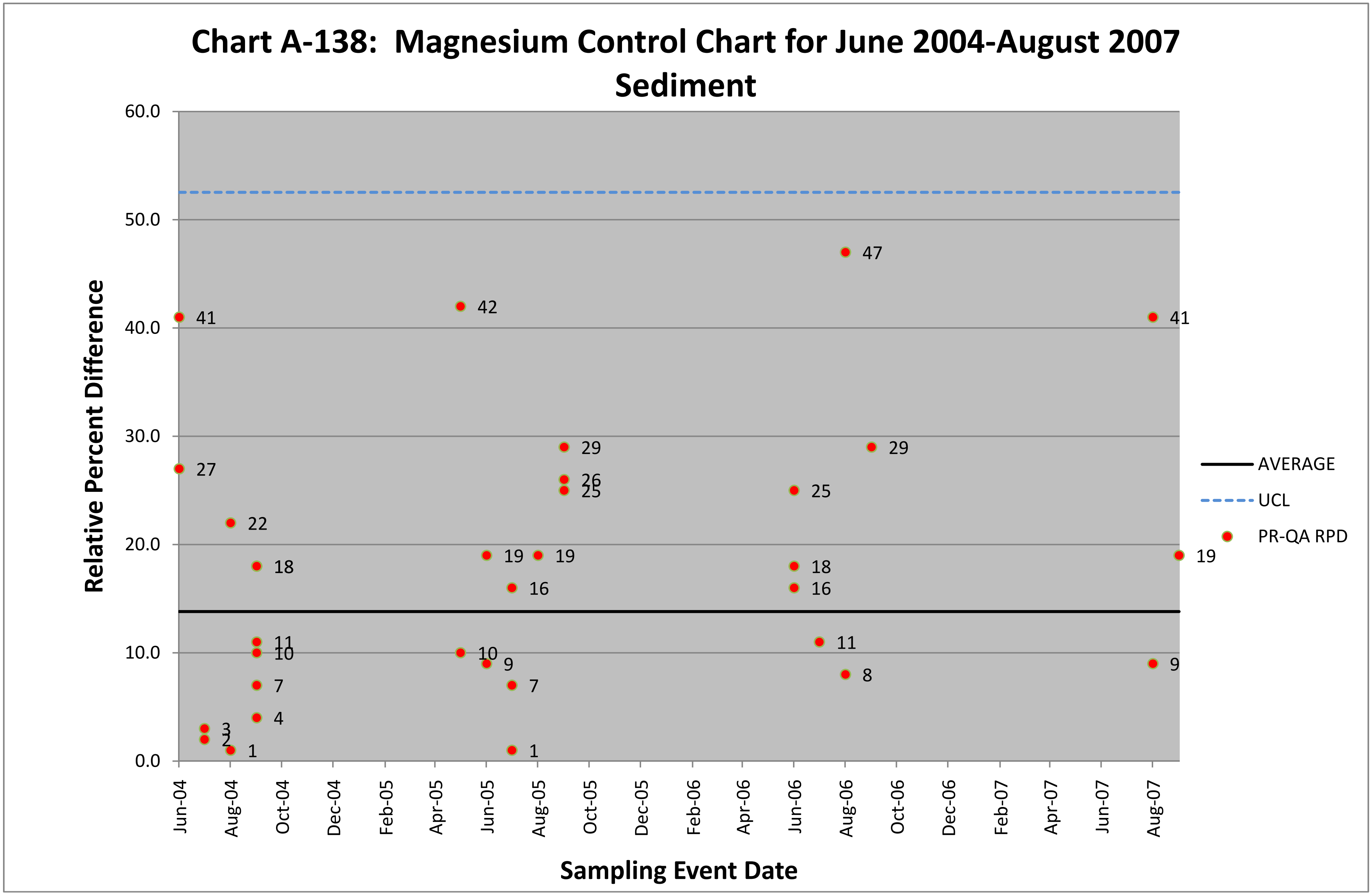
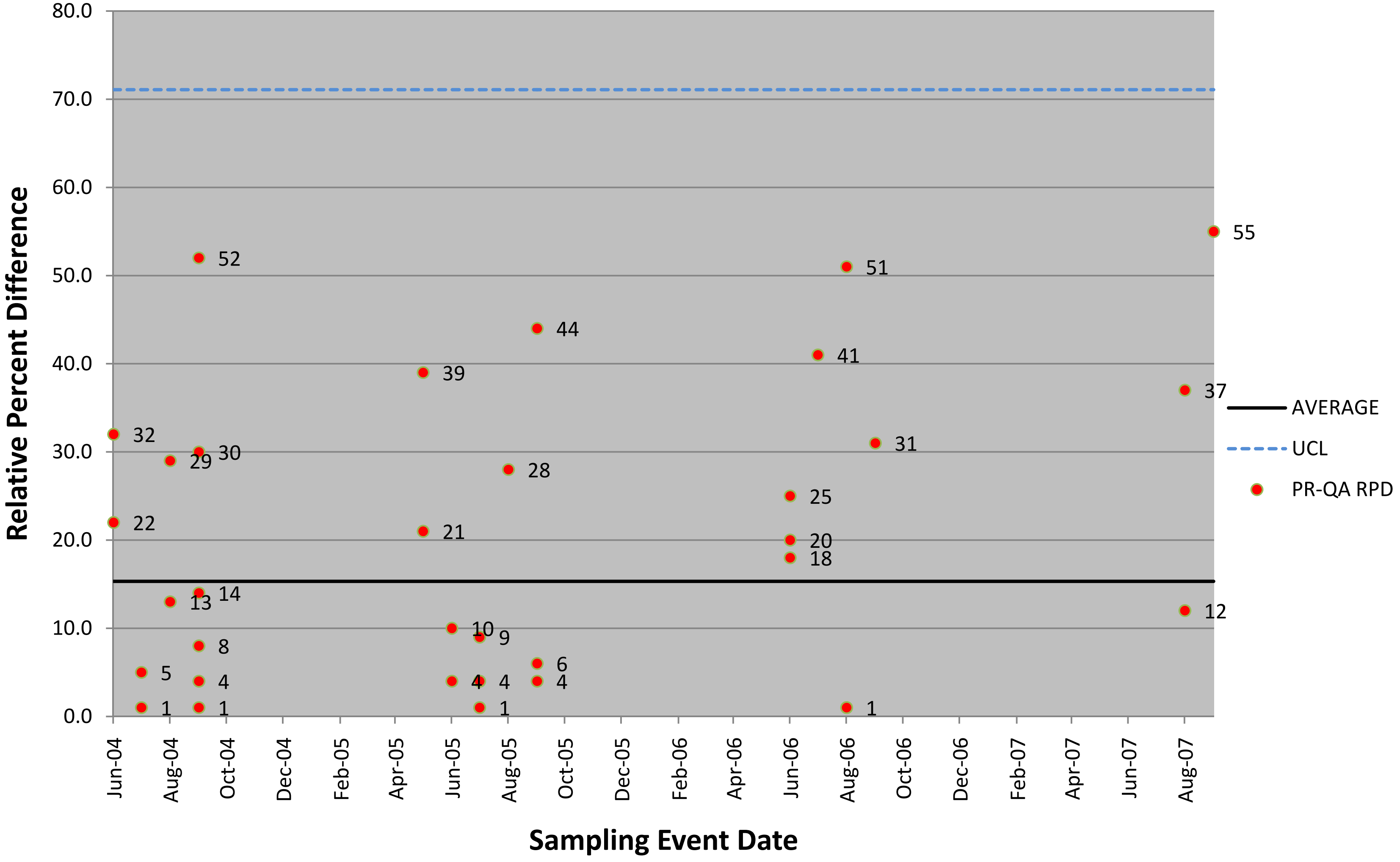


Chart A-138: Magnesium Control Chart for June 2004-August 2007
Sediment
Relative Percent Difference
60.0
50.0
40.0
30.0
20.0
10.0
0.0
41
27
3
2
1
22
18
11
10
7
4
42
10
19
9
16
7
1
19
29
26
25
25
18
16
11
47
8
29
41
9
19
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-139: Manganese Control Chart for June 2004-August 2007 Sediment



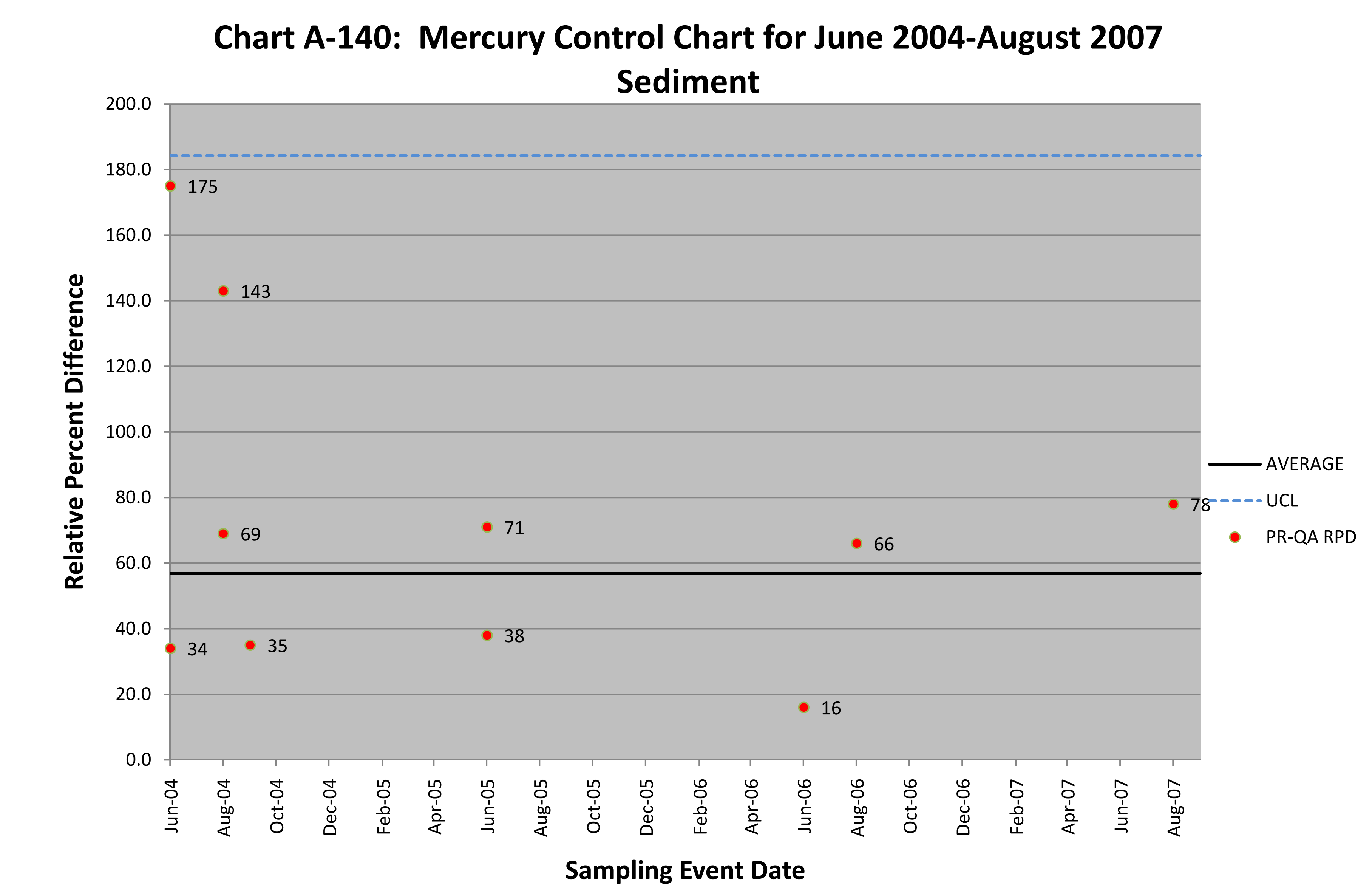


Chart A-140: Mercury Control Chart for June 2004-August 2007
Sediment
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
175
143
69
34
35
71
38
16
66
78
AVERAGE
UCL
PR-QA RPD
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date

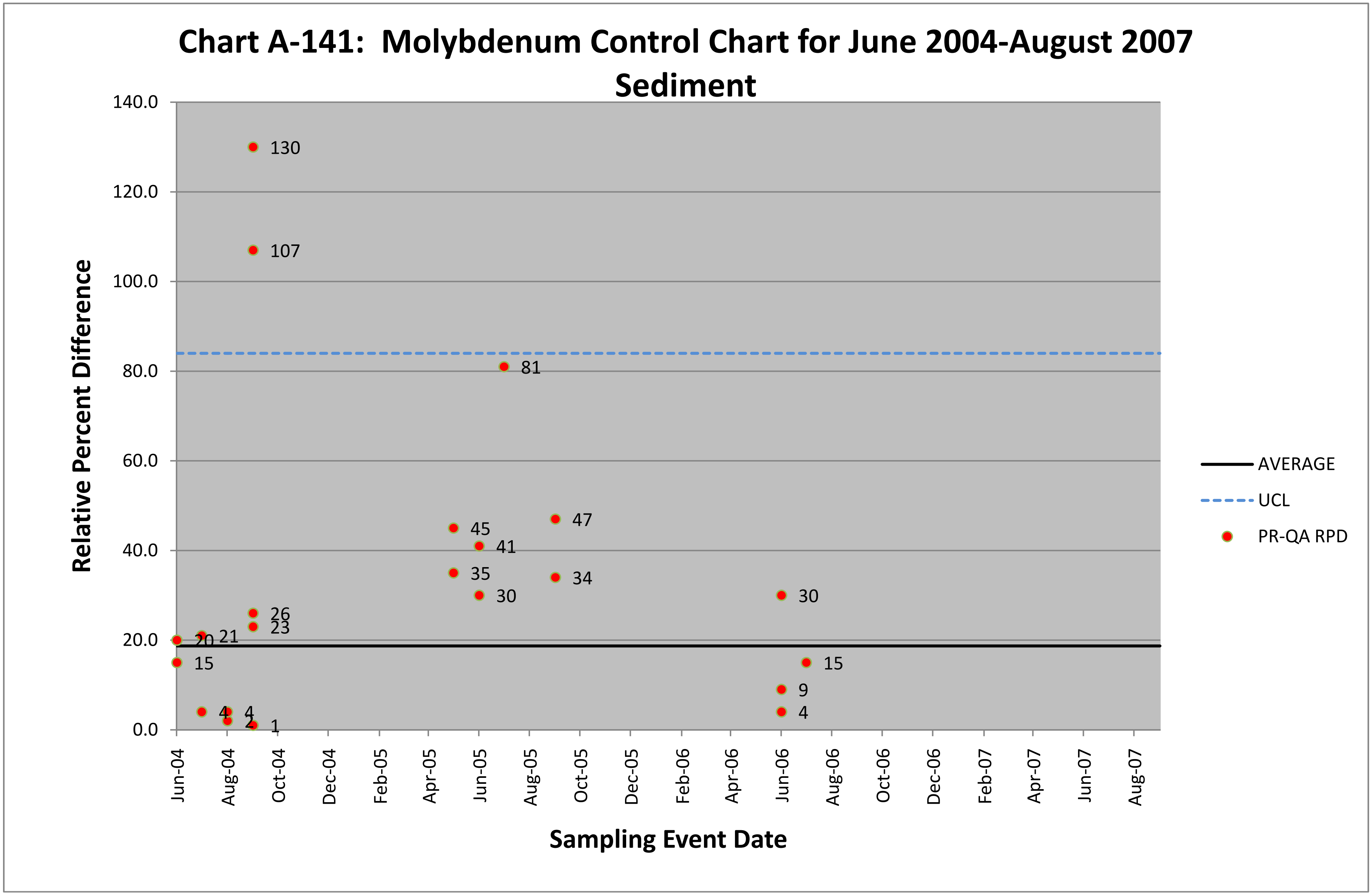


Chart A-141: Molybdenum Control Chart for June 2004-August 2007 Sediment

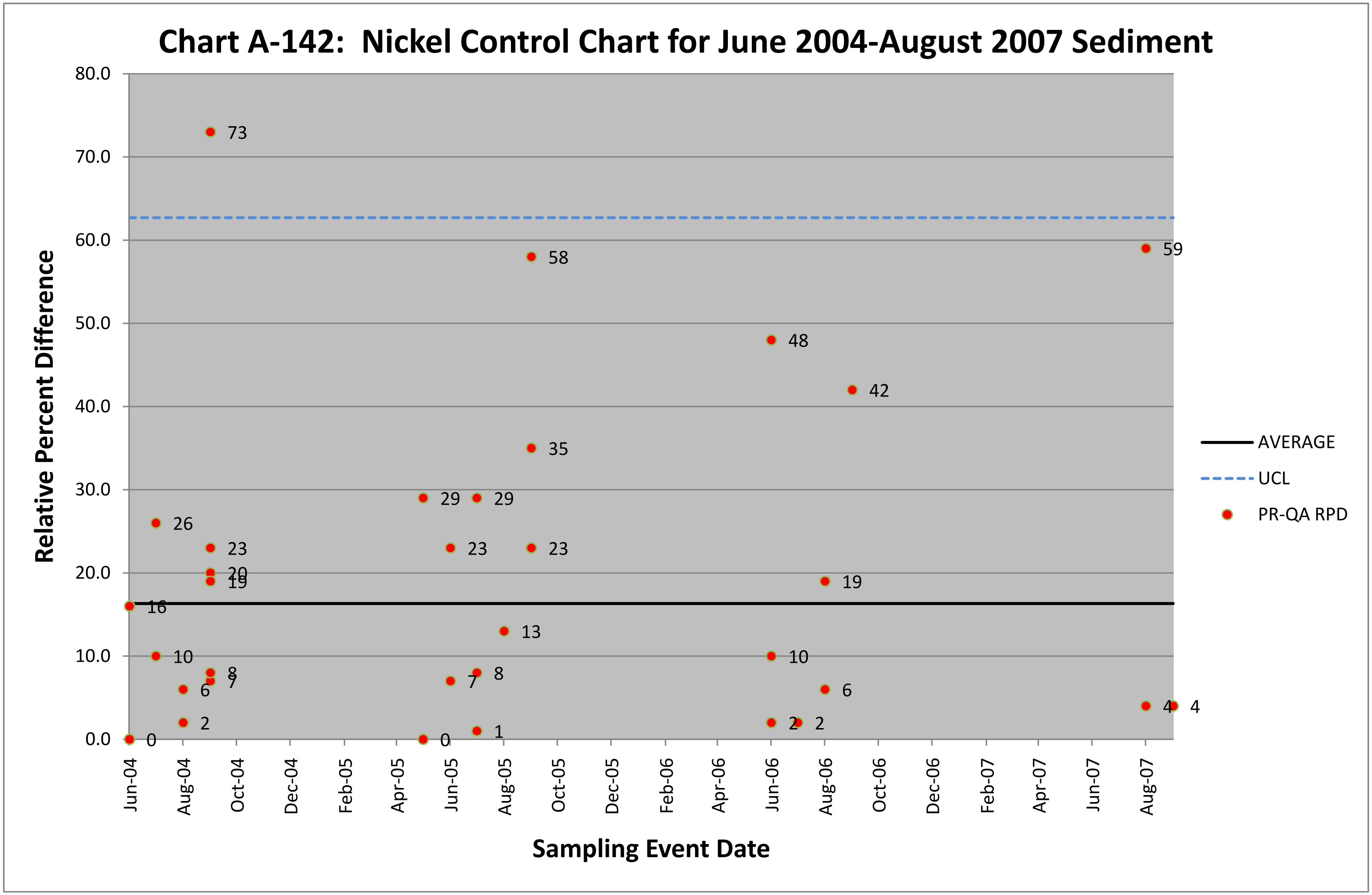


Chart A-142: Nickel Control Chart for June 2004-August 2007 Sediment
Relative Percent Difference
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
73
58
59
48
42
35
29
29
26
23
23
23
20
19
19
16
13
10
10
8
7
8
6
7
6
2
2
2
4
4
0
0
1
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

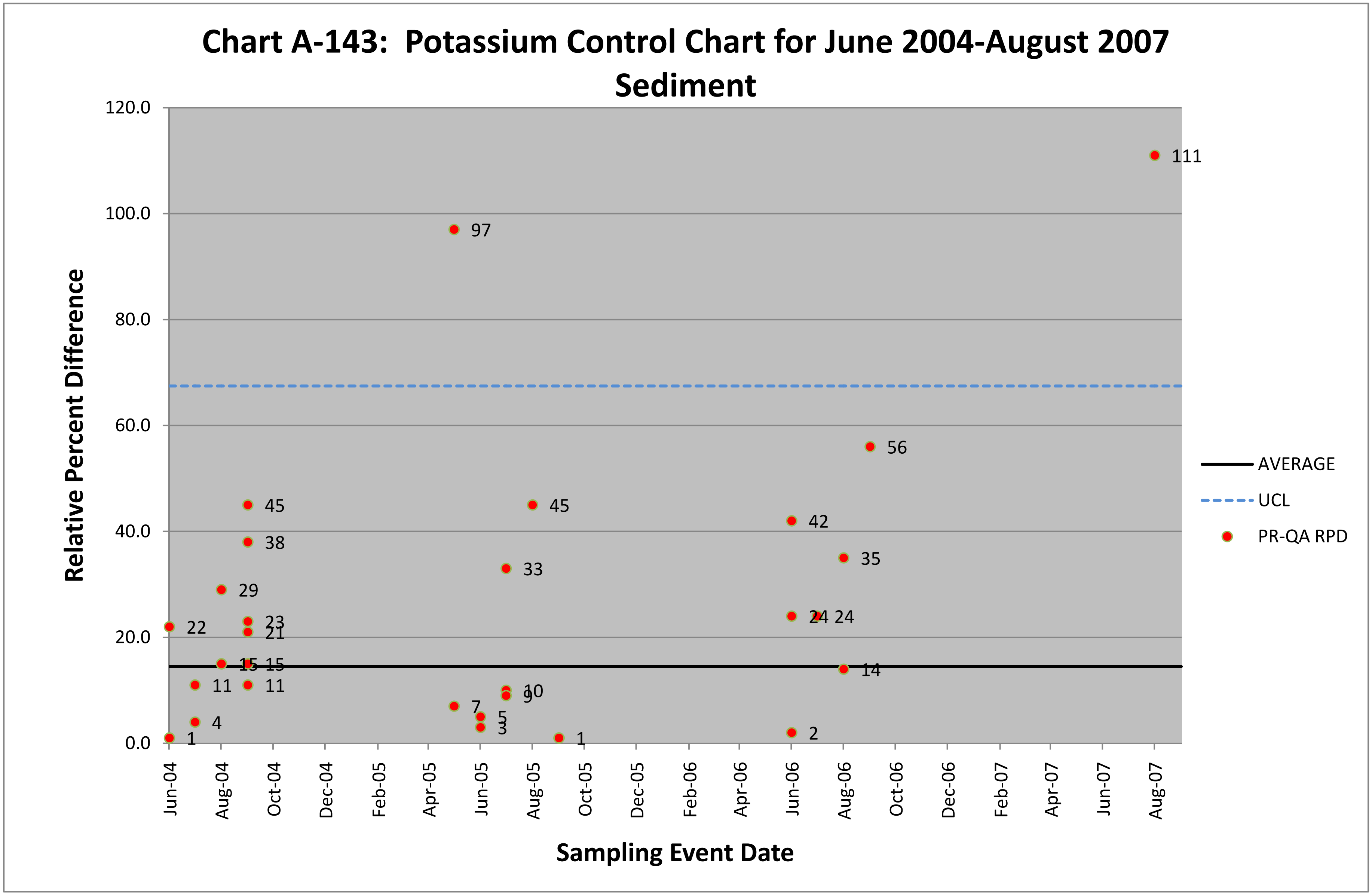


Chart A-143: Potassium Control Chart for June 2004-August 2007
Sediment
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD
111
97
56
45
45
42
38
35
33
29
24
24
23
22
21
15
15
14
11
11
10
9
7
5
4
3
2
1
1

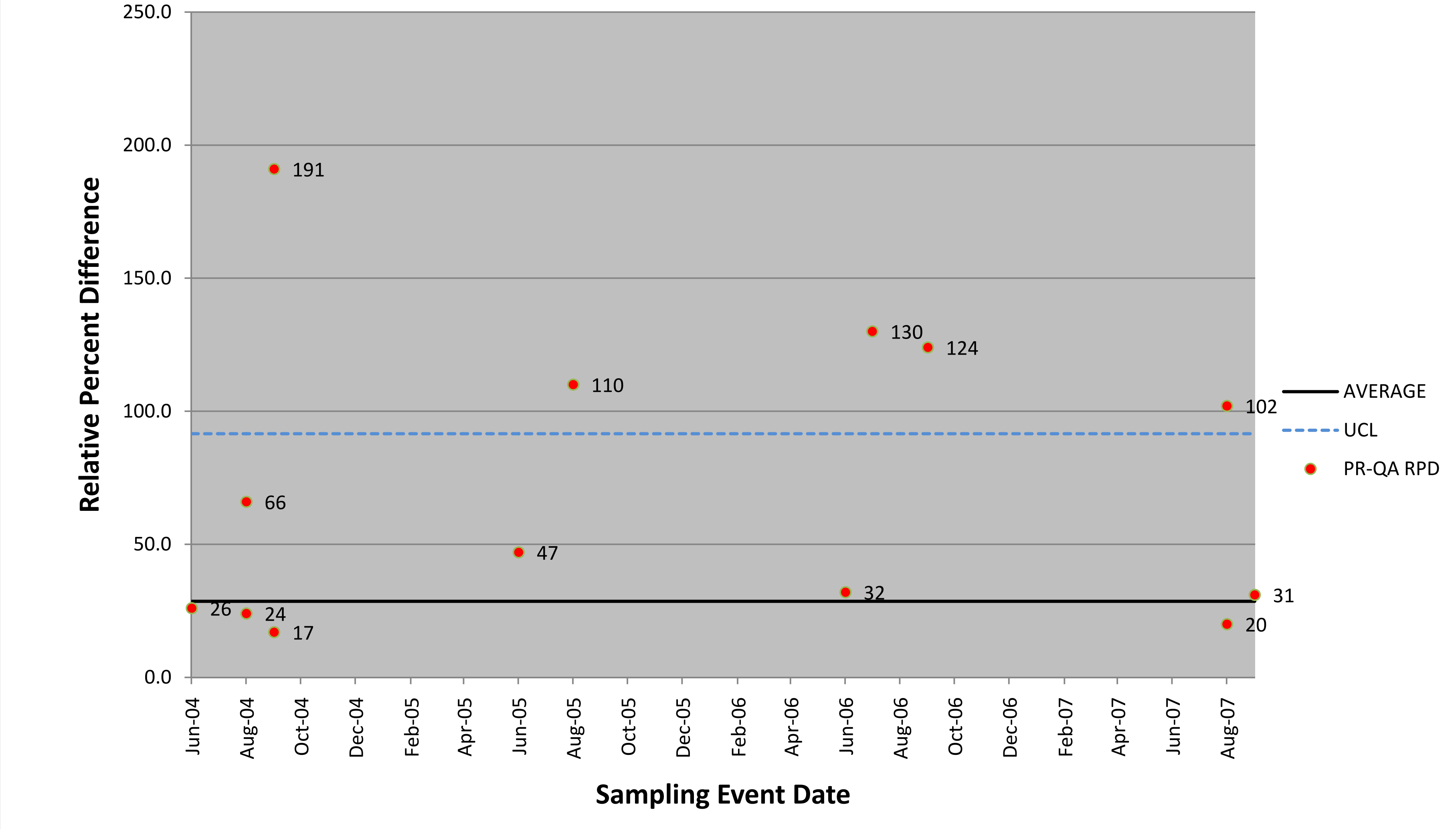


Chart A-144: Selenium Control Chart for June 2004-August 2007 Sediment

Chart A-145: Silver Control Chart for June 2004-August 2007 Sediment

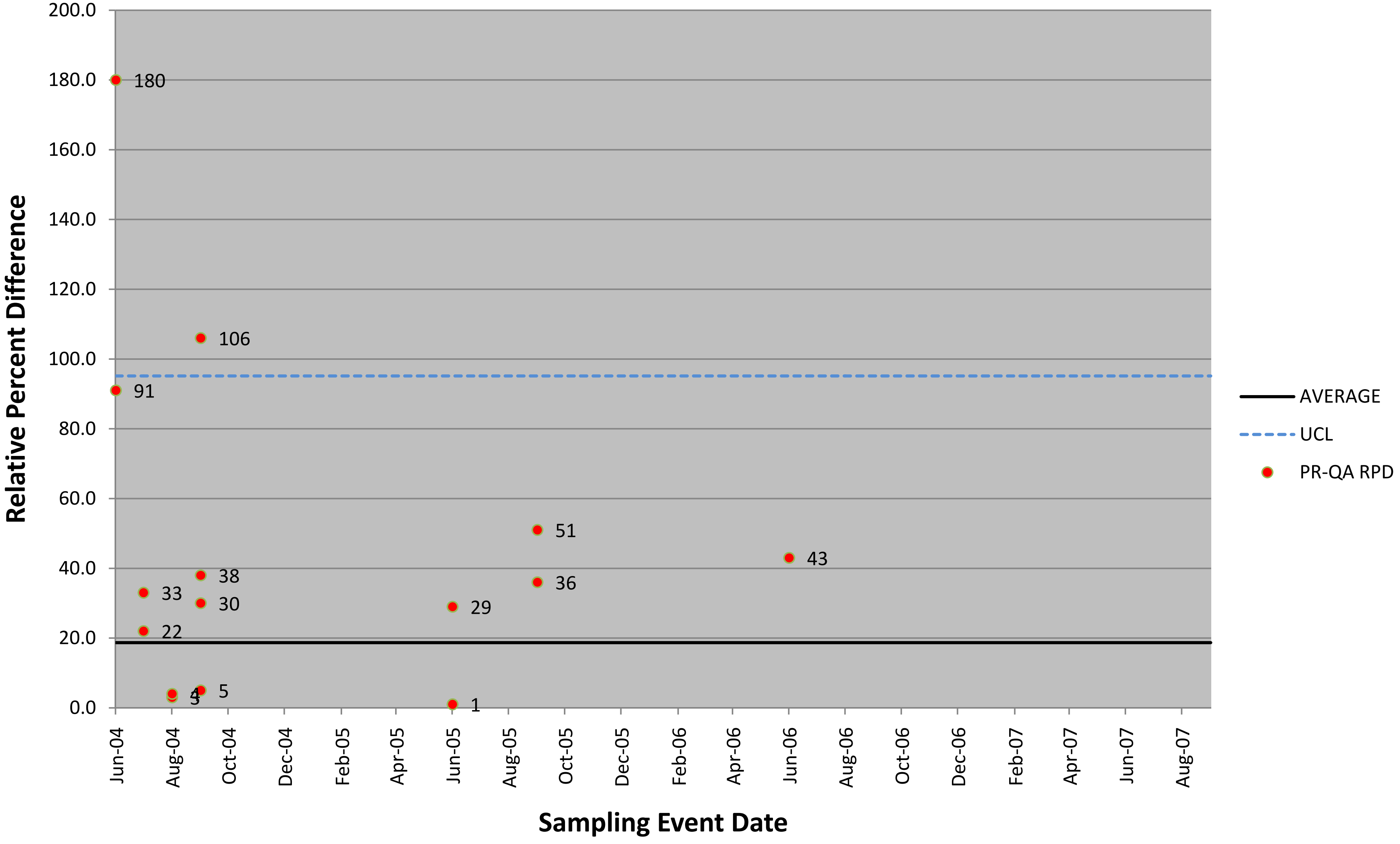


Chart A-146: Sodium Control Chart for June 2004-August 2007 Sediment

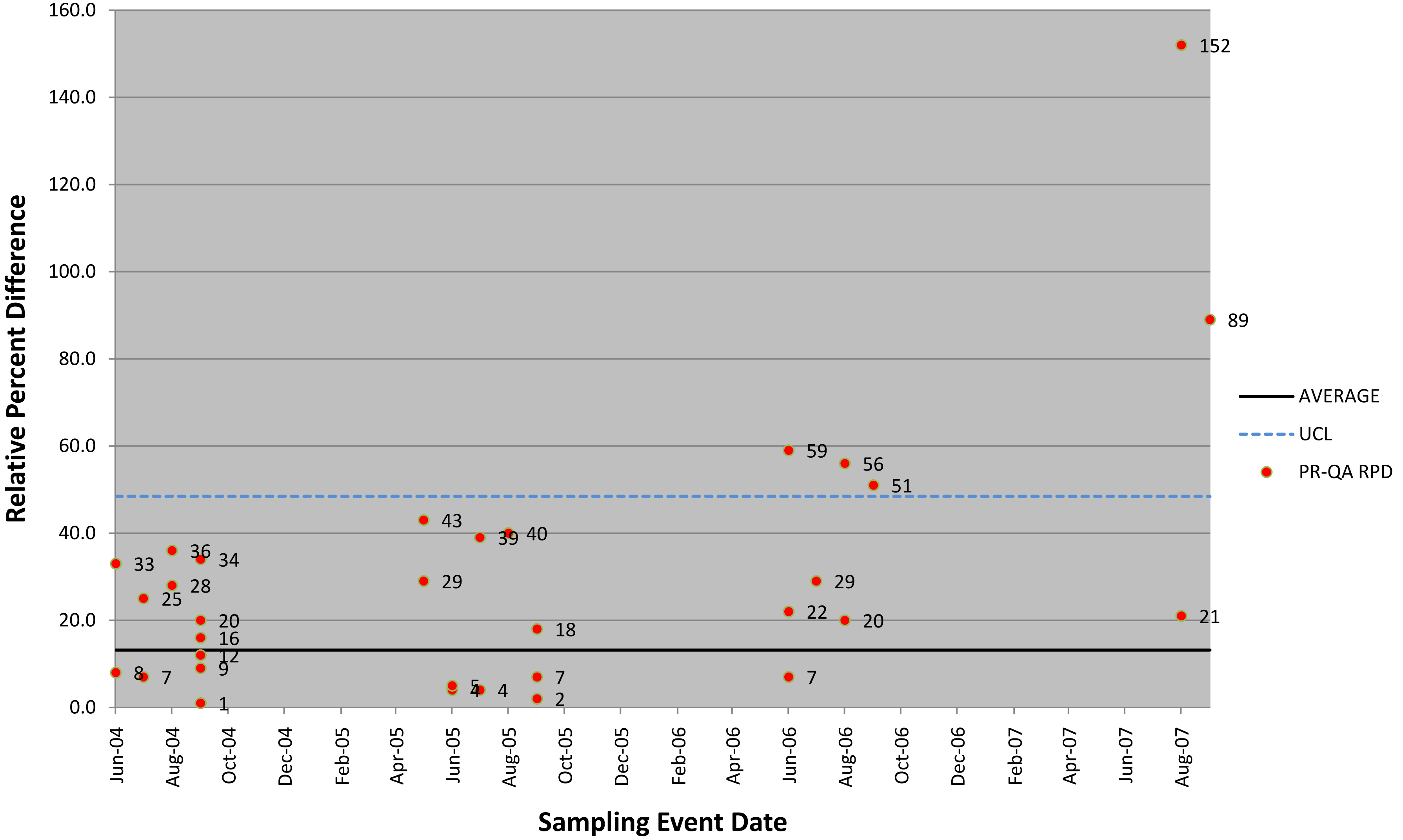


Chart A-147: Thallium Control Chart for June 2004-August 2007 Sediment

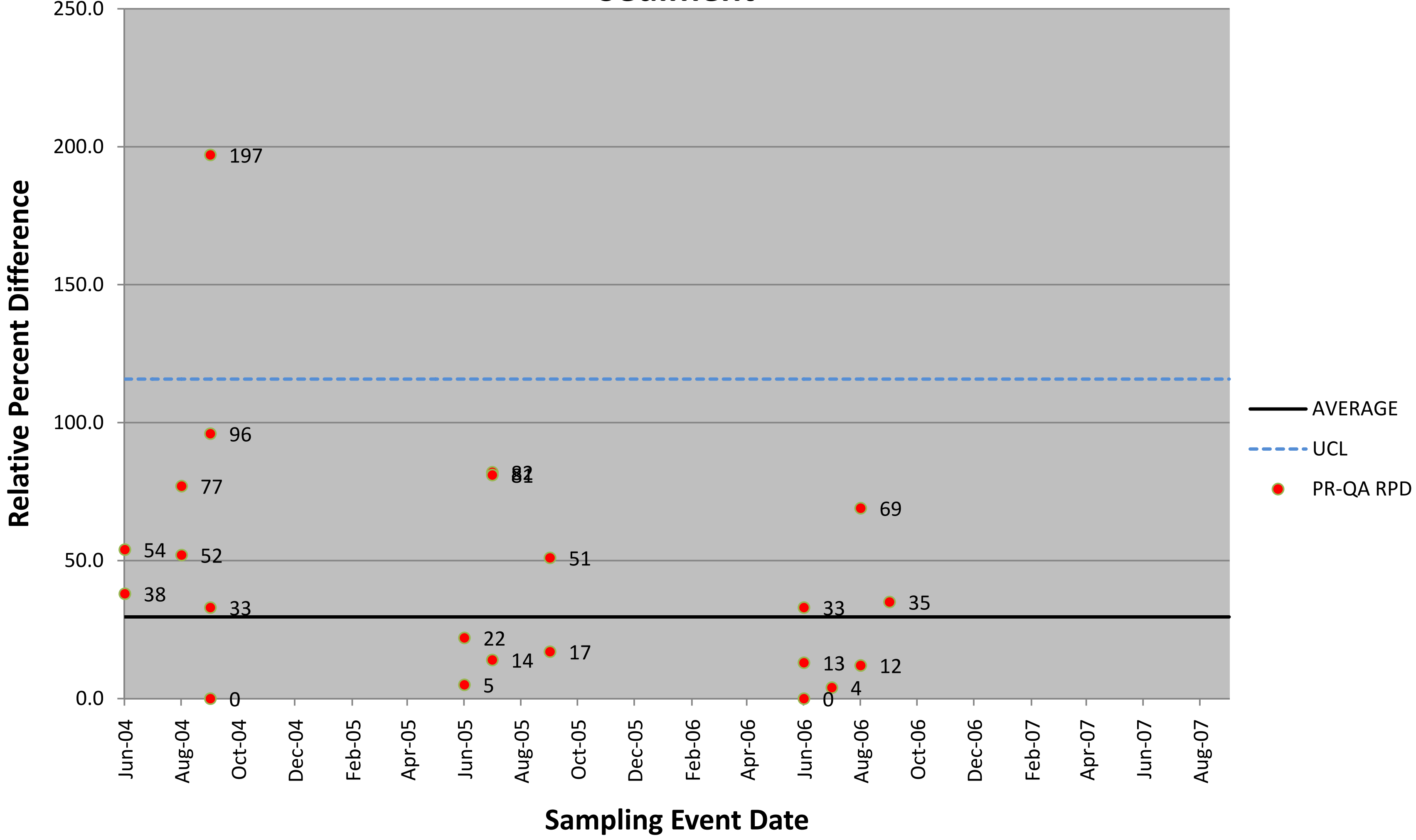
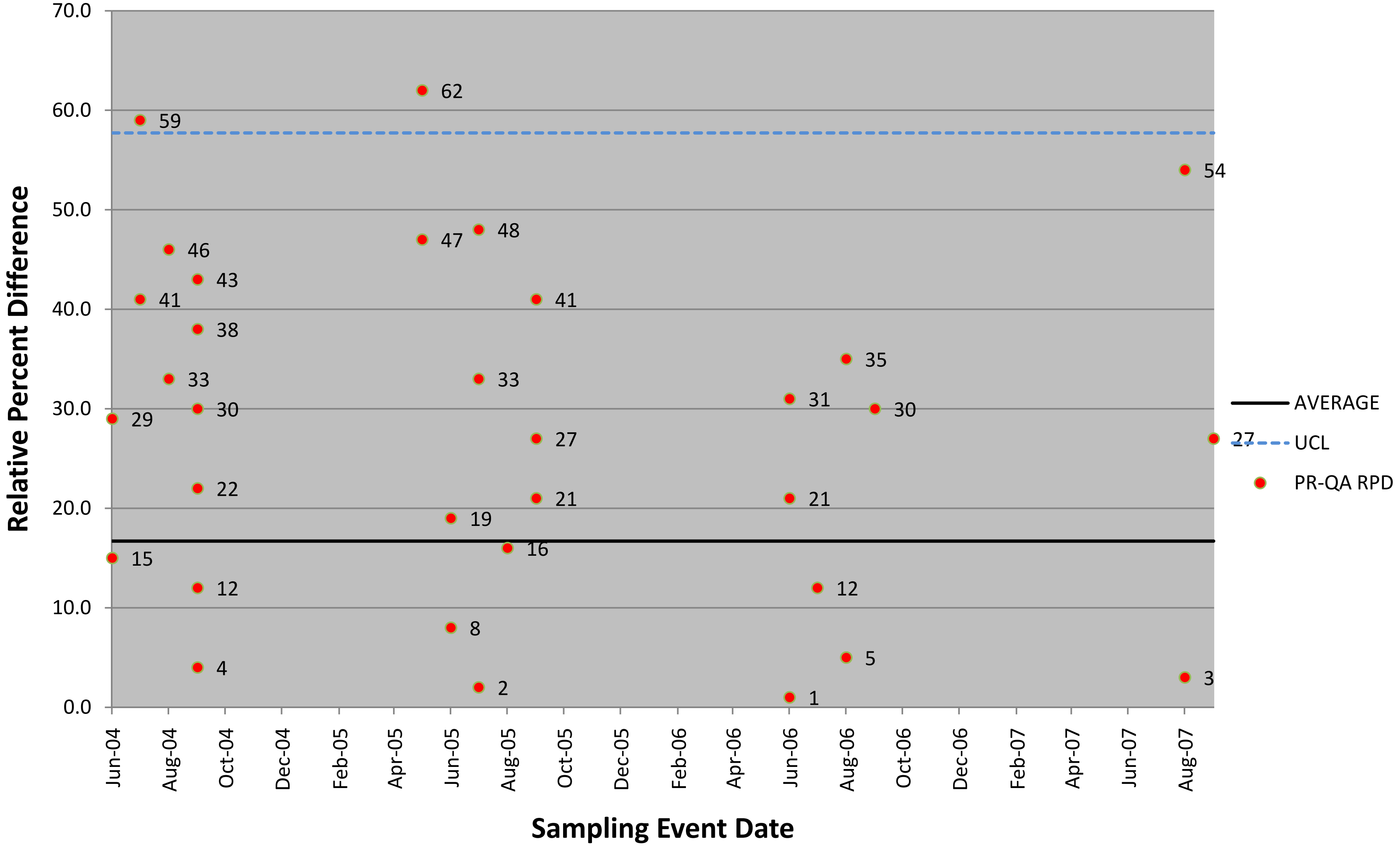


Chart A-148: Vanadium Control Chart for June 2004-August 2007 Sediment



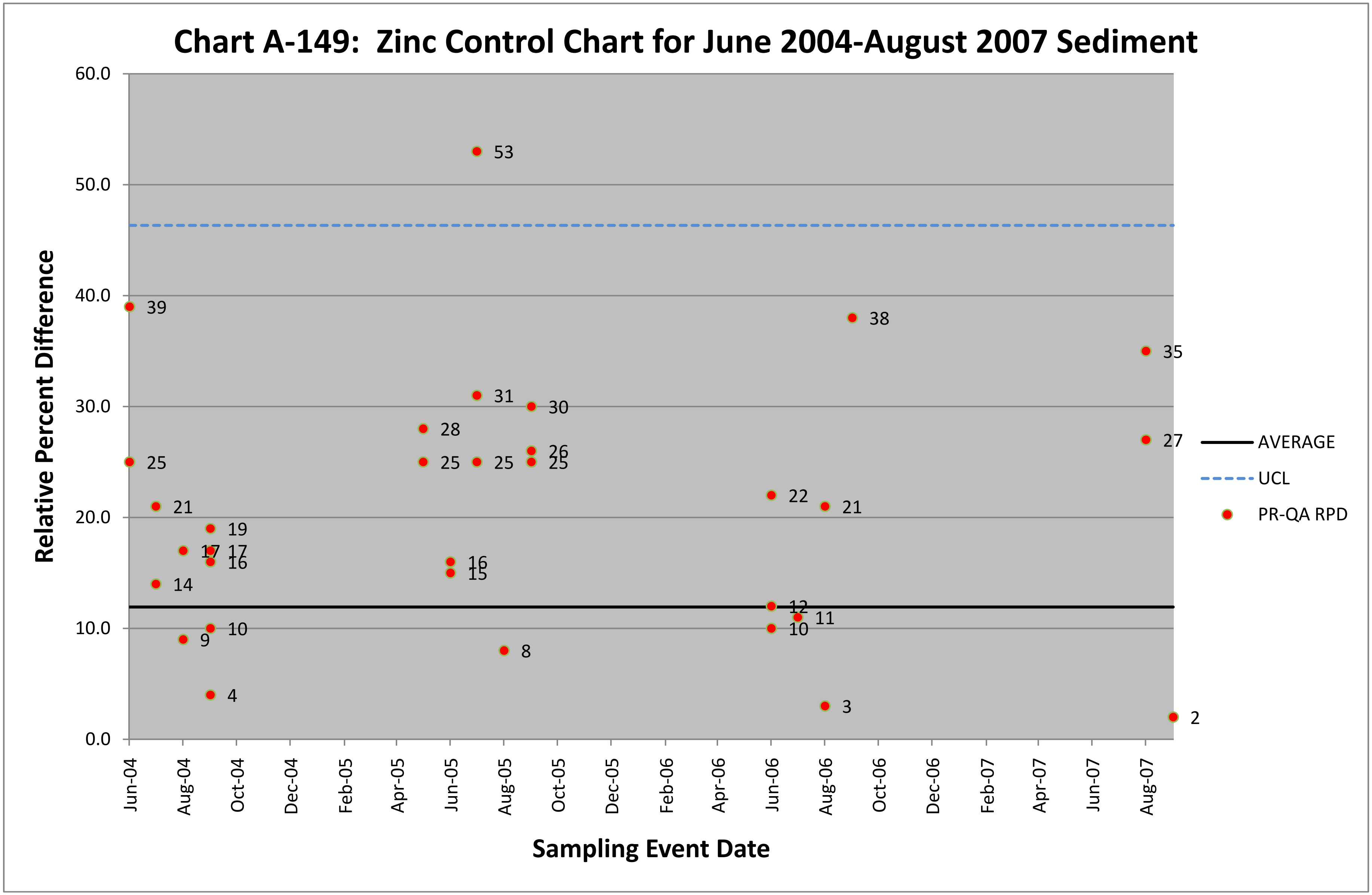
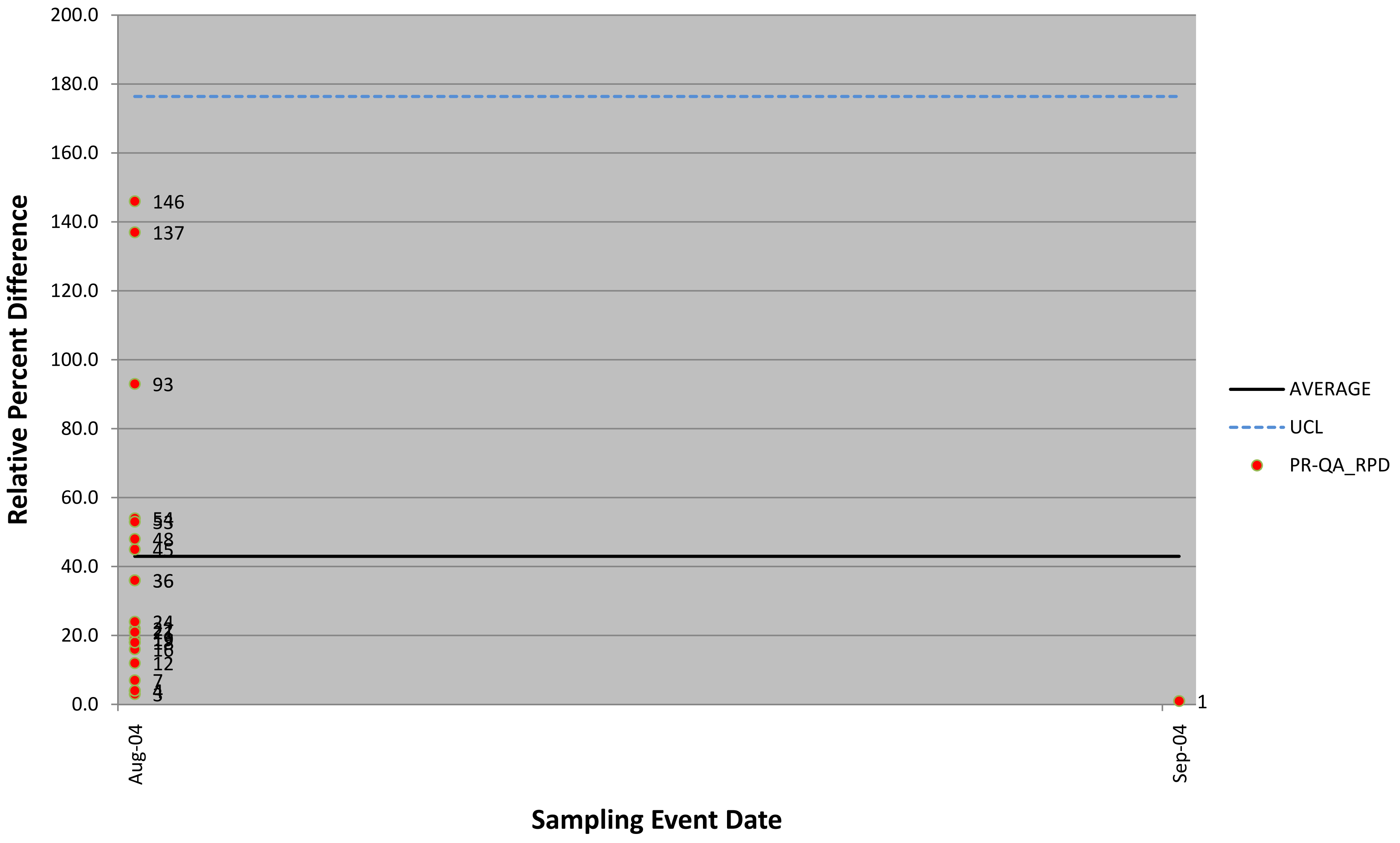


Chart A-149: Zinc Control Chart for June 2004-August 2007 Sediment
Relative Percent Difference
60.0
50.0
40.0
30.0
20.0
10.0
0.0
53
39
38
35
31
30
28
27
26
25
25
25
25
22
21
21
19
17
17
16
16
15
14
12
11
10
10
9
8
4
3
2
Jun-04
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-150: Chloride Control Chart for 2004 Vegetation



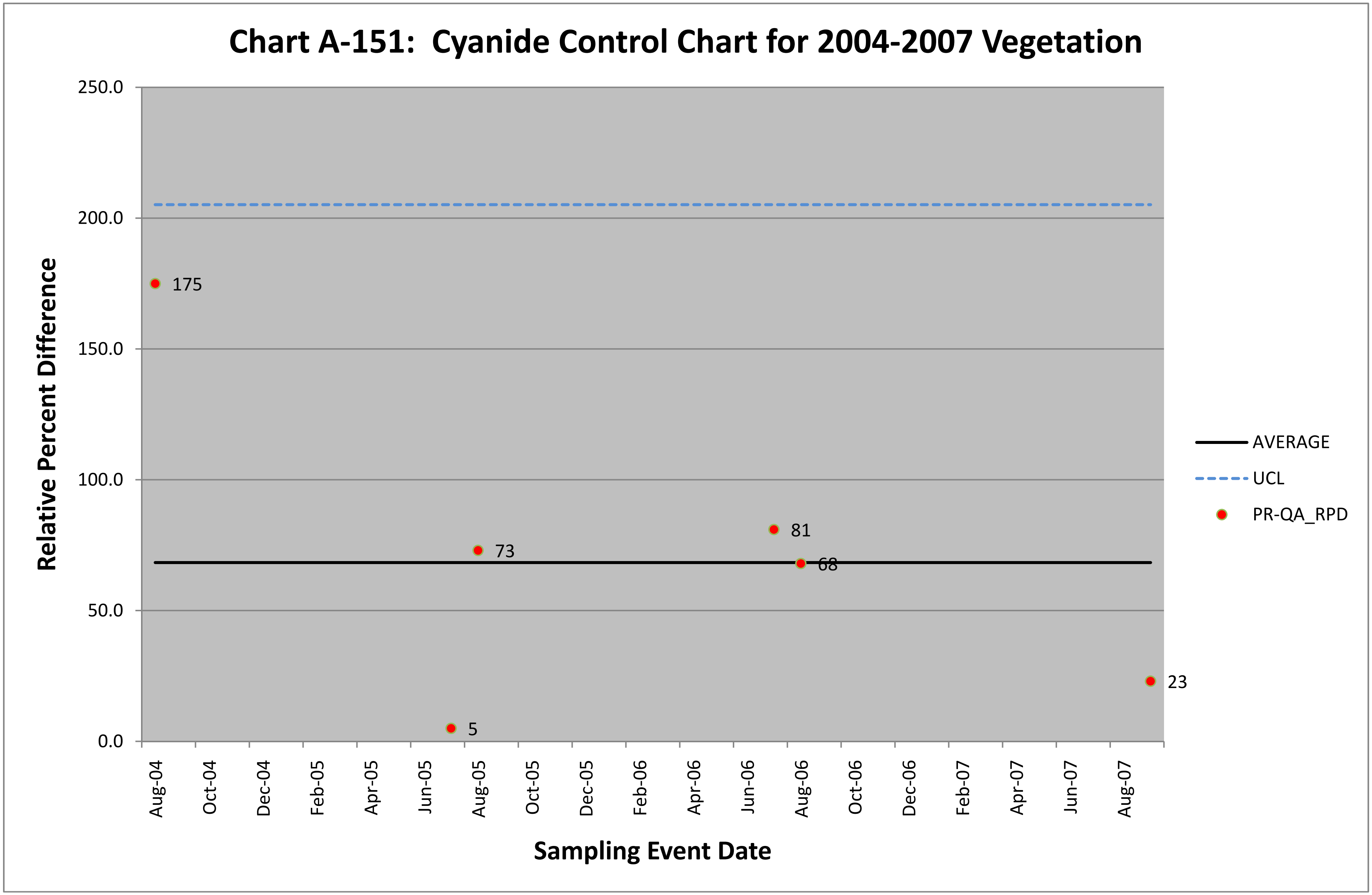


Chart A-151: Cyanide Control Chart for 2004-2007 Vegetation
Relative Percent Difference
250.0
200.0
150.0
100.0
50.0
0.0
175
73
5
81
68
23
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD

Chart A-152: Fluoride Control Chart for 2004 Vegetation

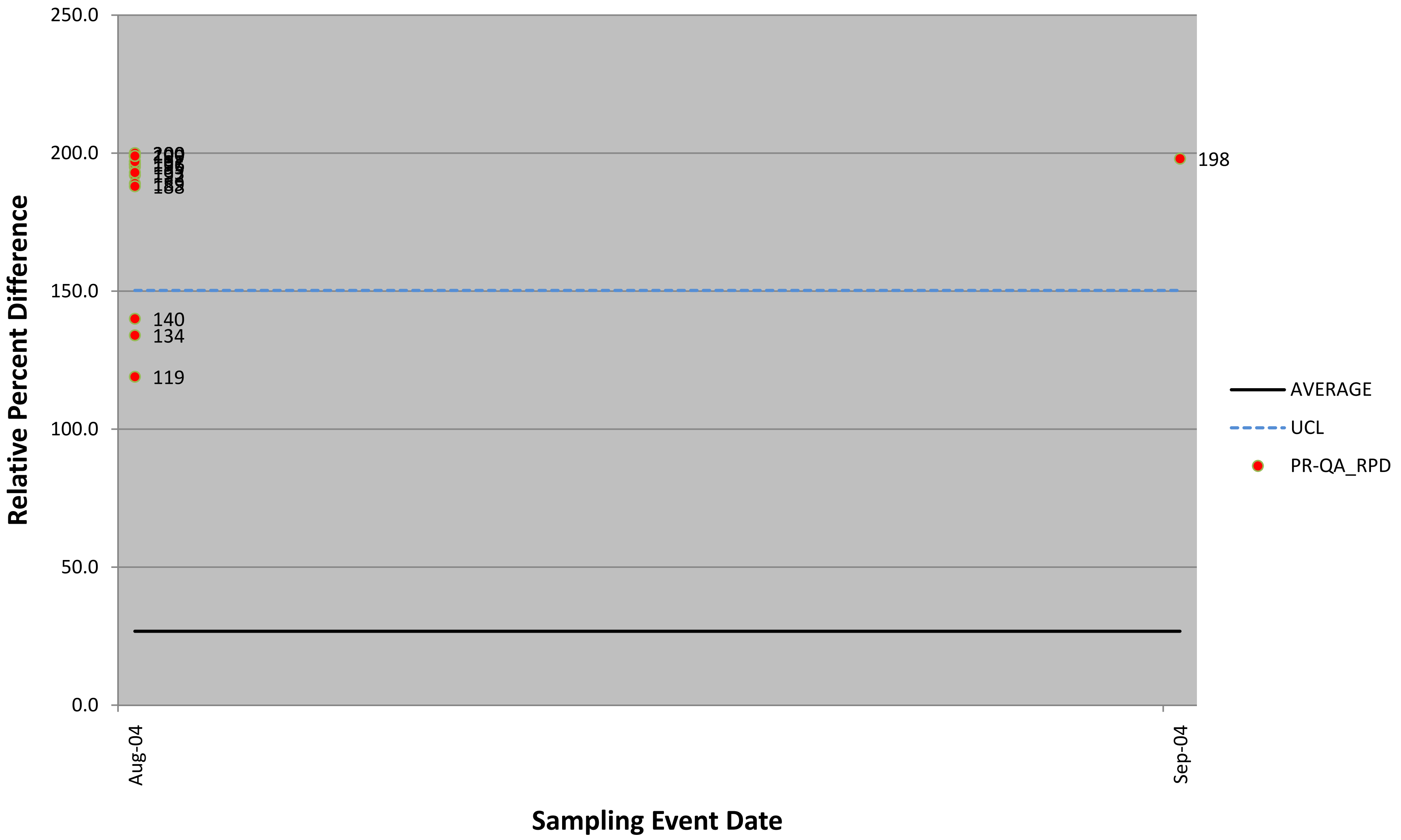


Chart A-153: Nitrogen: Ammonia (as N) Control Chart for 2004 Vegetation

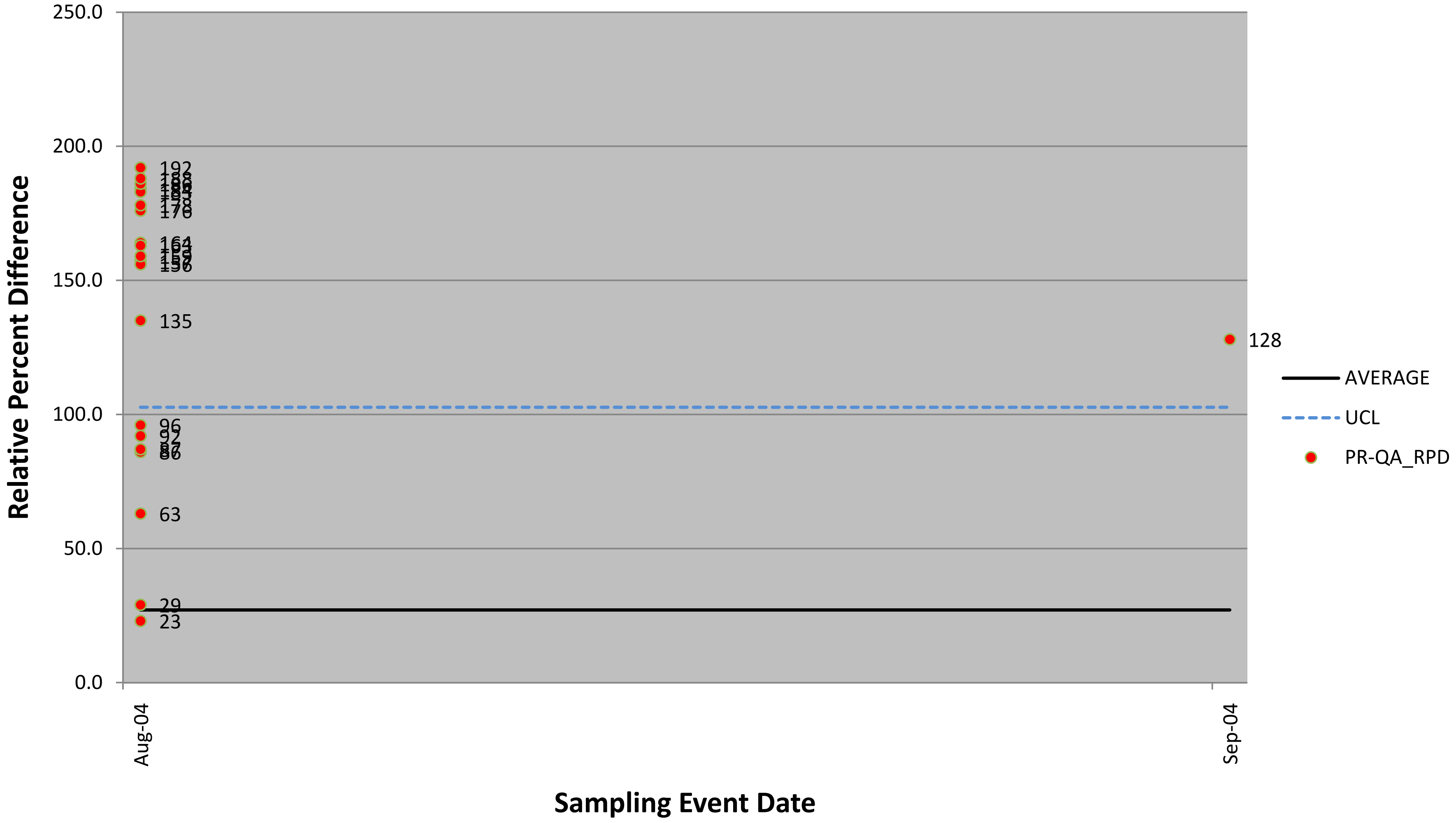
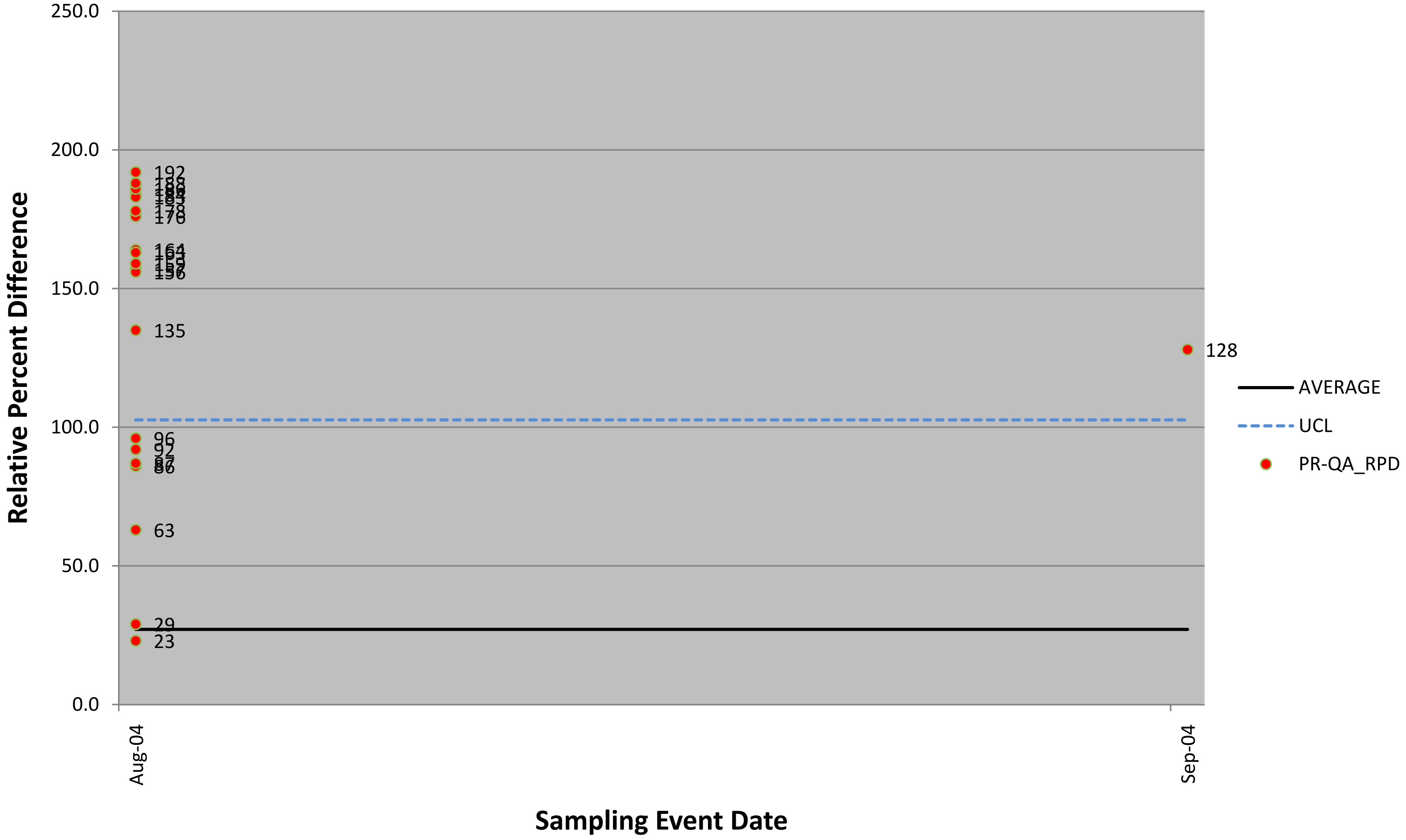


Chart A-154: Sulfate Control Chart for 2004 Vegetation



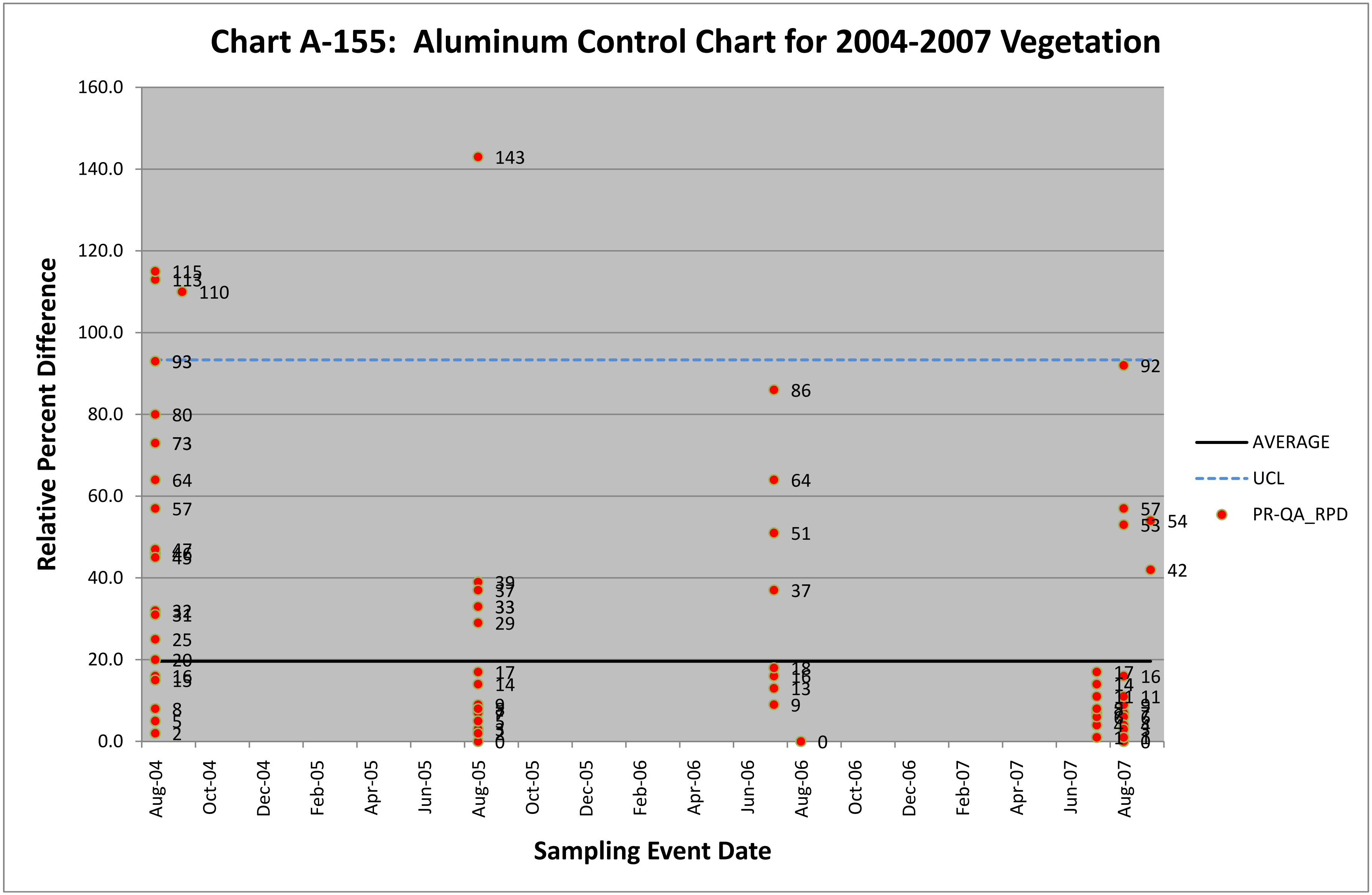


Chart A-155: Aluminum Control Chart for 2004-2007 Vegetation
Relative Percent Difference
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Sampling Event Date
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
115
113
110
93
80
73
64
57
47
46
45
32
31
25
20
16
15
8
5
2
143
39
37
33
29
17
14
9
8
7
5
3
2
0
86
64
51
37
18
16
13
9
0
92
57
53
54
42
17
14
11
16
11
9
1
0
AVERAGE
UCL
PR-QA_RPD

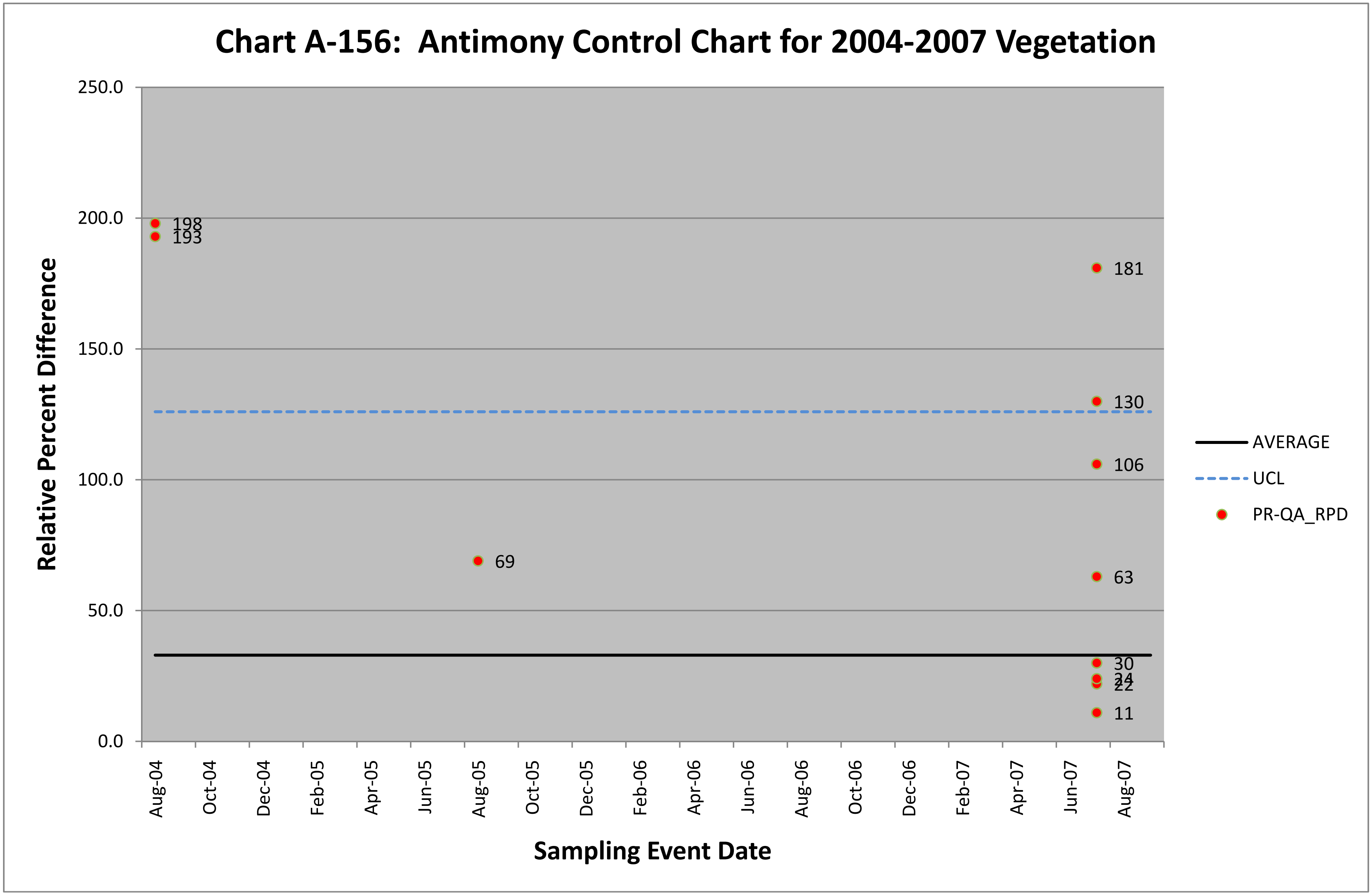


Chart A-156: Antimony Control Chart for 2004-2007 Vegetation
Relative Percent Difference
250.0
200.0
150.0
100.0
50.0
0.0
198
193
181
130
106
69
63
30
24
22
11
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD

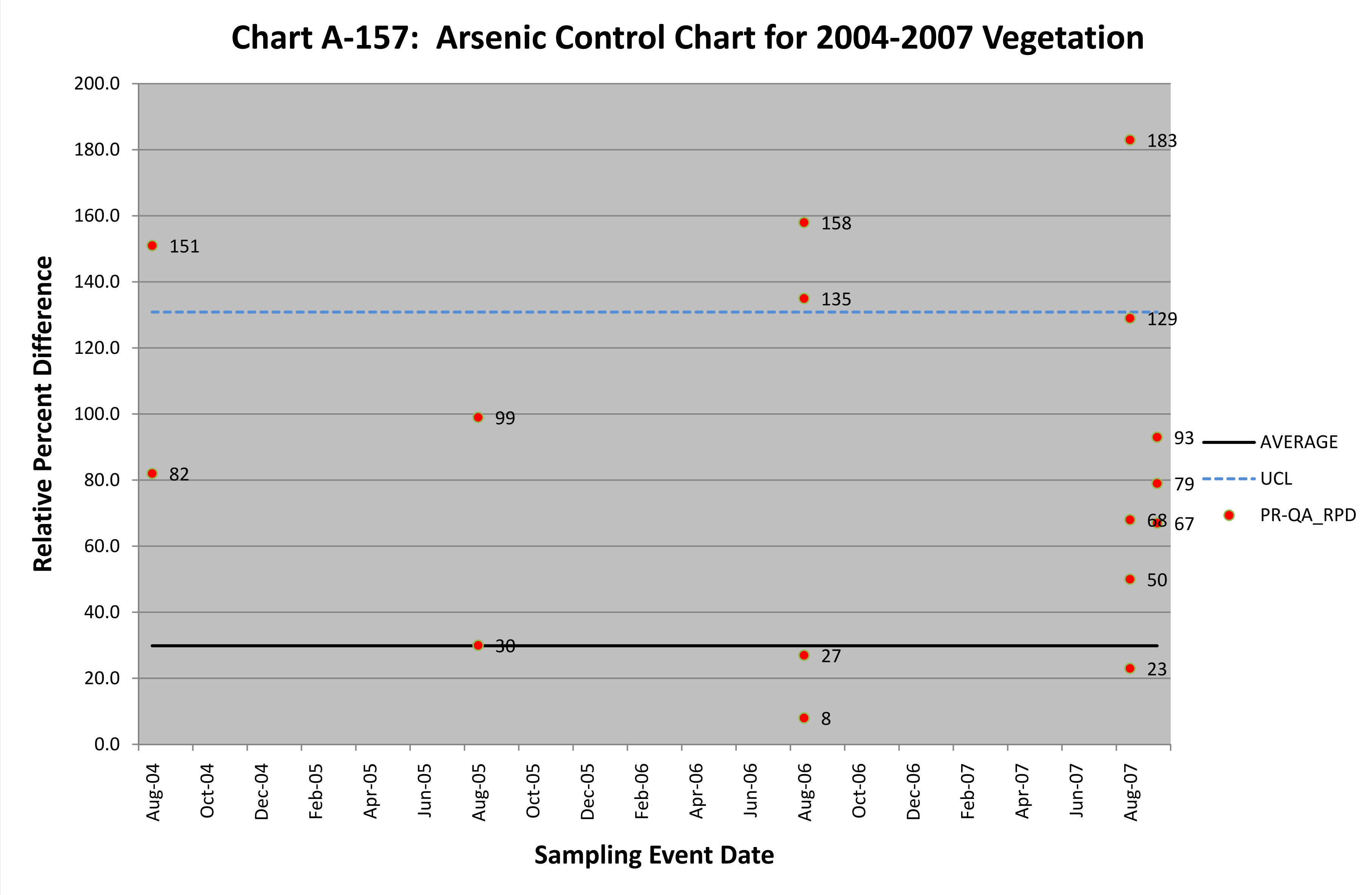


Chart A-157: Arsenic Control Chart for 2004-2007 Vegetation
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
151
82
99
30
158
135
27
8
183
129
68
50
23
93
79
67
AVERAGE
UCL
PR-QA_RPD

Chart A-158: Barium Control Chart for 2004-2007 Vegetation

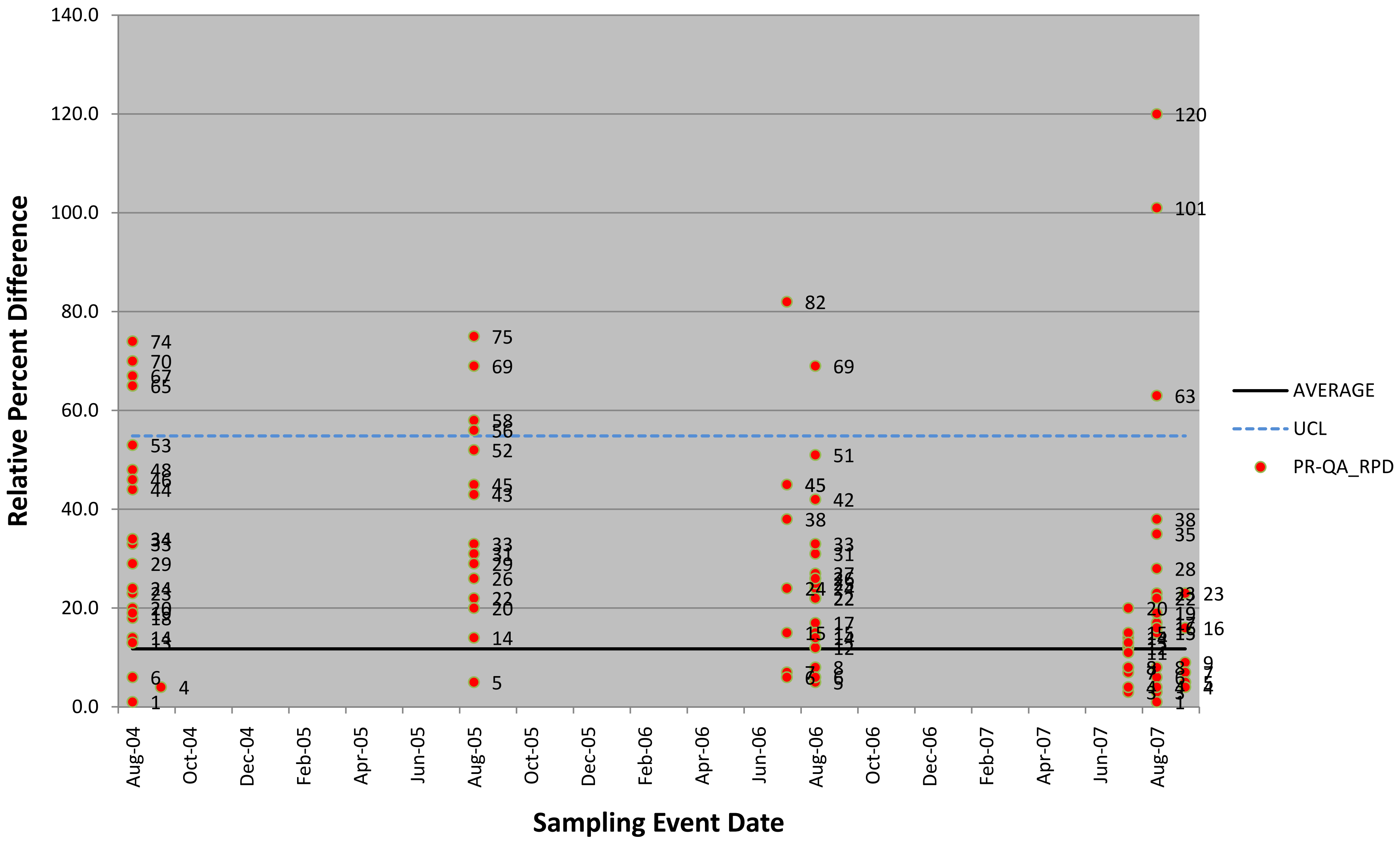
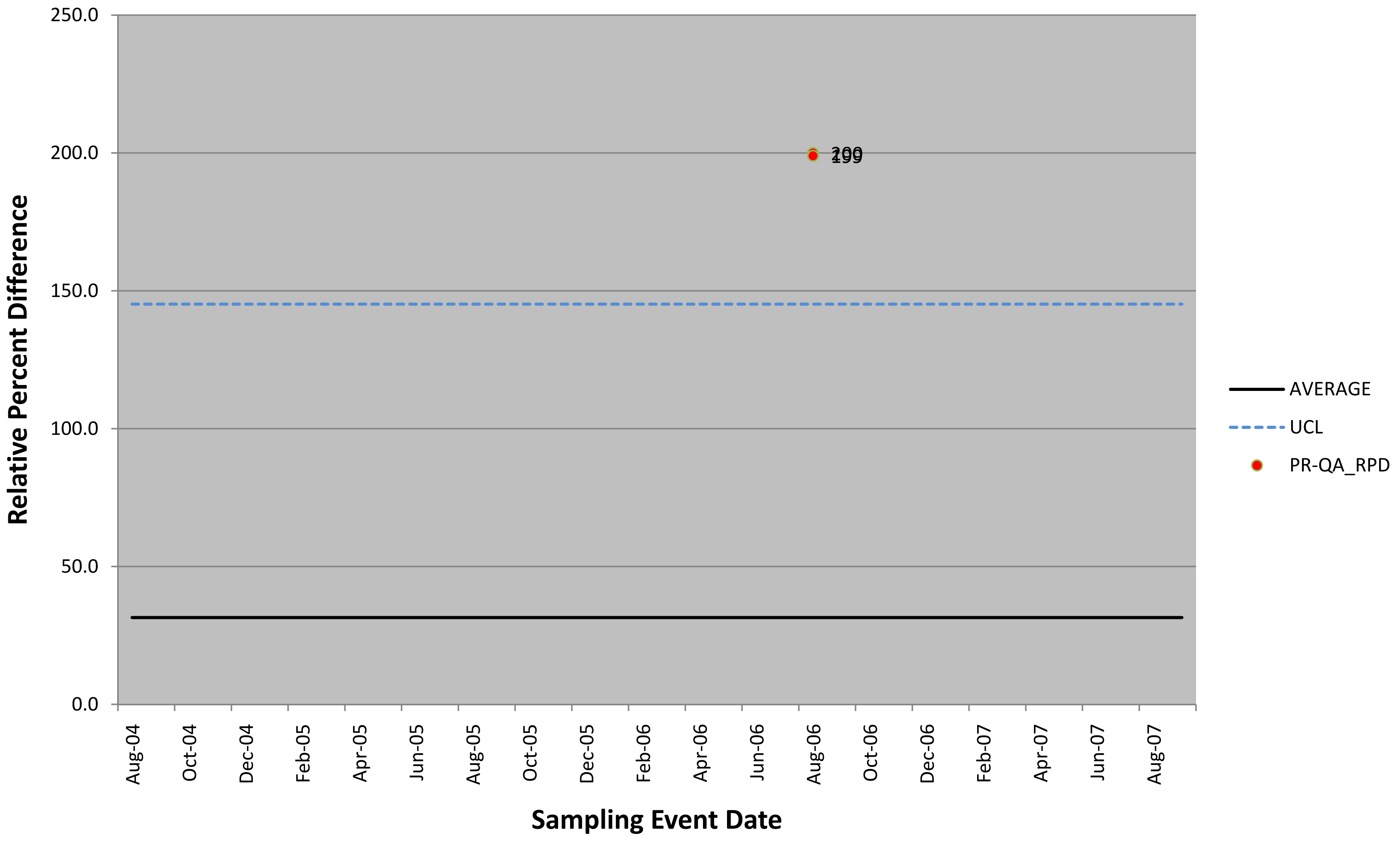


Chart A-159: Bismuth Control Chart for 2004-2007 Vegetation



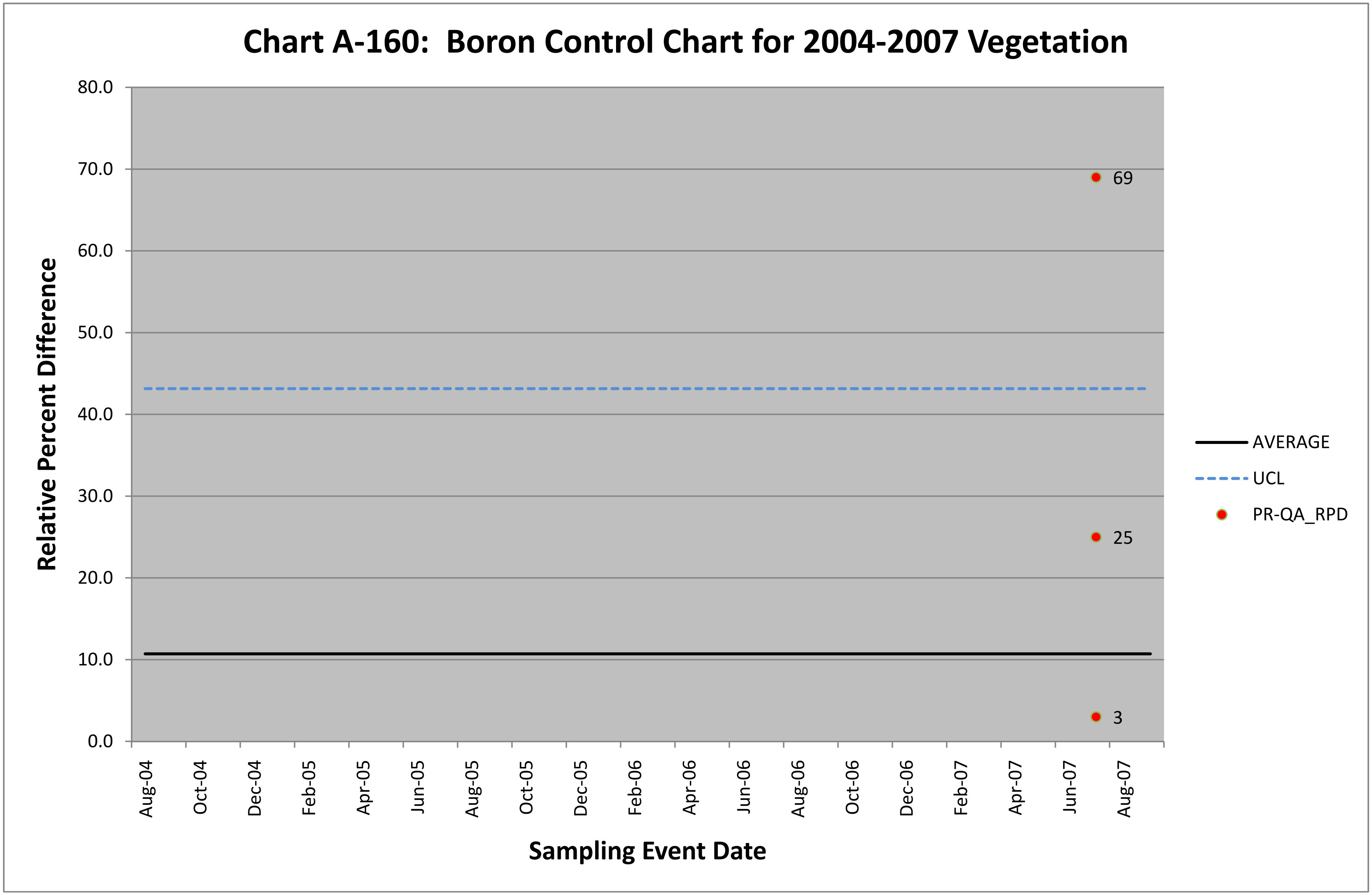


Chart A-160: Boron Control Chart for 2004-2007 Vegetation
Relative Percent Difference
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
69
25
3
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD

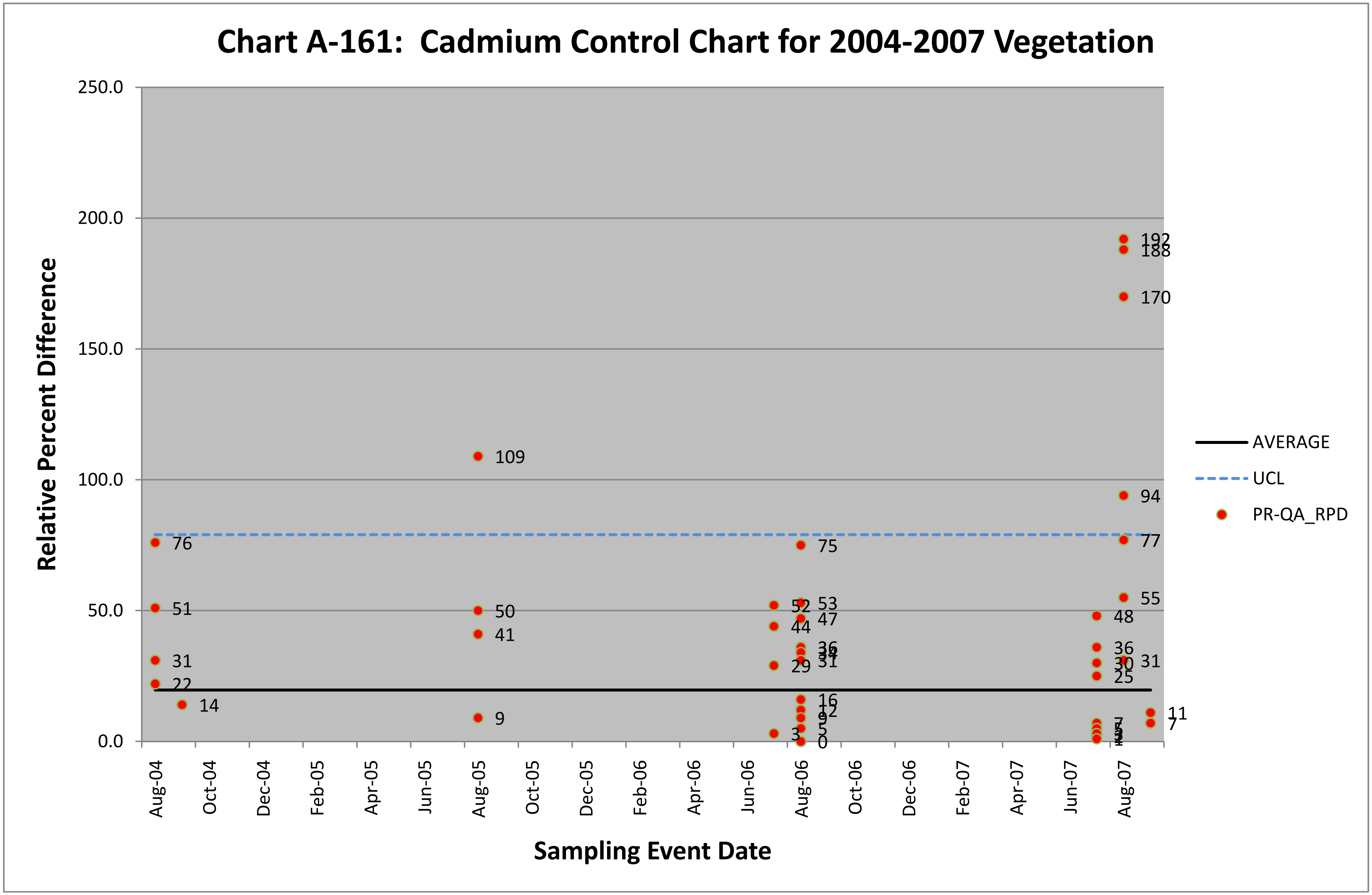
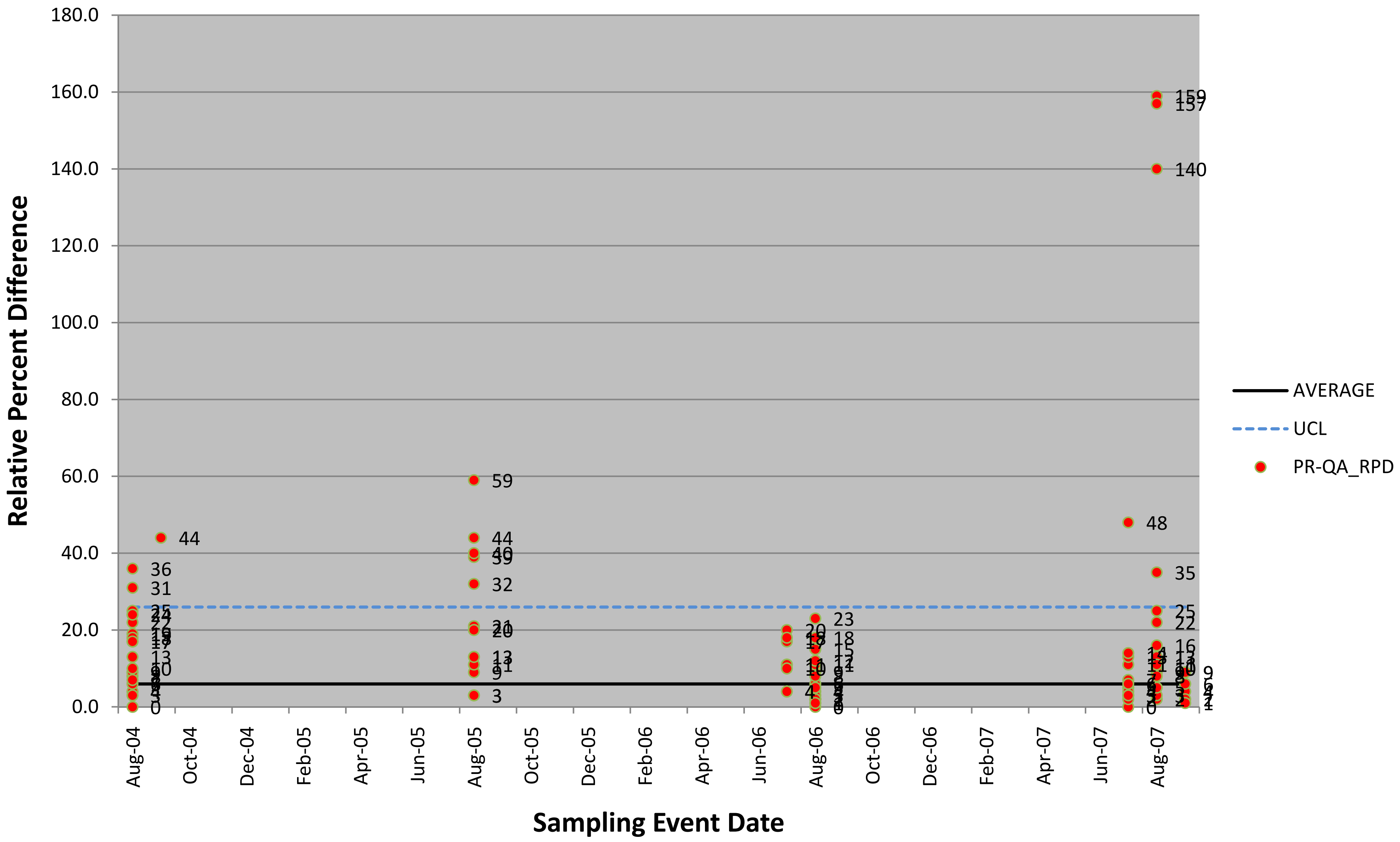


Chart A-161: Cadmium Control Chart for 2004-2007 Vegetation
Relative Percent Difference
250.0
200.0
150.0
100.0
50.0
0.0
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
76
51
31
22
14
109
50
41
9
52
44
29
3
75
53
47
36
34
31
16
12
9
5
0
48
36
30
25
7
5
3
2
1
192
188
170
94
77
55
31
11
7
AVERAGE
UCL
PR-QA_RPD

Chart A-162: Calcium Control Chart for 2004-2007 Vegetation



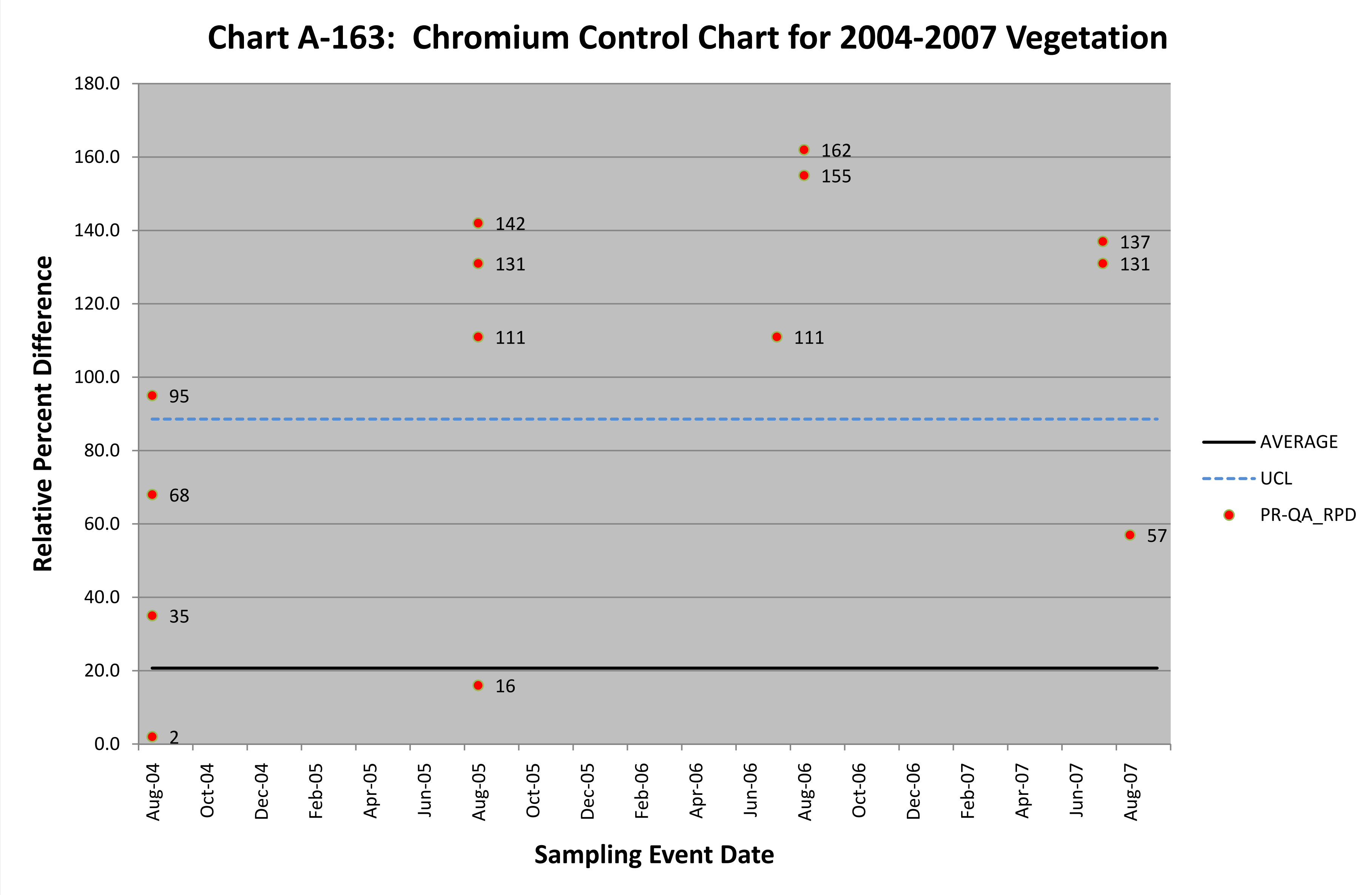
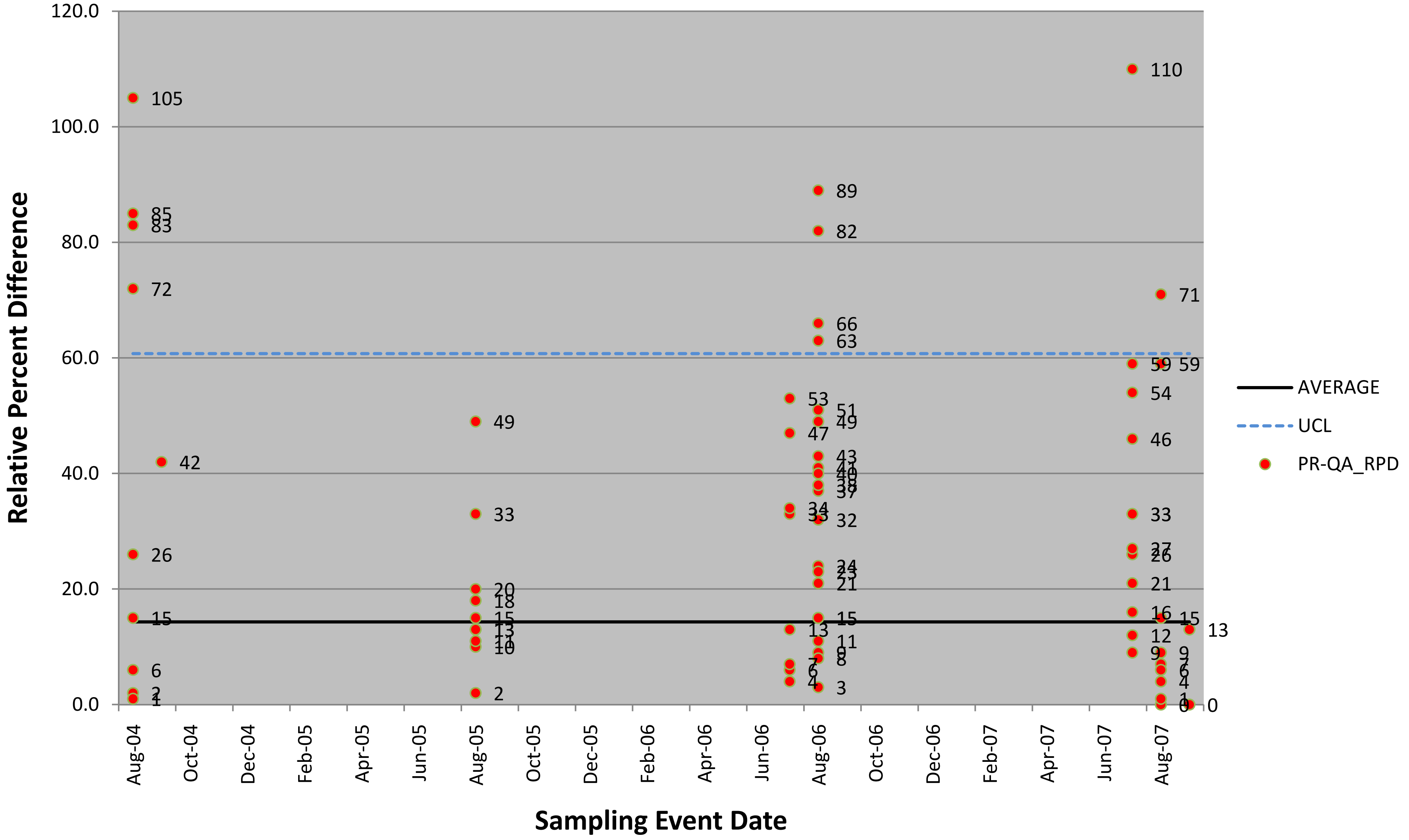


Chart A-163: Chromium Control Chart for 2004-2007 Vegetation
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
162
155
142
131
111
111
137
131
95
68
35
16
2
57
AVERAGE
UCL
PR-QA_RPD
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date

Chart A-164: Cobalt Control Chart for 2004-2007 Vegetation



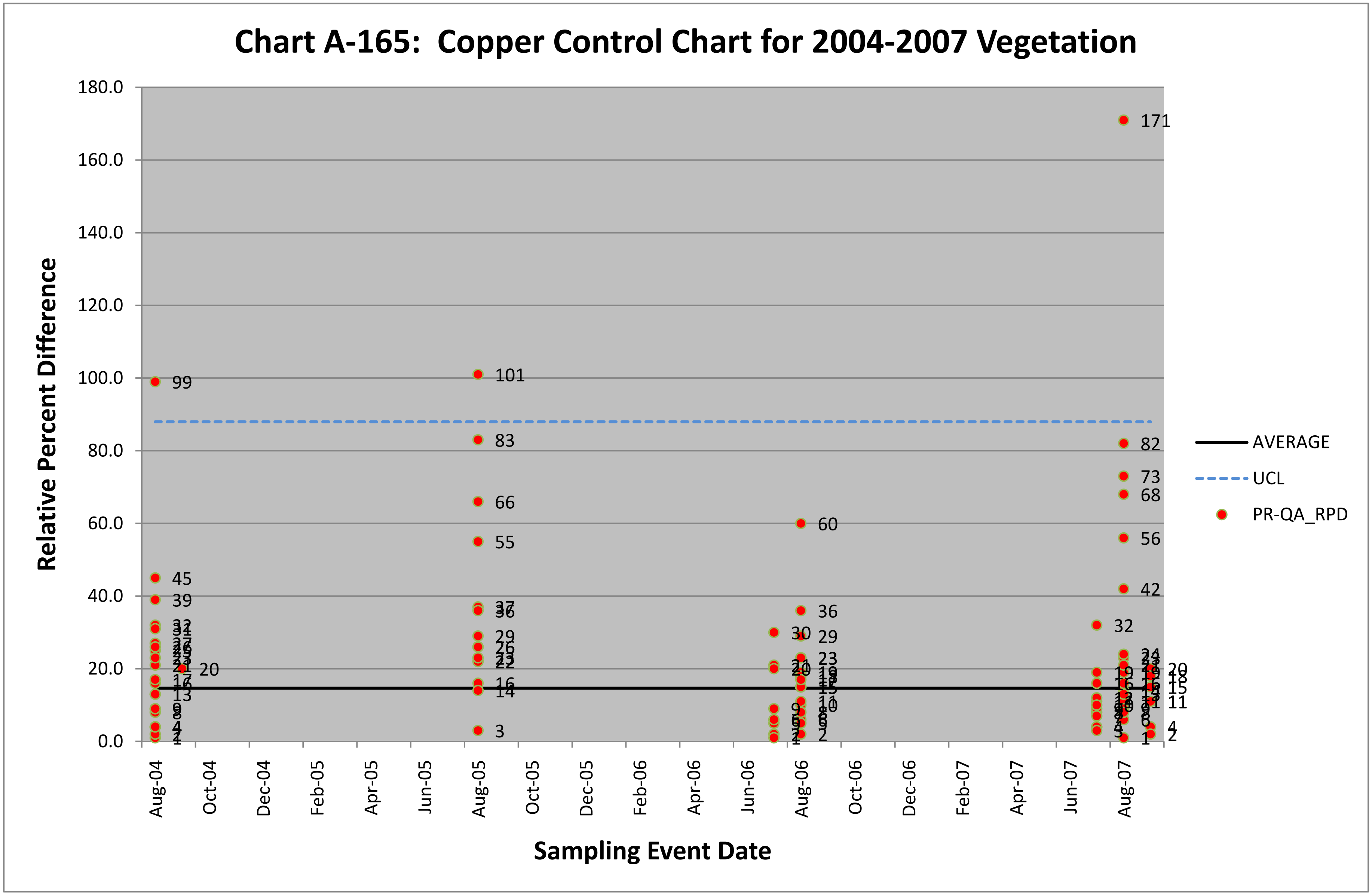


Chart A-165: Copper Control Chart for 2004-2007 Vegetation
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD
99
45
39
20
101
83
66
55
3
60
36
30
29
23
2
171
82
73
68
56
42
32
20
18
15
11
4
2

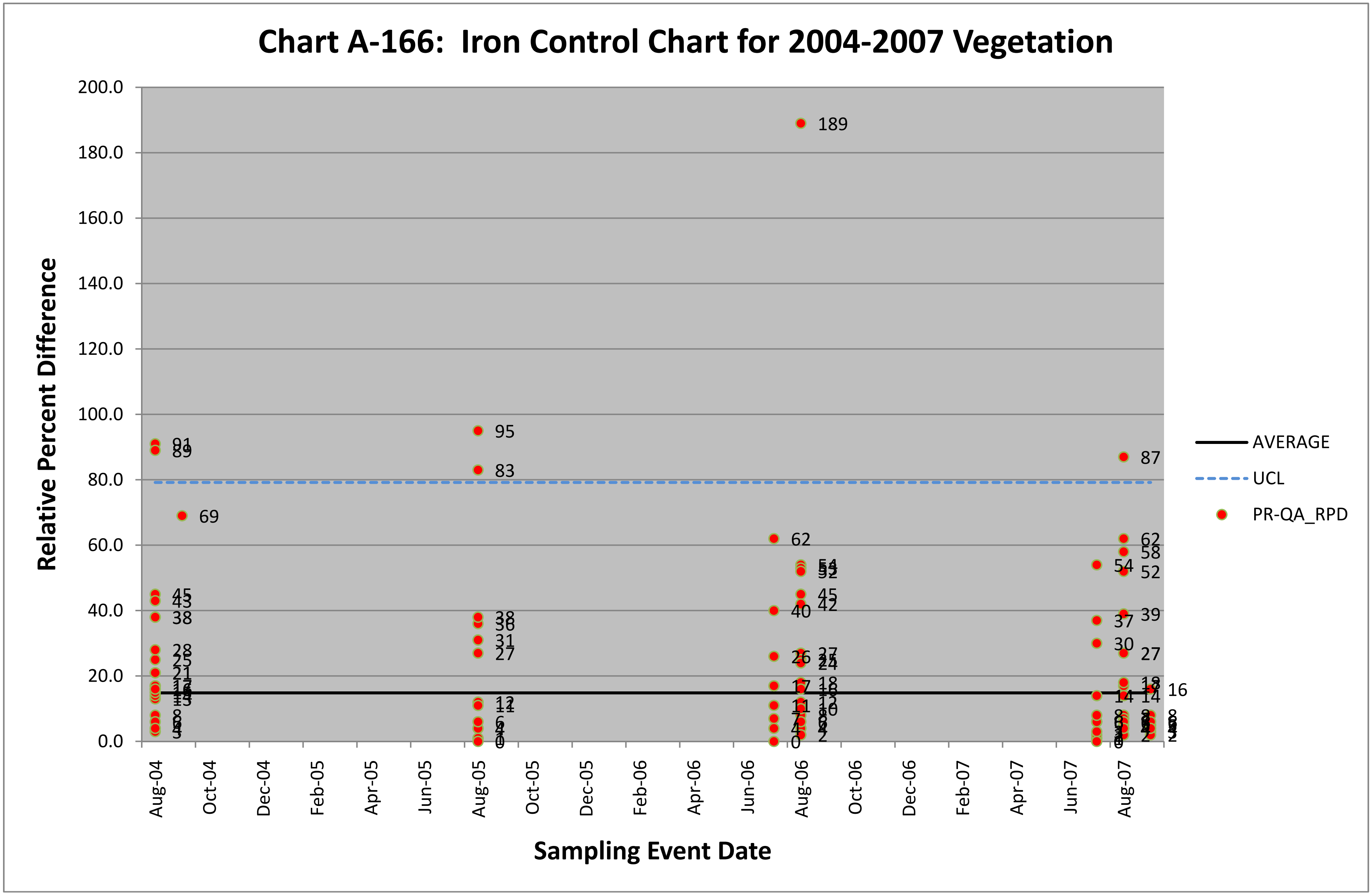


Chart A-166: Iron Control Chart for 2004-2007 Vegetation
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
Sampling Event Date
AVERAGE
UCL
PR-QA_RPD
189
95
91
89
87
83
69
62
62
58
54
54
52
45
45
43
42
40
39
38
38
37
36
31
30
28
27
27
27
26
25
24
21
18
18
17
16
14
14
13
12
11
11
10
8
8
6
4
3
2
2
0
0
0

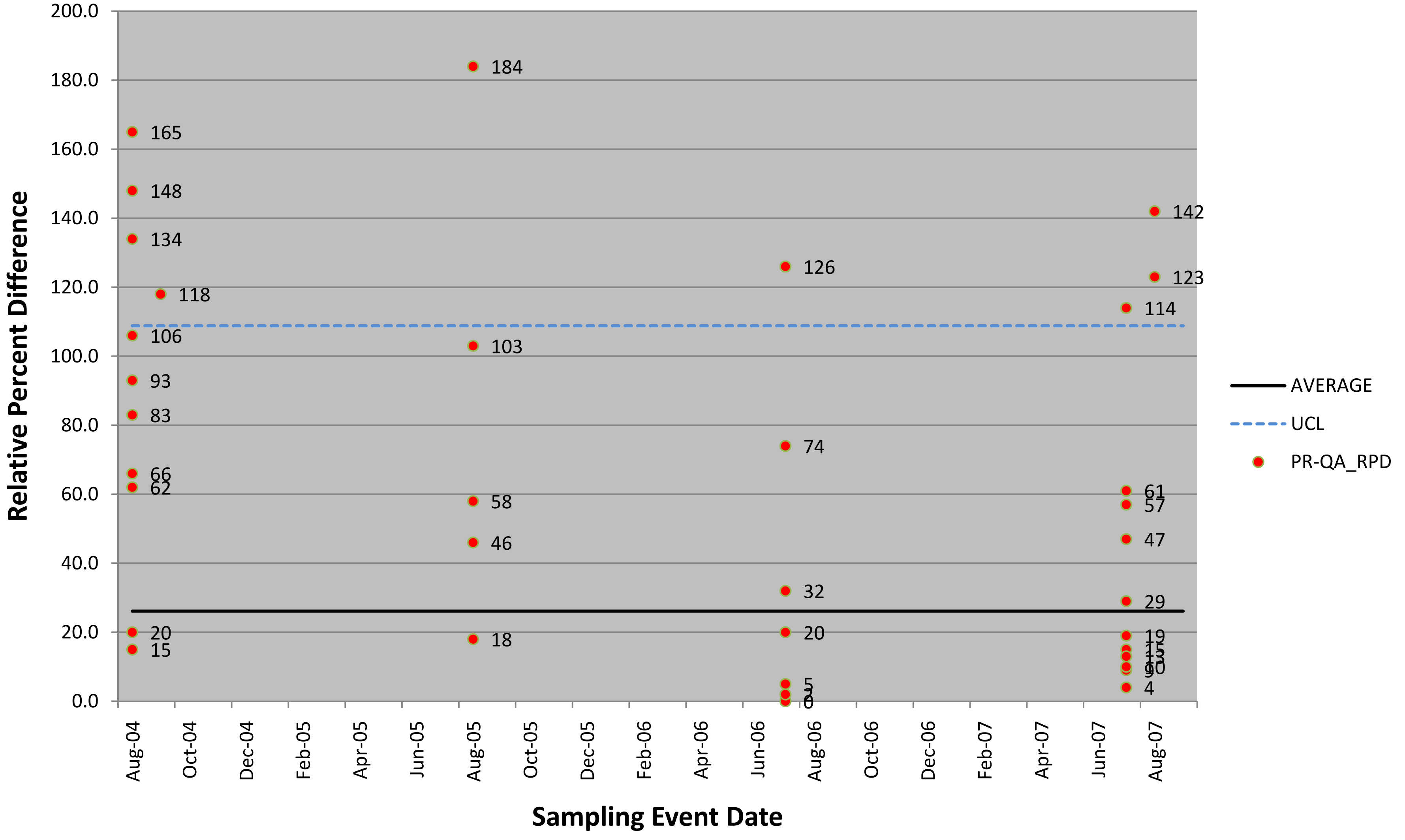
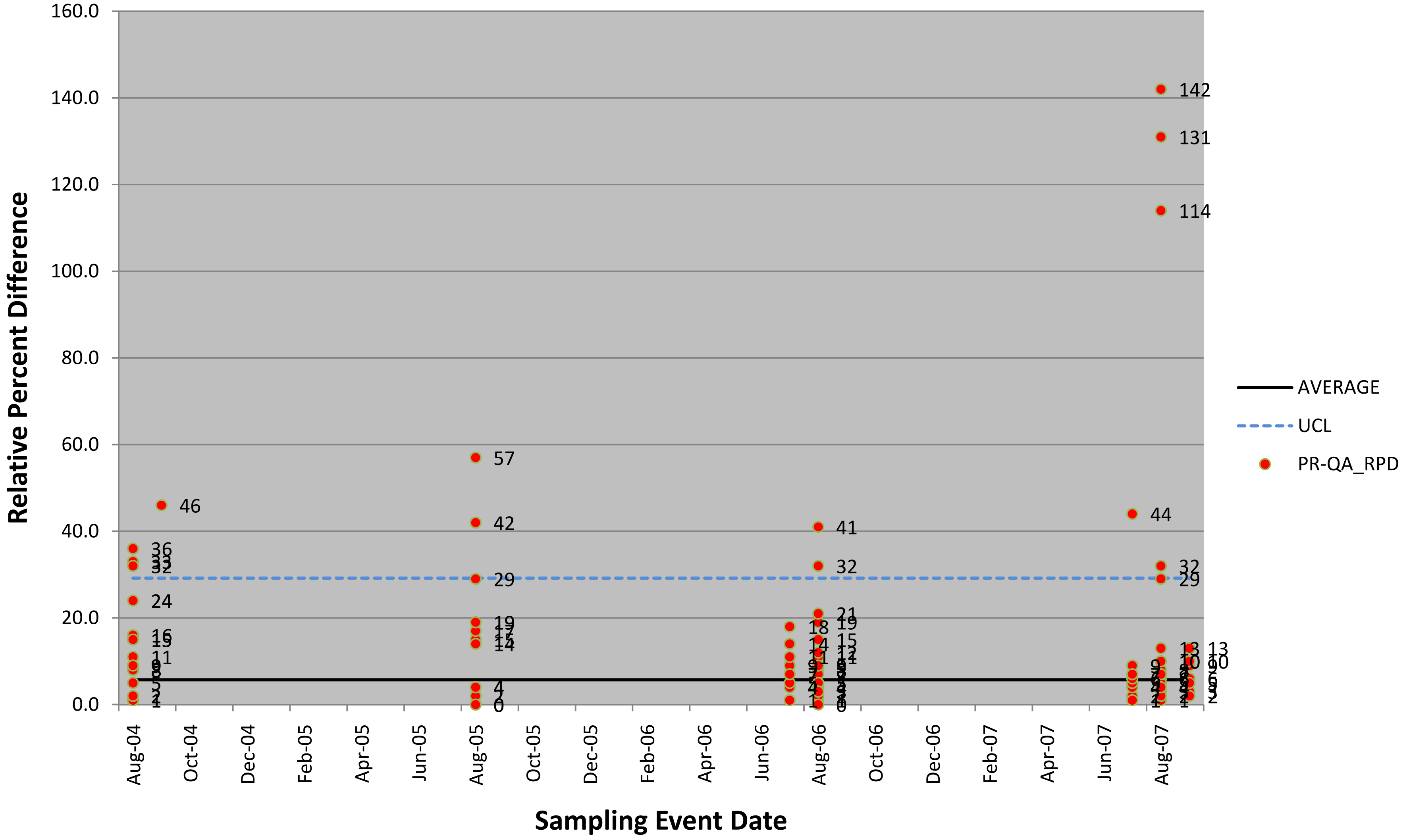


Chart A-167: Lead Control Chart for 2004-2007 Vegetation

Chart A-168: Magnesium Control Chart for 2004-2007 Vegetation



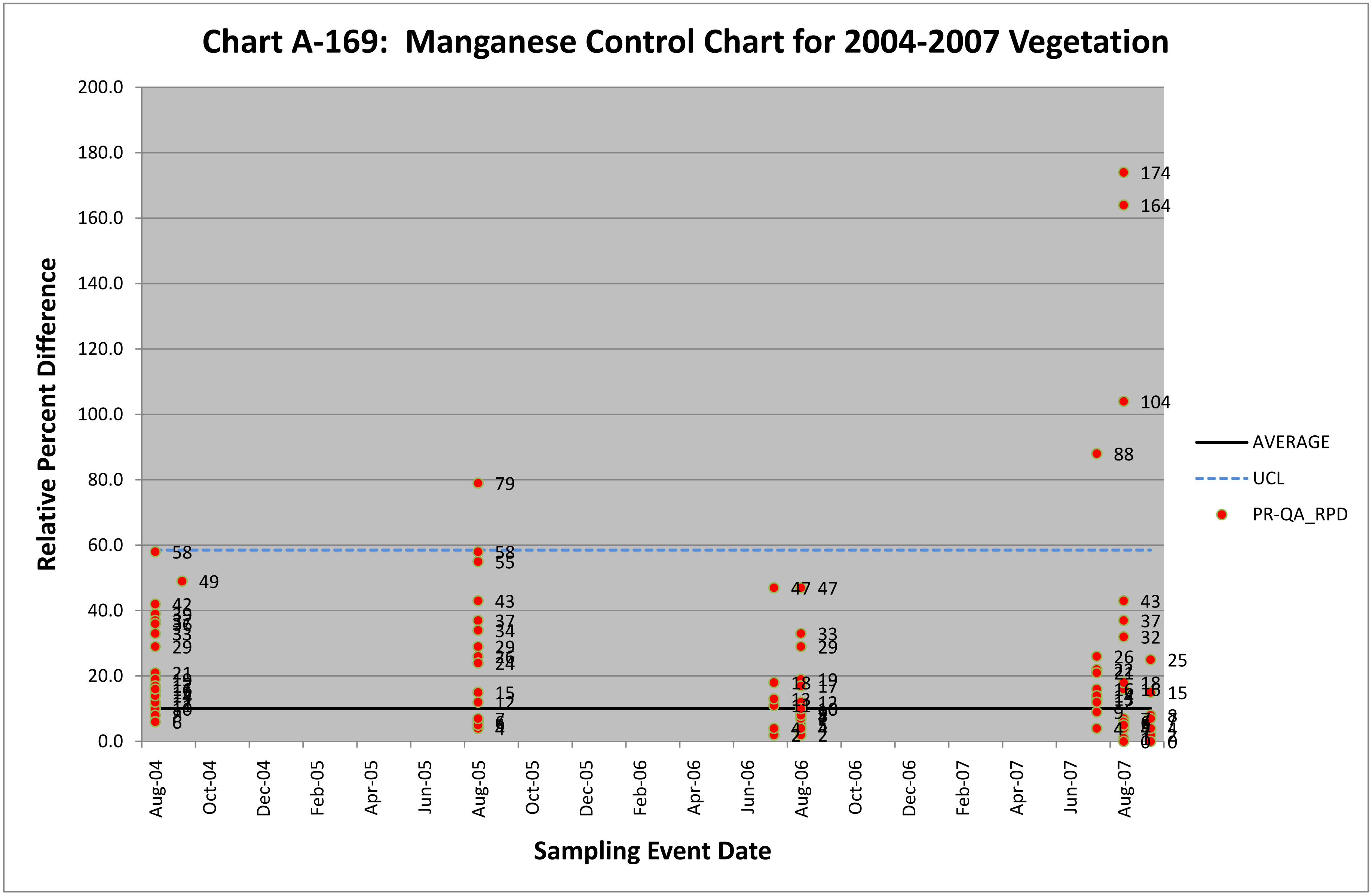


Chart A-169: Manganese Control Chart for 2004-2007 Vegetation
Relative Percent Difference
Sampling Event Date
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
160.0
180.0
200.0
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
AVERAGE
UCL
PR-QA_RPD
58
49
42
29
21
6
79
58
55
43
37
34
29
24
15
12
4
47
47
33
29
19
18
17
2
2
174
164
104
88
43
37
32
26
25
18
15
0

Chart A-170: Mercury Control Chart for 2004-2007 Vegetation

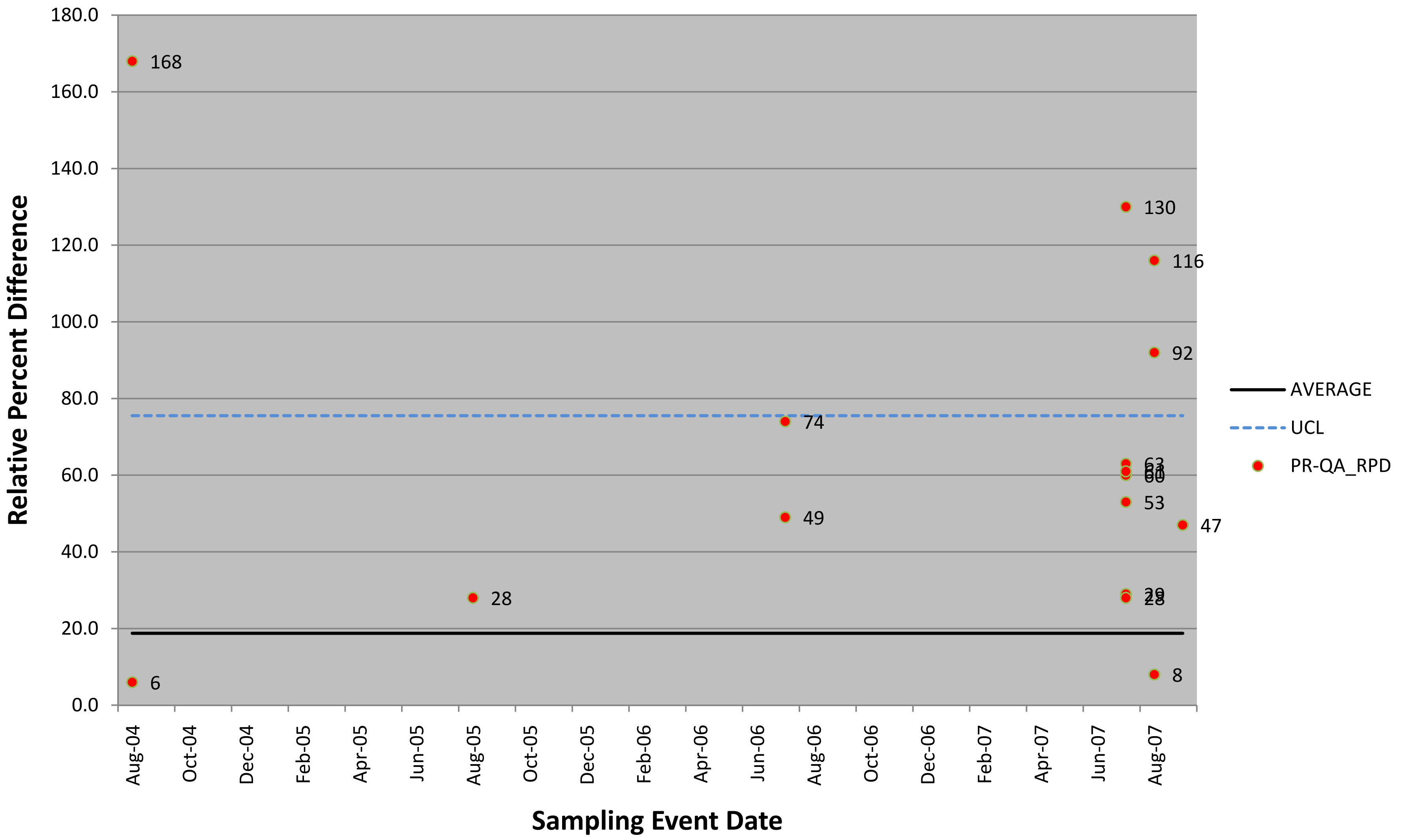


Chart A-171: Molybdenum Control Chart for 2004-2007 Vegetation

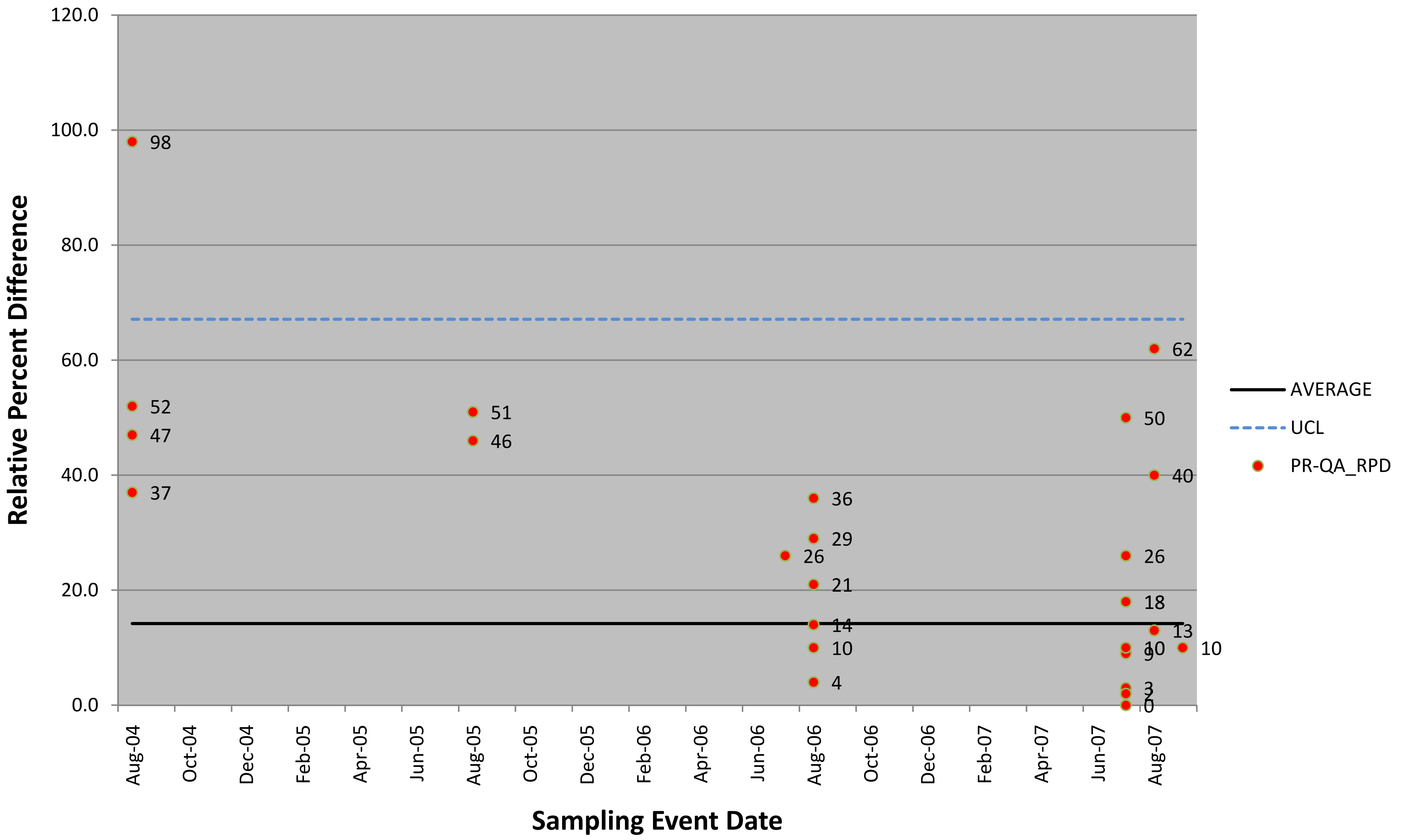
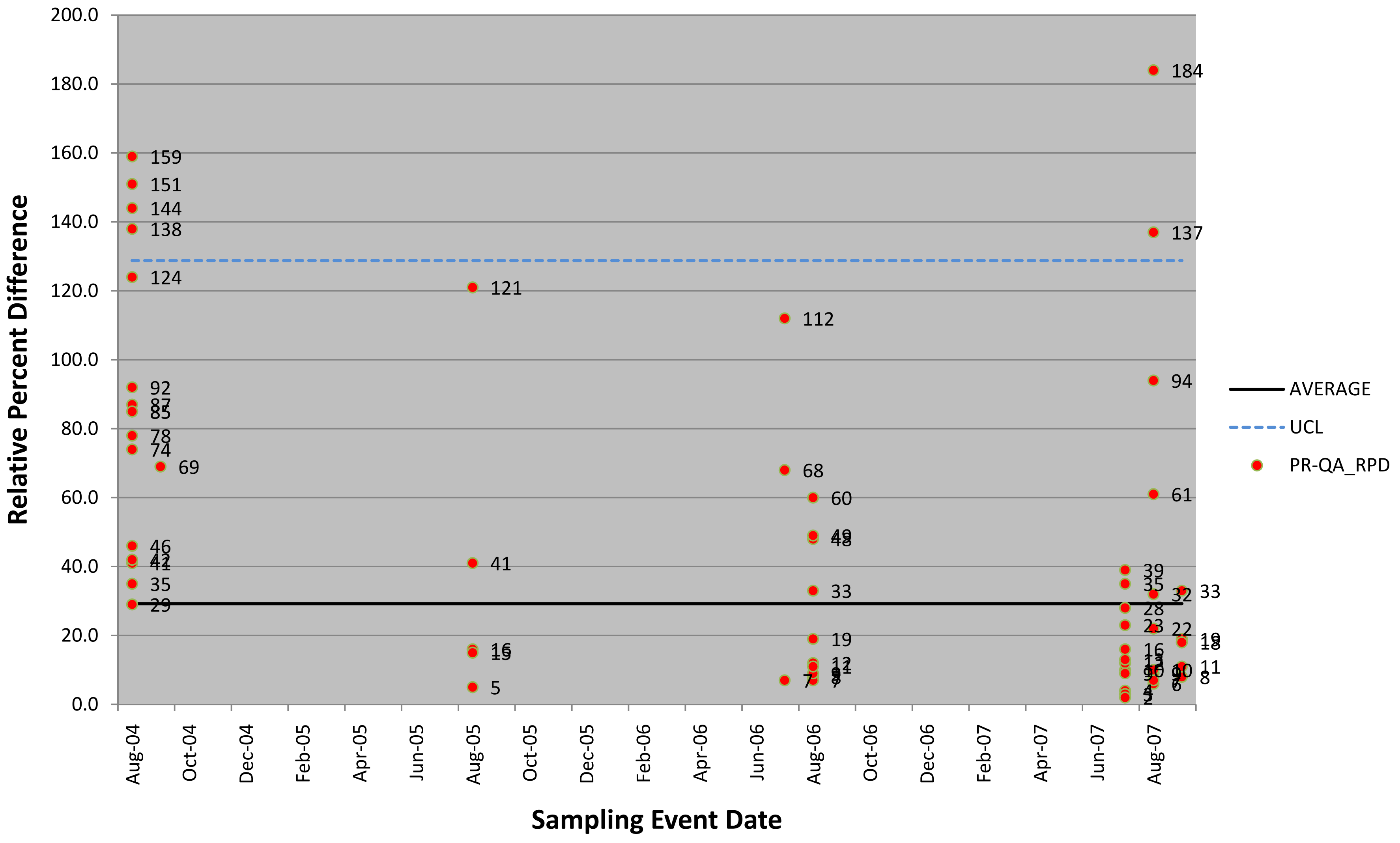


Chart A-172: Nickel Control Chart for 2004-2007 Vegetation



Sampling Event Date

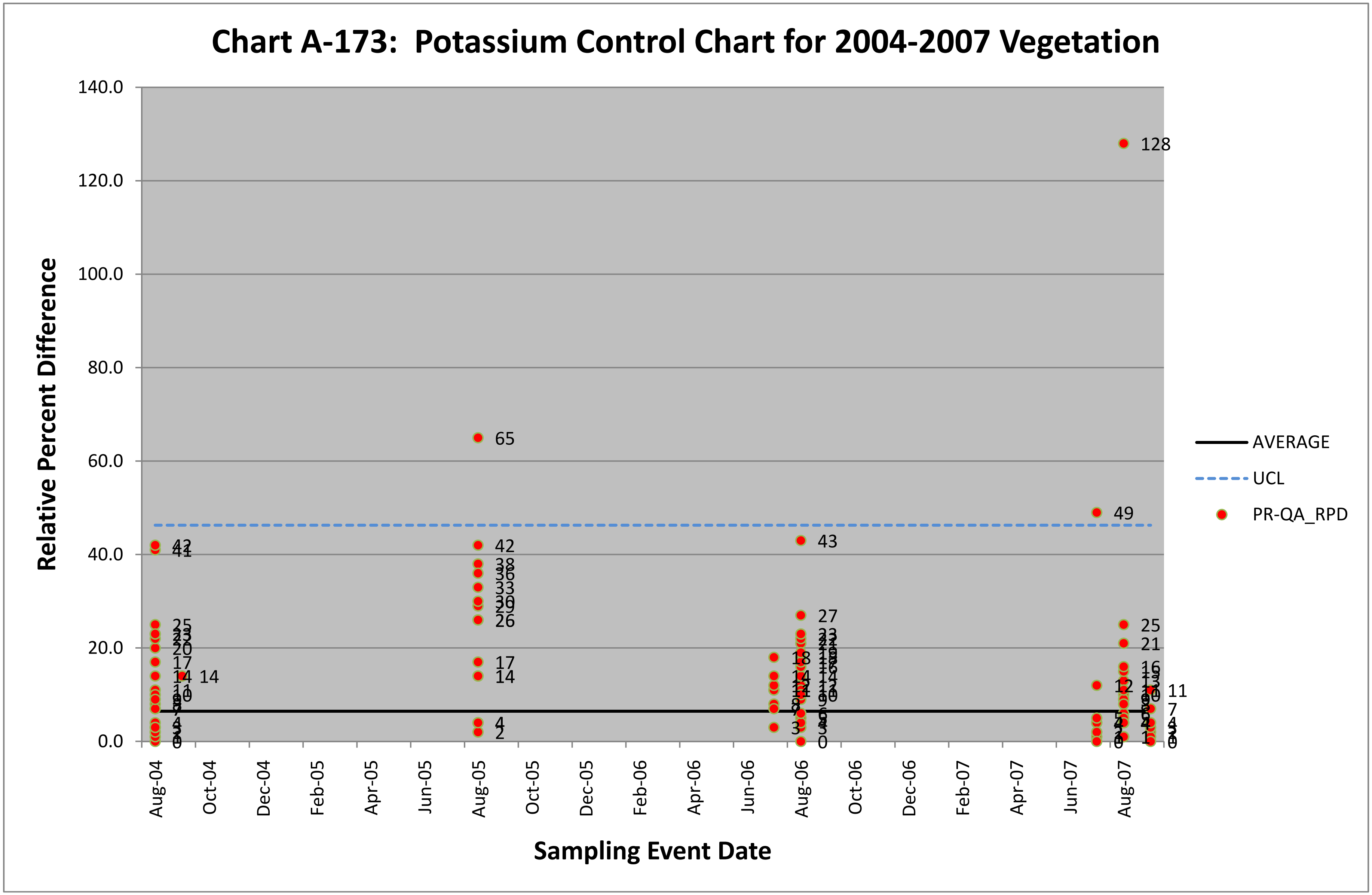


Chart A-173: Potassium Control Chart for 2004-2007 Vegetation
Relative Percent Difference
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Sampling Event Date
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Aug-05
Oct-05
Dec-05
Feb-06
Apr-06
Jun-06
Aug-06
Oct-06
Dec-06
Feb-07
Apr-07
Jun-07
Aug-07
AVERAGE
UCL
PR-QA_RPD
128
65
49
43
42
41
25
23
20
17
14
14
11
10
9
7
4
3
1
0
42
38
36
33
30
29
26
17
14
4
2
27
23
21
19
18
14
12
11
10
9
8
7
6
4
3
0
25
21
16
13
12
11
10
7
5
4
2
1
0

Chart A-174: Selenium Control Chart for 2004-2007 Vegetation

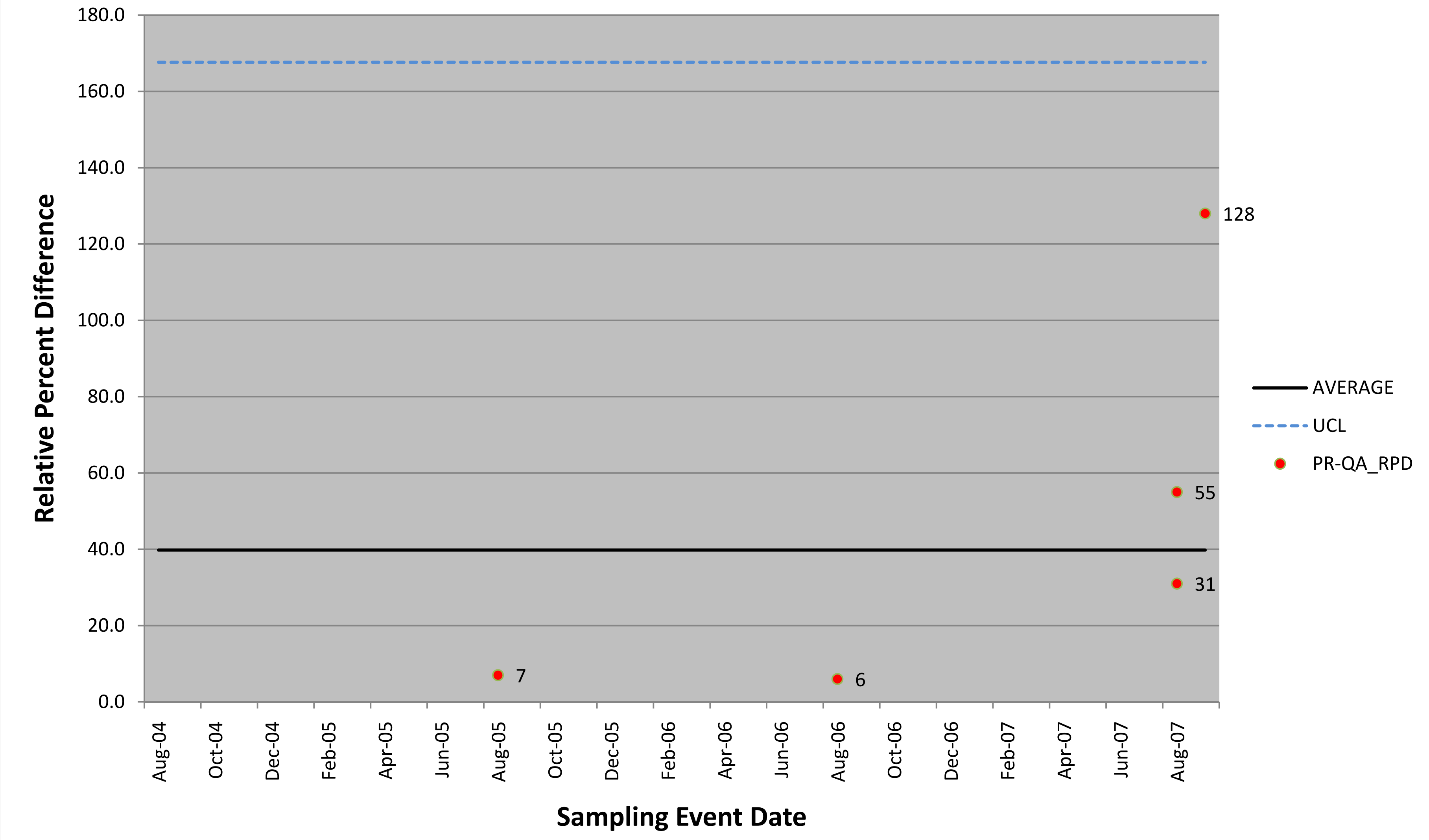


Chart A-175: Silver Control Chart for 2004-2007 Vegetation

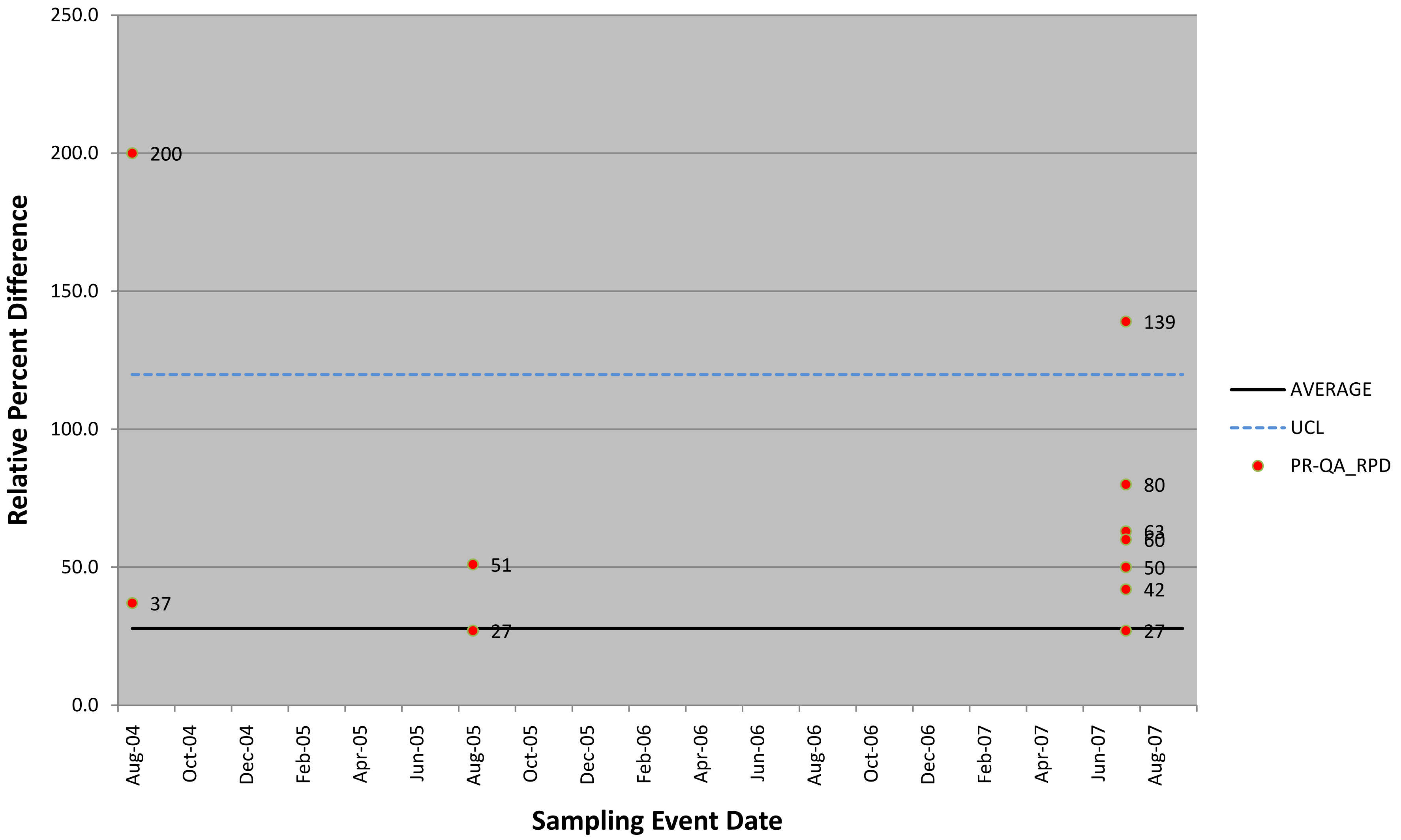


Chart A-176: Sodium Control Chart for 2004-2007 Vegetation

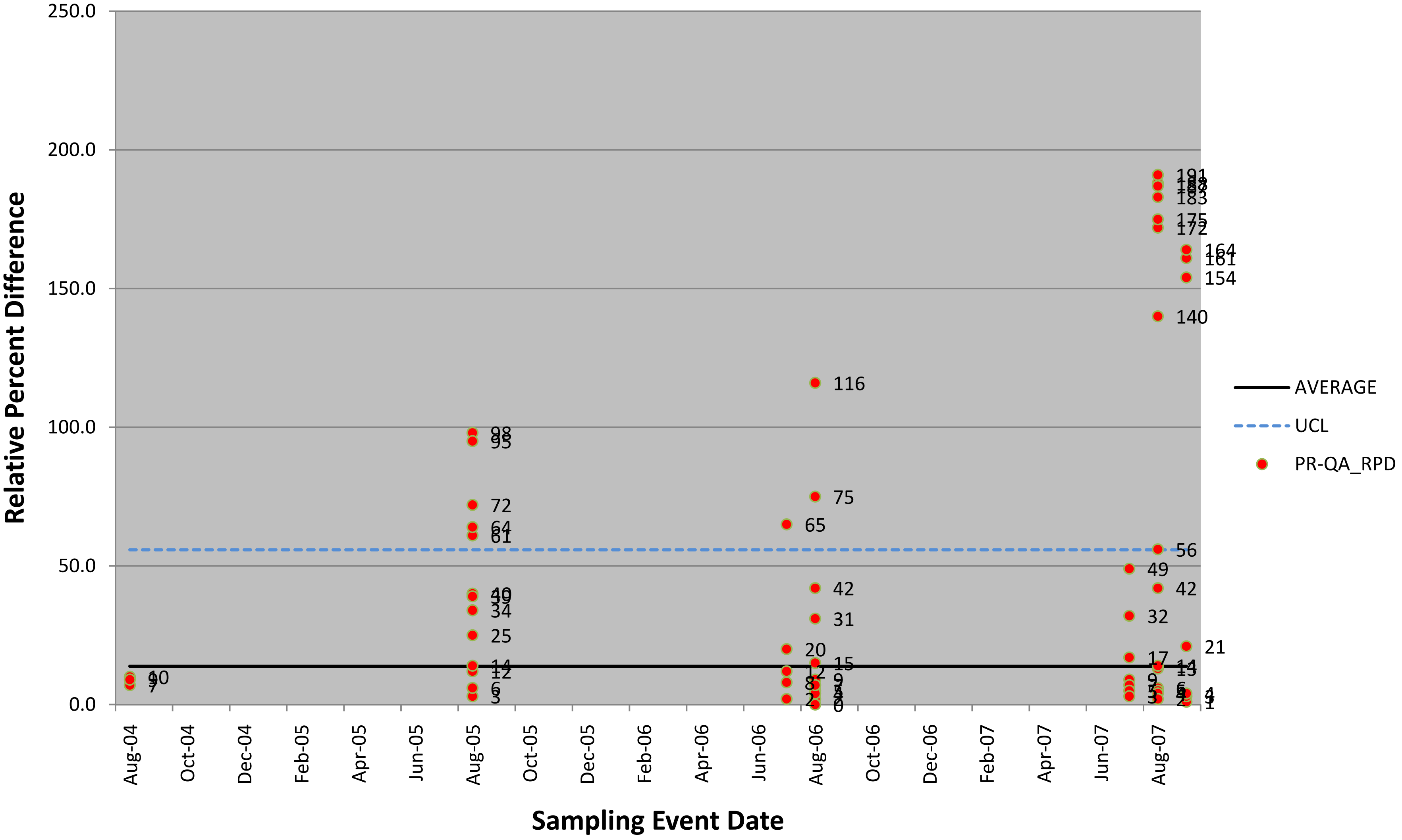
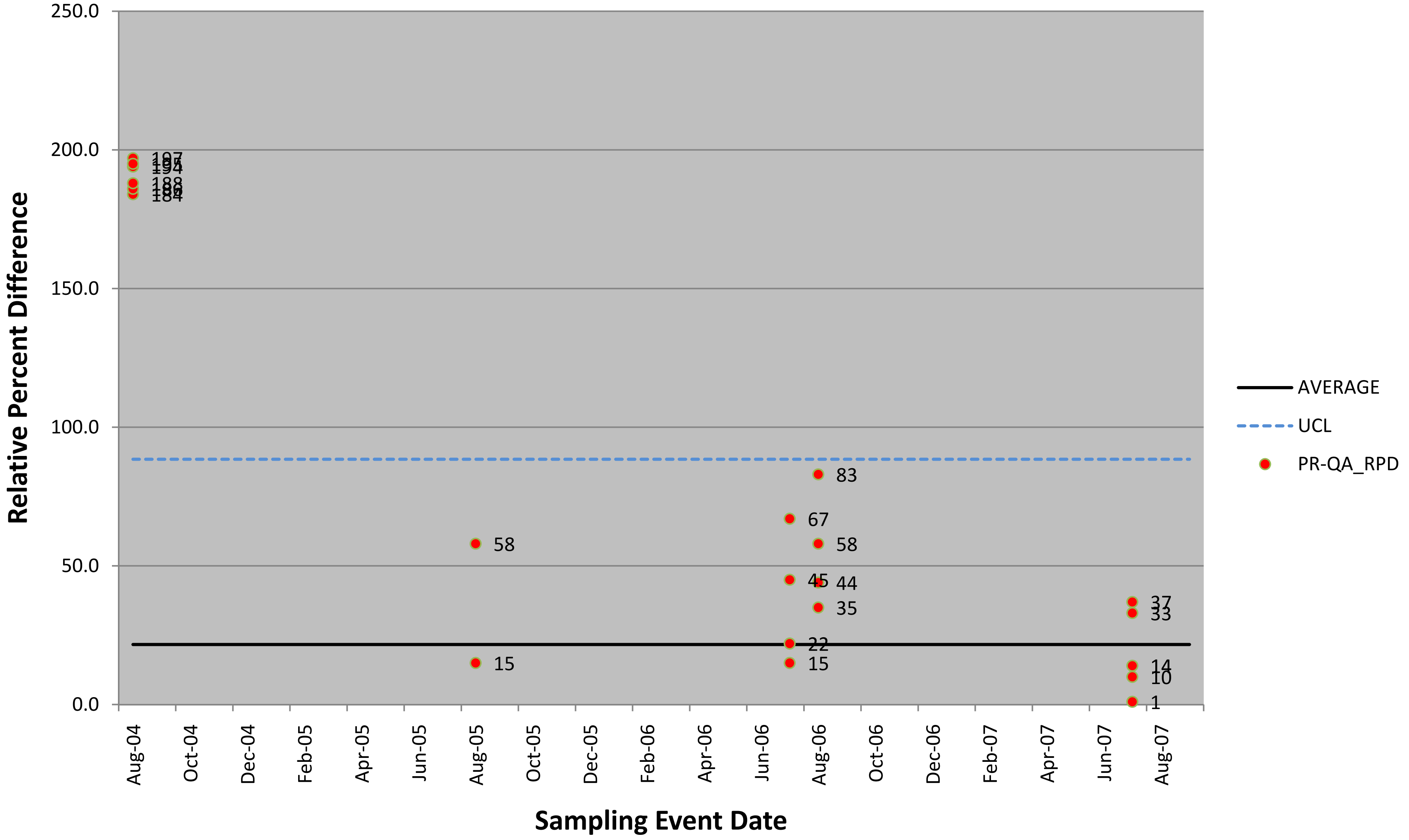


Chart A-177: Thallium Control Chart for 2004-2007 Vegetation



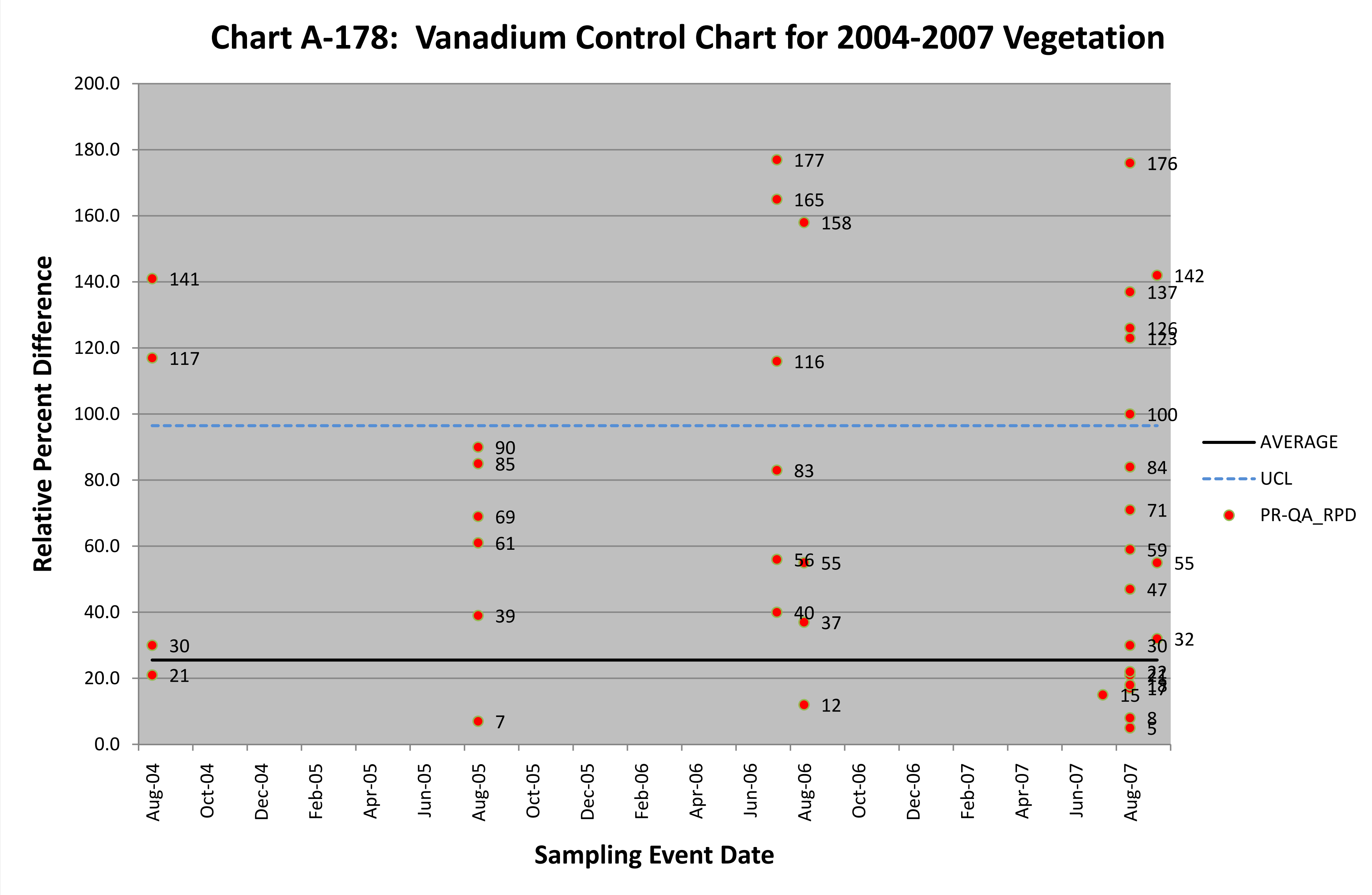


Chart A-178: Vanadium Control Chart for 2004-2007 Vegetation

Chart A-179: Zinc Control Chart for 2004-2007 Vegetation

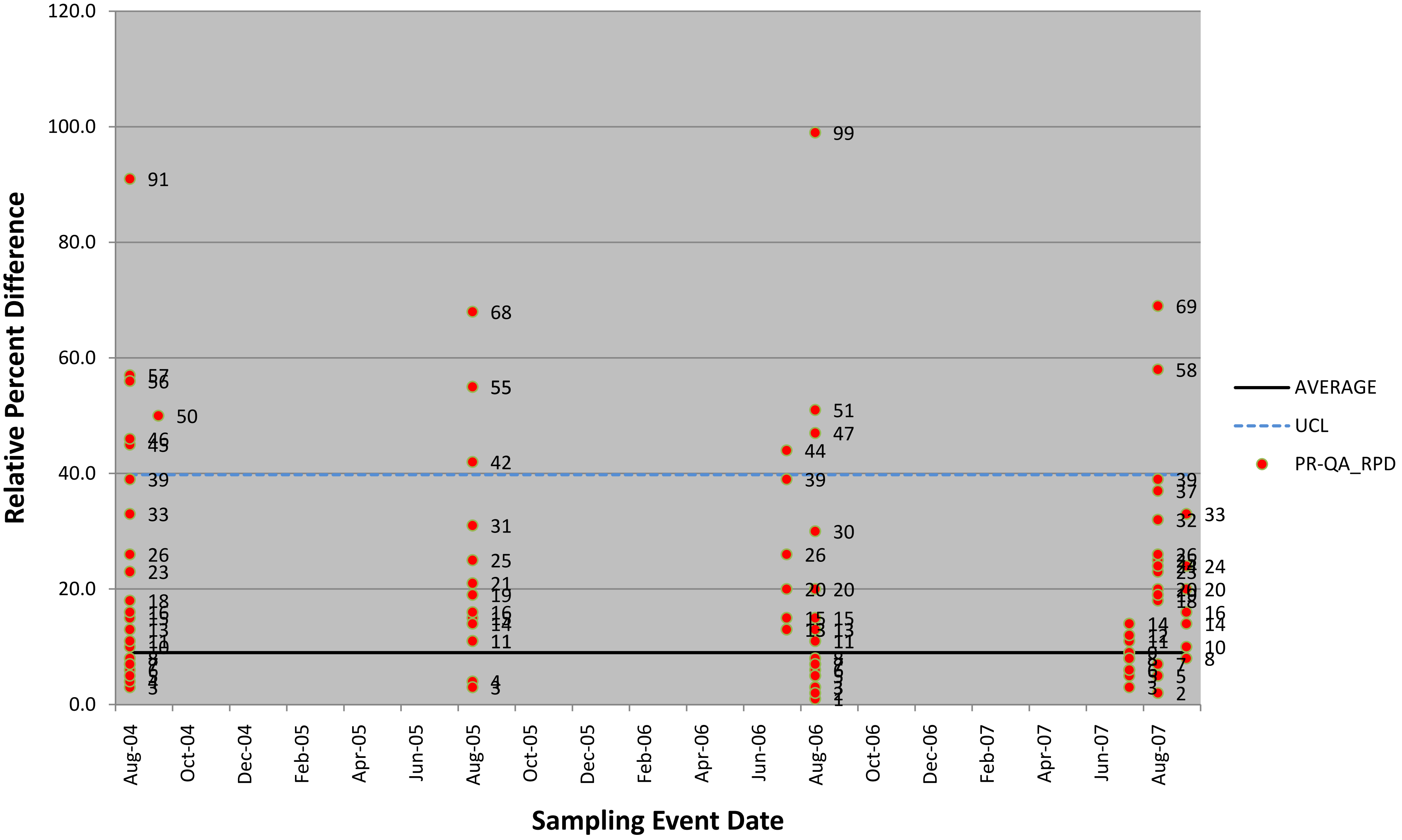
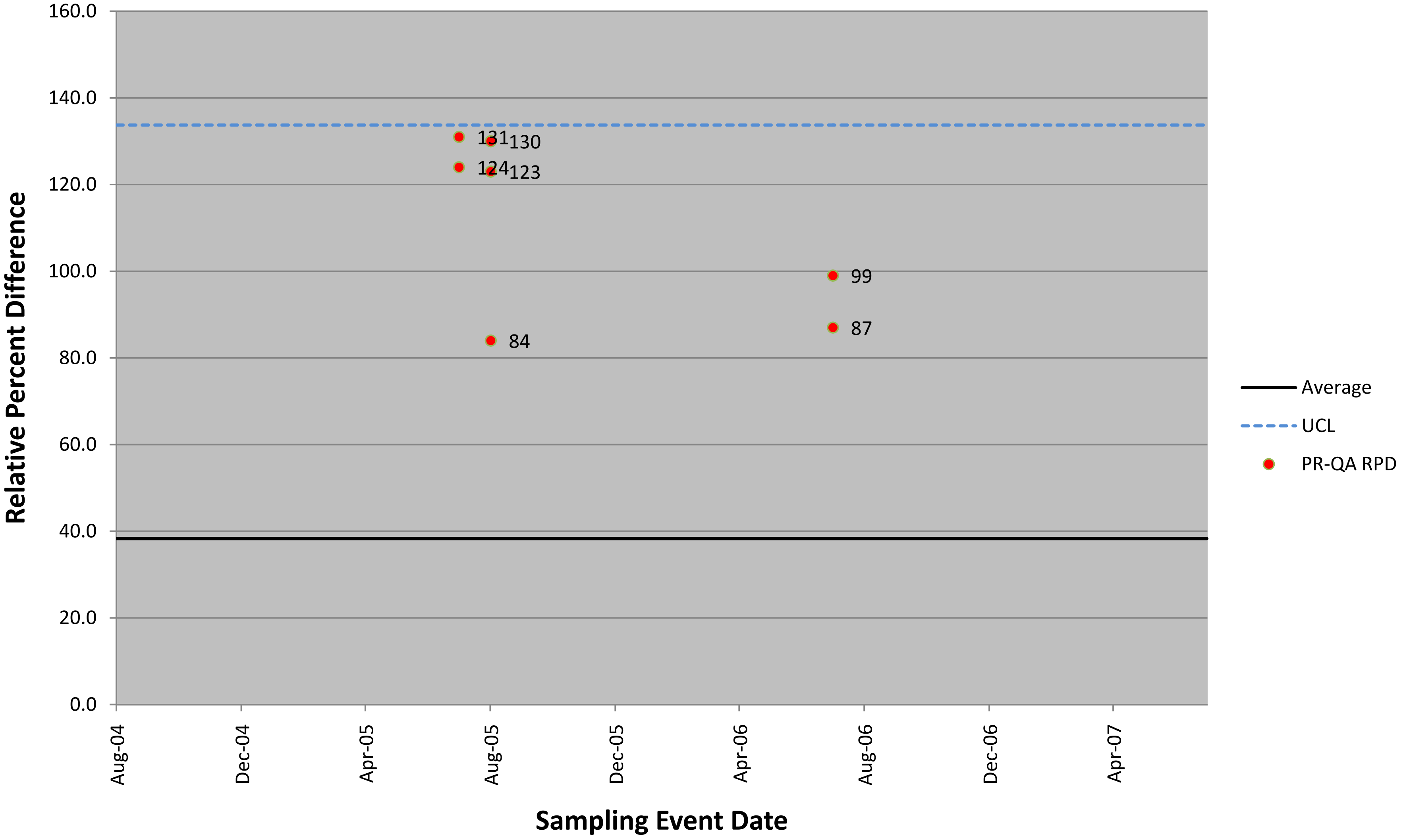


Chart A-180: Chloride Control Chart for 2004-2007 Soil



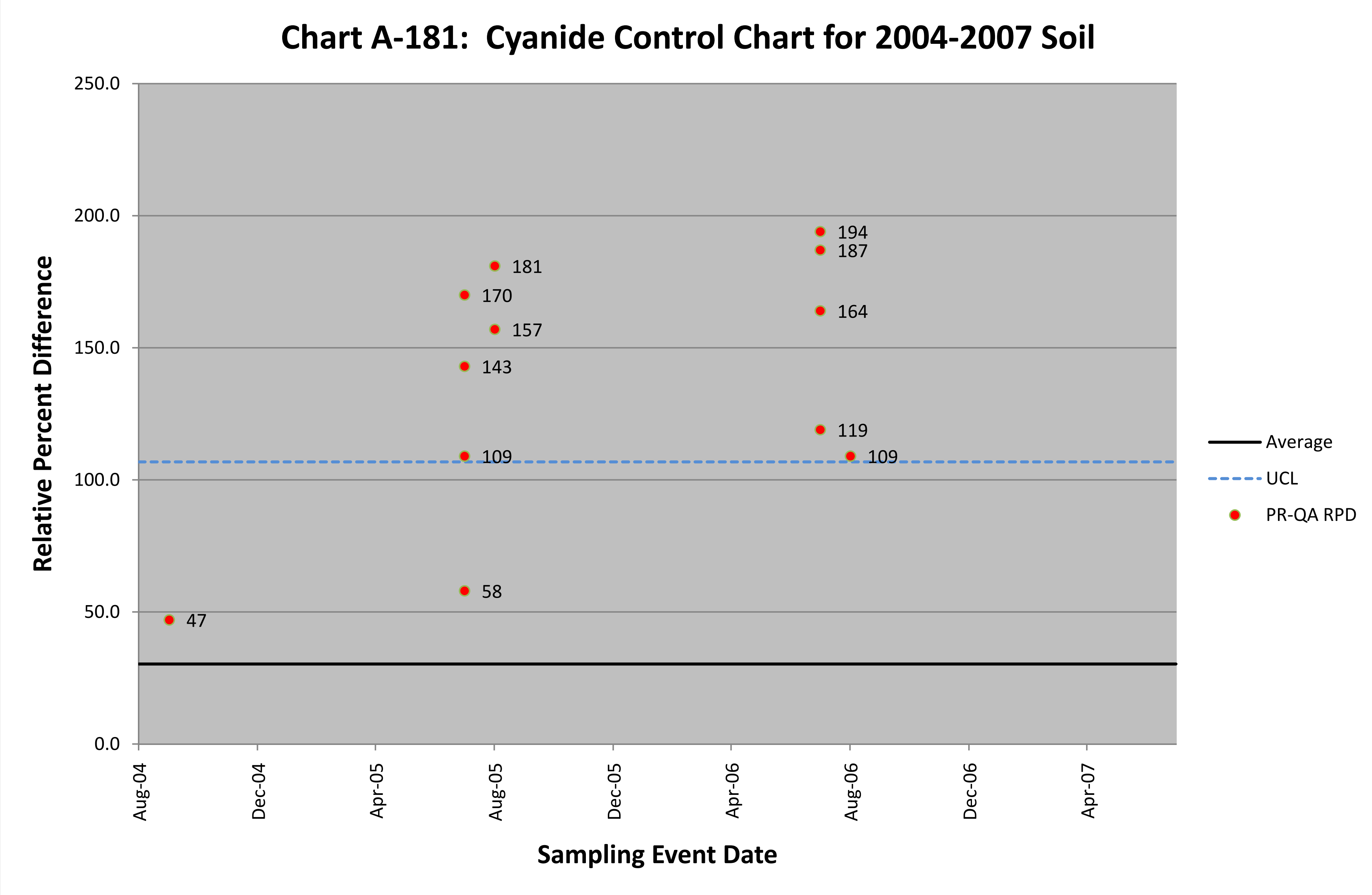


Chart A-181: Cyanide Control Chart for 2004-2007 Soil
Relative Percent Difference
250.0
200.0
150.0
100.0
50.0
0.0
47
58
109
143
170
157
181
194
187
164
119
109
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

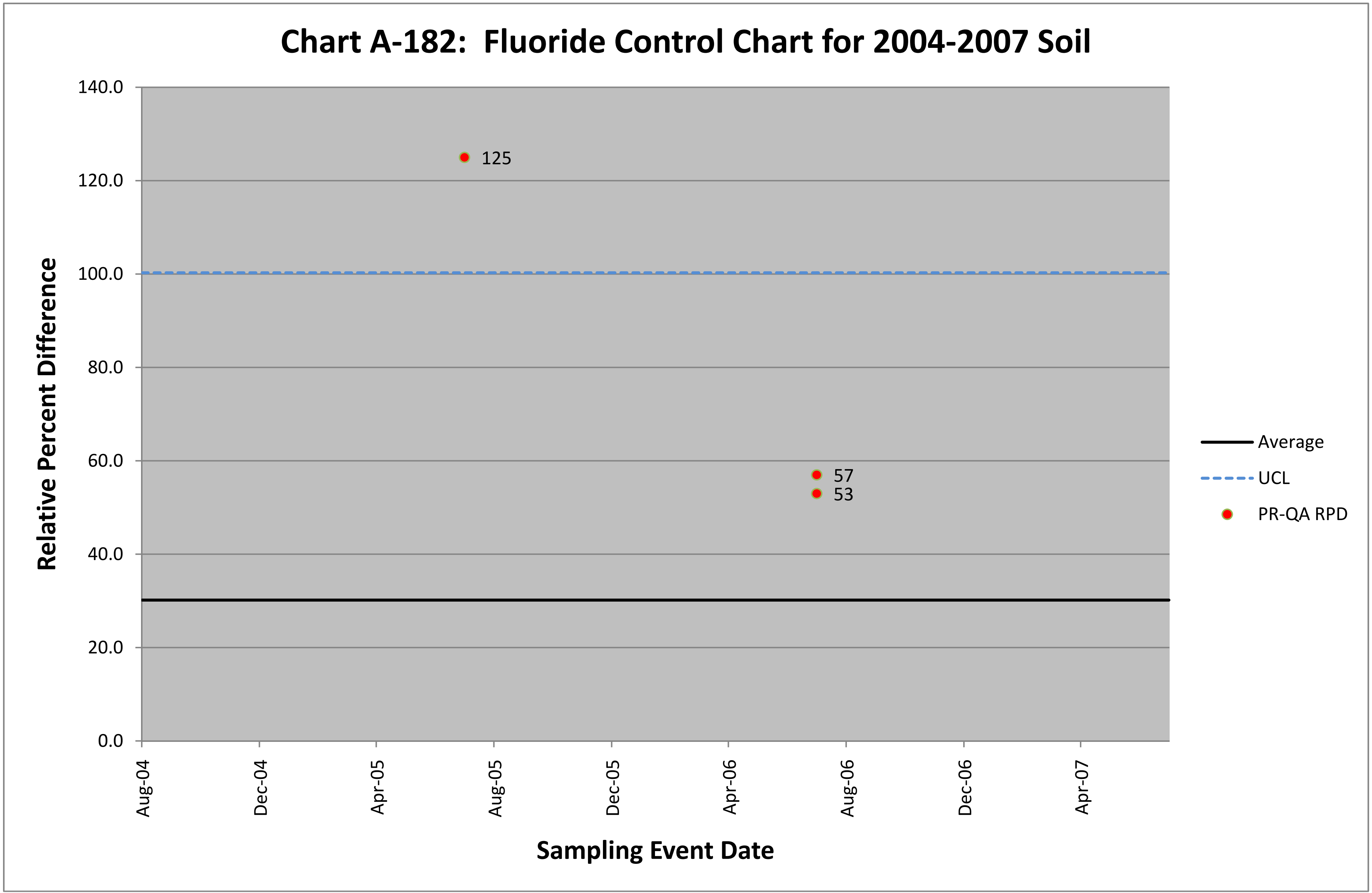
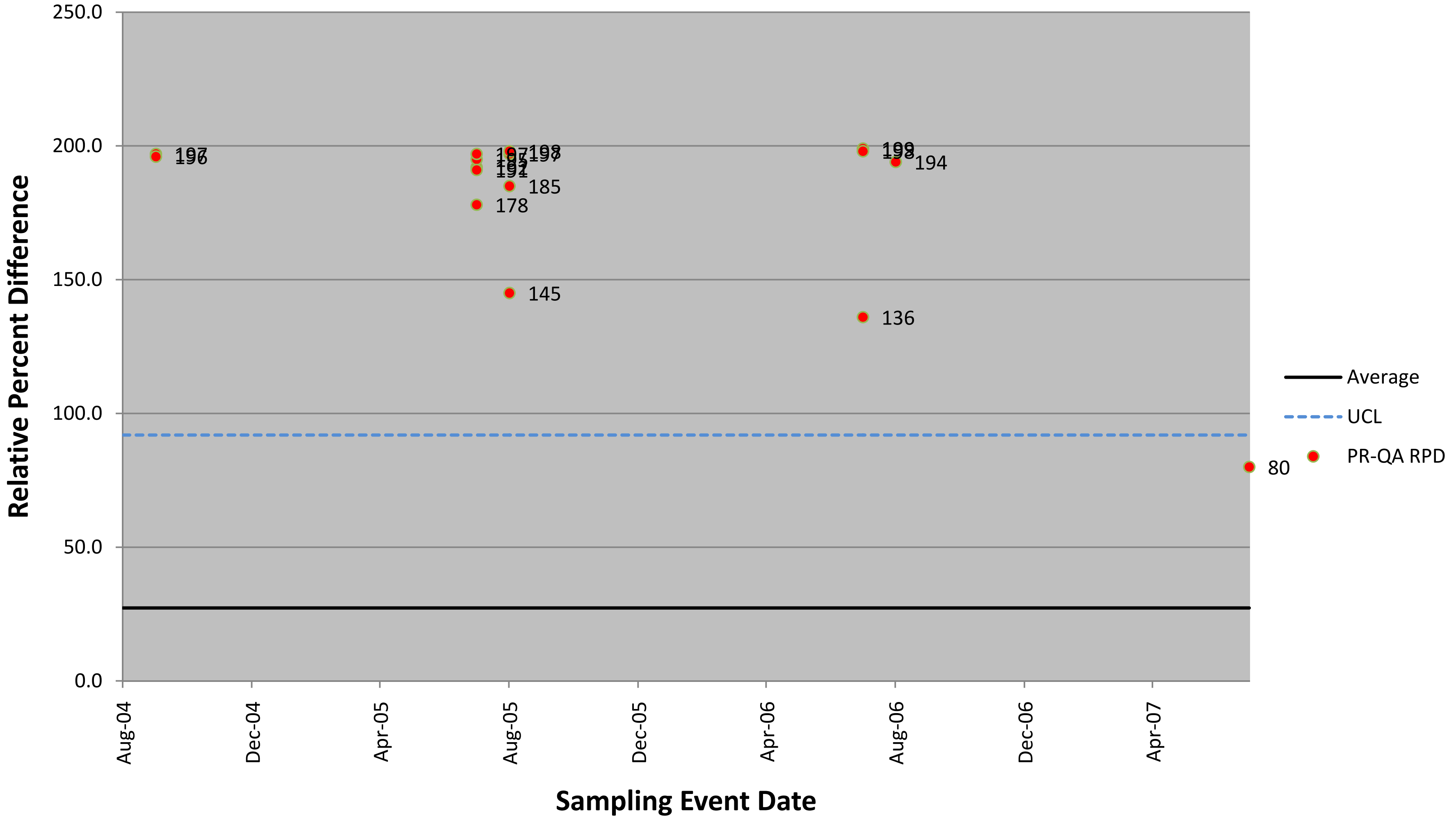


Chart A-182: Fluoride Control Chart for 2004-2007 Soil
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Relative Percent Difference
125
57
53
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

Chart A-183: Nitrogen: Ammonia (as N) Control Chart for 2004-2007 Soil



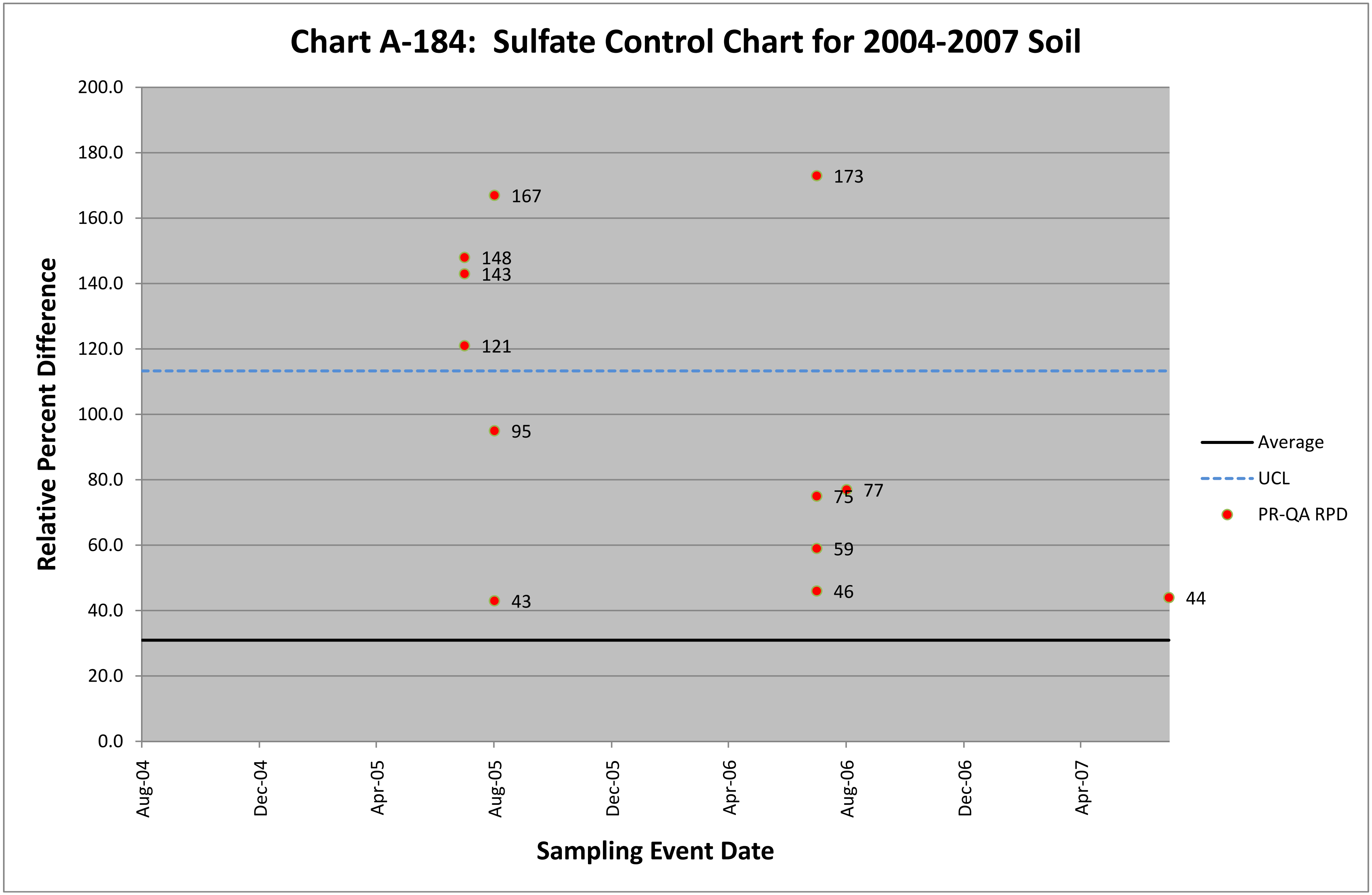


Chart A-184: Sulfate Control Chart for 2004-2007 Soil
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
167
148
143
121
95
43
173
75
77
59
46
44
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

Chart A-185: Total Organic Carbon Control Chart for 2004-2007 Soil

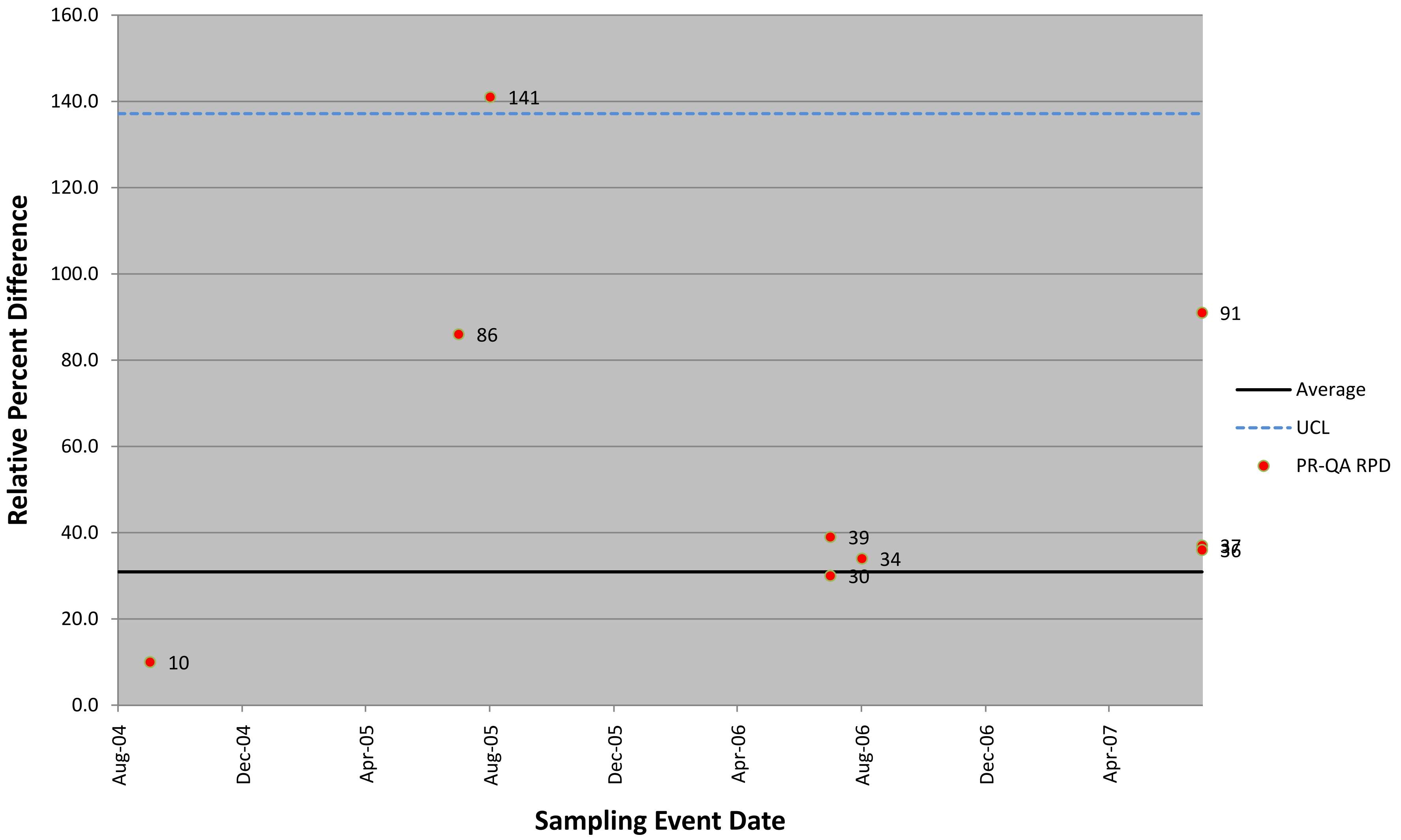
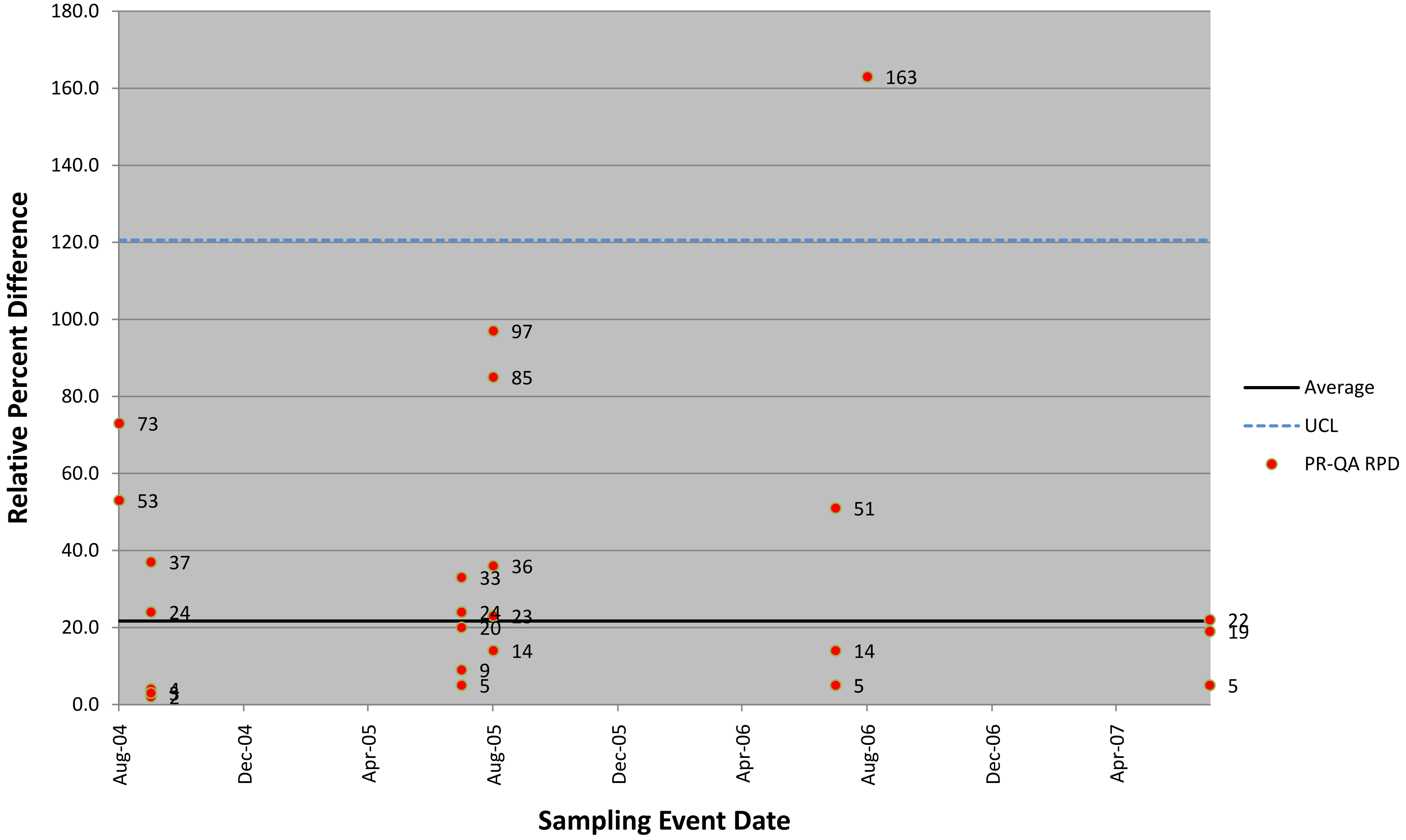


Chart A-186: Aluminum Control Chart for 2004-2007 Soil



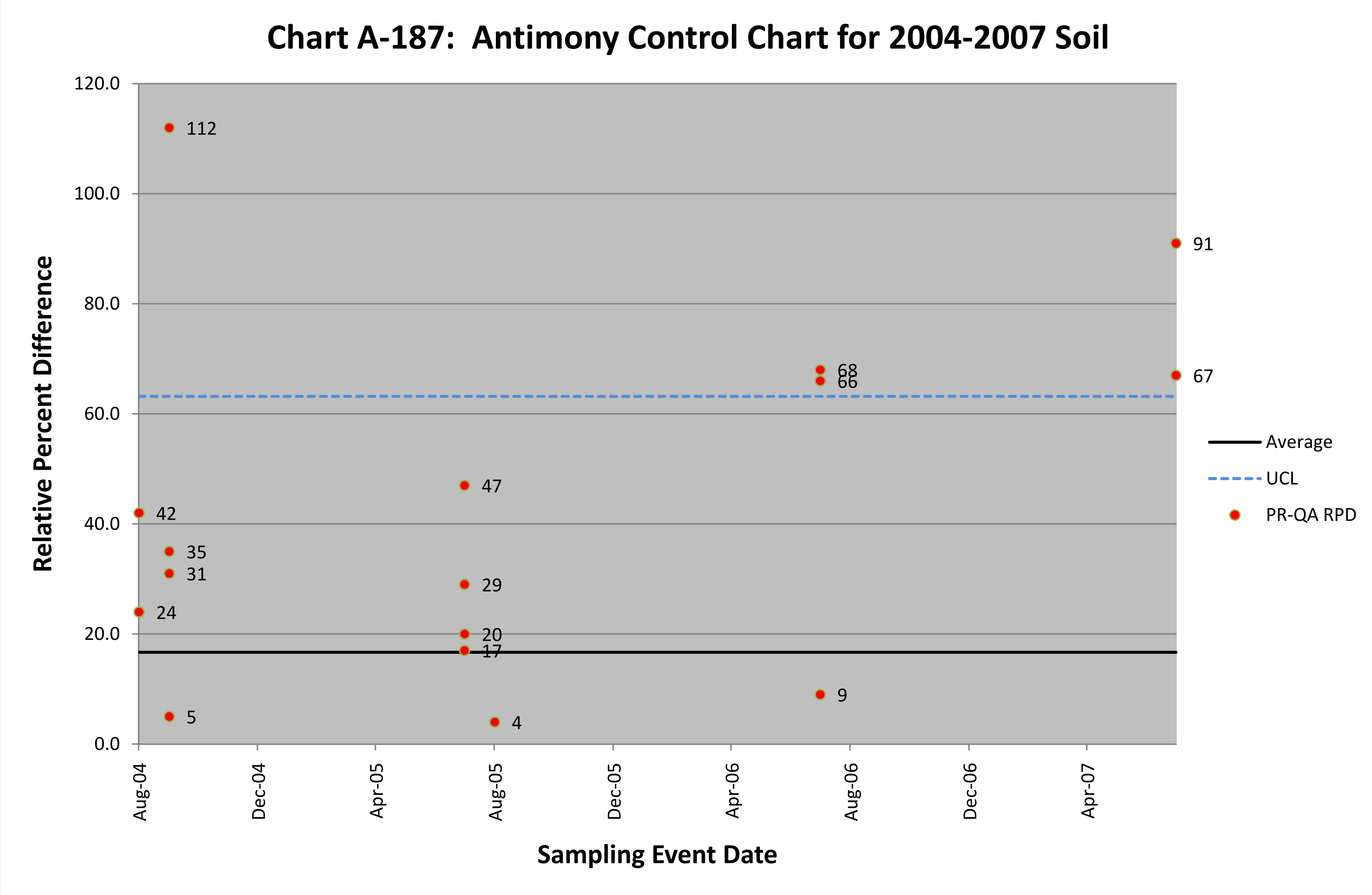


Chart A-187: Antimony Control Chart for 2004-2007 Soil
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
112
42
35
31
24
5
47
29
20
17
4
68
66
9
91
67
Average
UCL
PR-QA RPD

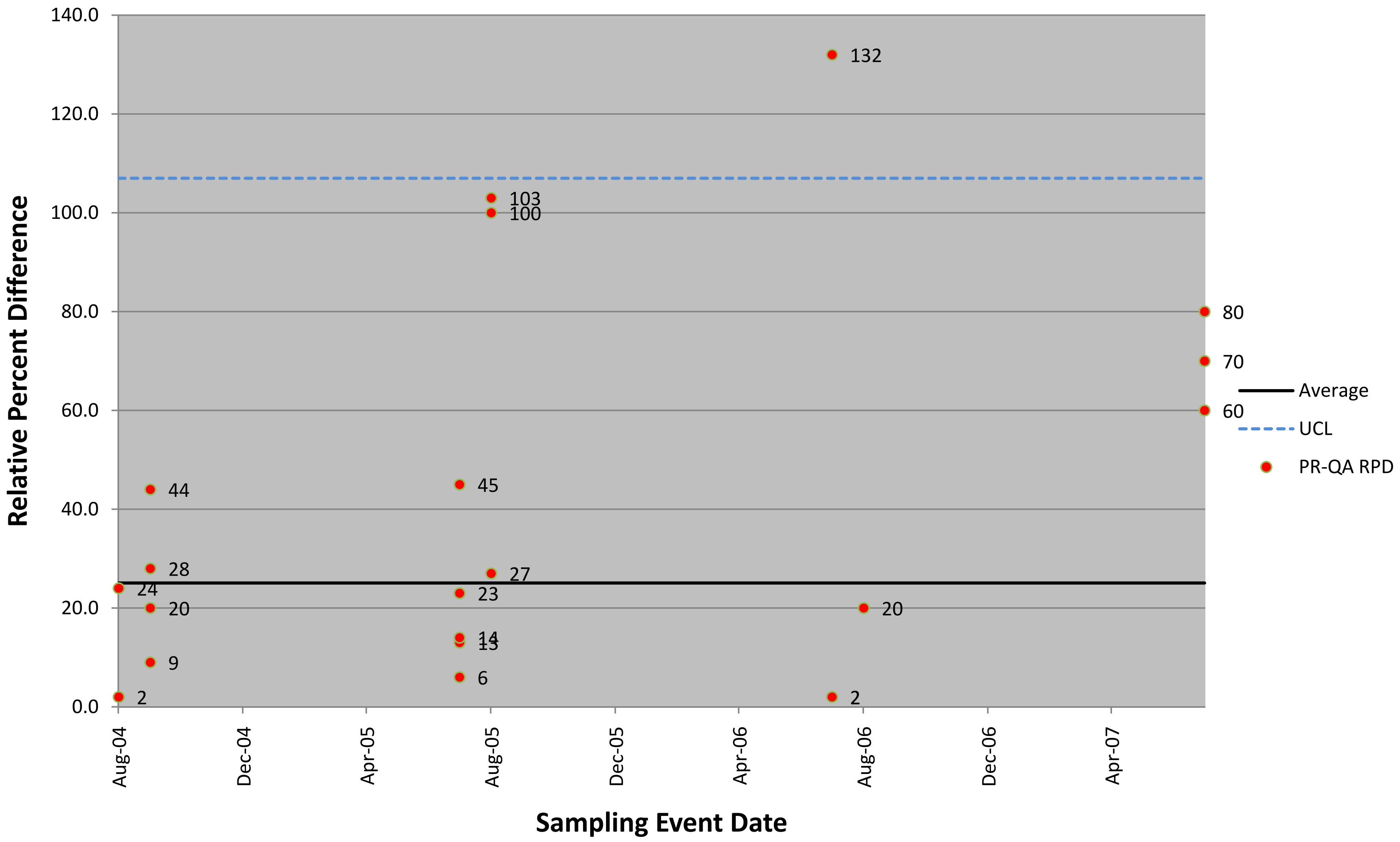


Chart A-188: Arsenic Control Chart for 2004-2007 Soil

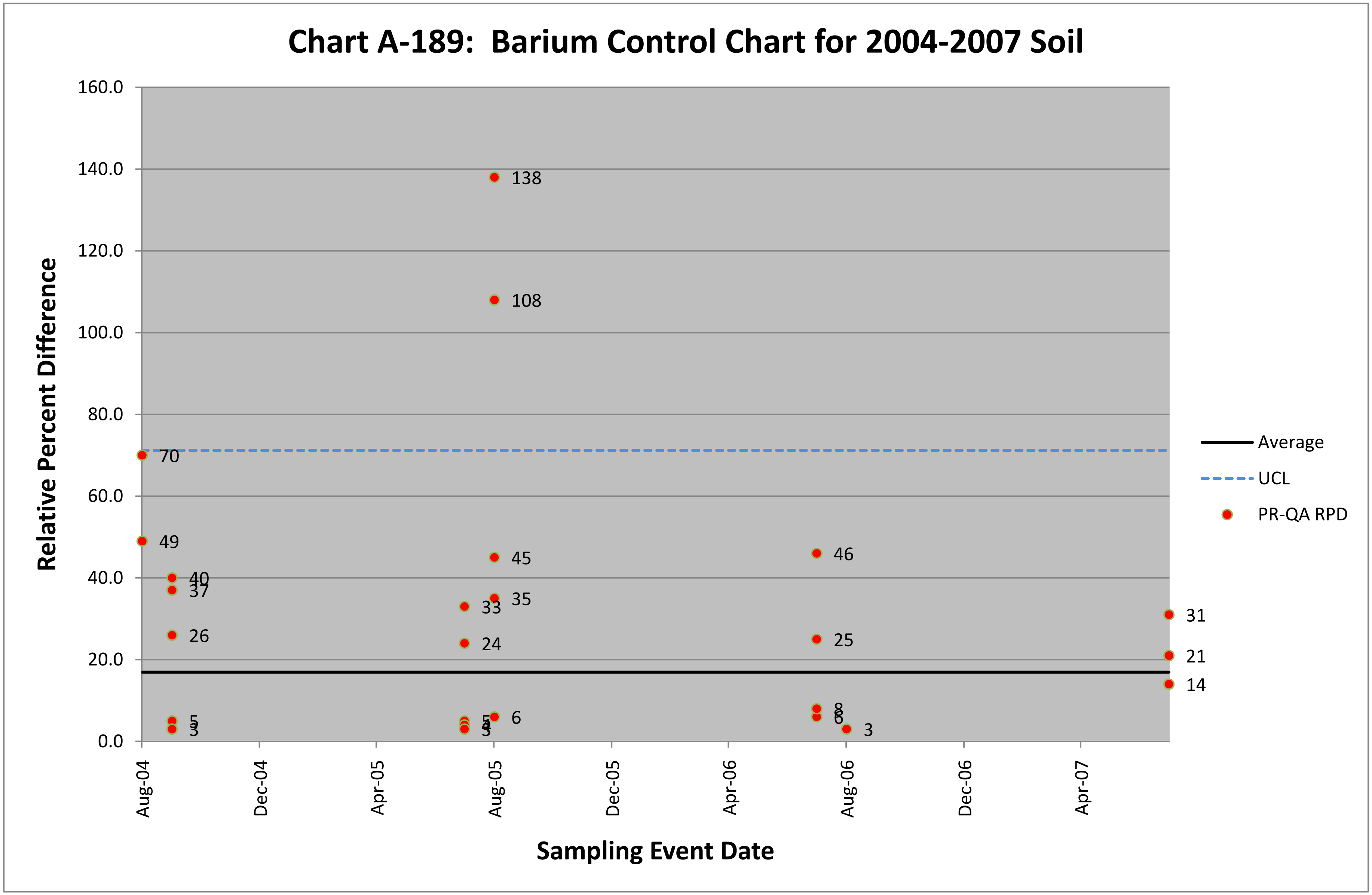
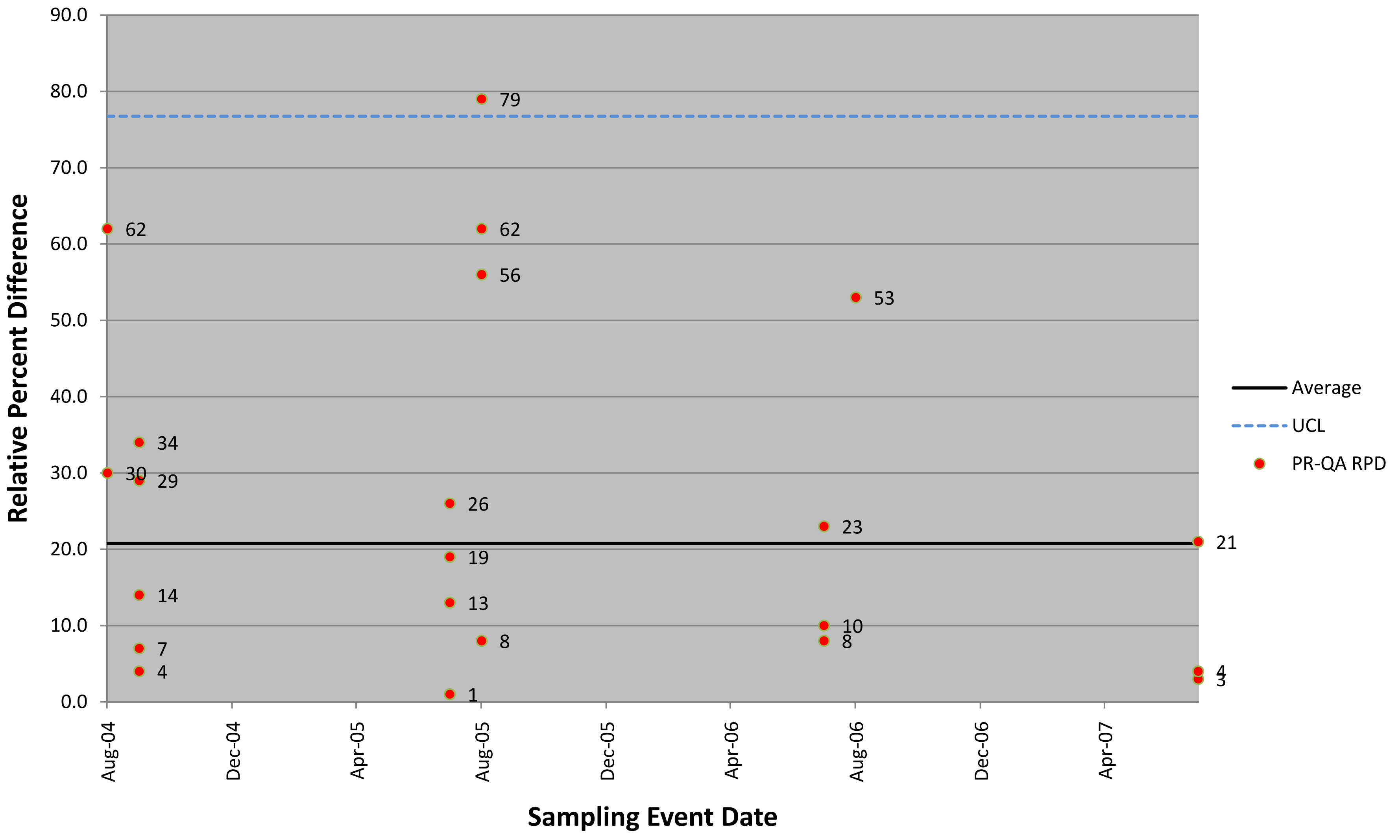


Chart A-189: Barium Control Chart for 2004-2007 Soil
Relative Percent Difference
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD
70
49
40
37
26
5
3
138
108
45
35
33
24
5
4
3
6
46
25
8
6
3
31
21
14

Chart A-190: Beryllium Control Chart for 2004-2007 Soil



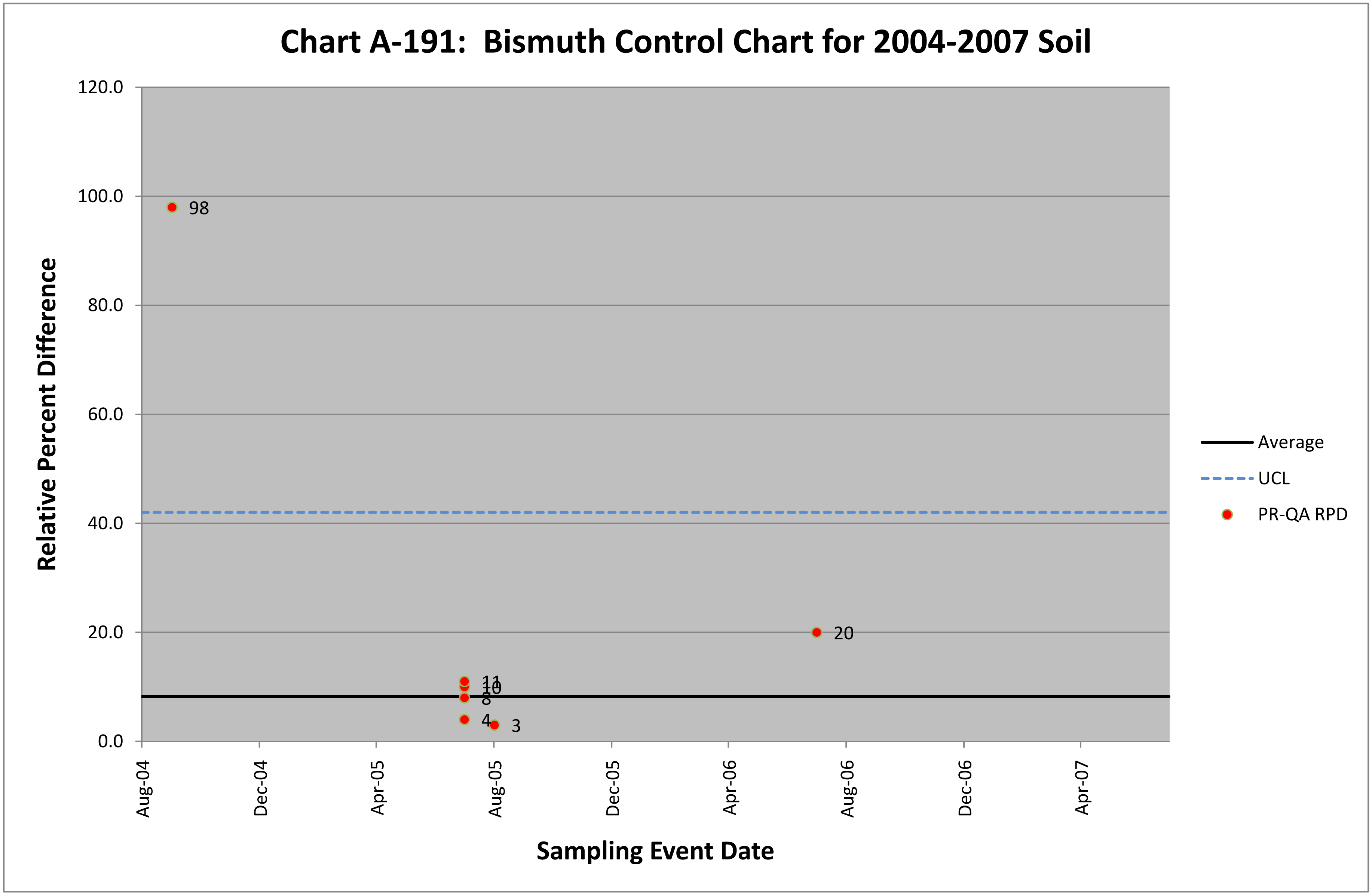


Chart A-191: Bismuth Control Chart for 2004-2007 Soil
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
98
20
11
10
8
4
3
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

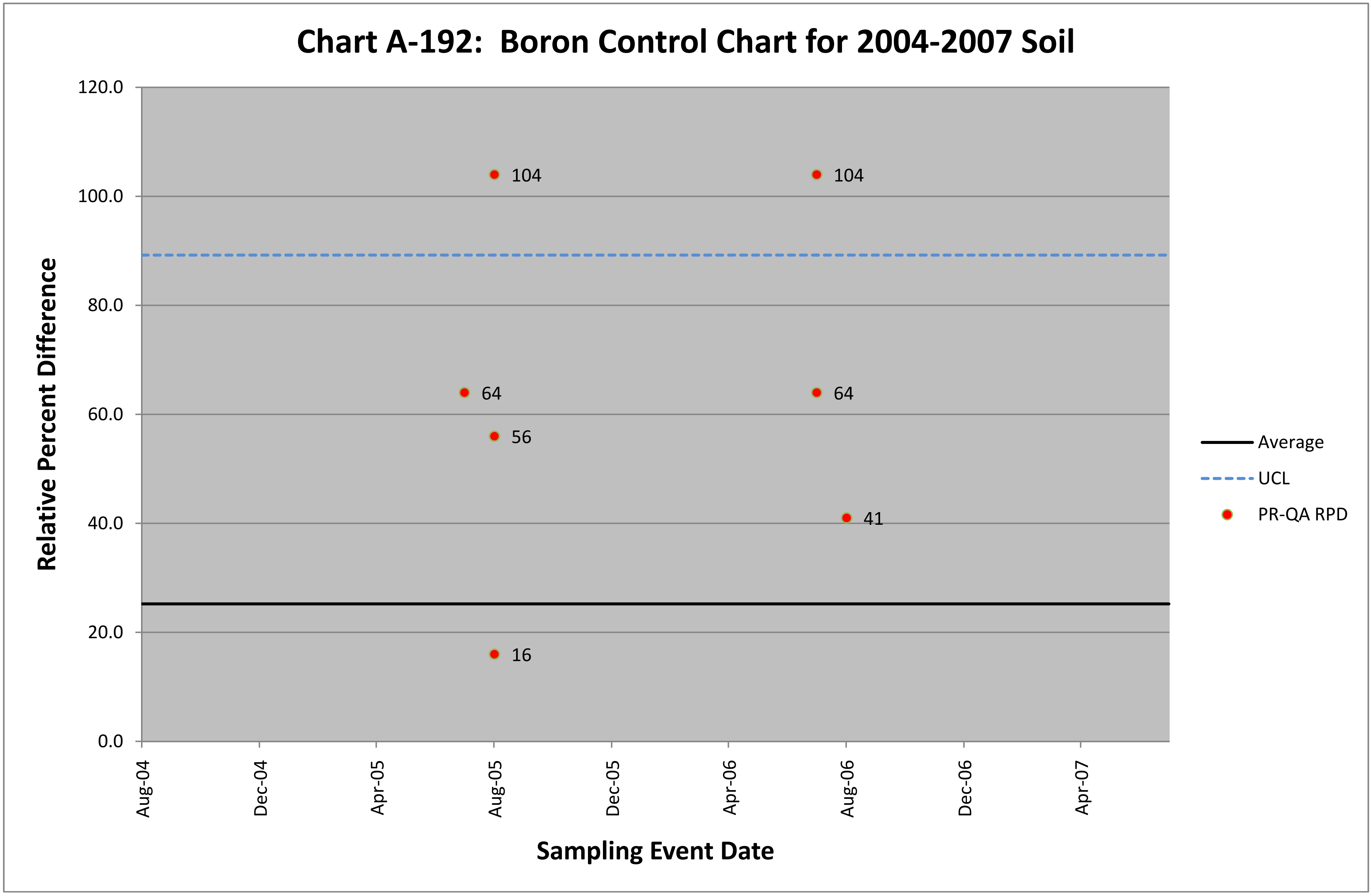


Chart A-192: Boron Control Chart for 2004-2007 Soil
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
104
104
64
64
56
41
16
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

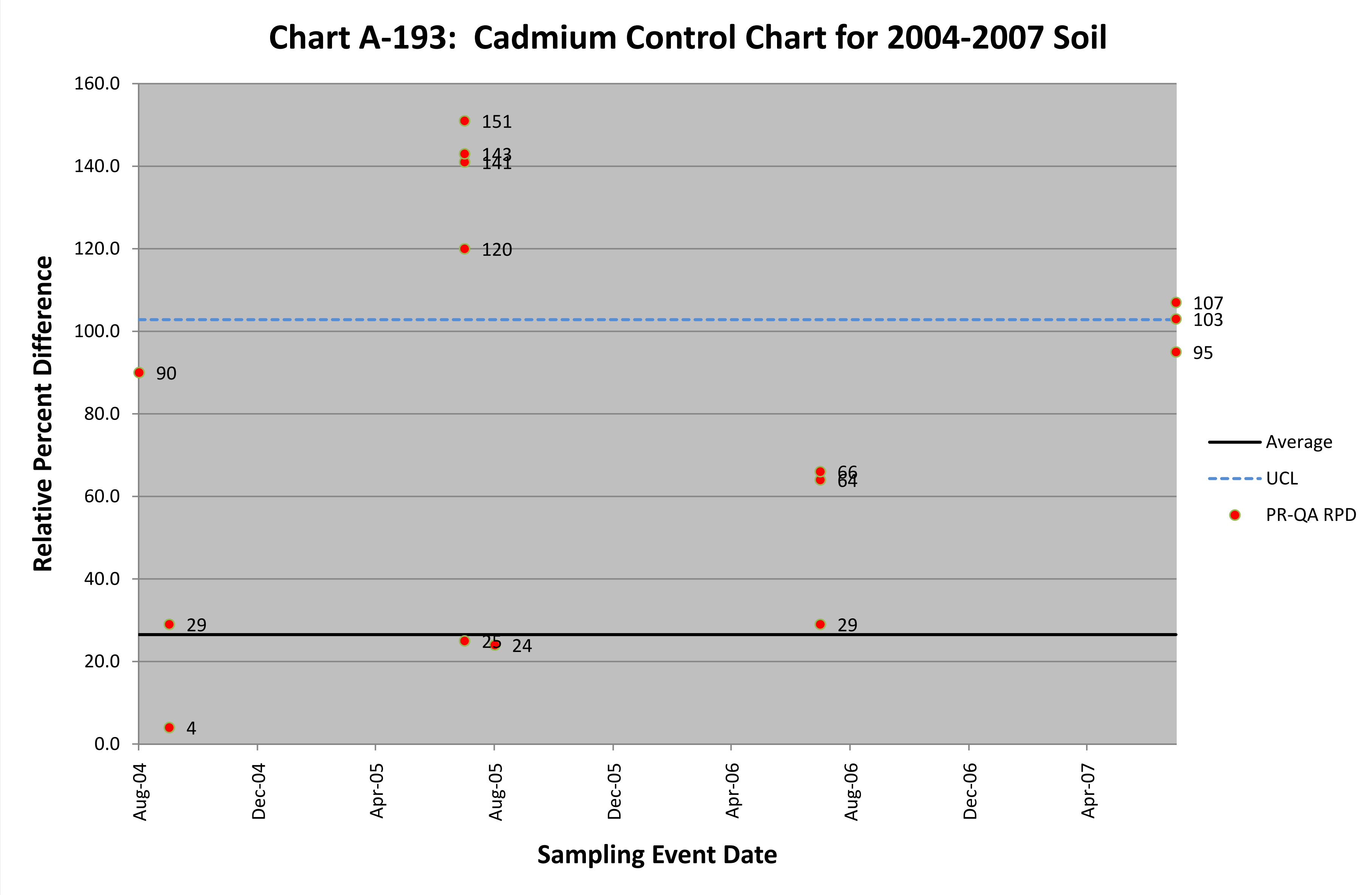


Chart A-193: Cadmium Control Chart for 2004-2007 Soil
Relative Percent Difference
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
151
143
141
120
107
103
95
90
66
64
29
29
25
24
4
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

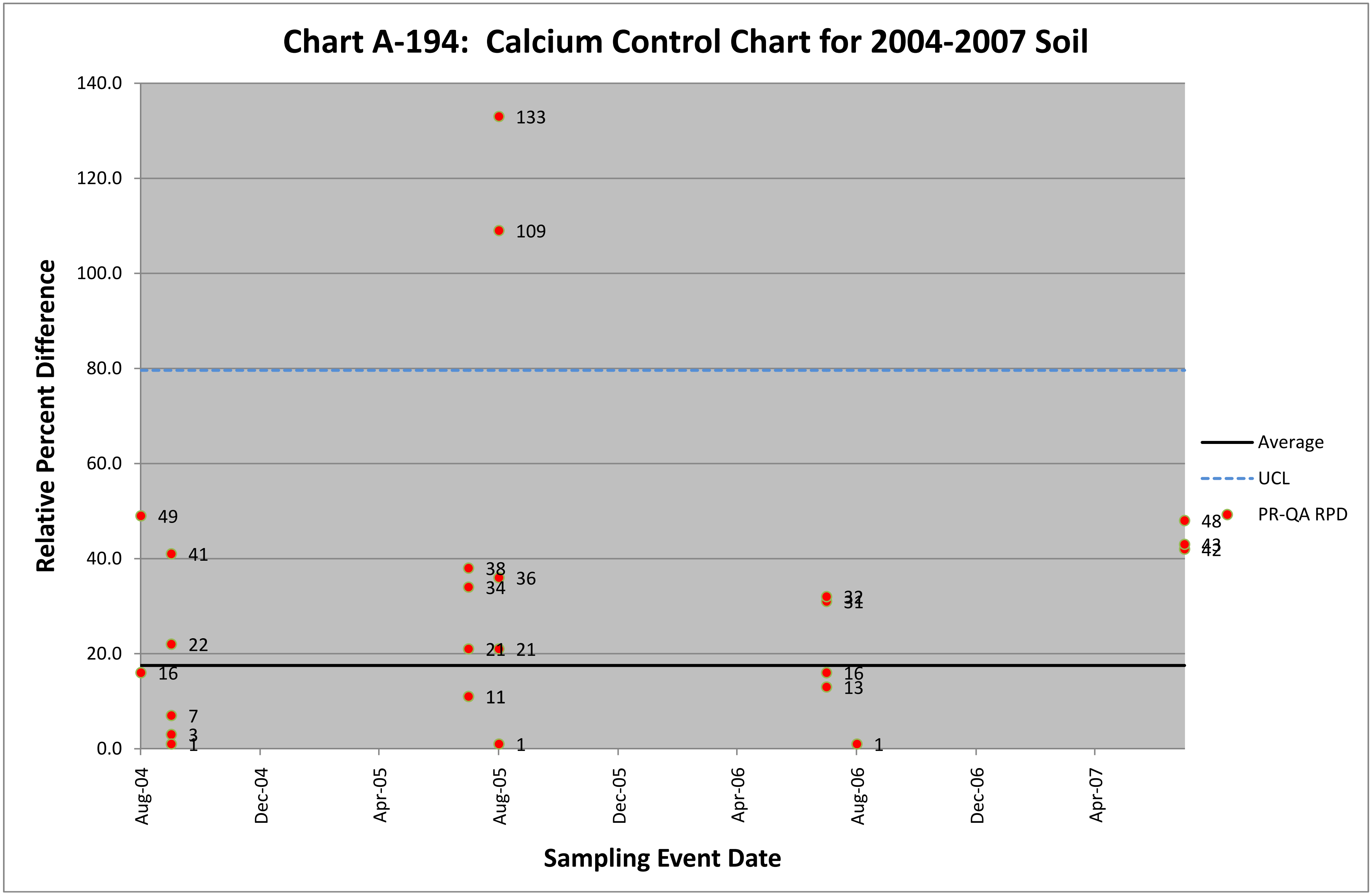


Chart A-194: Calcium Control Chart for 2004-2007 Soil

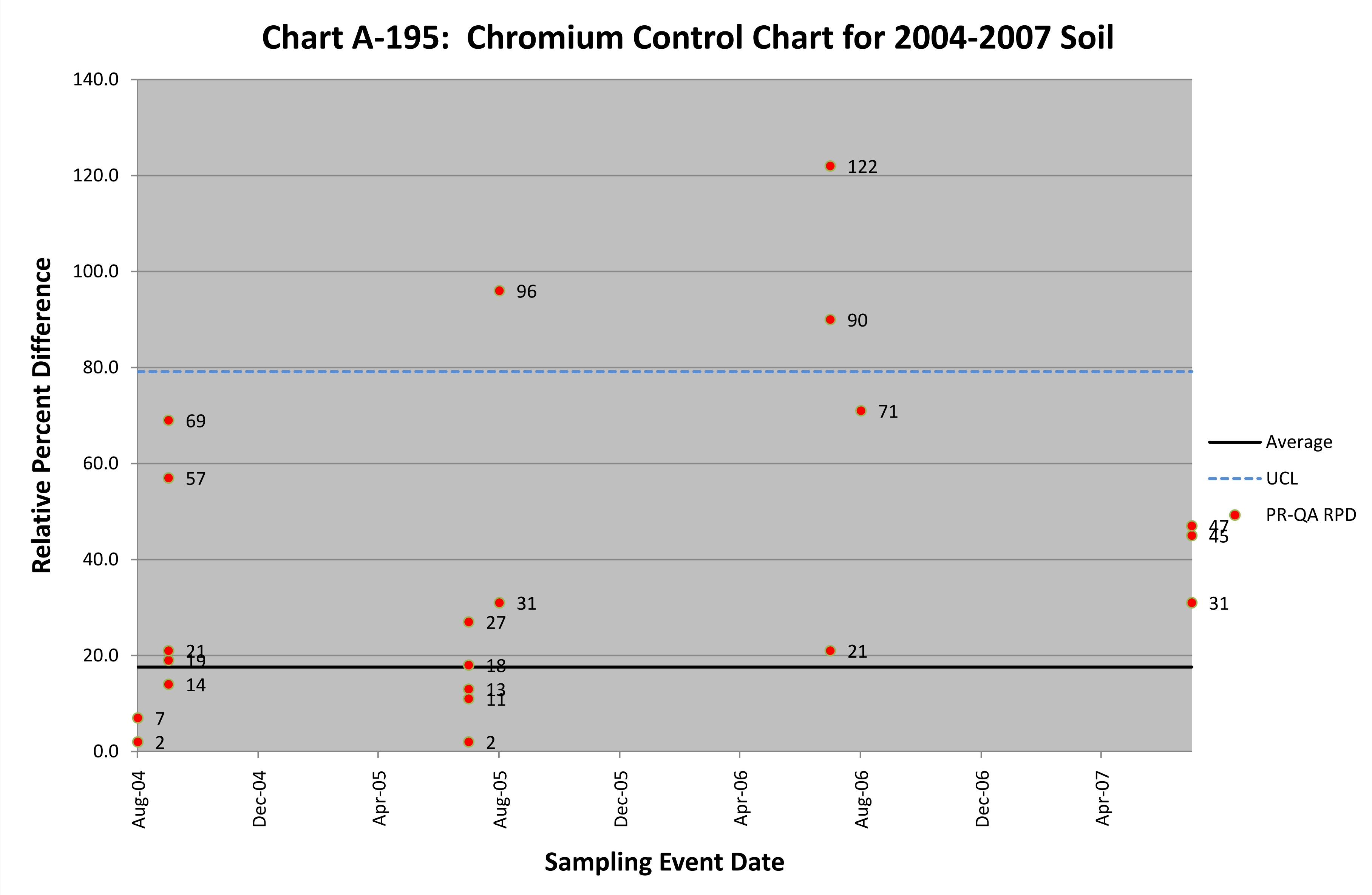


Chart A-195: Chromium Control Chart for 2004-2007 Soil
Relative Percent Difference
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
122
96
90
69
71
57
47
45
31
31
27
21
19
14
7
2
18
13
11
2
21
31
Average
UCL
PR-QA RPD

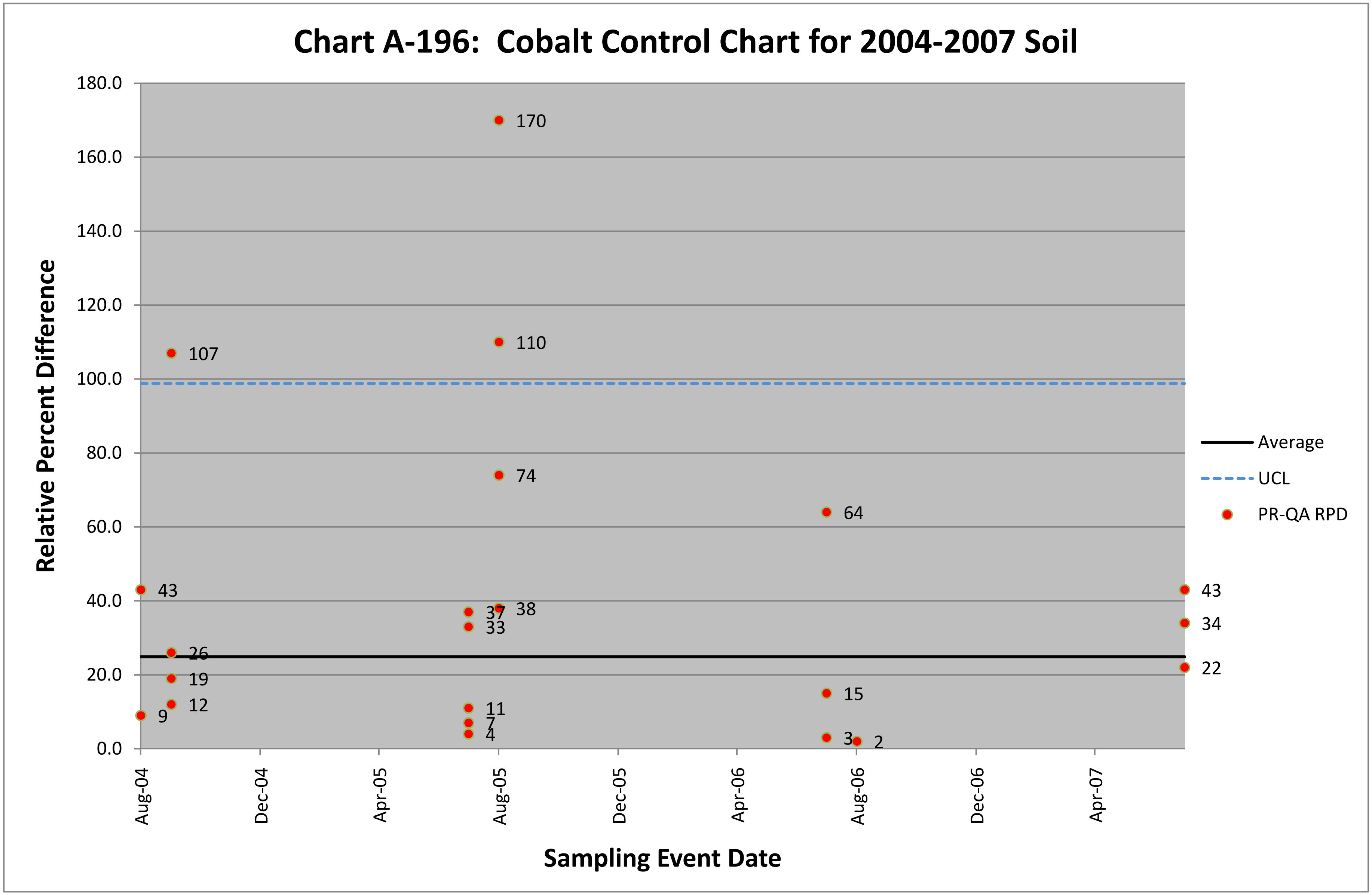


Chart A-196: Cobalt Control Chart for 2004-2007 Soil
Relative Percent Difference
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
170
107
110
74
64
43
37
38
33
26
19
12
9
11
7
4
15
3
2
43
34
22
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

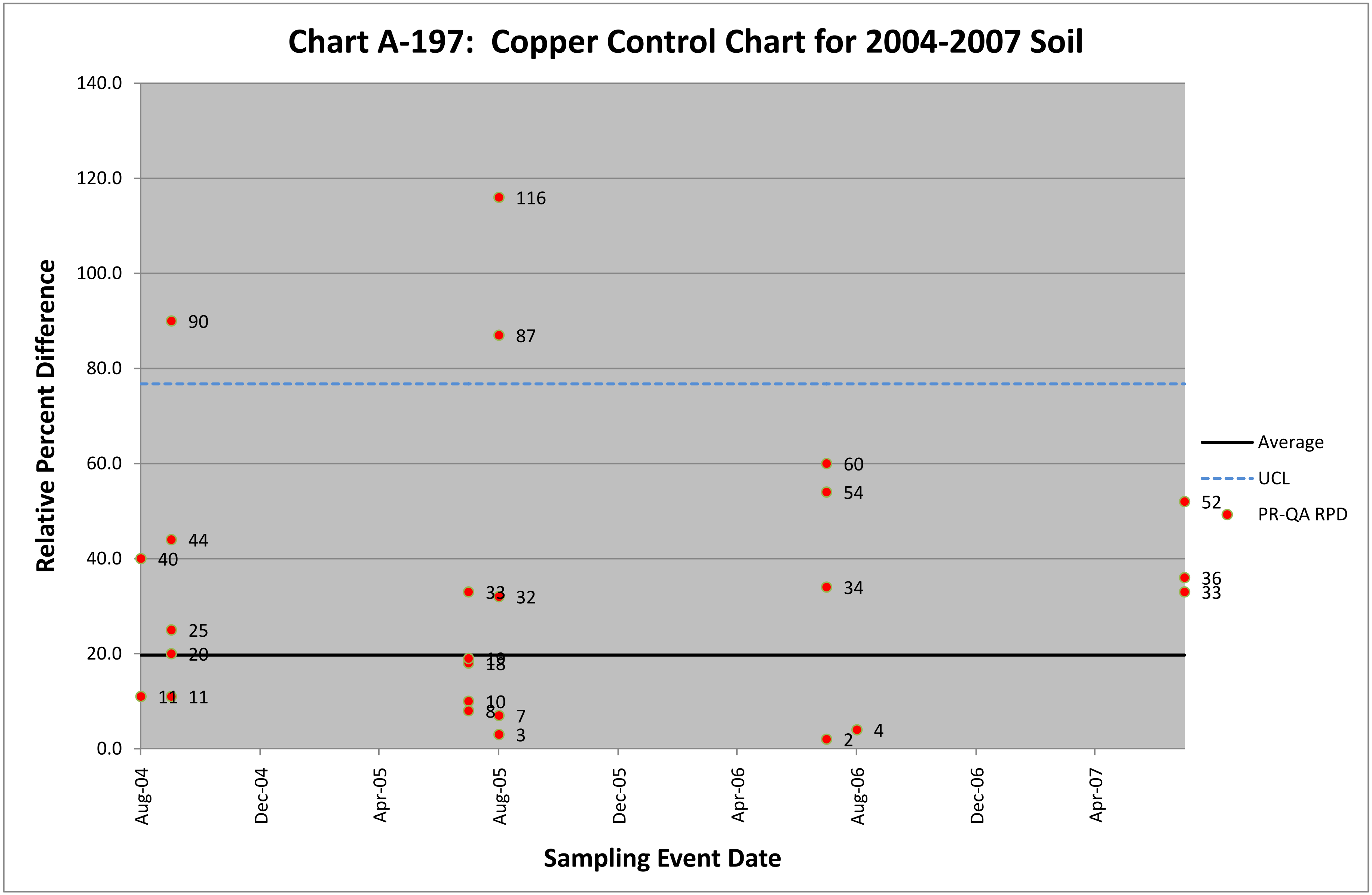


Chart A-197: Copper Control Chart for 2004-2007 Soil

Chart A-198: Iron Control Chart for 2004-2007 Soil

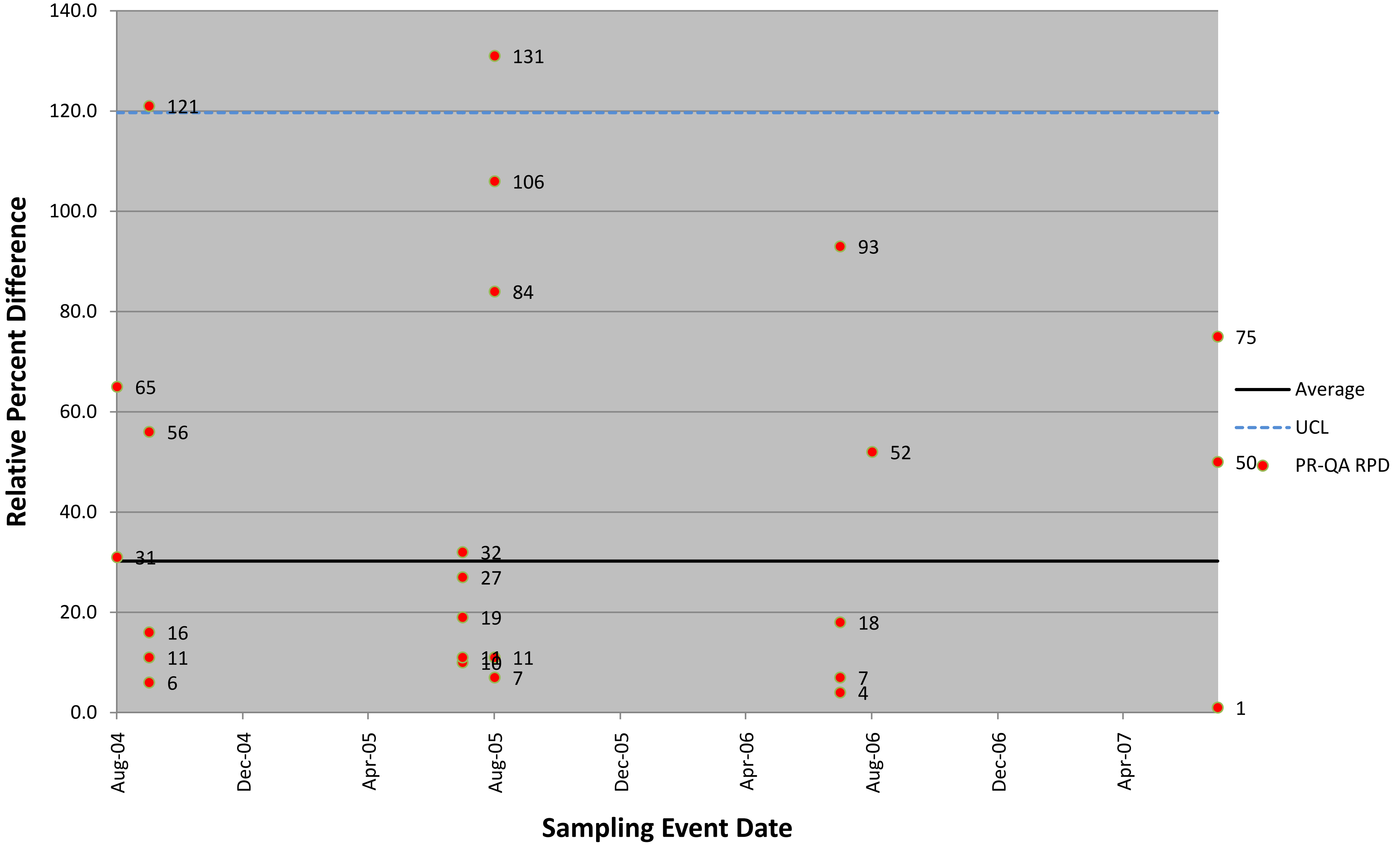
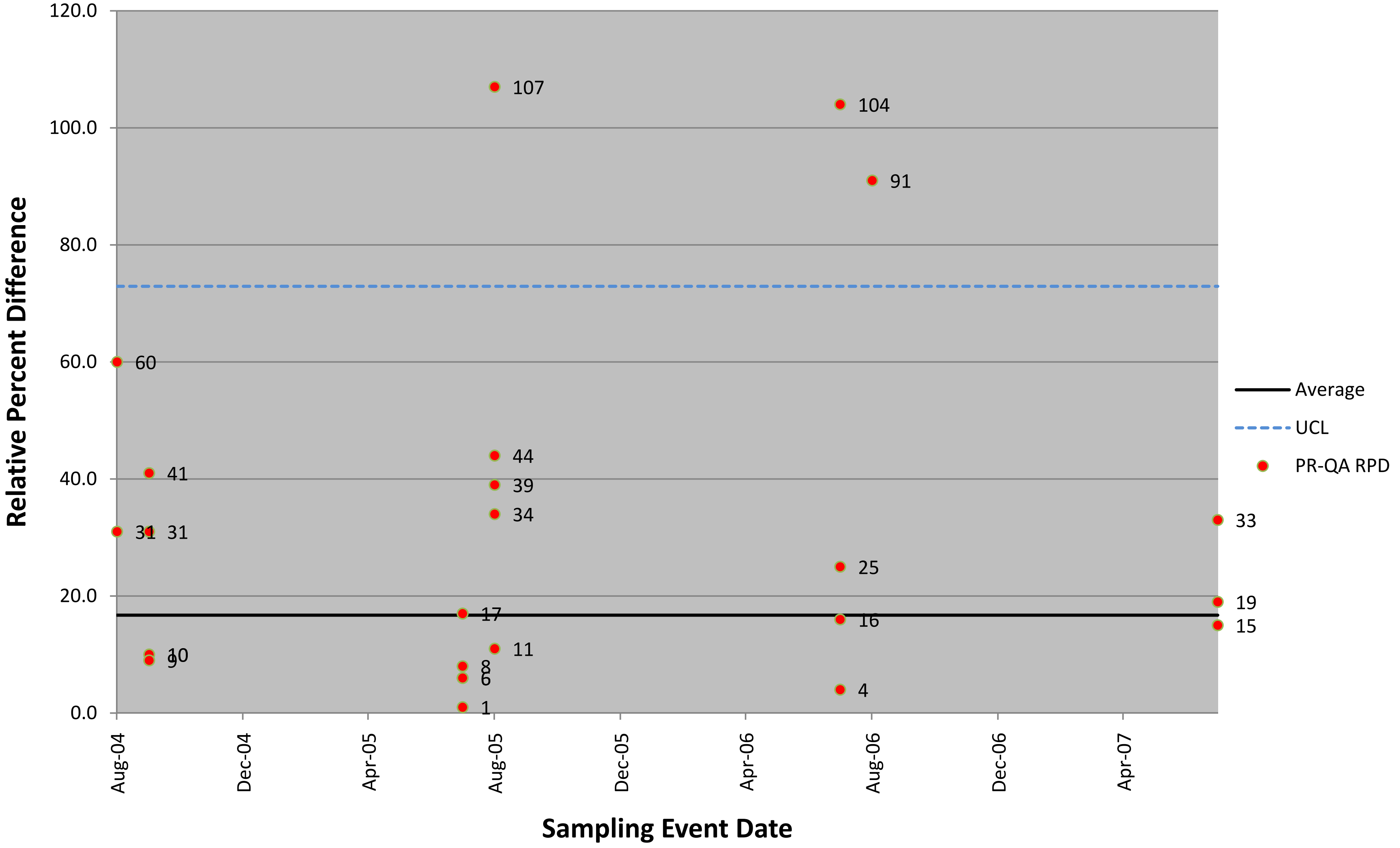


Chart A-199: Lead Control Chart for 2004-2007 Soil



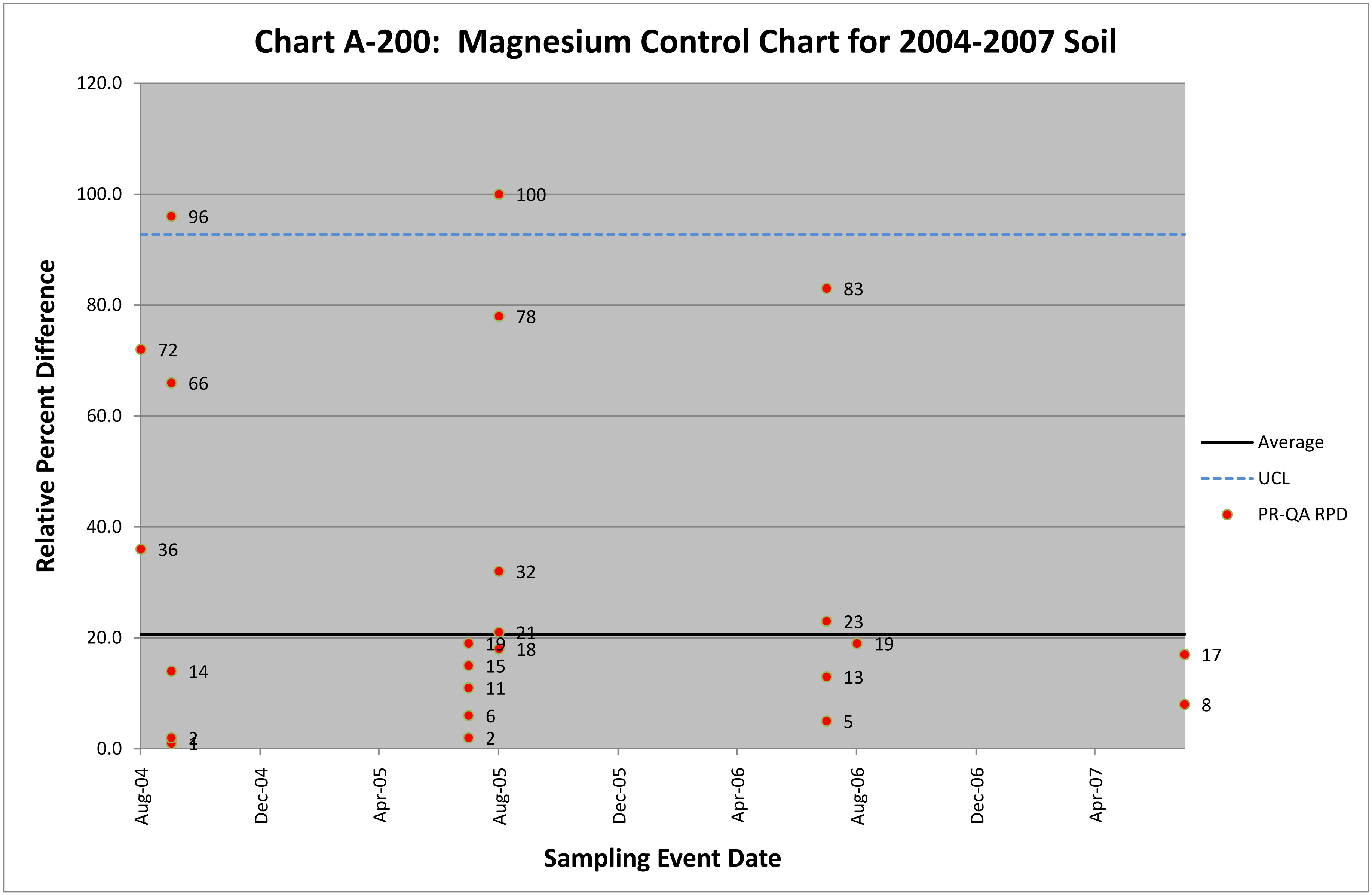


Chart A-200: Magnesium Control Chart for 2004-2007 Soil
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Sampling Event Date
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Average
UCL
PR-QA RPD
72
36
96
66
14
2
1
100
78
32
21
19
18
15
11
6
2
83
23
19
13
5
17
8

Chart A-201: Manganese Control Chart for 2004-2007 Soil

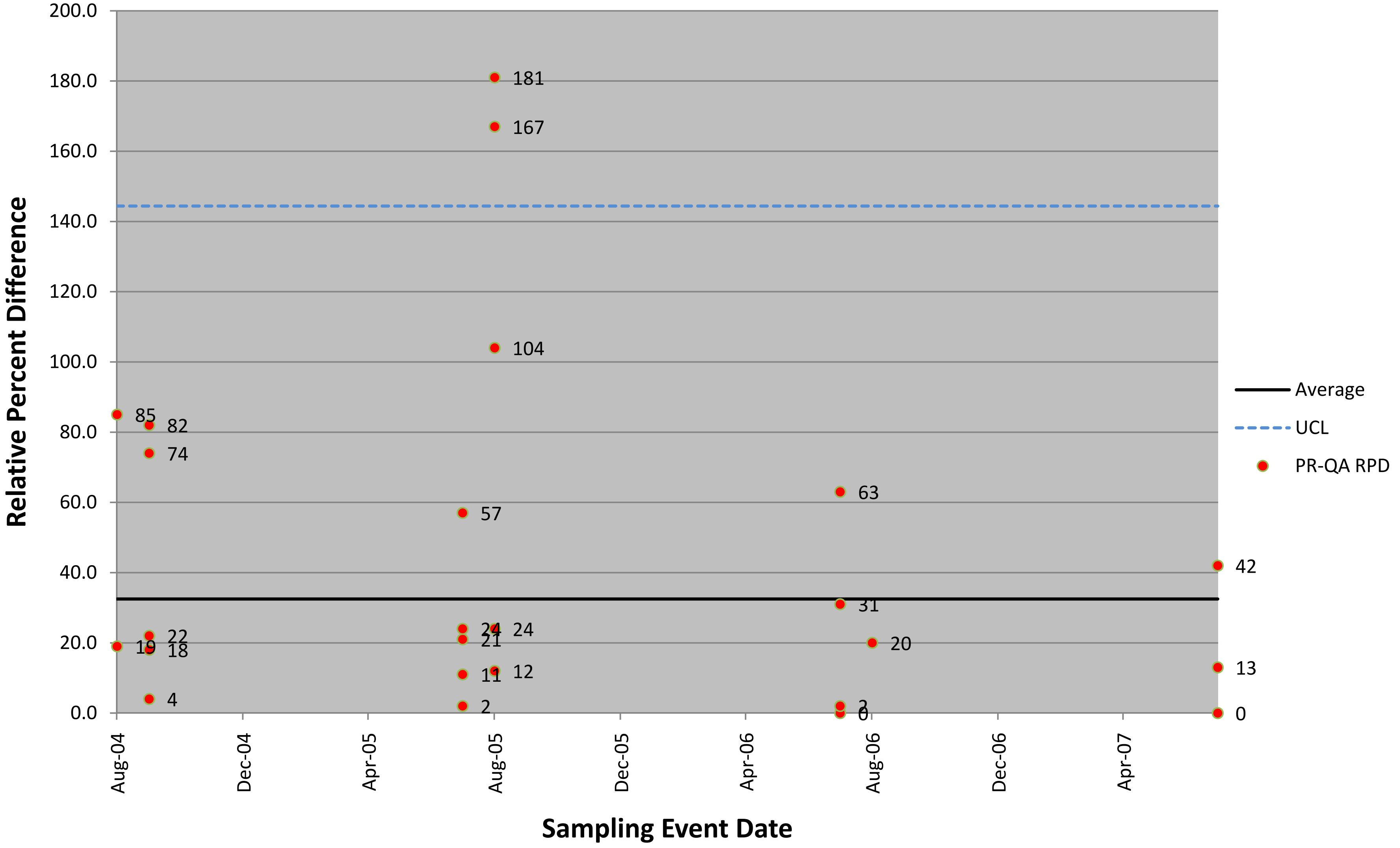
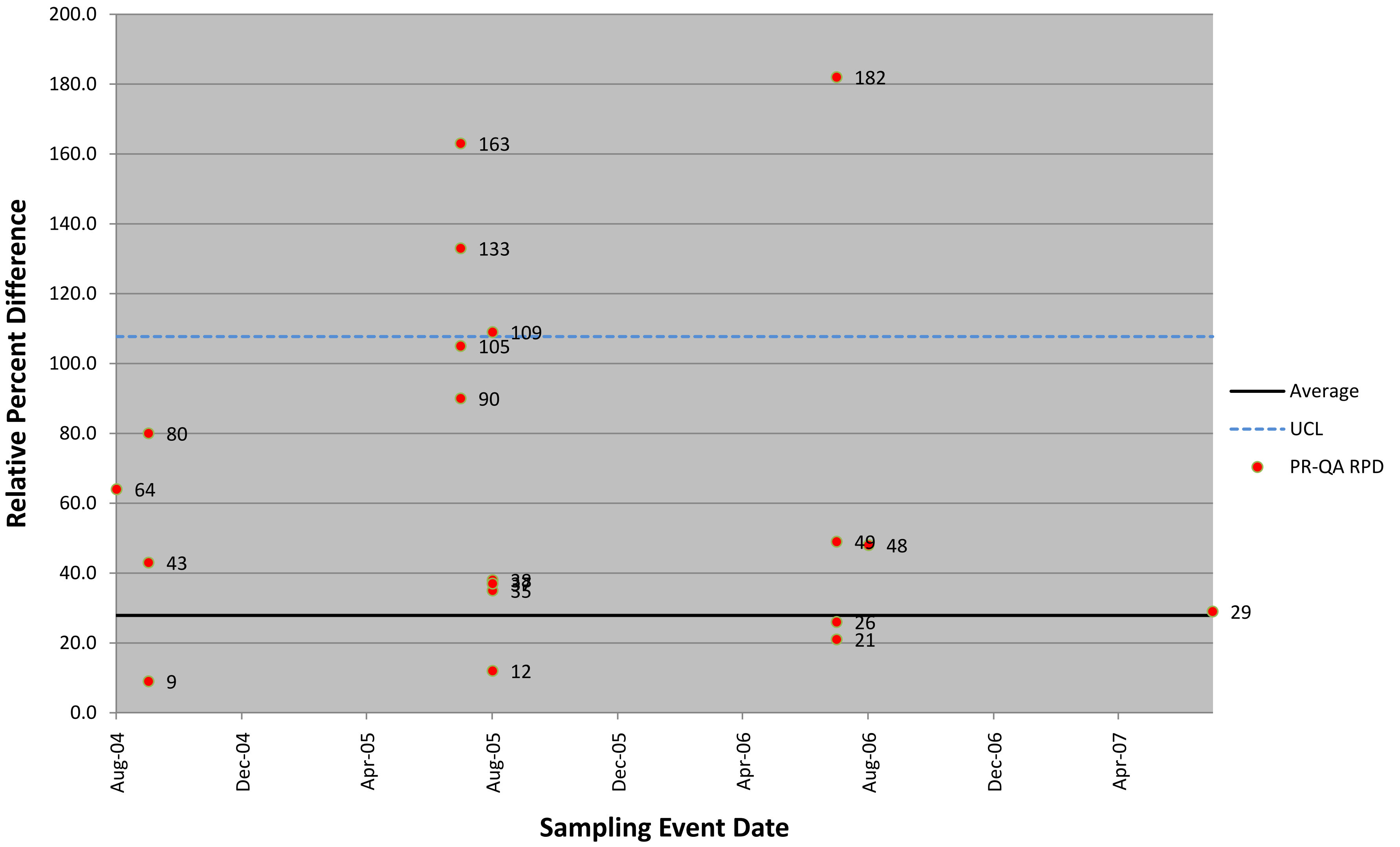


Chart A-202: Mercury Control Chart for 2004-2007 Soil



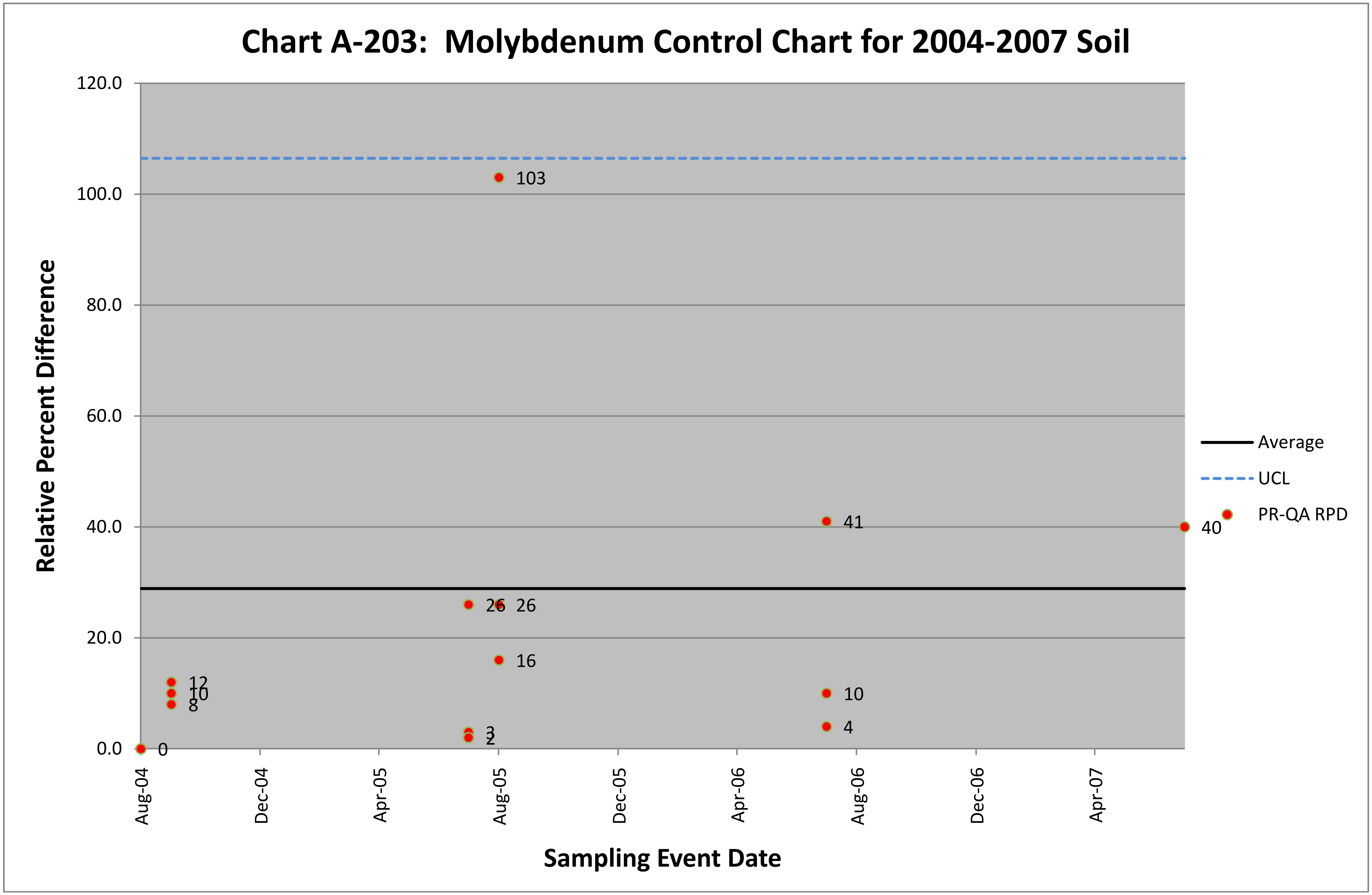


Chart A-203: Molybdenum Control Chart for 2004-2007 Soil
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
103
41
40
26
26
16
12
10
8
10
4
3
2
0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

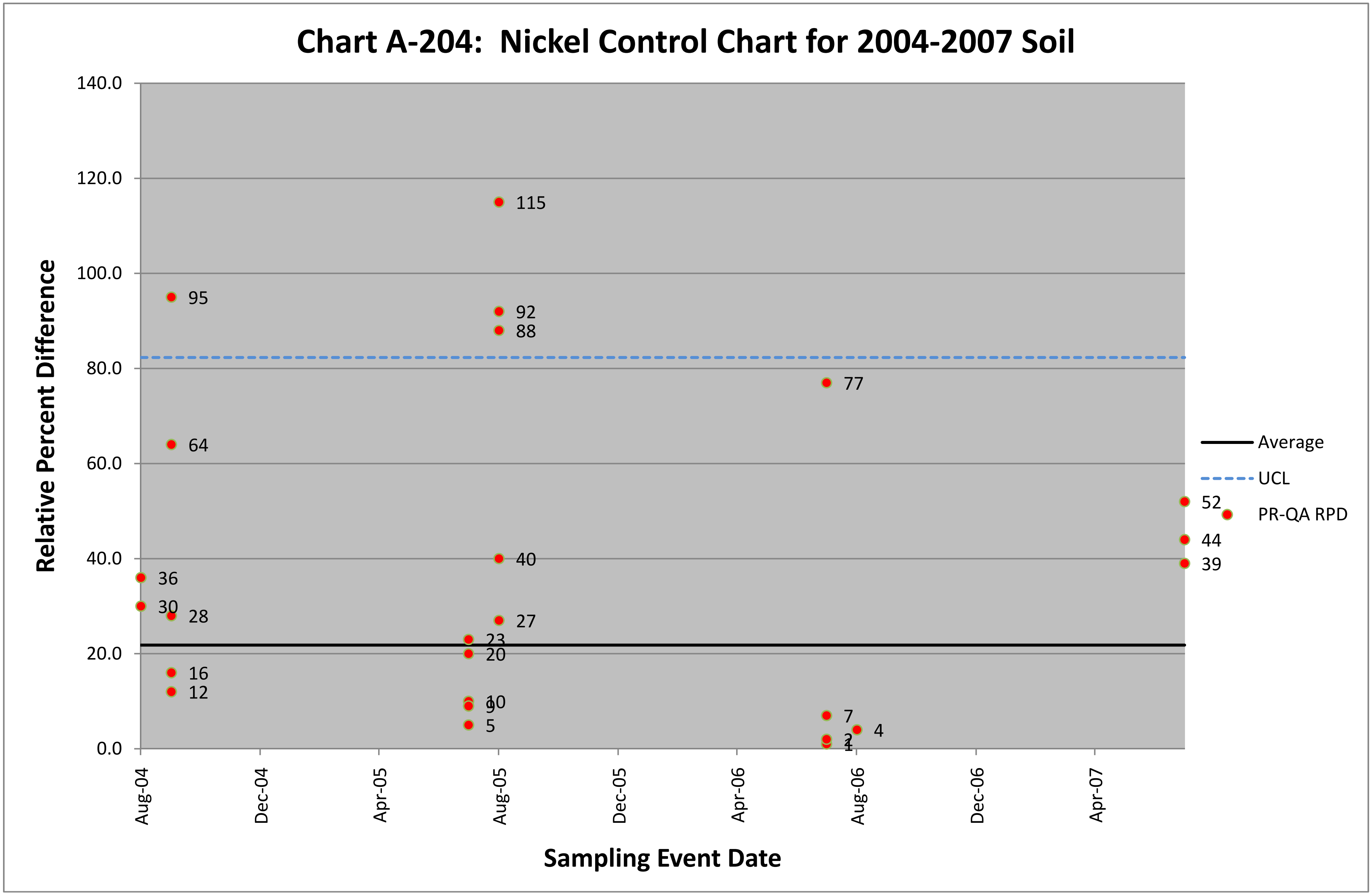


Chart A-204: Nickel Control Chart for 2004-2007 Soil
Relative Percent Difference
0.0
20.0
40.0
60.0
80.0
100.0
120.0
140.0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD
115
95
92
88
77
64
52
44
39
40
36
30
28
27
23
20
16
12
10
9
5
7
4
2
1

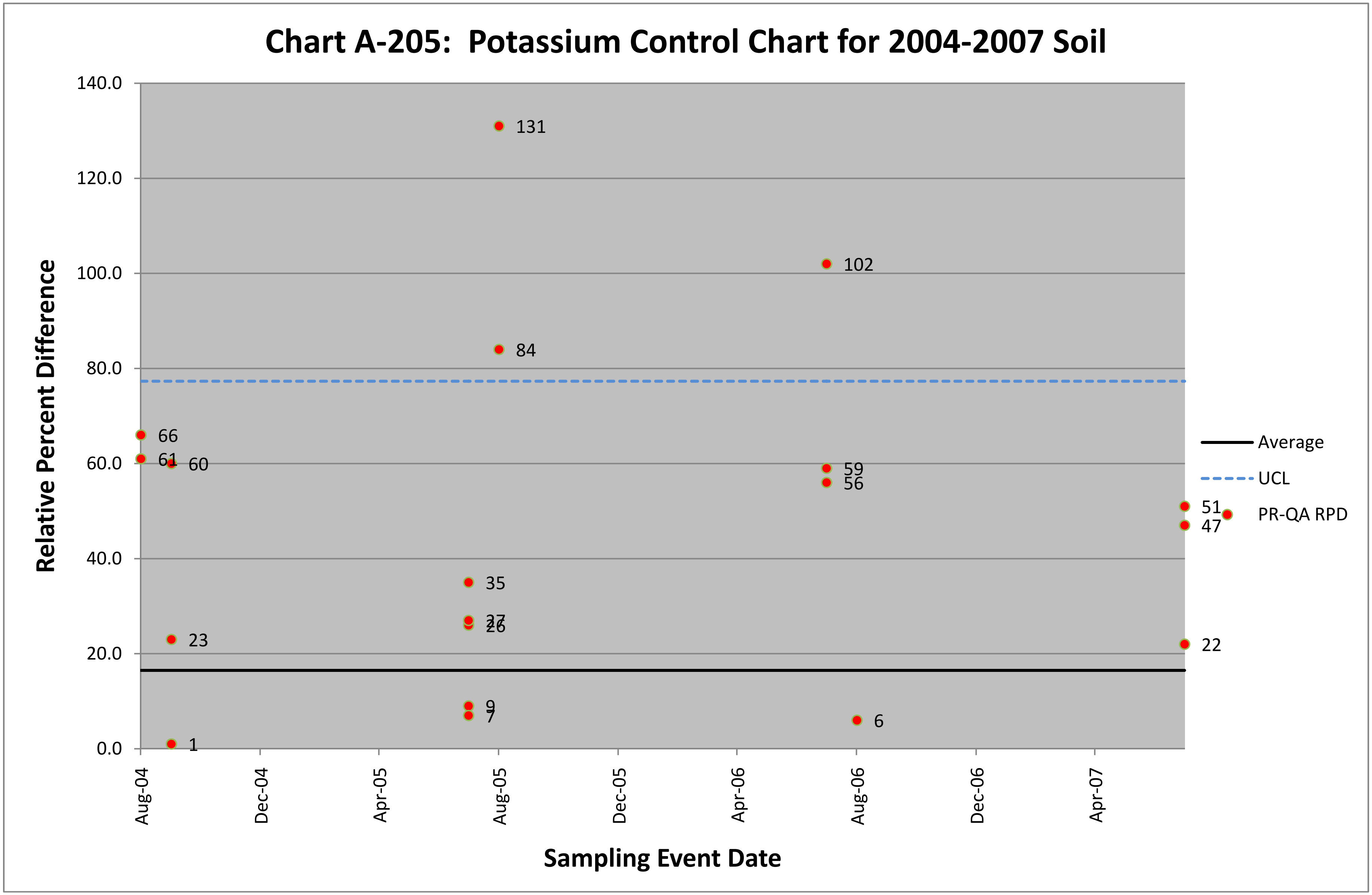


Chart A-205: Potassium Control Chart for 2004-2007 Soil
Relative Percent Difference
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
131
102
84
66
61
60
59
56
51
47
35
27
26
23
22
9
7
6
1
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

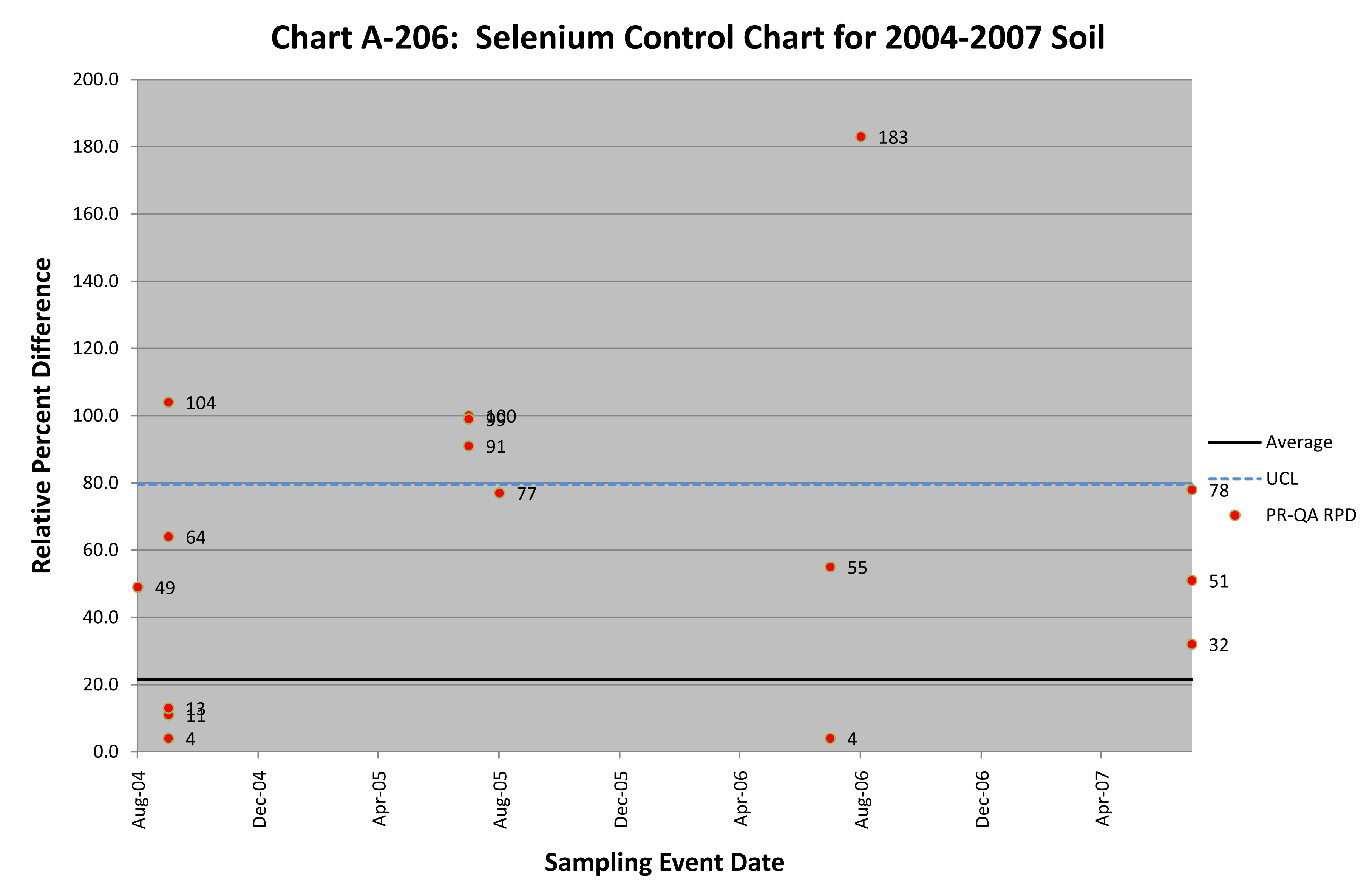
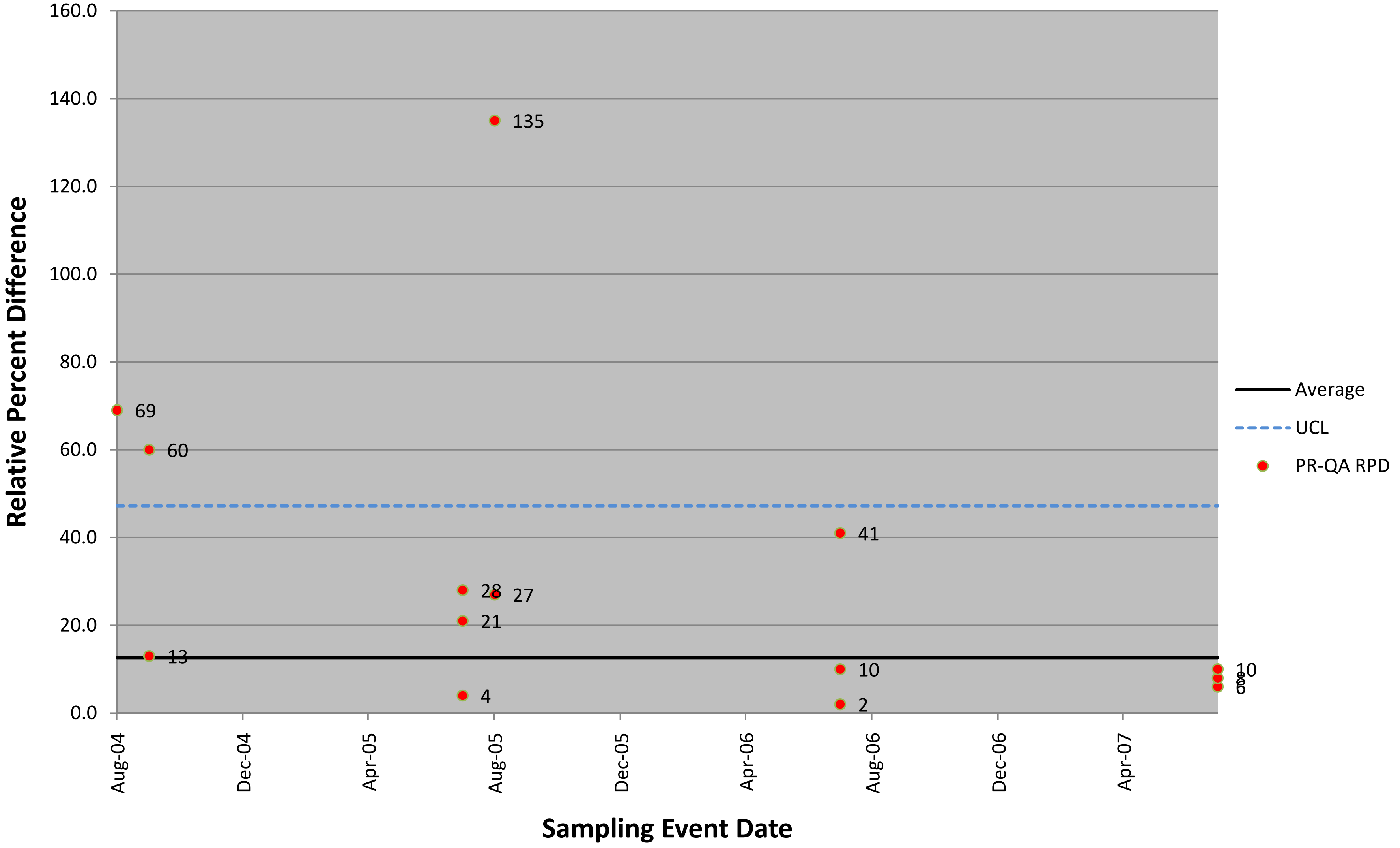


Chart A-206: Selenium Control Chart for 2004-2007 Soil
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD
183
104
100
99
91
77
78
64
55
49
51
32
13
11
4
4

Chart A-207: Silver Control Chart for 2004-2007 Soil



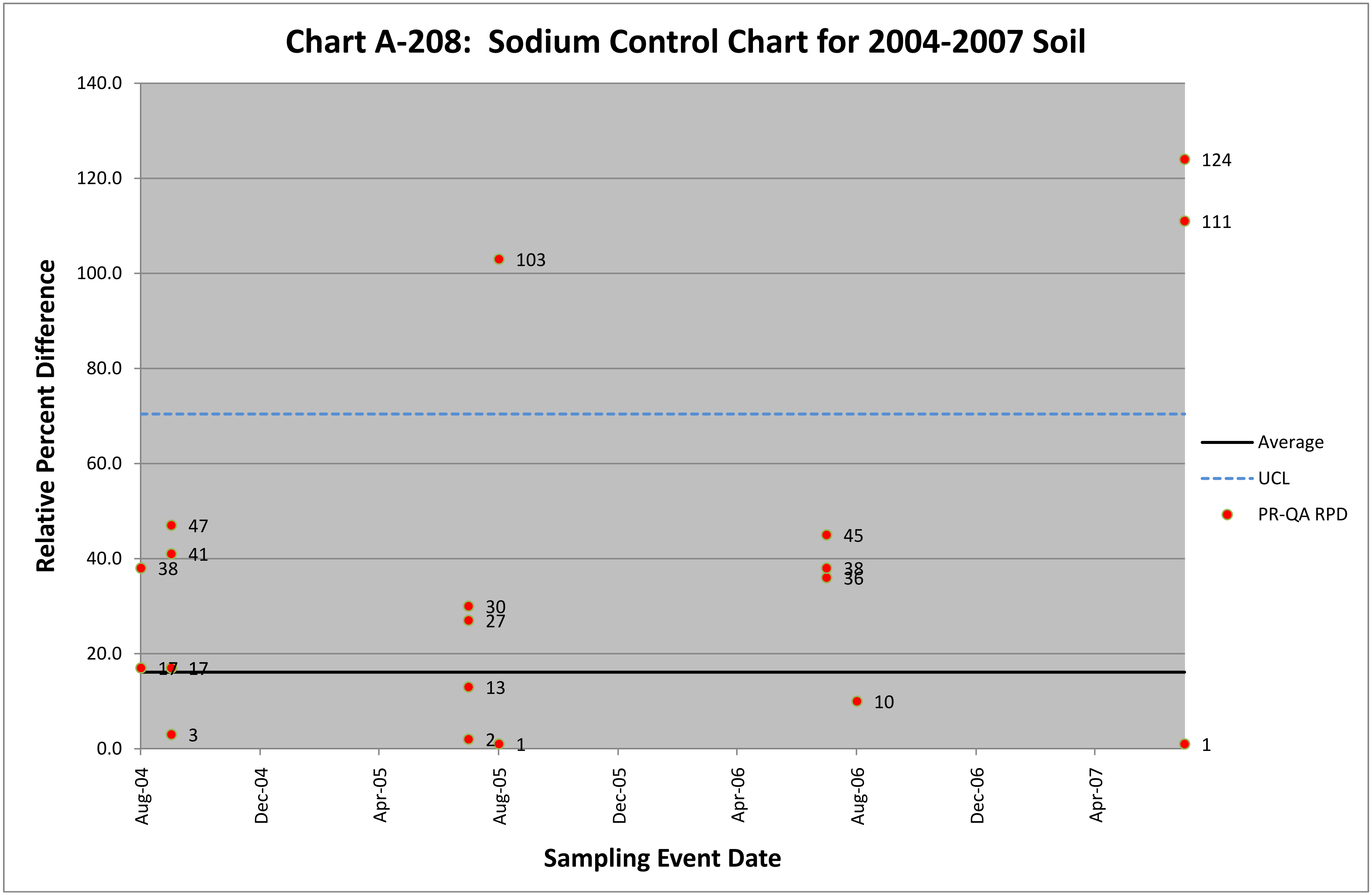


Chart A-208: Sodium Control Chart for 2004-2007 Soil
Relative Percent Difference
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
124
111
103
47
41
38
45
38
36
30
27
17
17
17
13
10
3
2
1
1
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

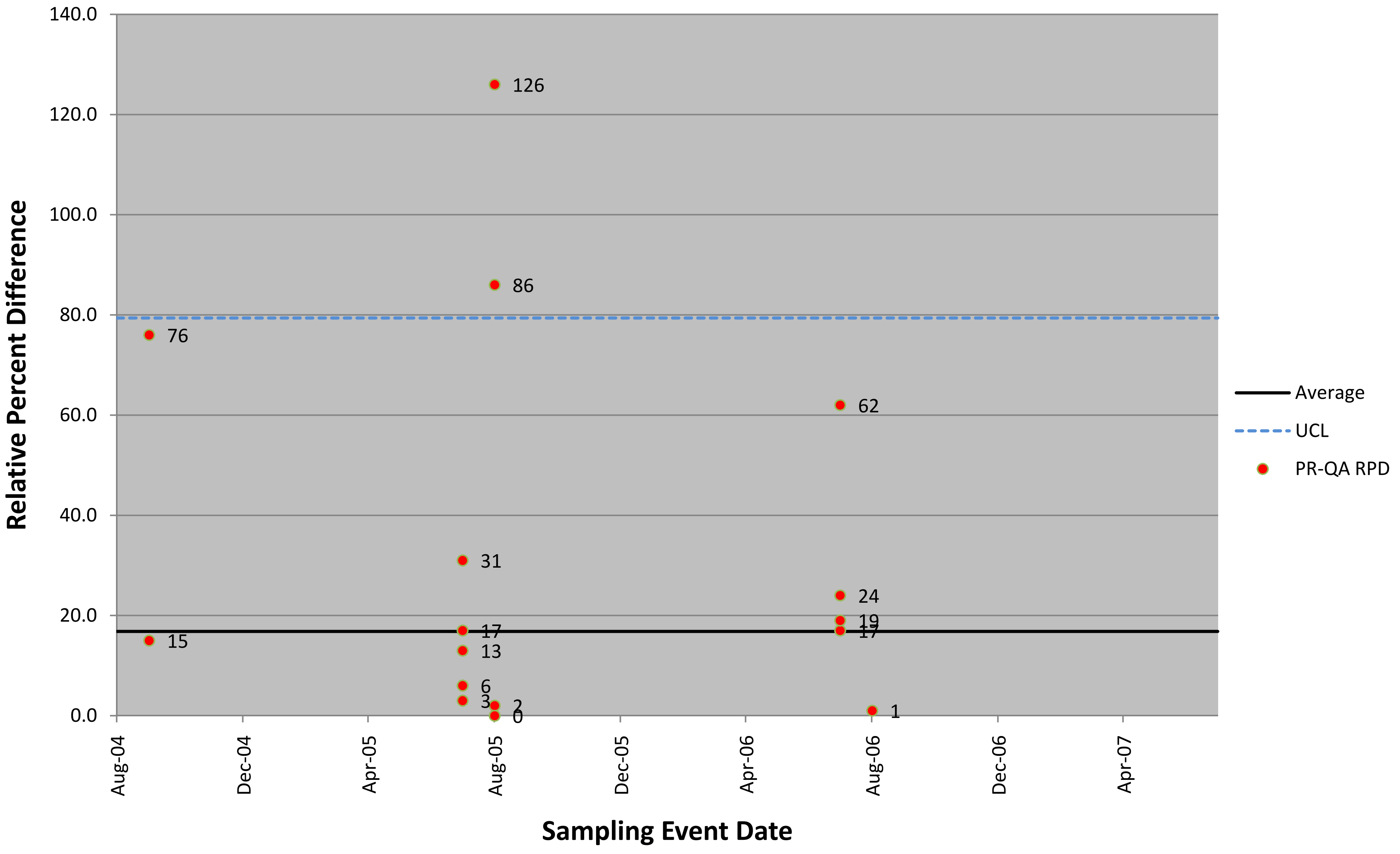
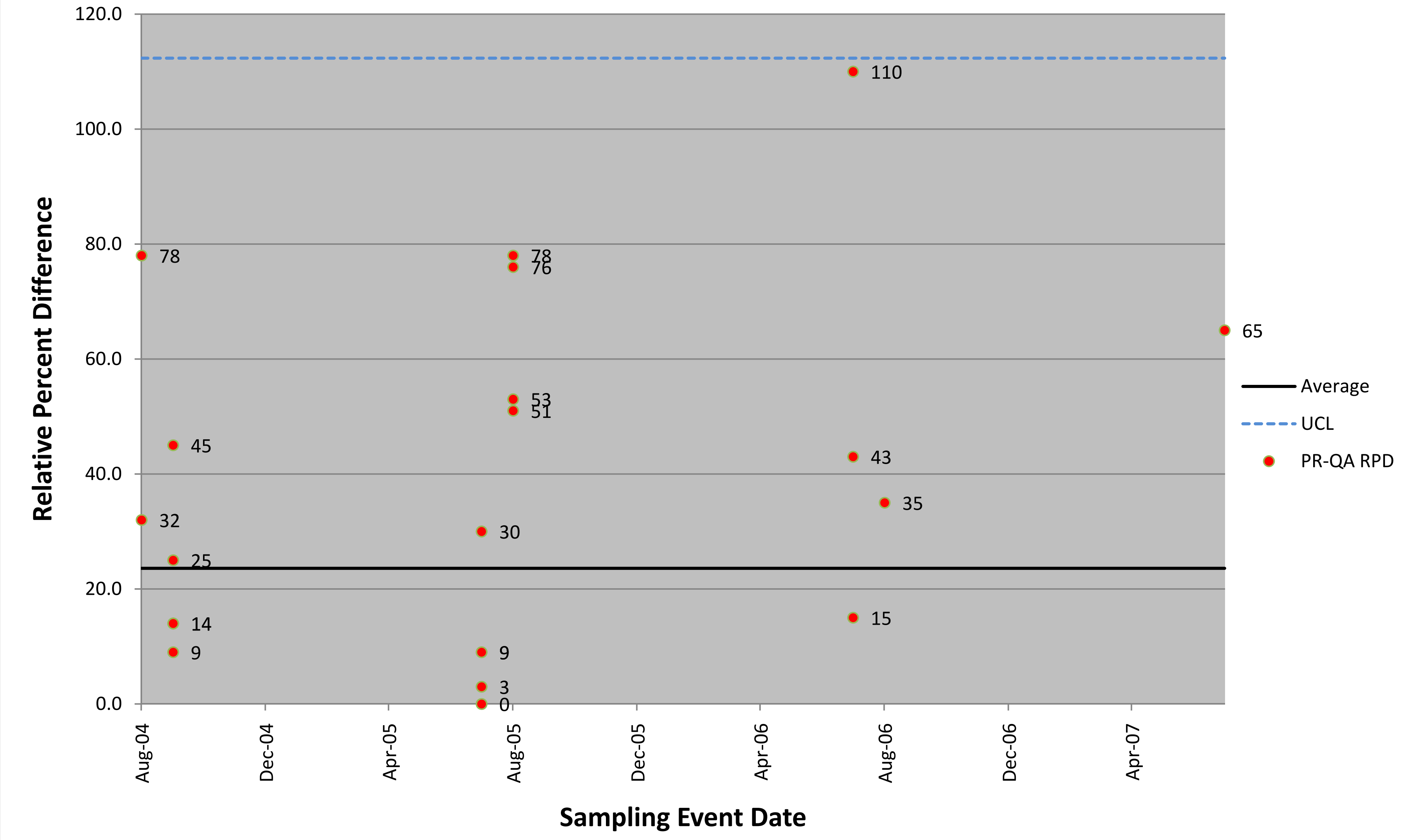


Chart A-209: Thallium Control Chart for 2004-2007 Soil

Chart A-210: Vanadium Control Chart for 2004-2007 Soil



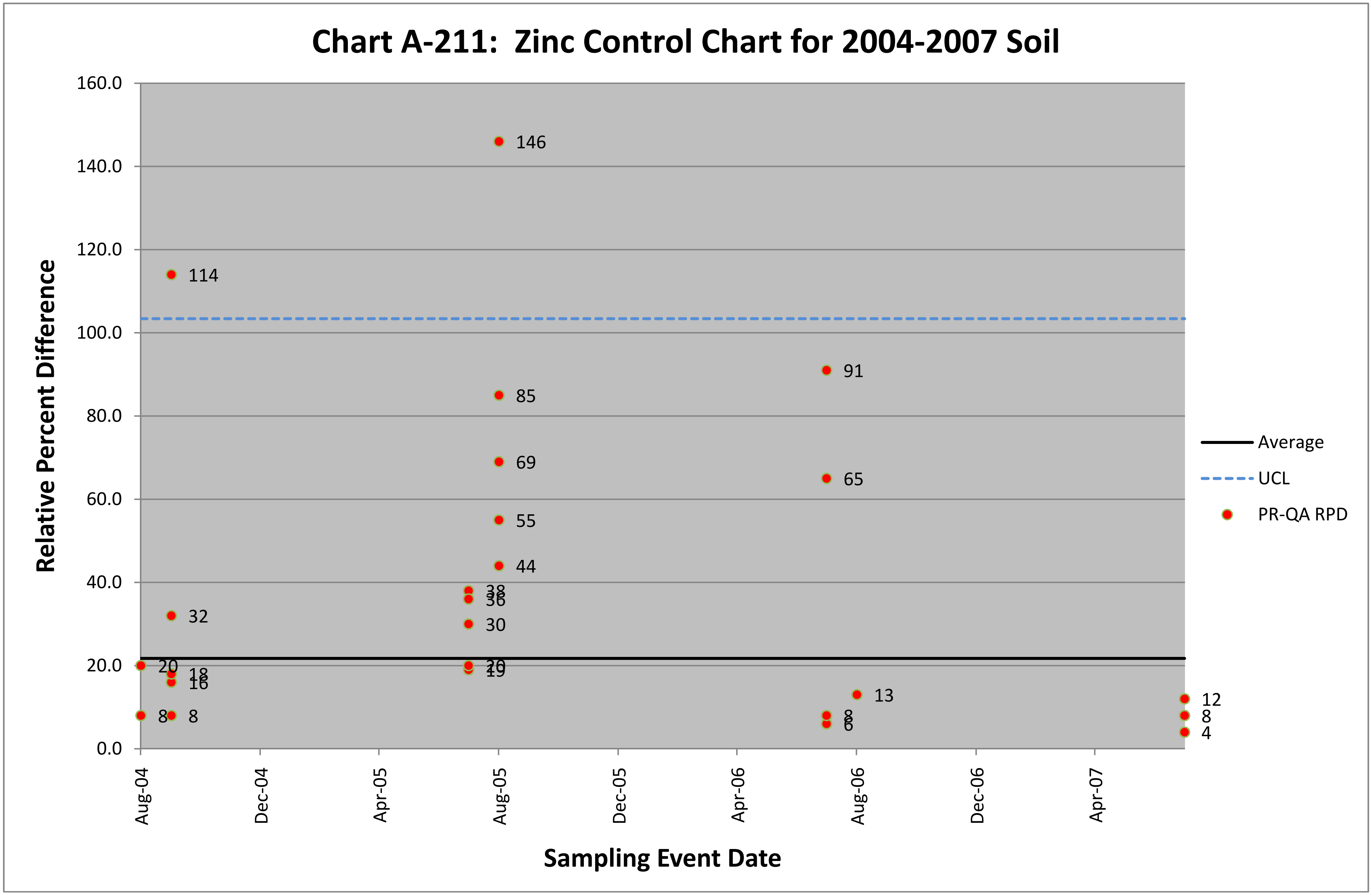


Chart A-211: Zinc Control Chart for 2004-2007 Soil
Relative Percent Difference
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
146
114
91
85
69
65
55
44
38
36
32
30
20
18
16
20
19
13
12
8
8
8
6
8
4
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD

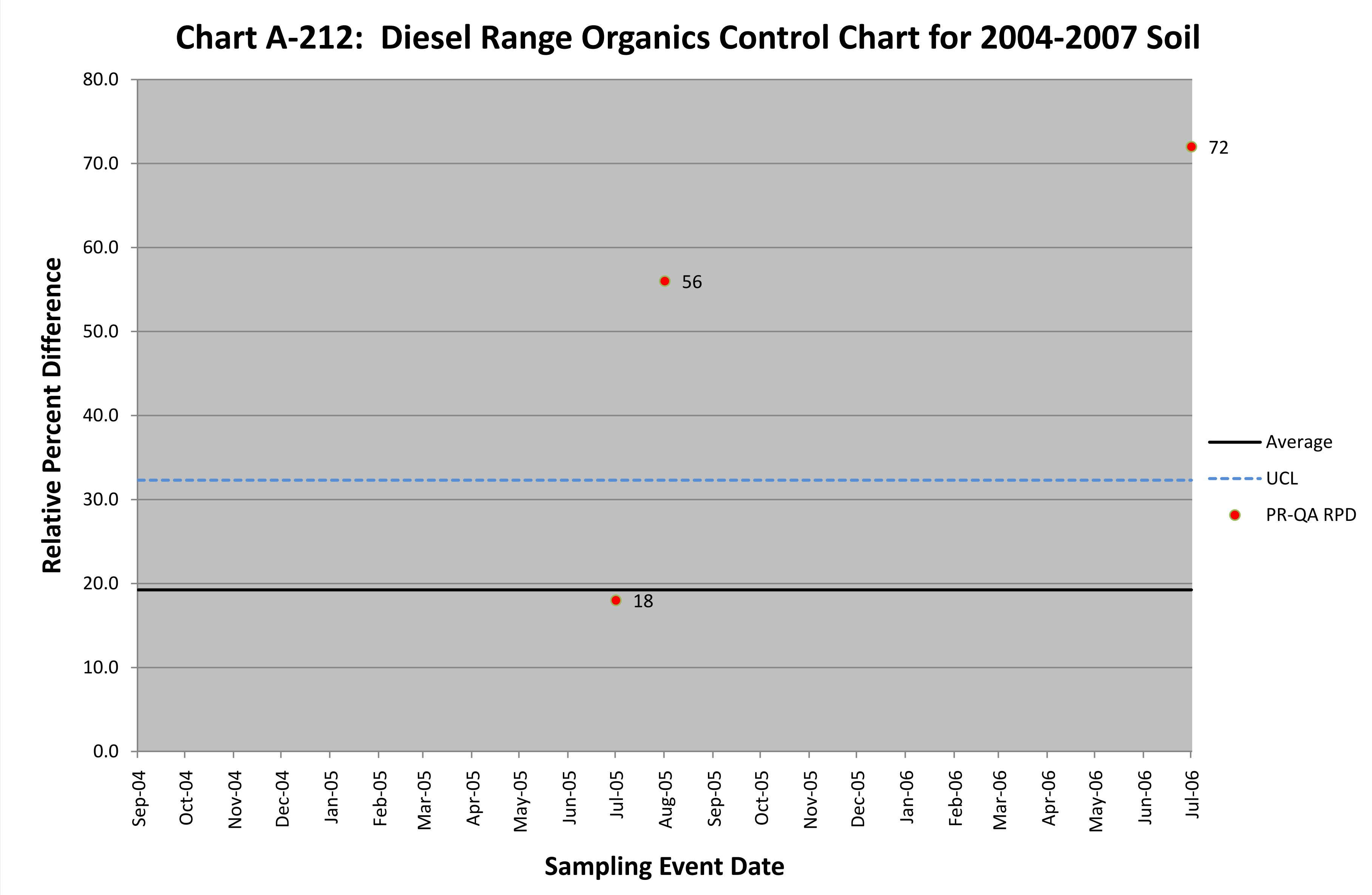
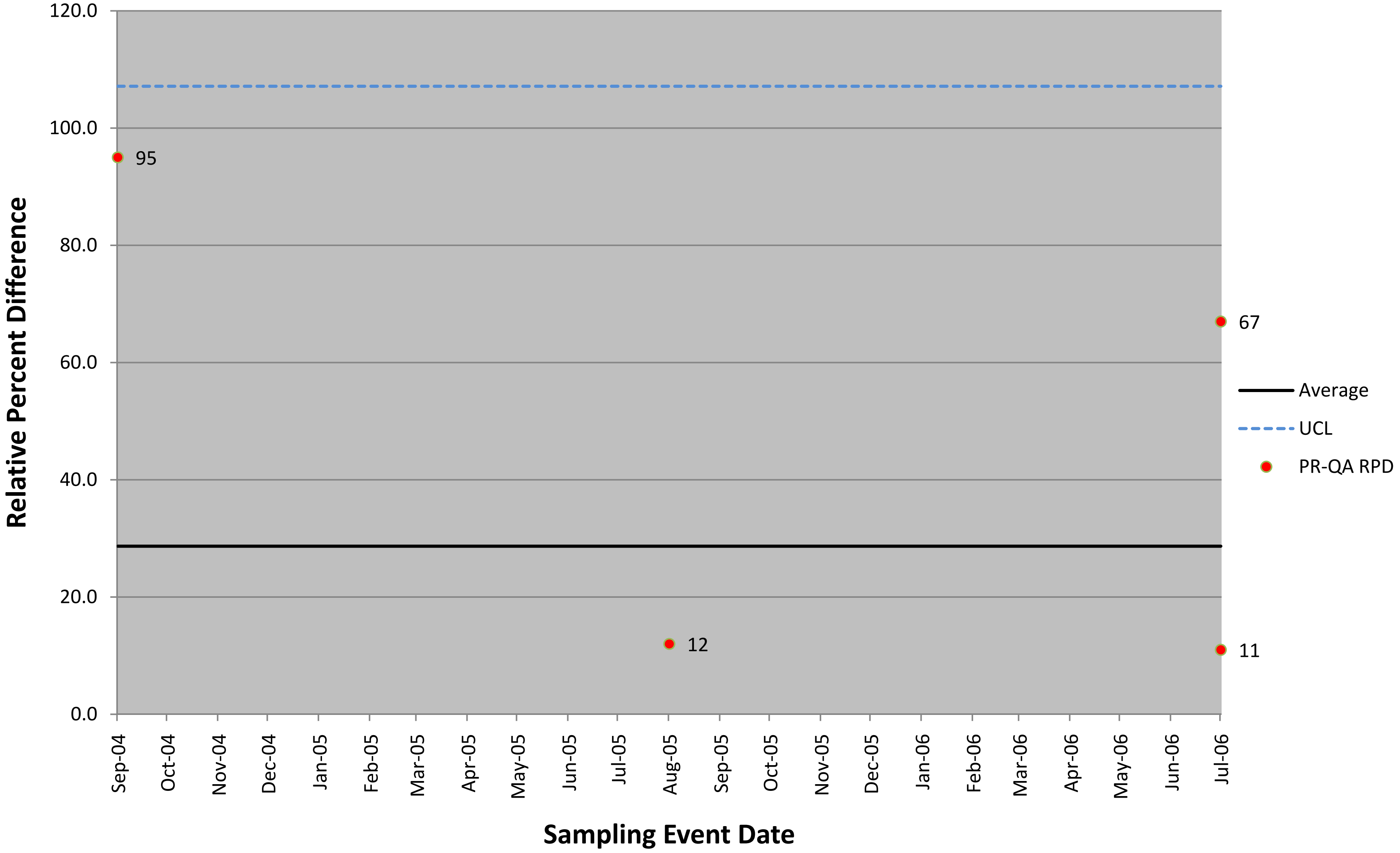


Chart A-212: Diesel Range Organics Control Chart for 2004-2007 Soil
Relative Percent Difference
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
72
56
18
Average
UCL
PR-QA RPD
Sep-04
Oct-04
Nov-04
Dec-04
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Sampling Event Date

Chart A-213: Residual Range Organics Control Chart for 2004-2007 Soil



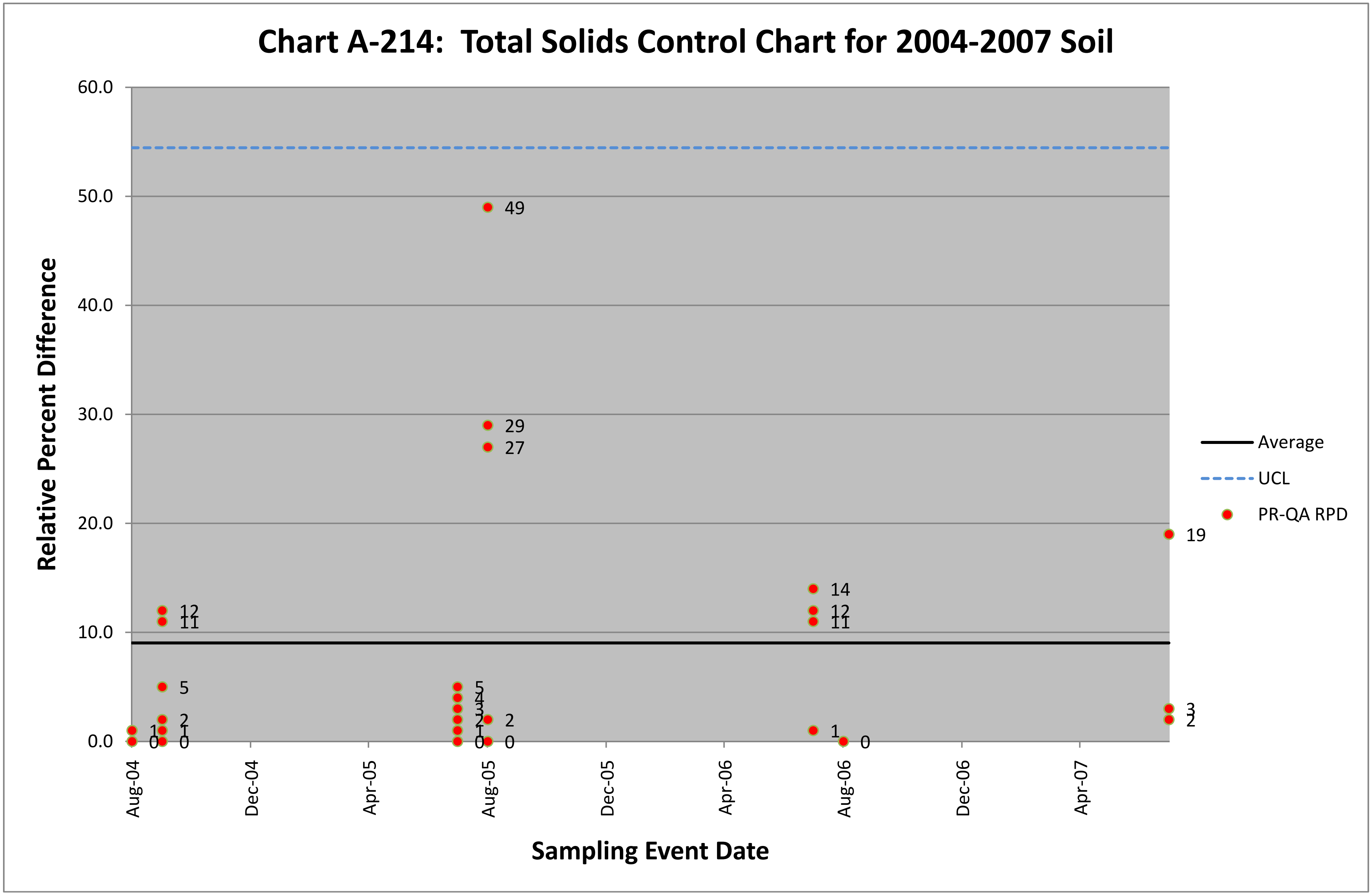
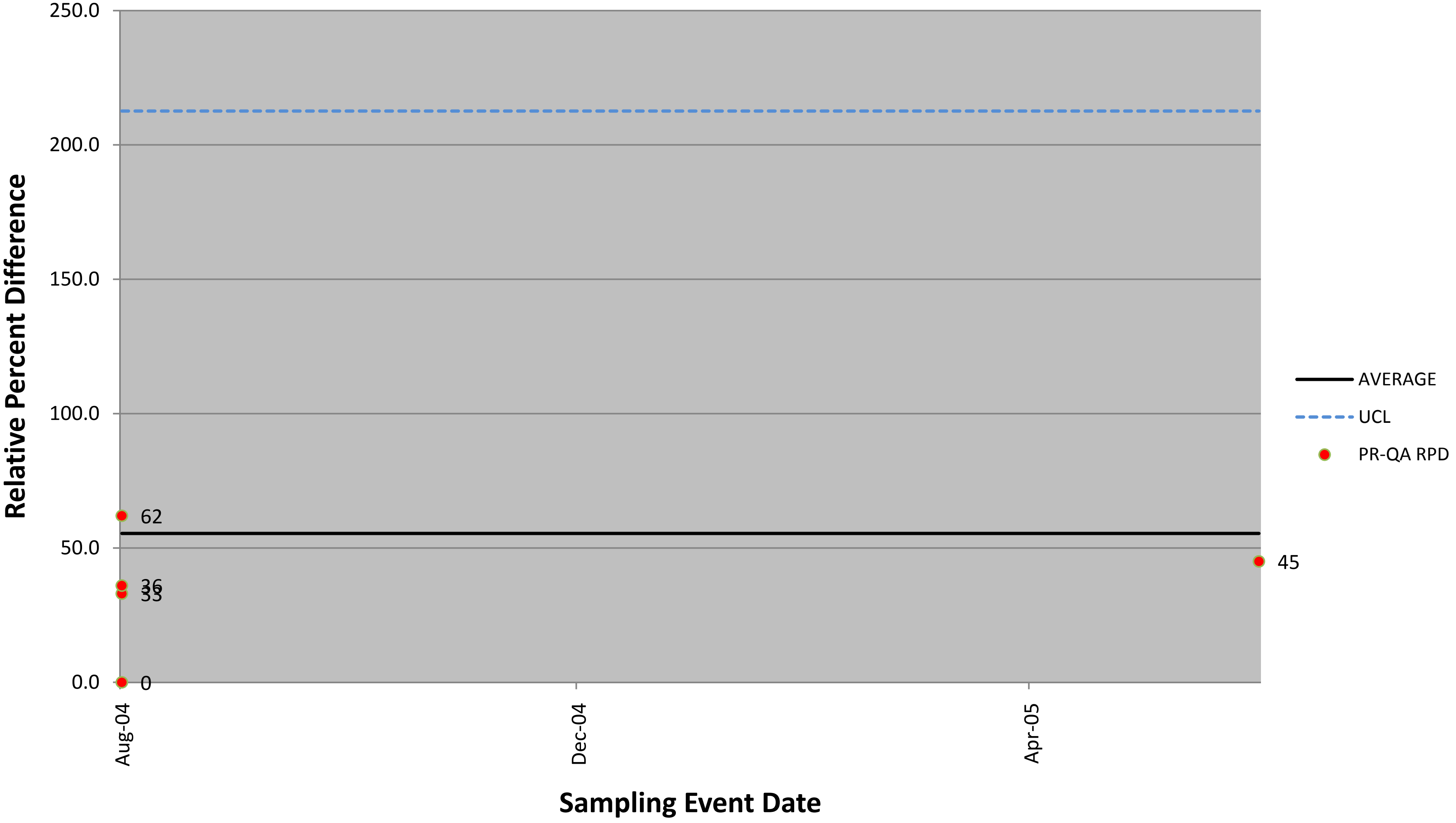


Chart A-214: Total Solids Control Chart for 2004-2007 Soil
Relative Percent Difference
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Sampling Event Date
Average
UCL
PR-QA RPD
49
29
27
19
14
12
11
12
11
5
2
1
0
1
0
5
4
3
2
1
0
2
0
1
0
3
2

Chart A-215: Copper Control Chart for 2004-2005 Fish and Mussel Tissue



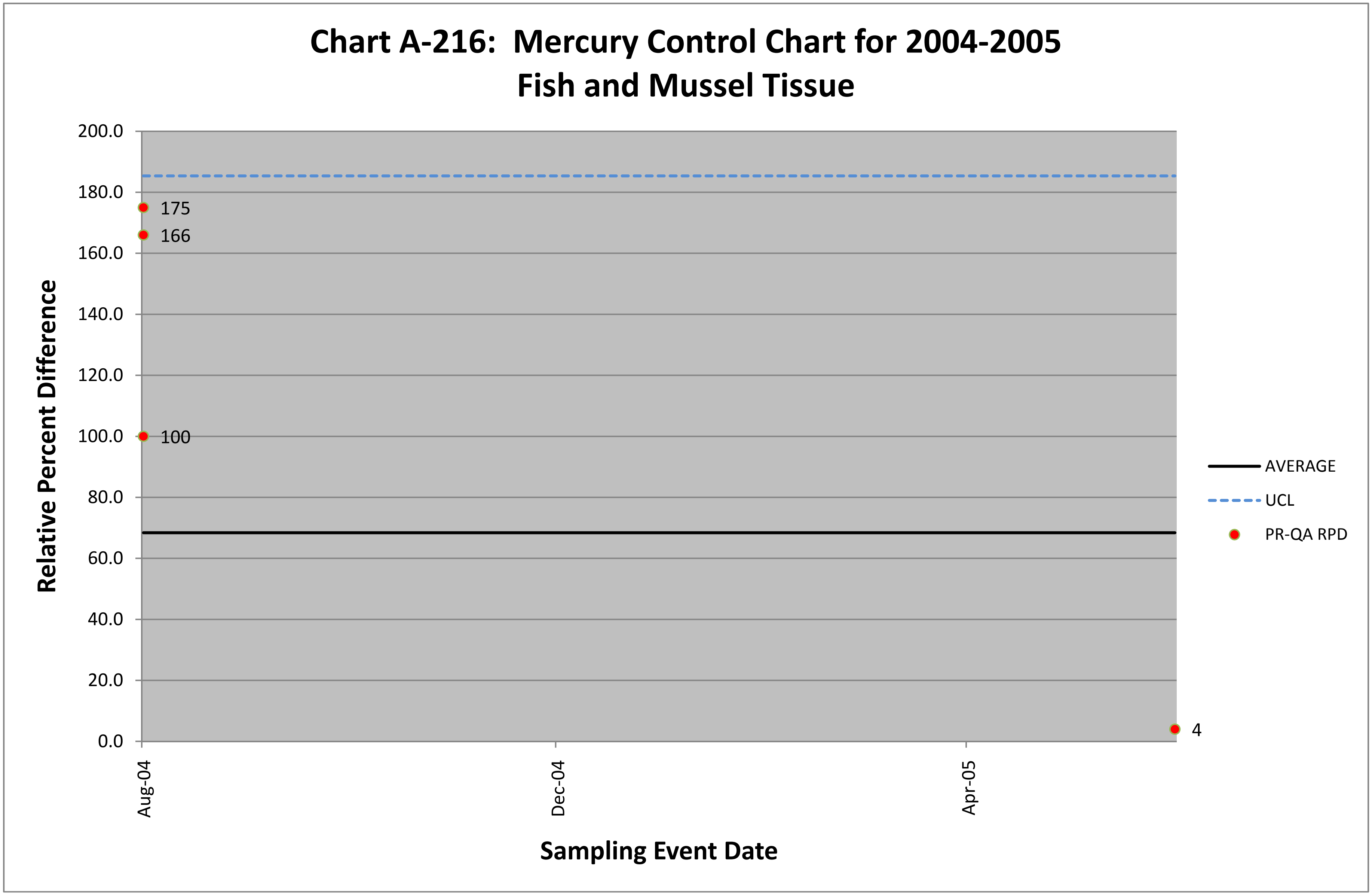


Chart A-216: Mercury Control Chart for 2004-2005
Fish and Mussel Tissue
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
175
166
100
4
Aug-04
Dec-04
Apr-05
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

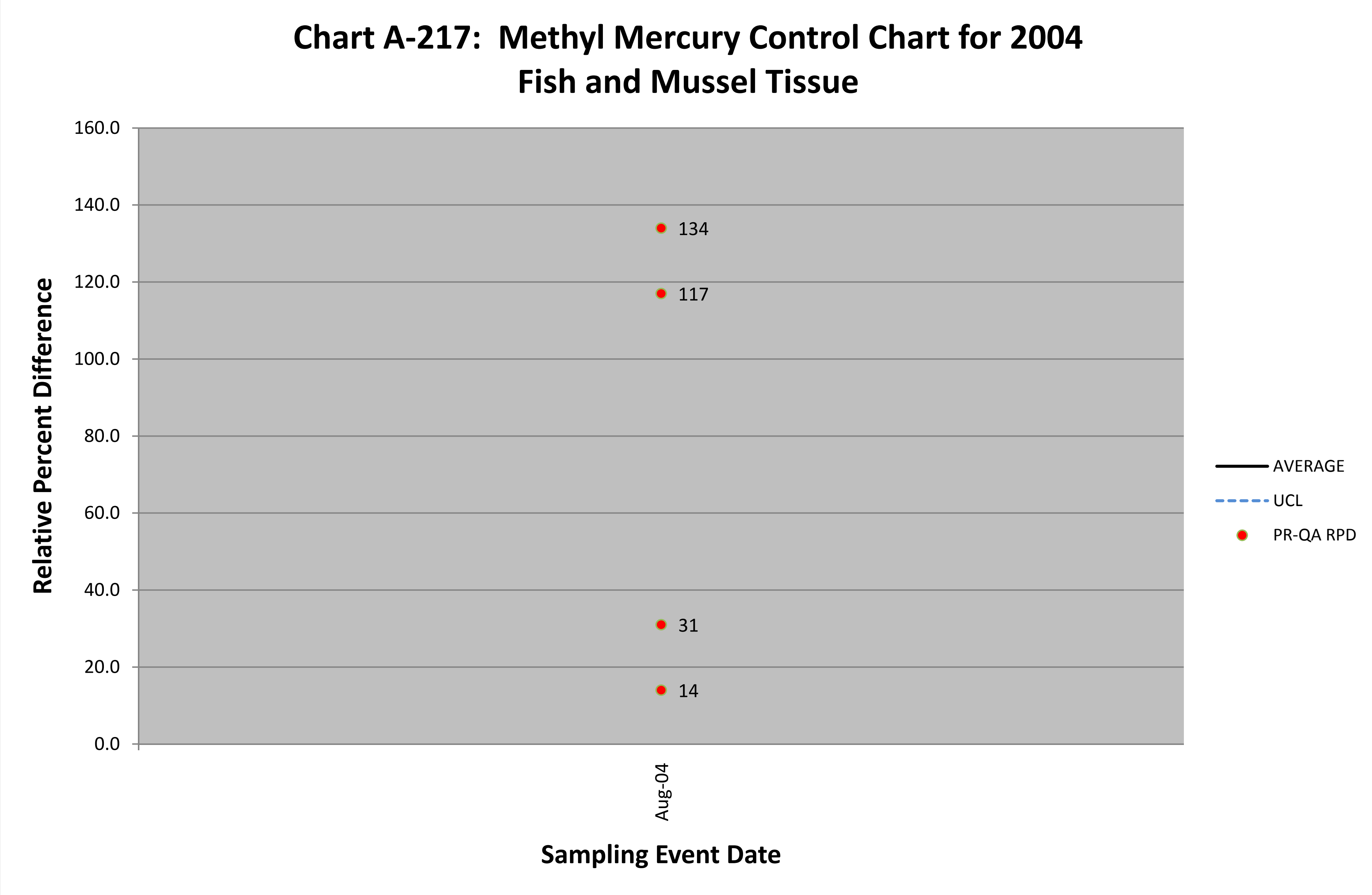


Chart A-217: Methyl Mercury Control Chart for 2004
Fish and Mussel Tissue
Relative Percent Difference
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
134
117
31
14
Aug-04
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-218: Nickel Control Chart for 2004-2005 Fish and Mussel Tissue

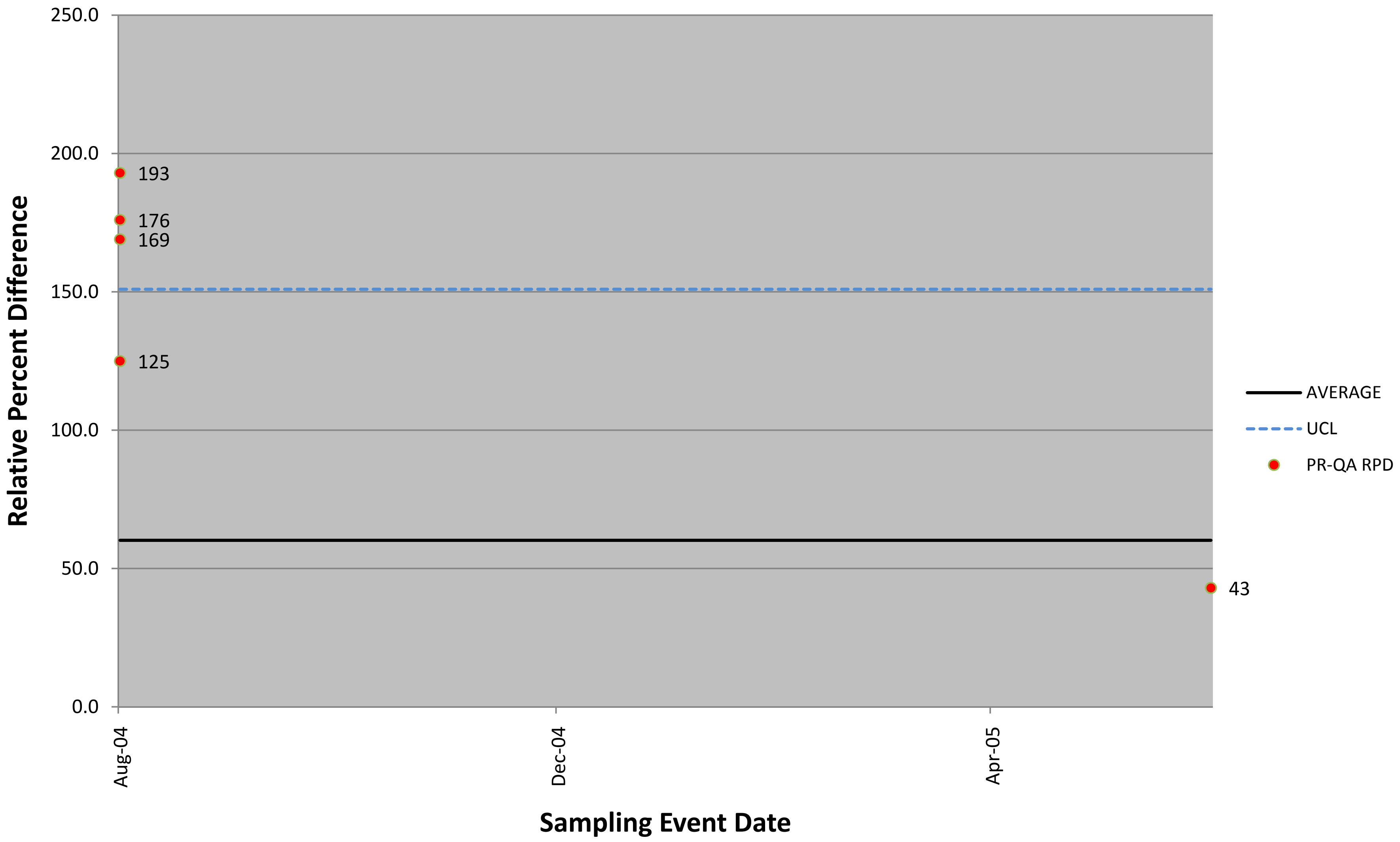
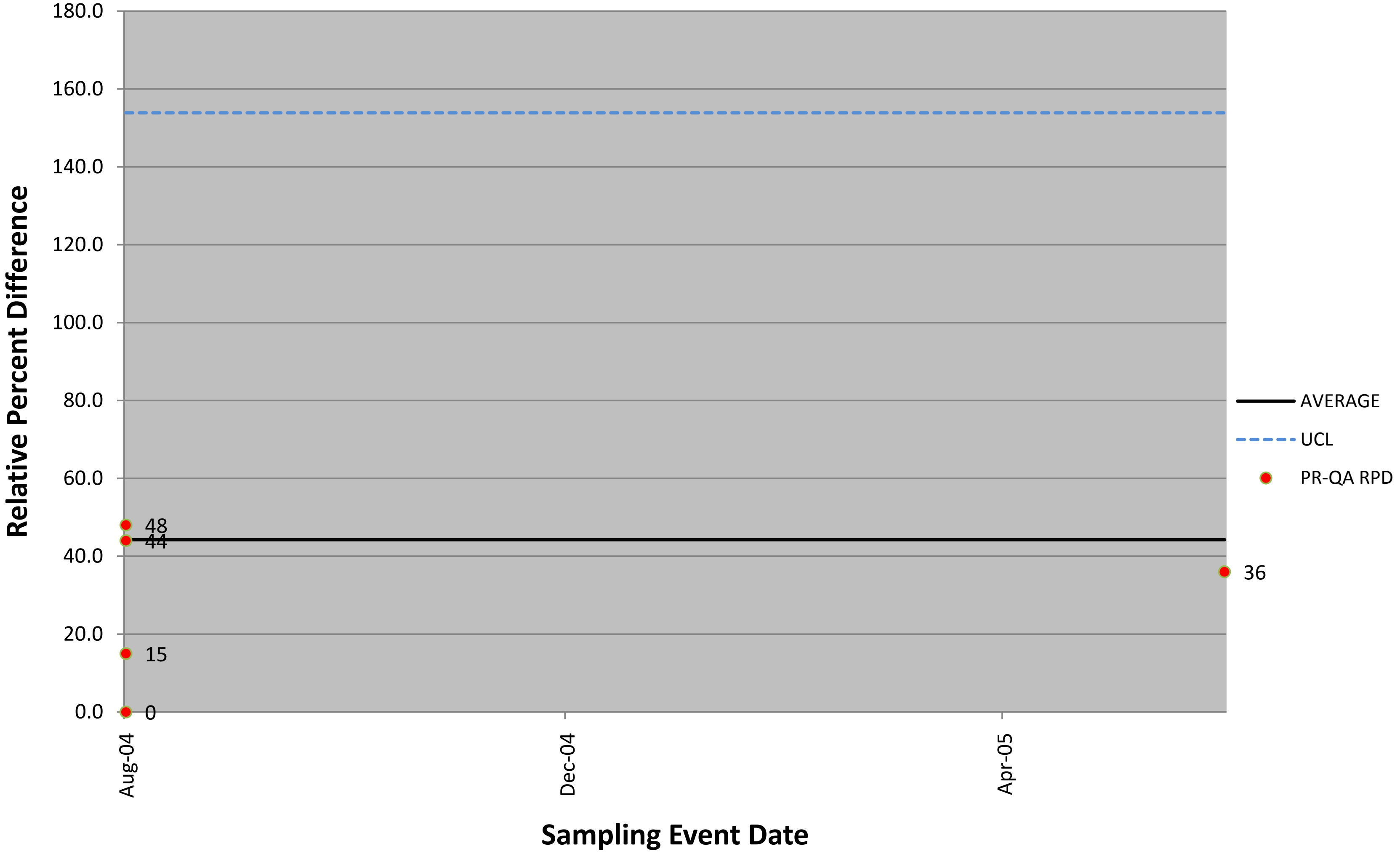


Chart A-219: Selenium Control Chart for 2004-2005
Fish and Mussel Tissue



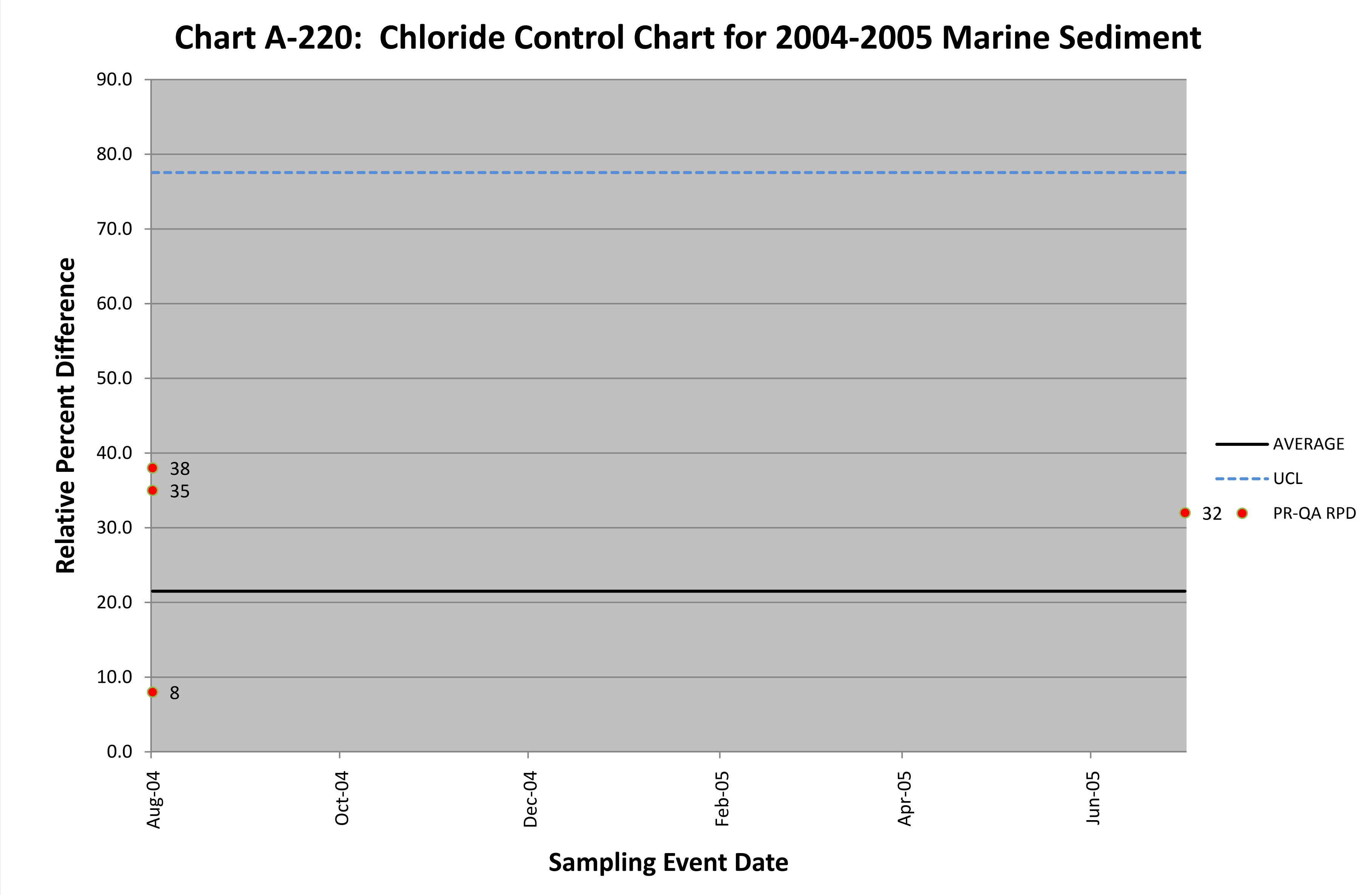
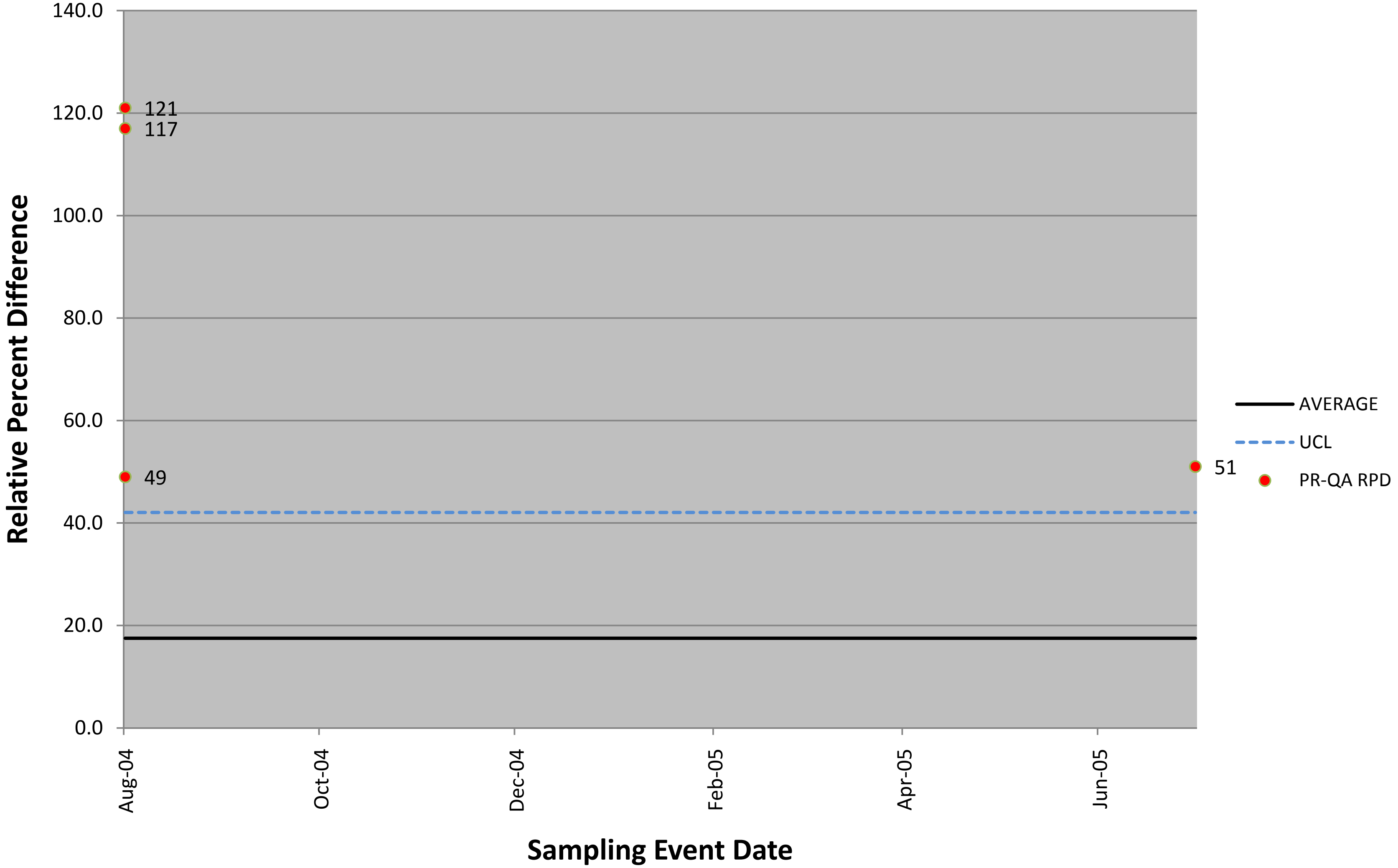


Chart A-220: Chloride Control Chart for 2004-2005 Marine Sediment
Relative Percent Difference
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
38
35
8
32
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-221: Nitrogen: Ammonia (as N) Control Chart for 2004-2005 Marine Sediment



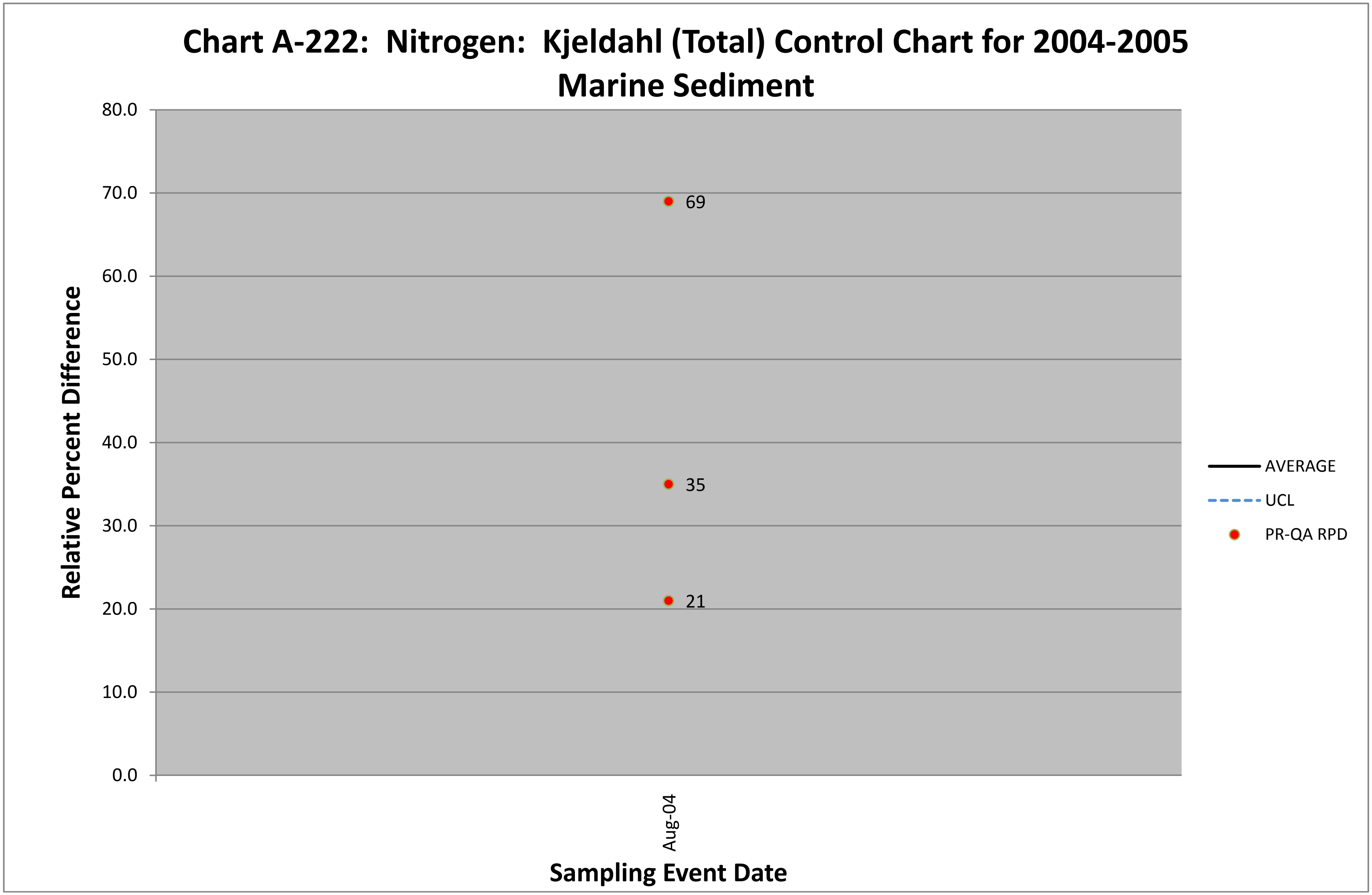
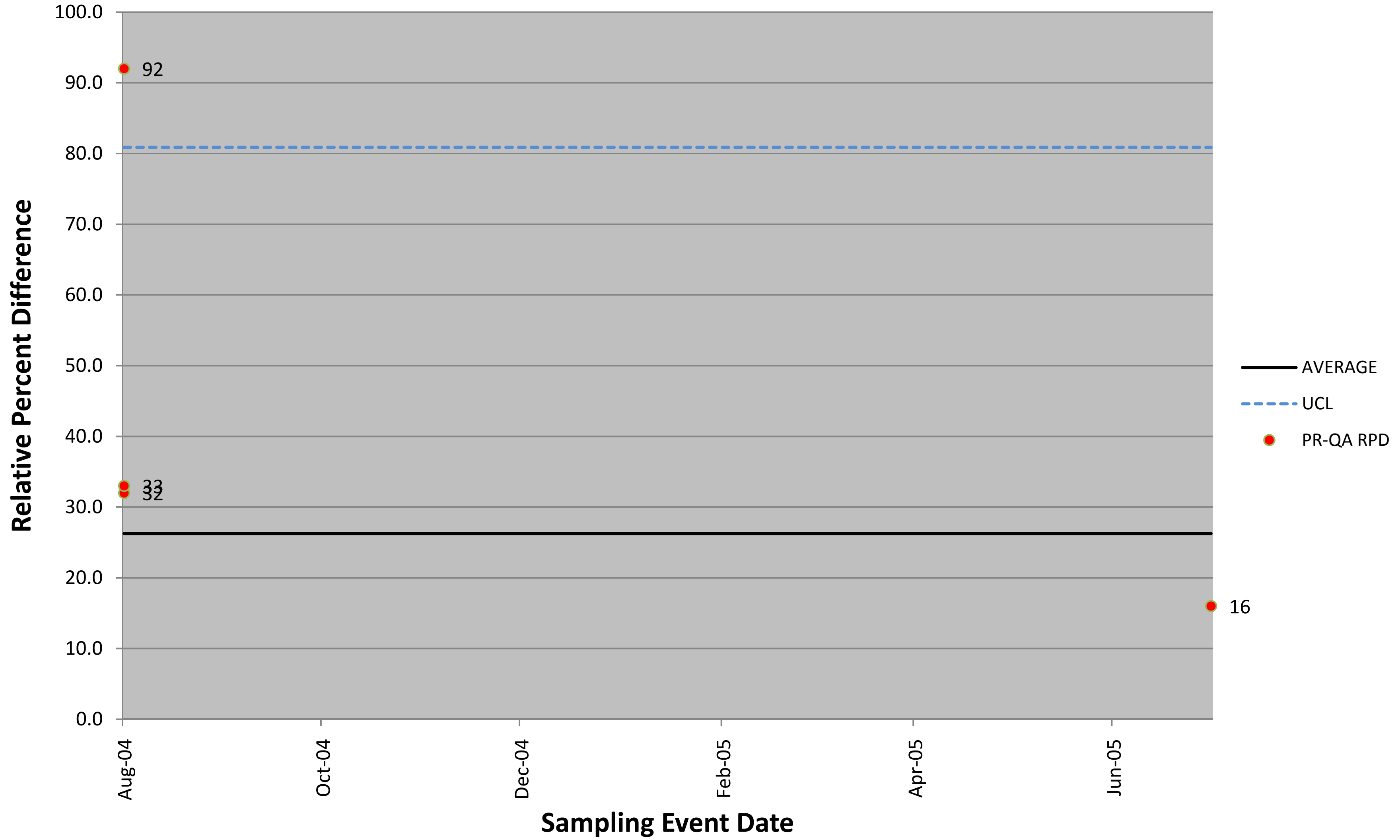


Chart A-222: Nitrogen: Kjeldahl (Total) Control Chart for 2004-2005
Marine Sediment
Relative Percent Difference
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
69
35
21
Aug-04
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-223: Sulfate Control Chart for 2004-2005 Marine Sediment



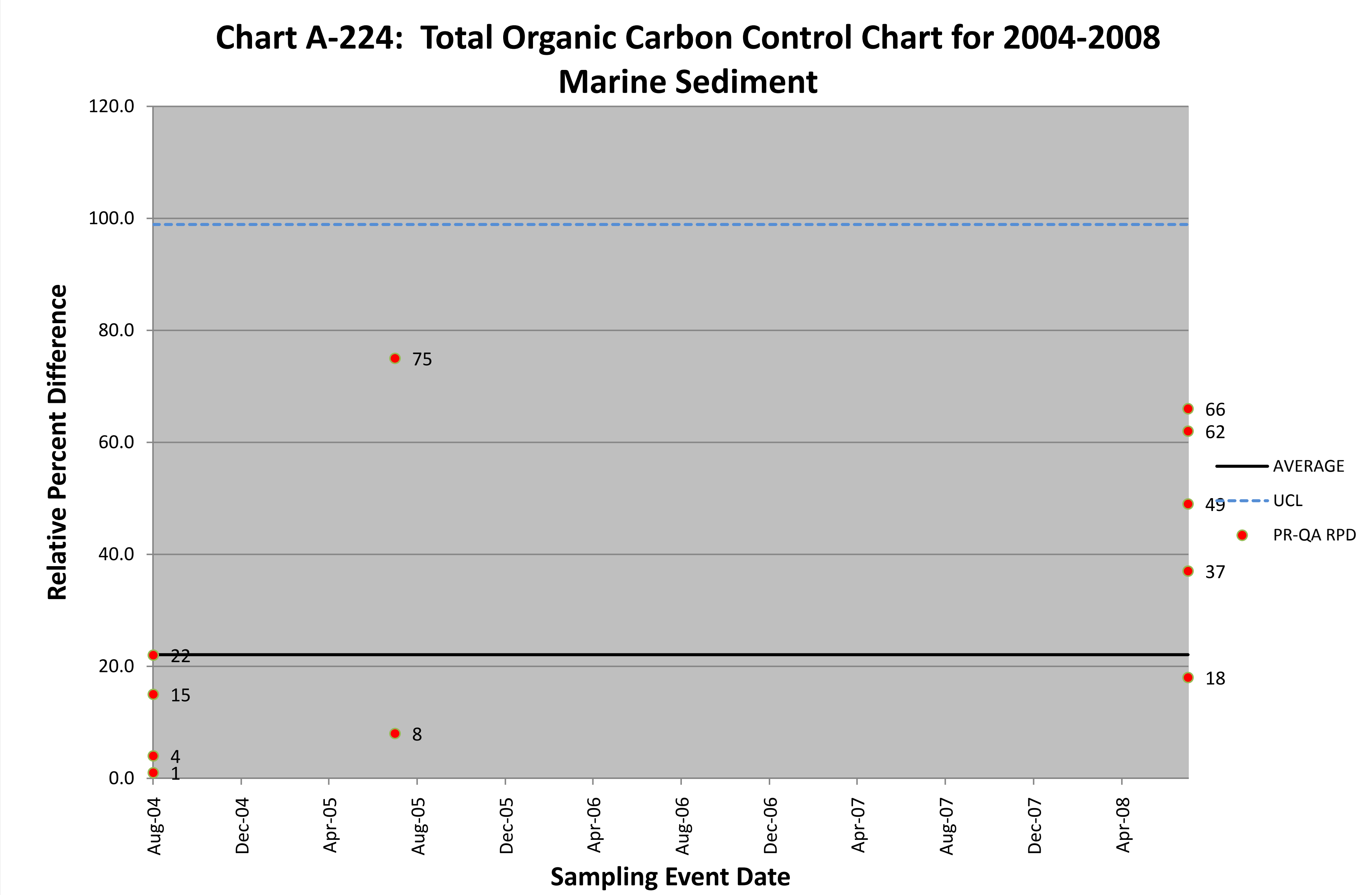


Chart A-224: Total Organic Carbon Control Chart for 2004-2008
Marine Sediment
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
75
66
62
49
37
22
18
15
8
4
1
AVERAGE
UCL
PR-QA RPD
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Sampling Event Date

Chart A-225: Total Organic Carbon Control Chart for 2004-2008 Marine Sediment

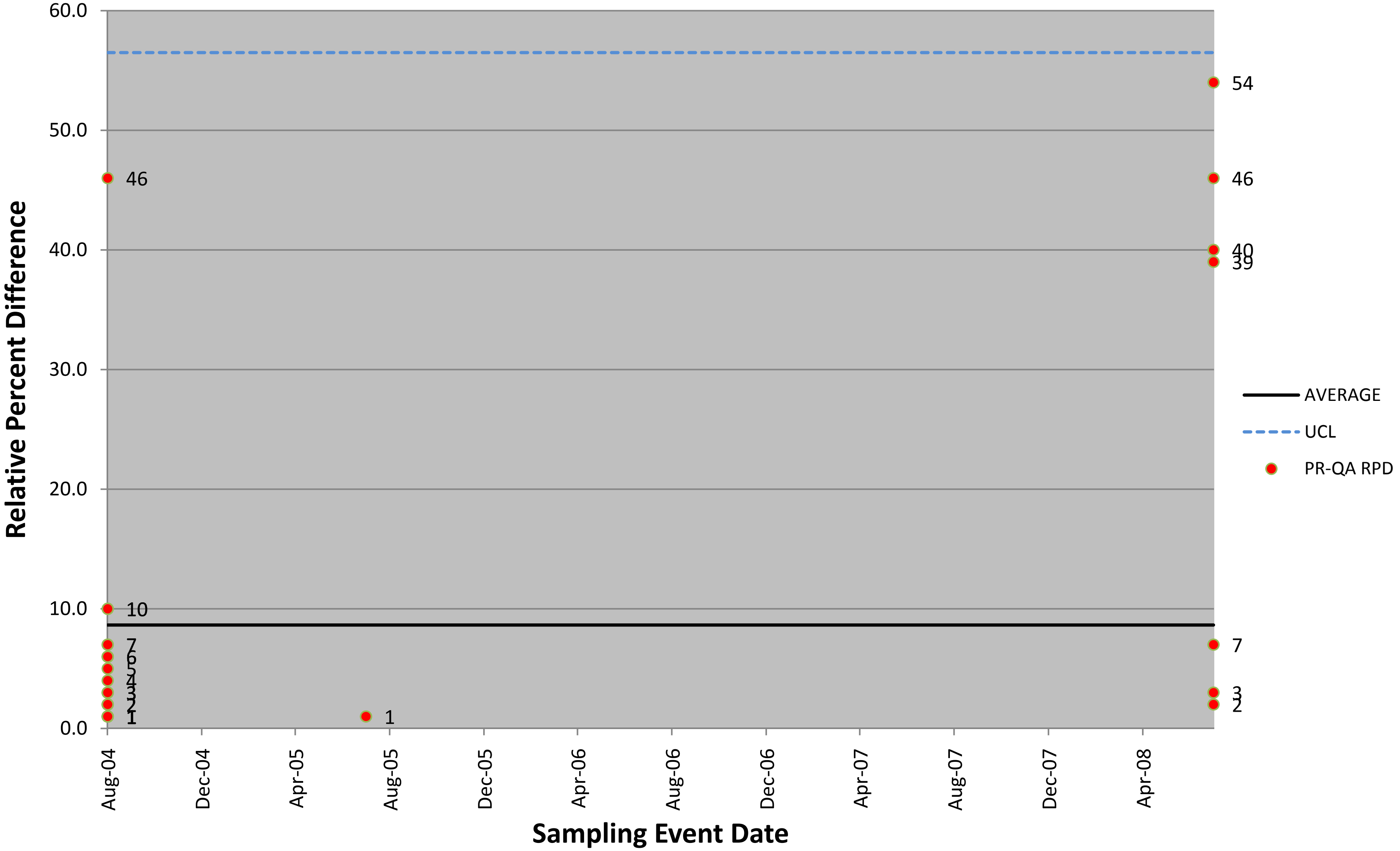


Chart A-226: Aluminum Control Chart for 2004-2008 Marine Sediment

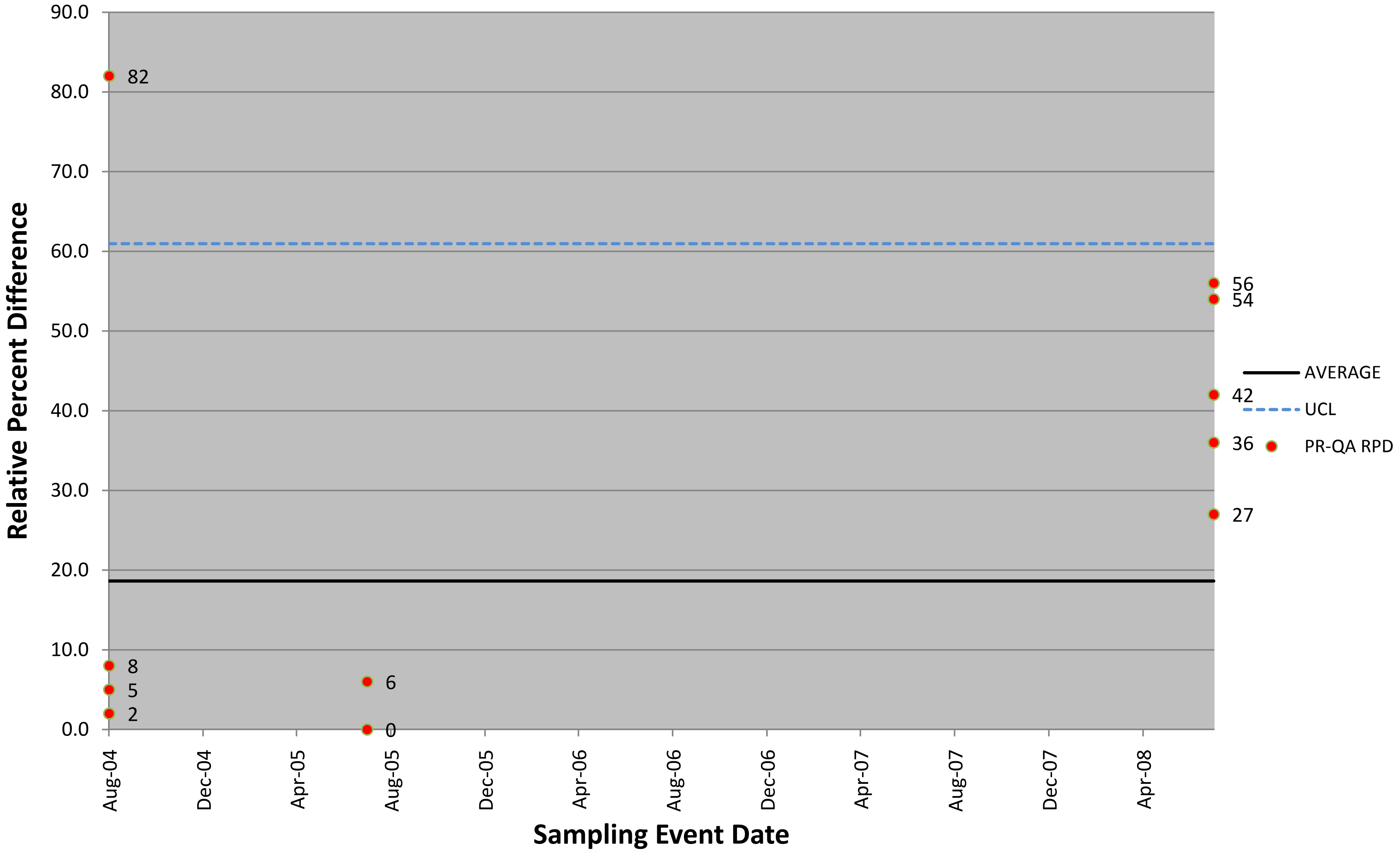


Chart A-227: Antimony Control Chart for 2004-2008 Marine Sediment

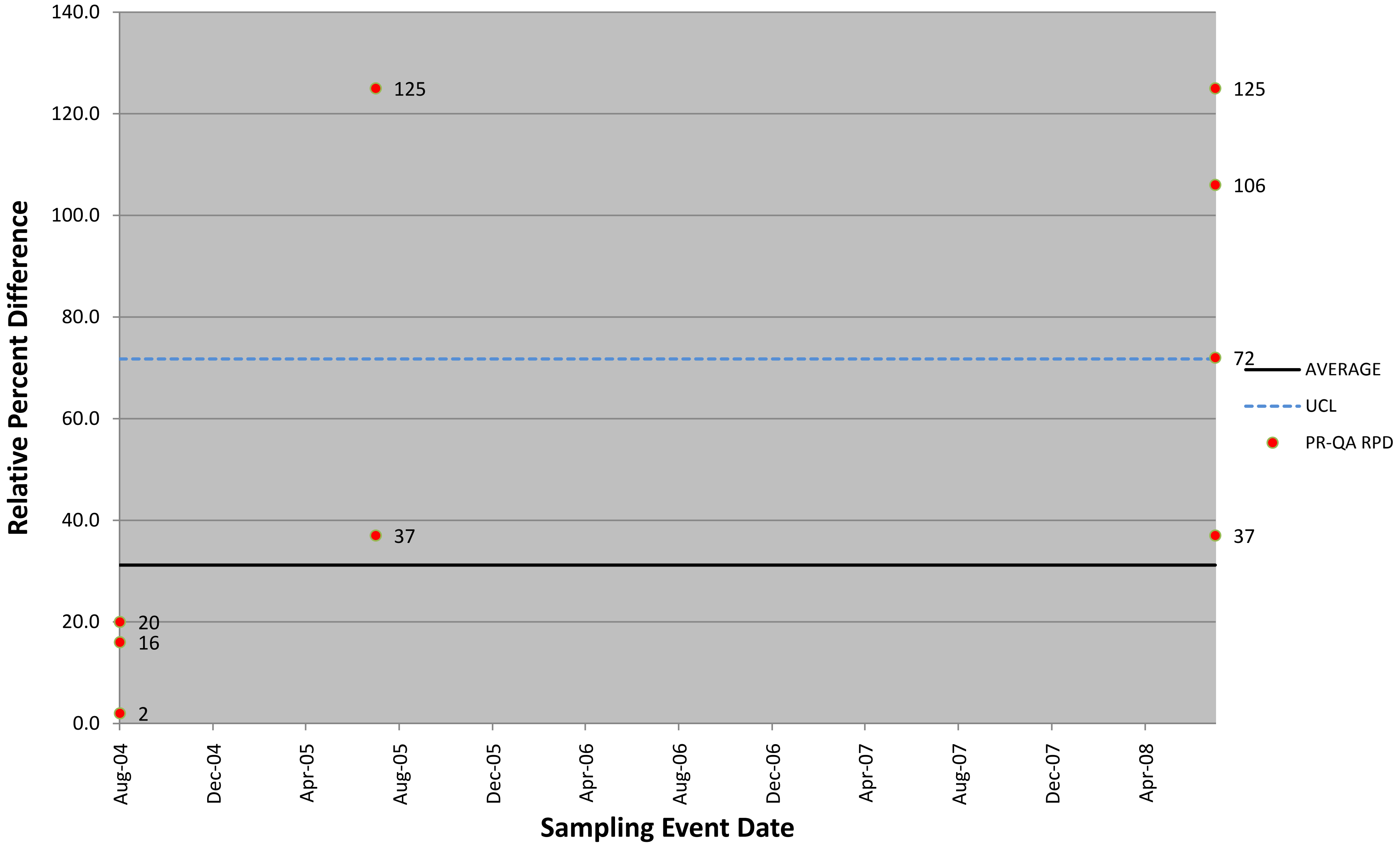


Chart A-228: Arsenic Control Chart for 2004-2008 Marine Sediment

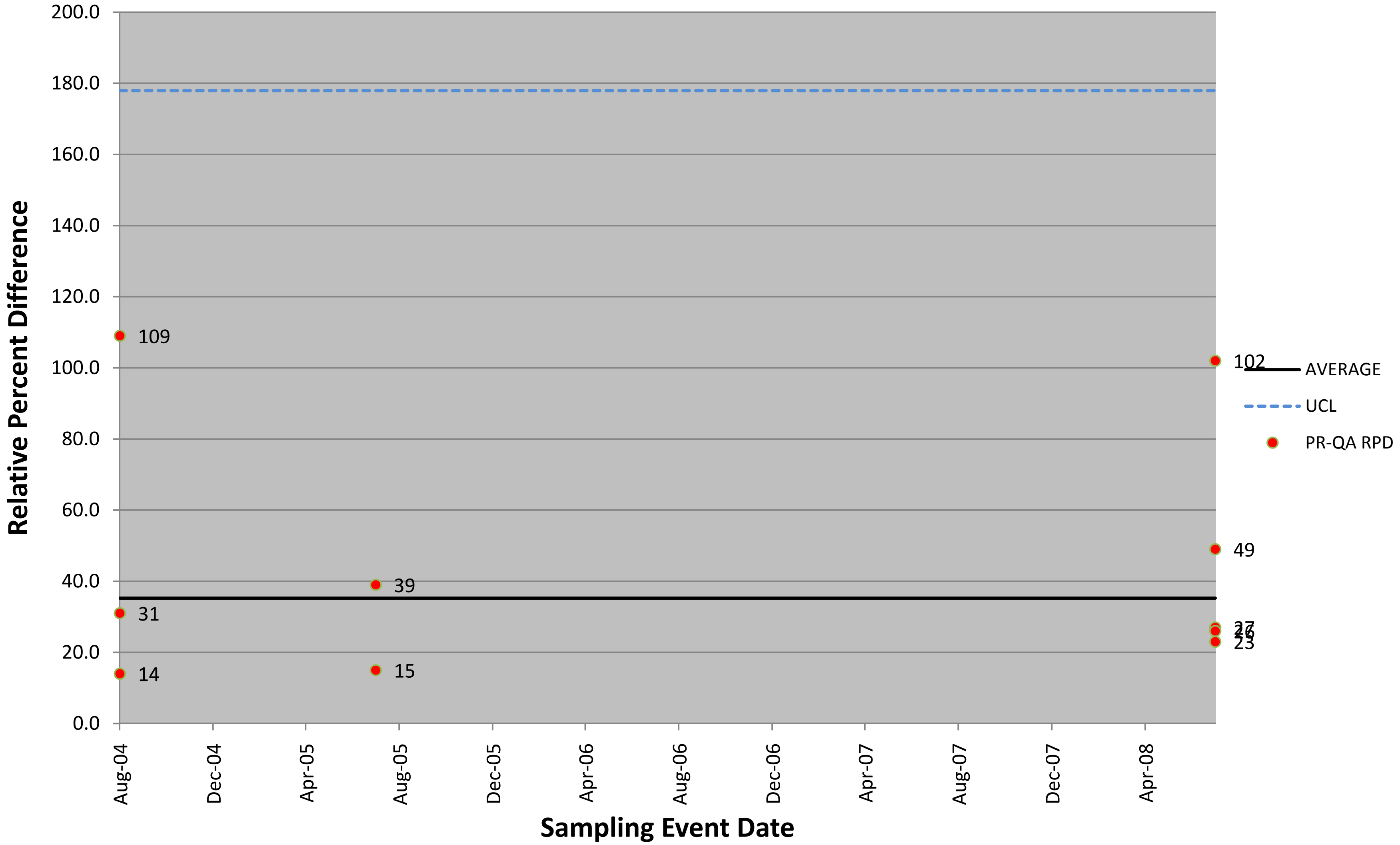


Chart A-229: Barium Control Chart for 2004-2008 Marine Sediment

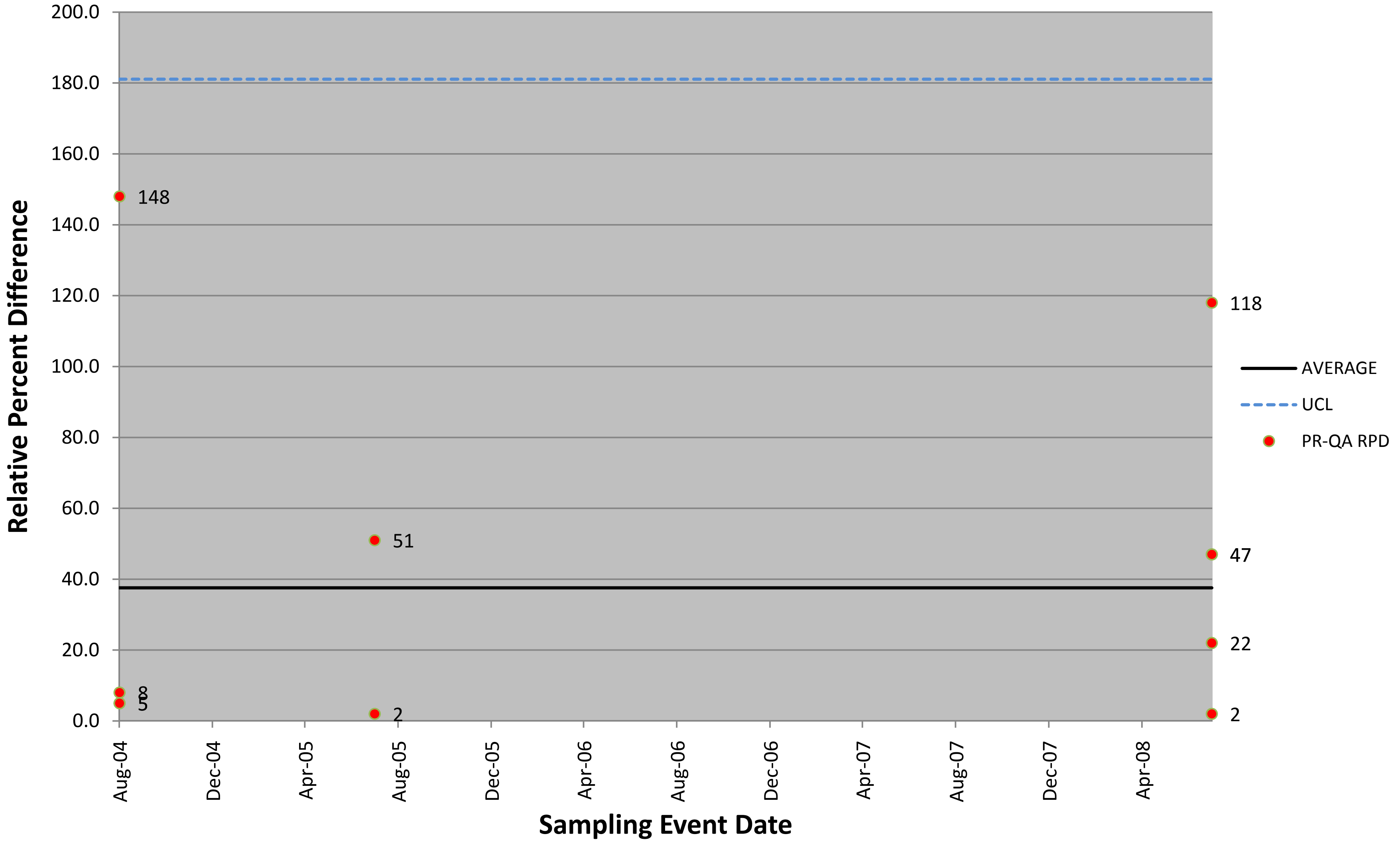


Chart A-230 : Beryllium Control Chart for 2004-2005 Marine Sediment

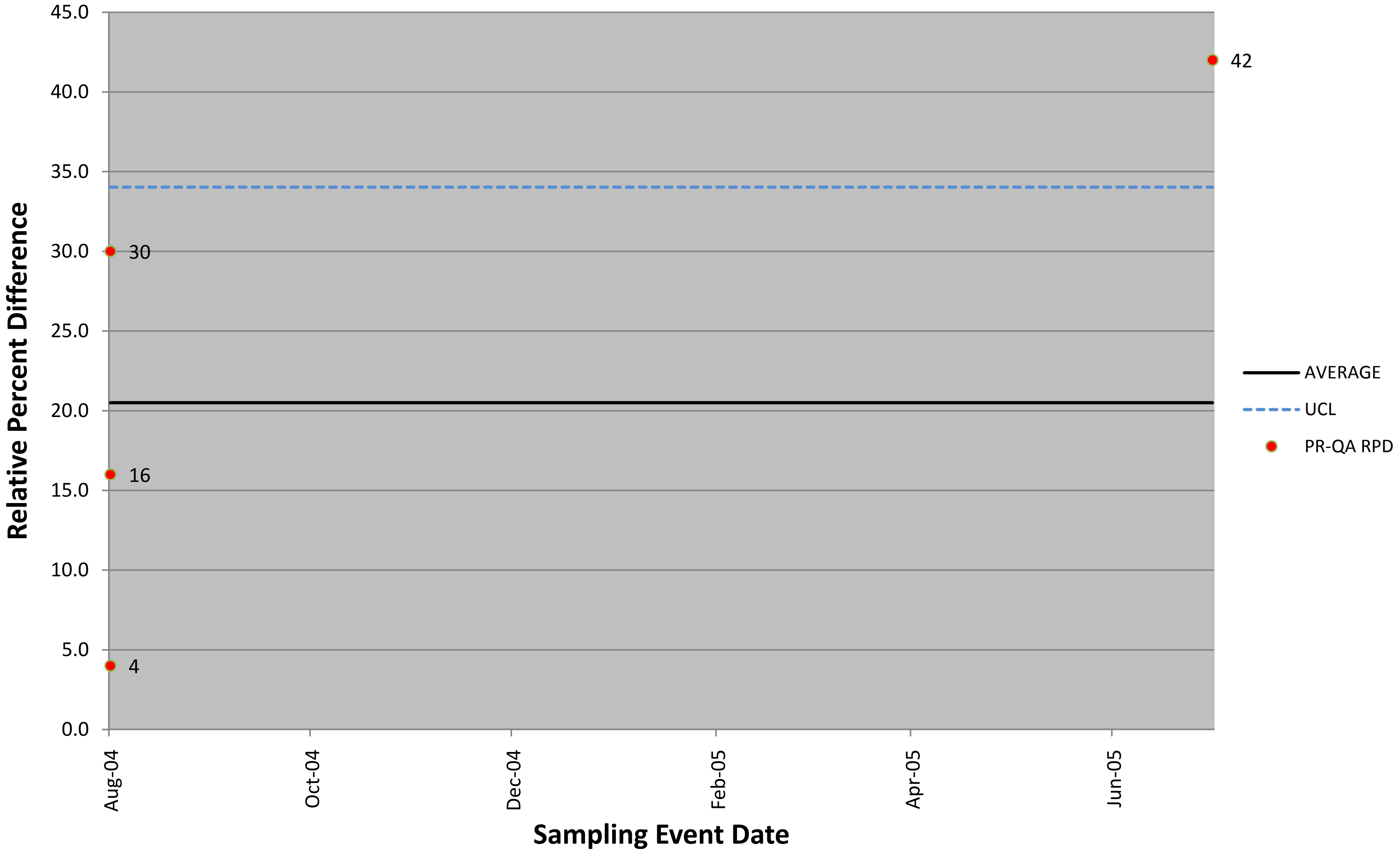
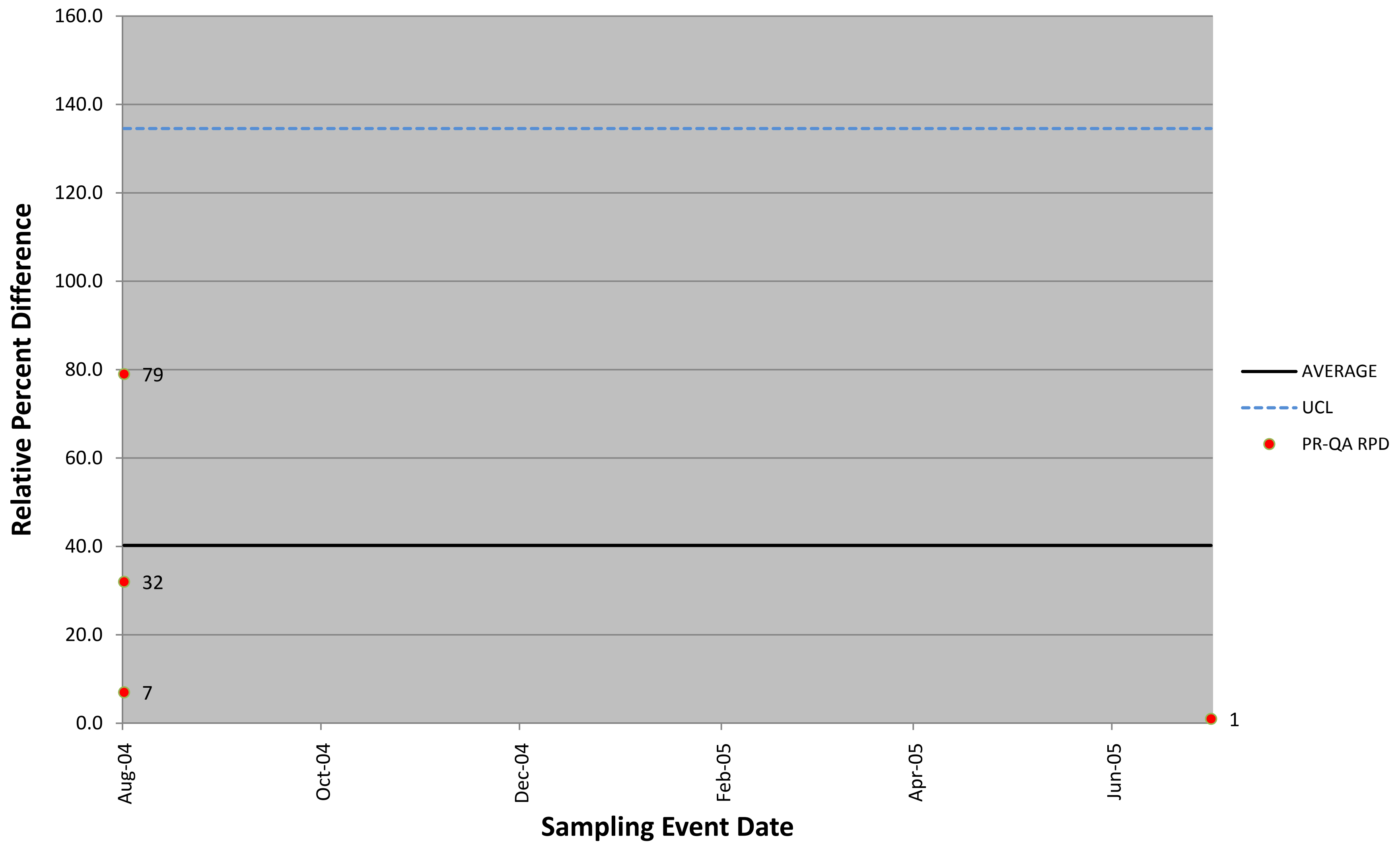


Chart A-231: Boron Control Chart for 2004-2005 Marine Sediment



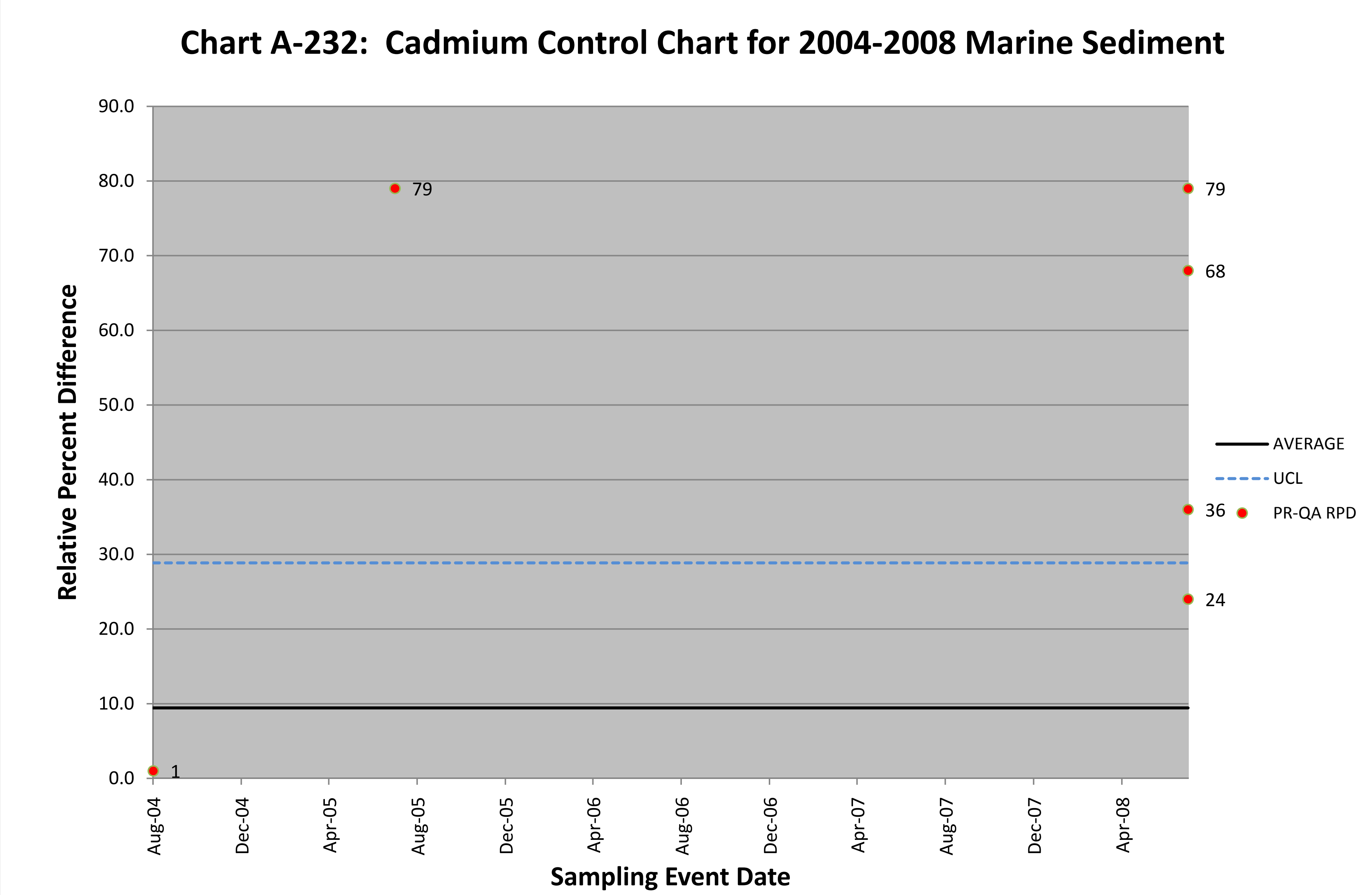


Chart A-232: Cadmium Control Chart for 2004-2008 Marine Sediment
Relative Percent Difference
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
79
79
68
36
24
1
AVERAGE
UCL
PR-QA RPD
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Sampling Event Date

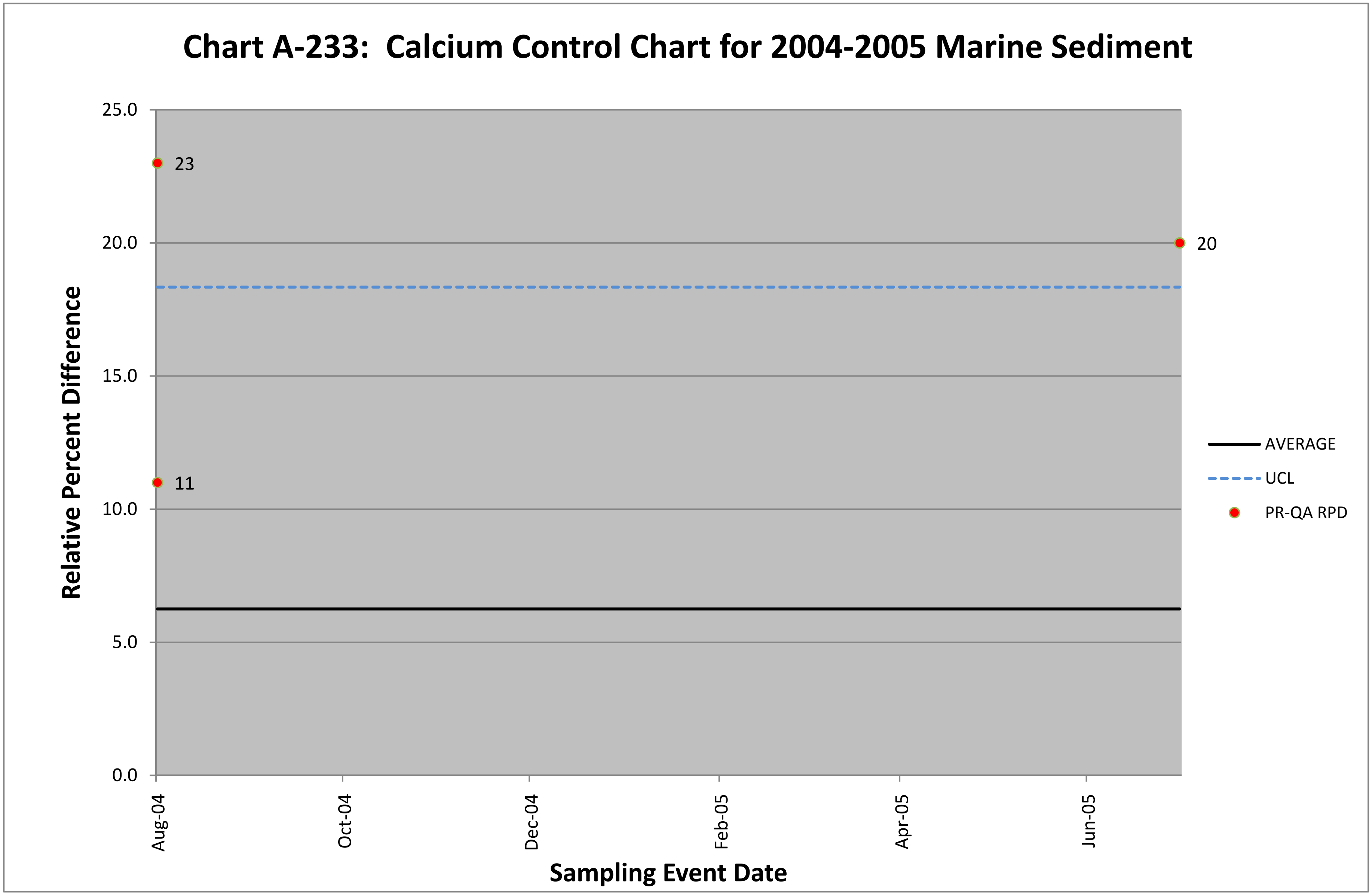
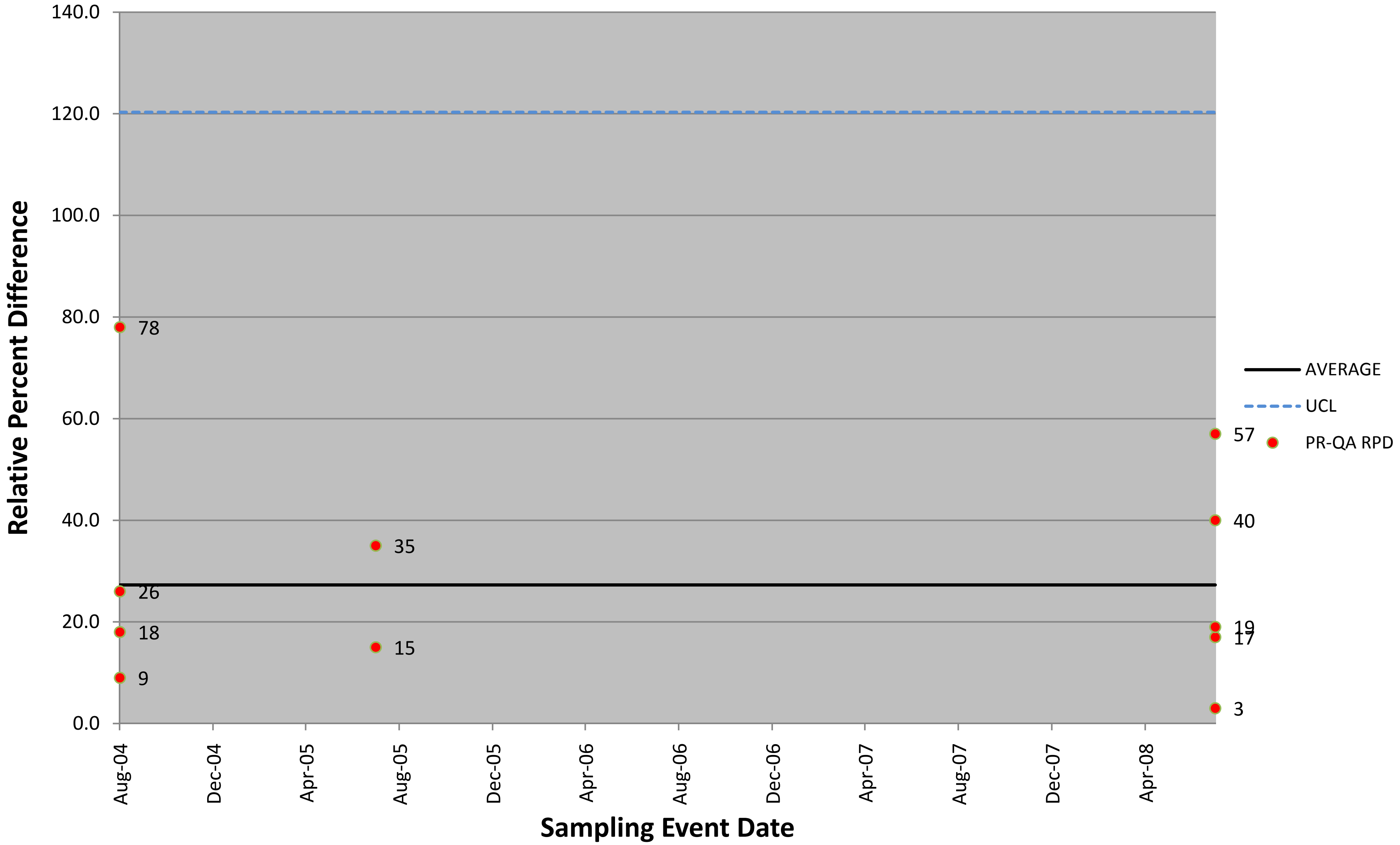


Chart A-233: Calcium Control Chart for 2004-2005 Marine Sediment
Relative Percent Difference
25.0
20.0
15.0
10.0
5.0
0.0
23
20
11
AVERAGE
UCL
PR-QA RPD
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Sampling Event Date

Chart A-234: Chromium Control Chart for 2004-2008 Marine Sediment



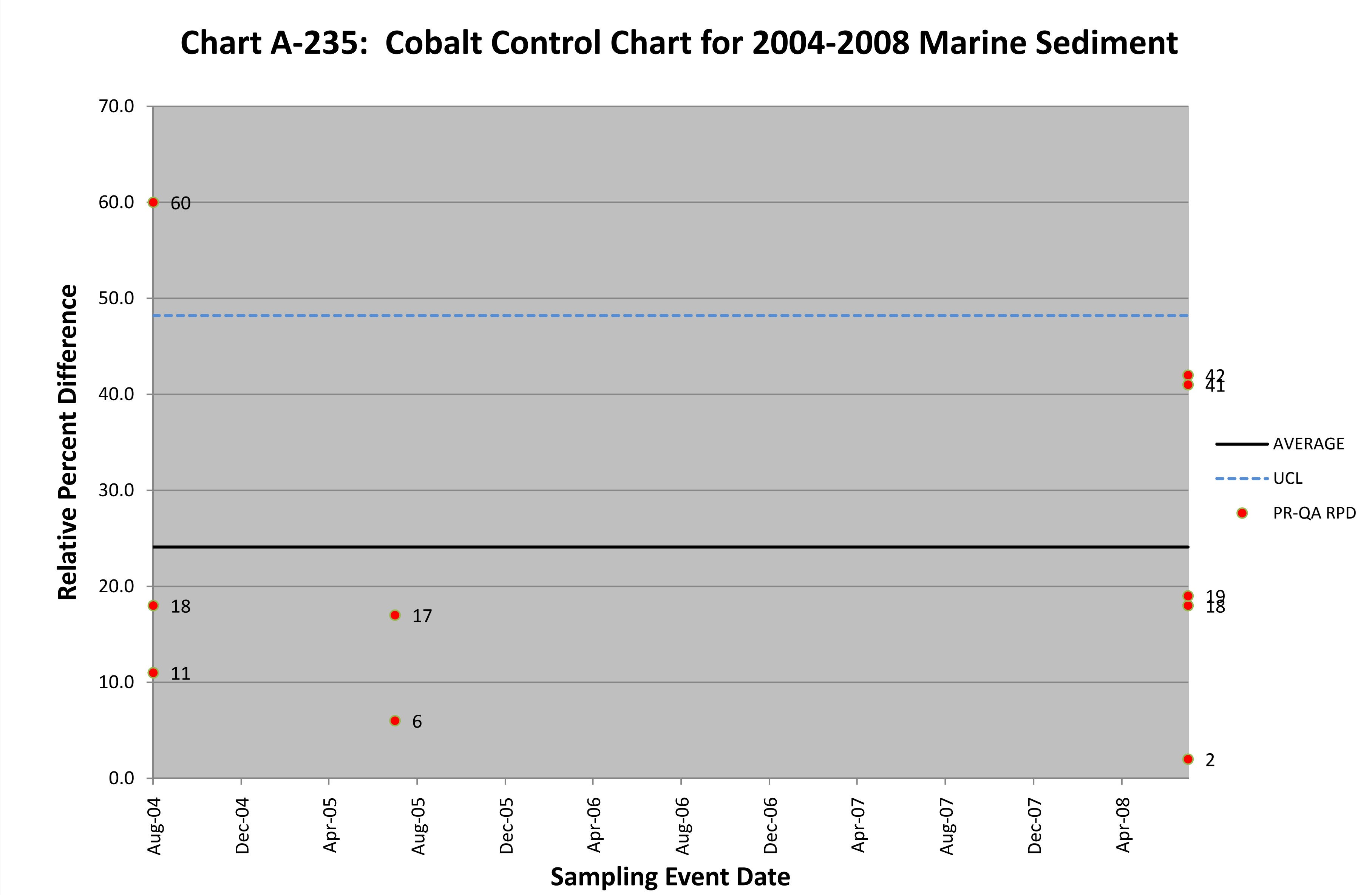


Chart A-235: Cobalt Control Chart for 2004-2008 Marine Sediment
Relative Percent Difference
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
60
18
11
17
6
42
41
19
18
2
AVERAGE
UCL
PR-QA RPD
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Sampling Event Date

Chart A-236: Copper Control Chart for 2004-2008 Marine Sediment

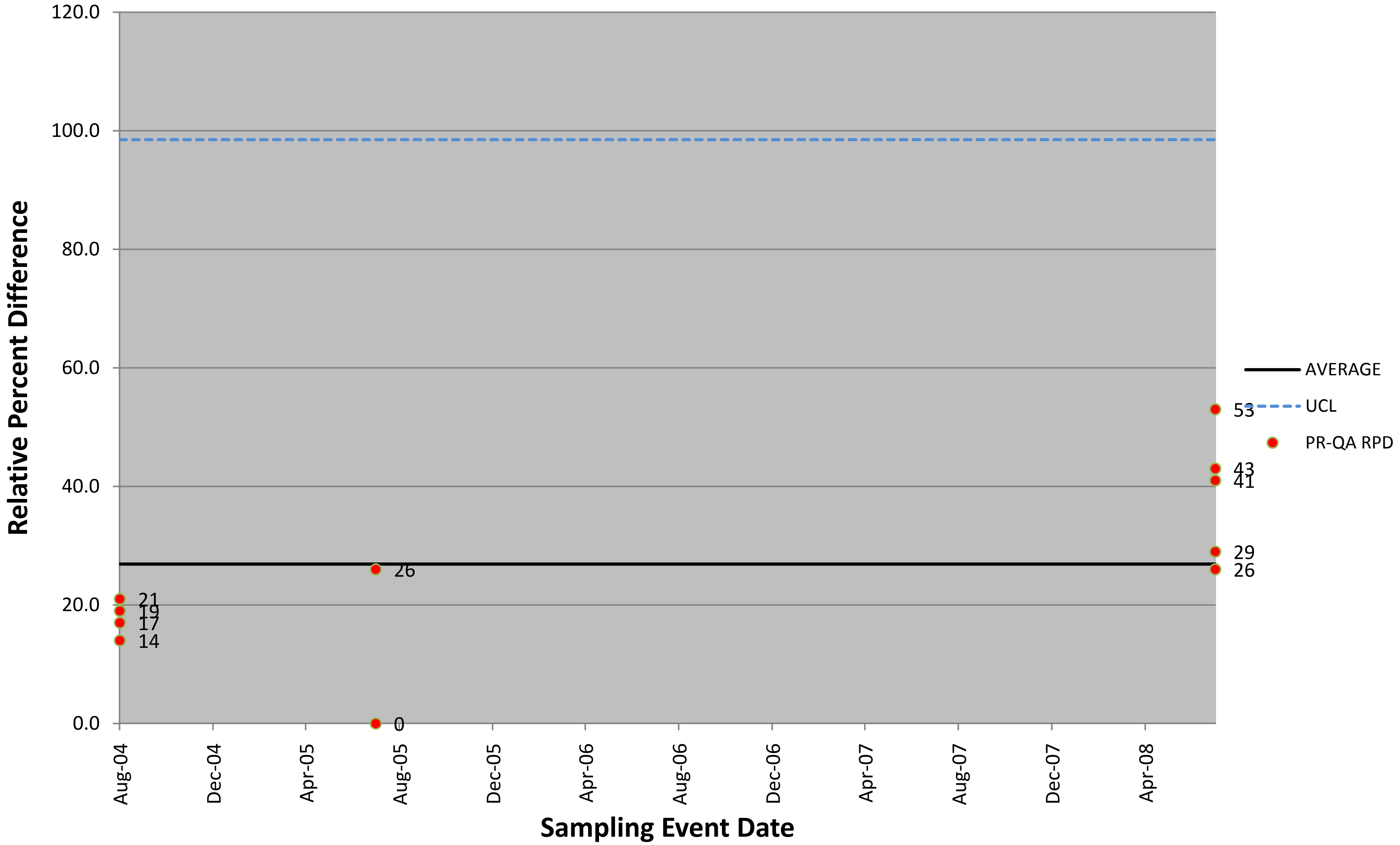


Chart A-237: SEM Copper Control Chart for 2008 Marine Sediment

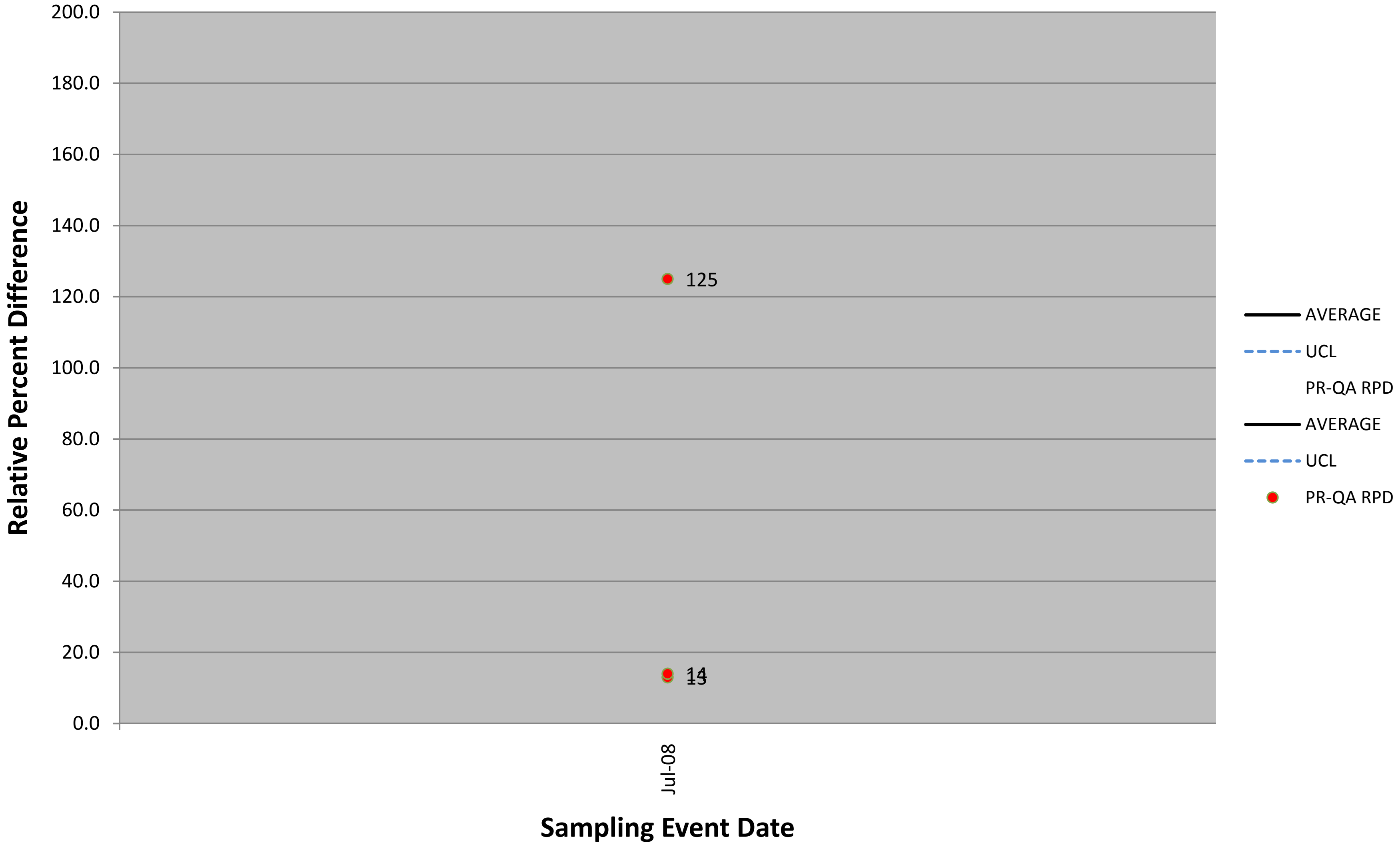


Chart A-238: Iron Control Chart for 2004-2008 Marine Sediment

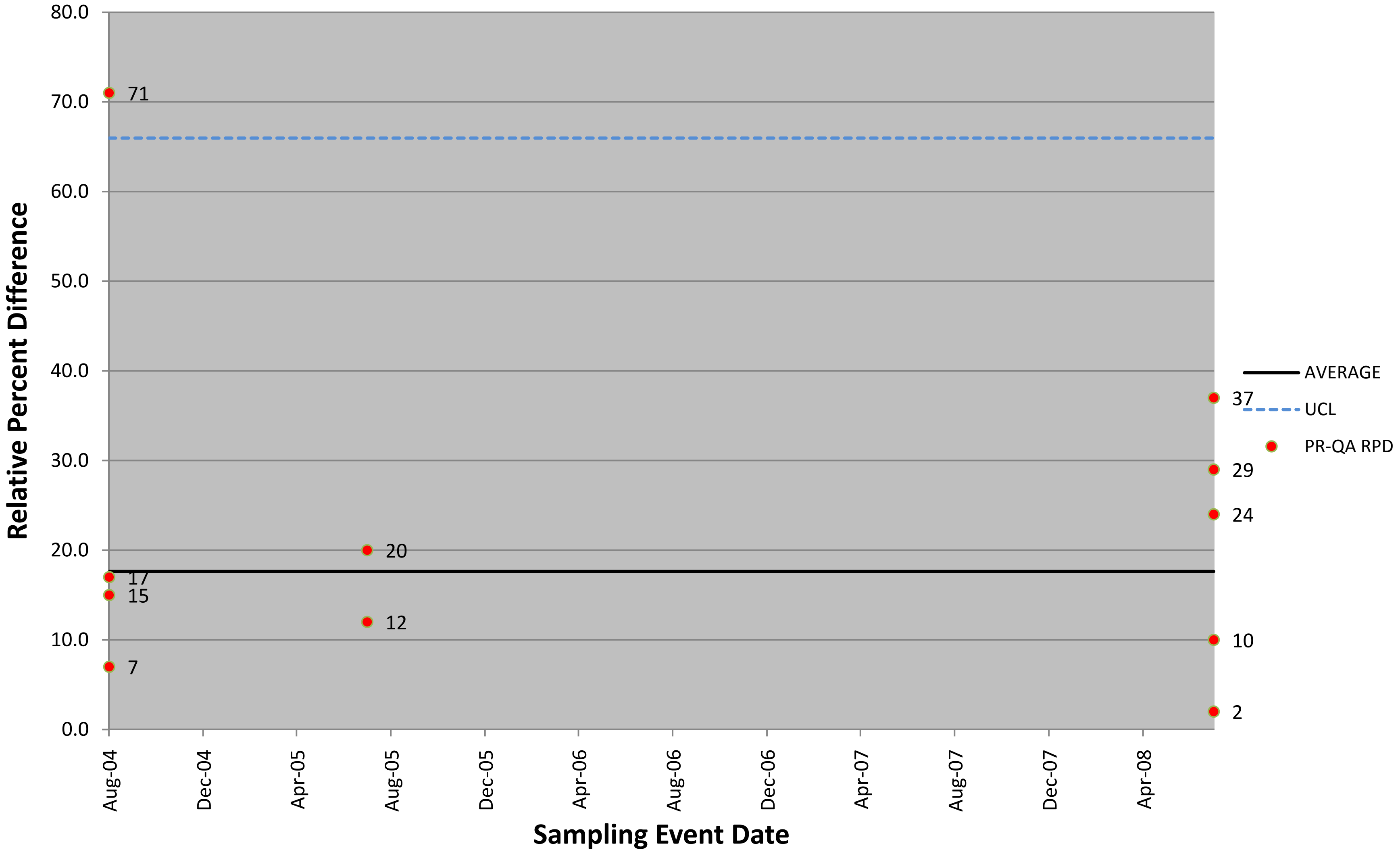
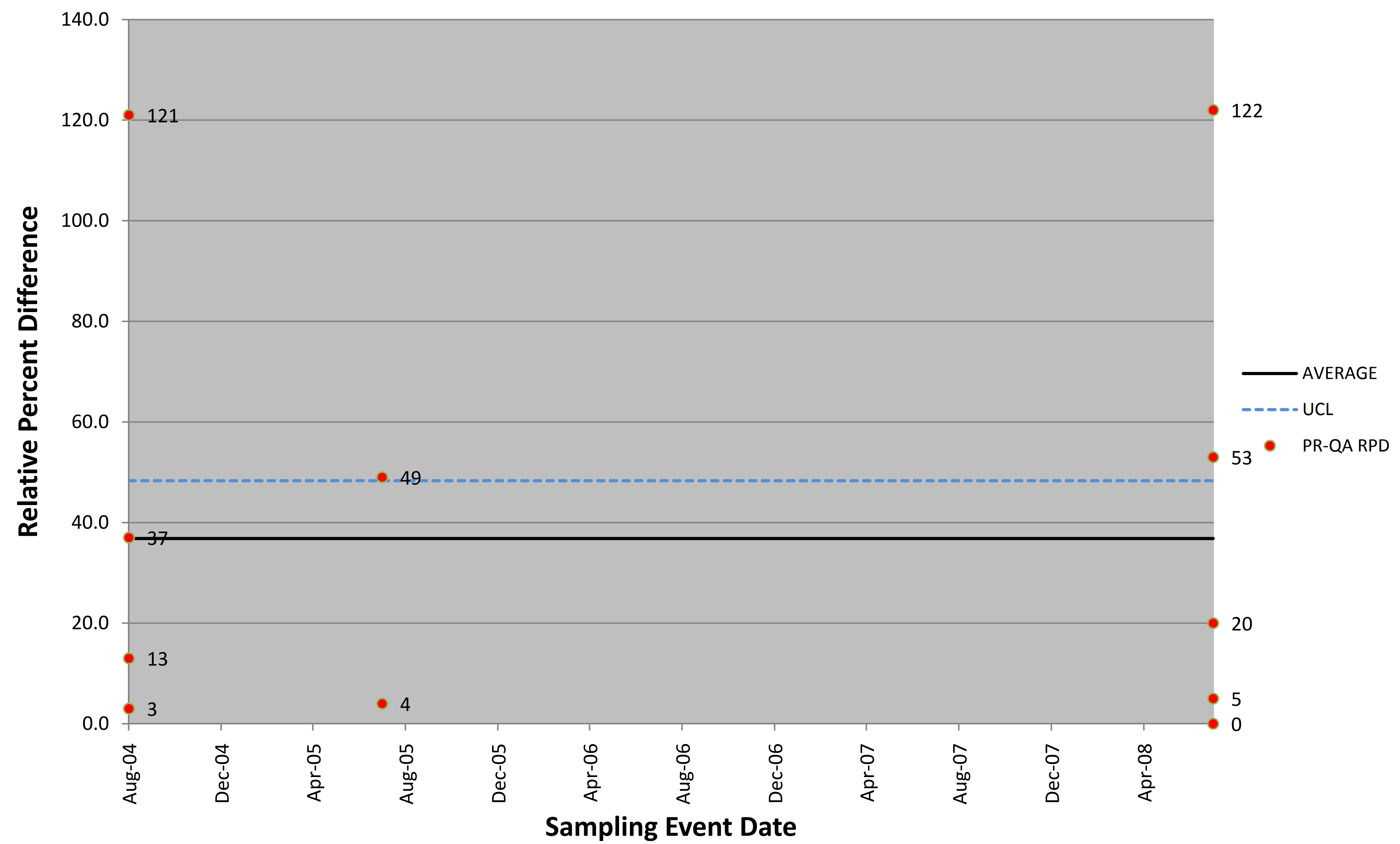


Chart A-239: Lead Control Chart for 2004-2008 Marine Sediment



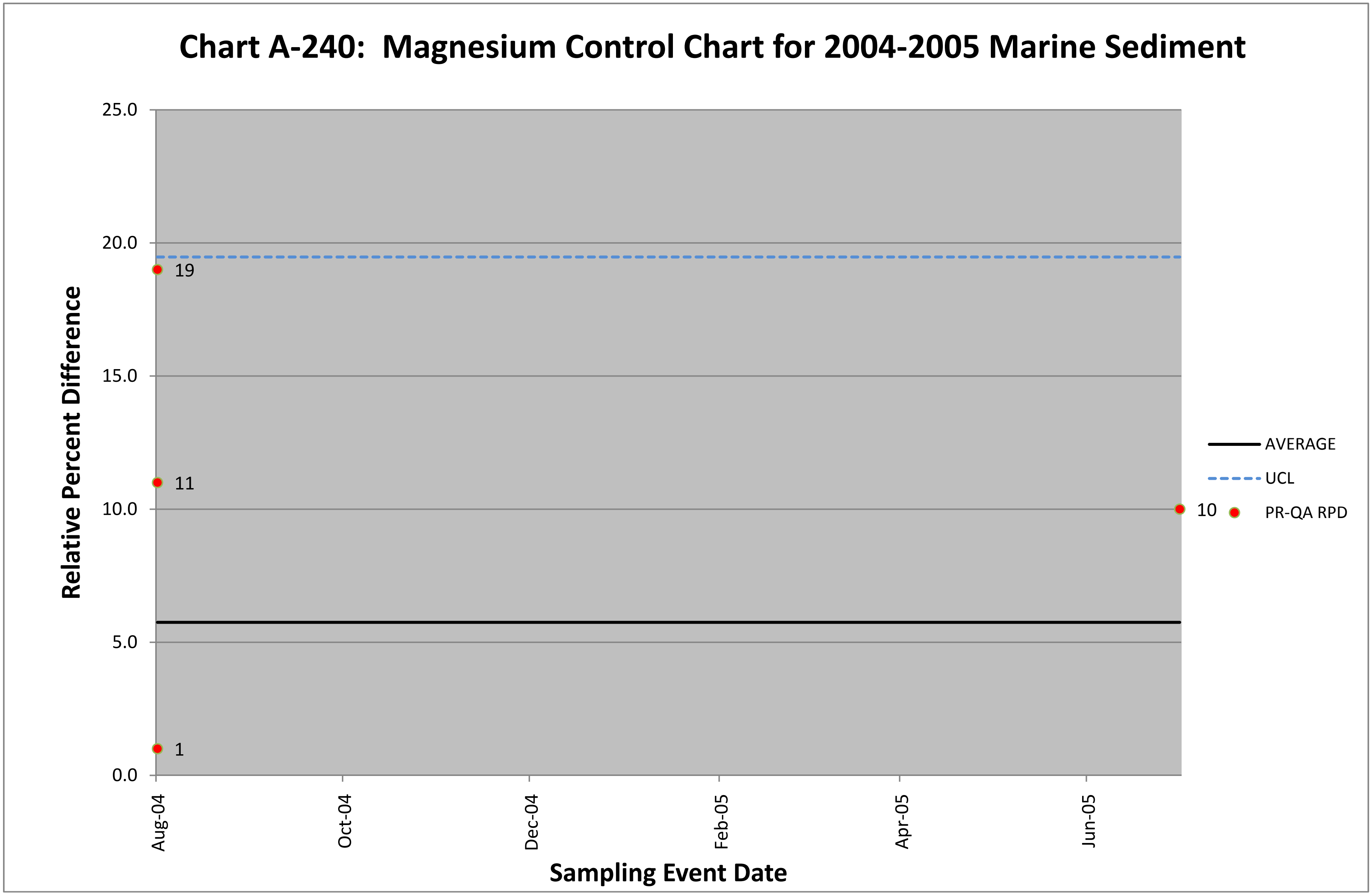


Chart A-240: Magnesium Control Chart for 2004-2005 Marine Sediment
Relative Percent Difference
25.0
20.0
15.0
10.0
5.0
0.0
19
11
1
10
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-241: Manganese Control Chart for 2004-2008 Marine Sediment

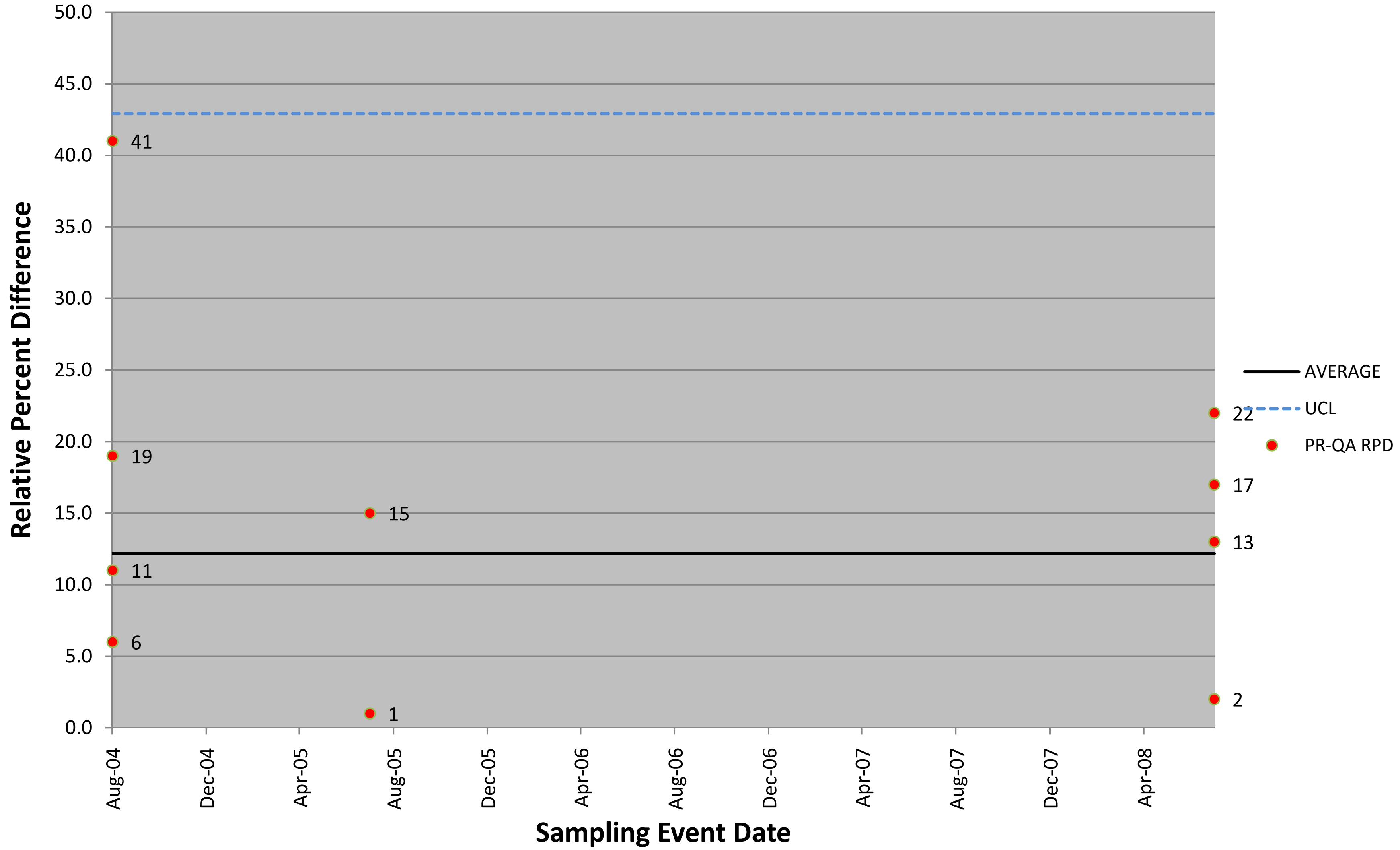


Chart A-242: Mercury Control Chart for 2004-2008 Marine Sediment

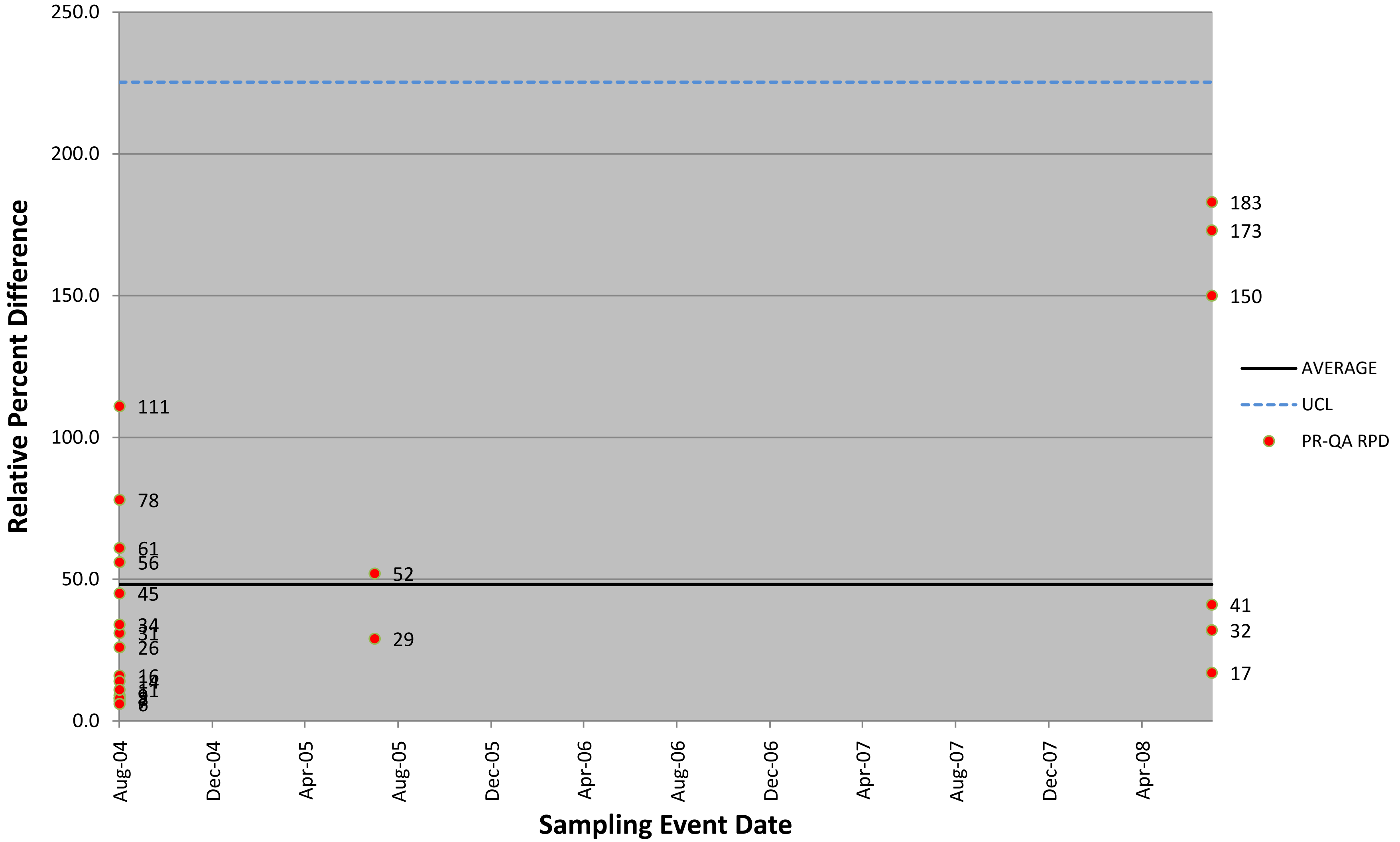


Chart A-243: Molybdenum Control Chart for 2004-2005 Marine Sediment

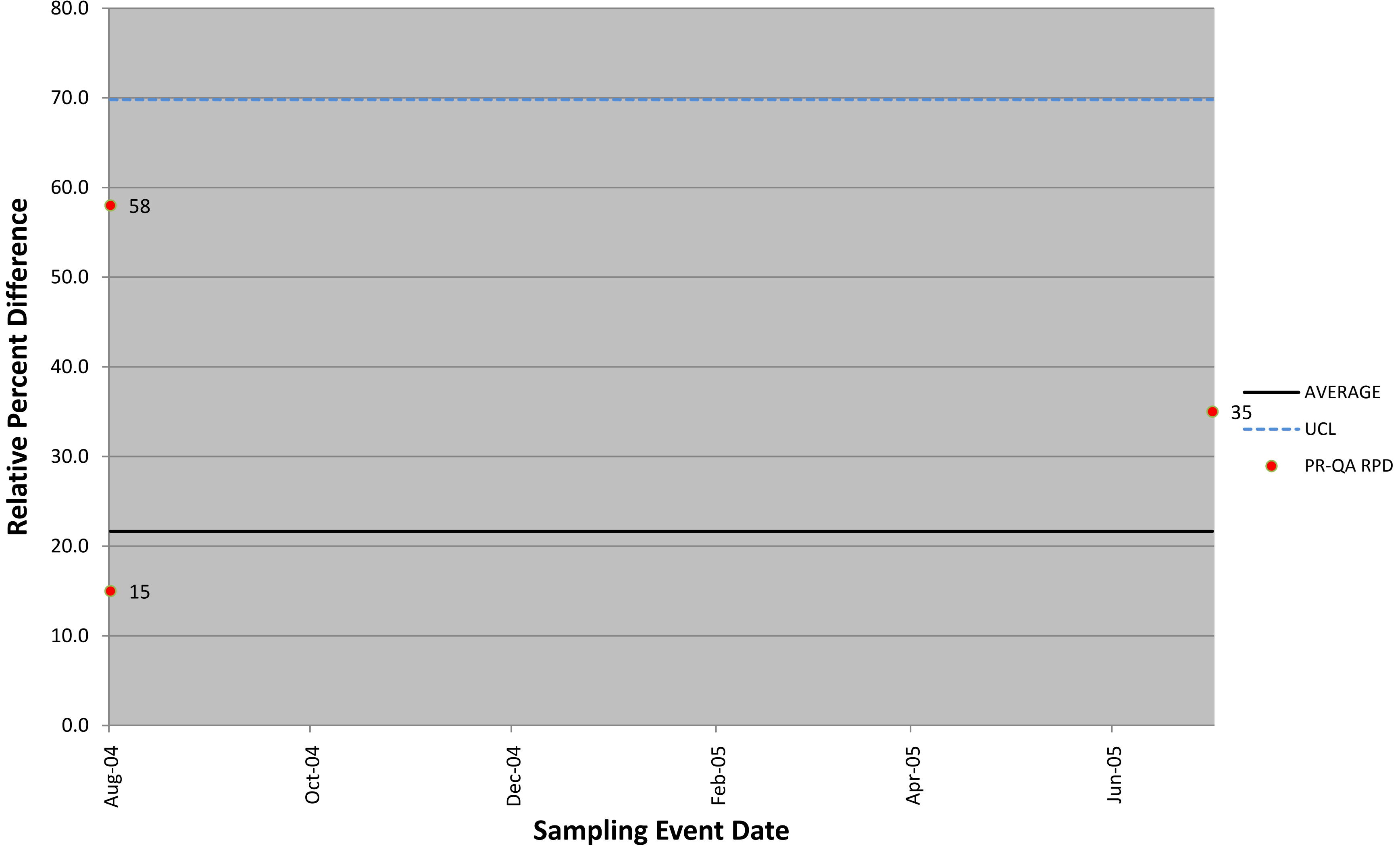


Chart A-244: Nickel Control Chart for 2004-2008 Marine Sediment

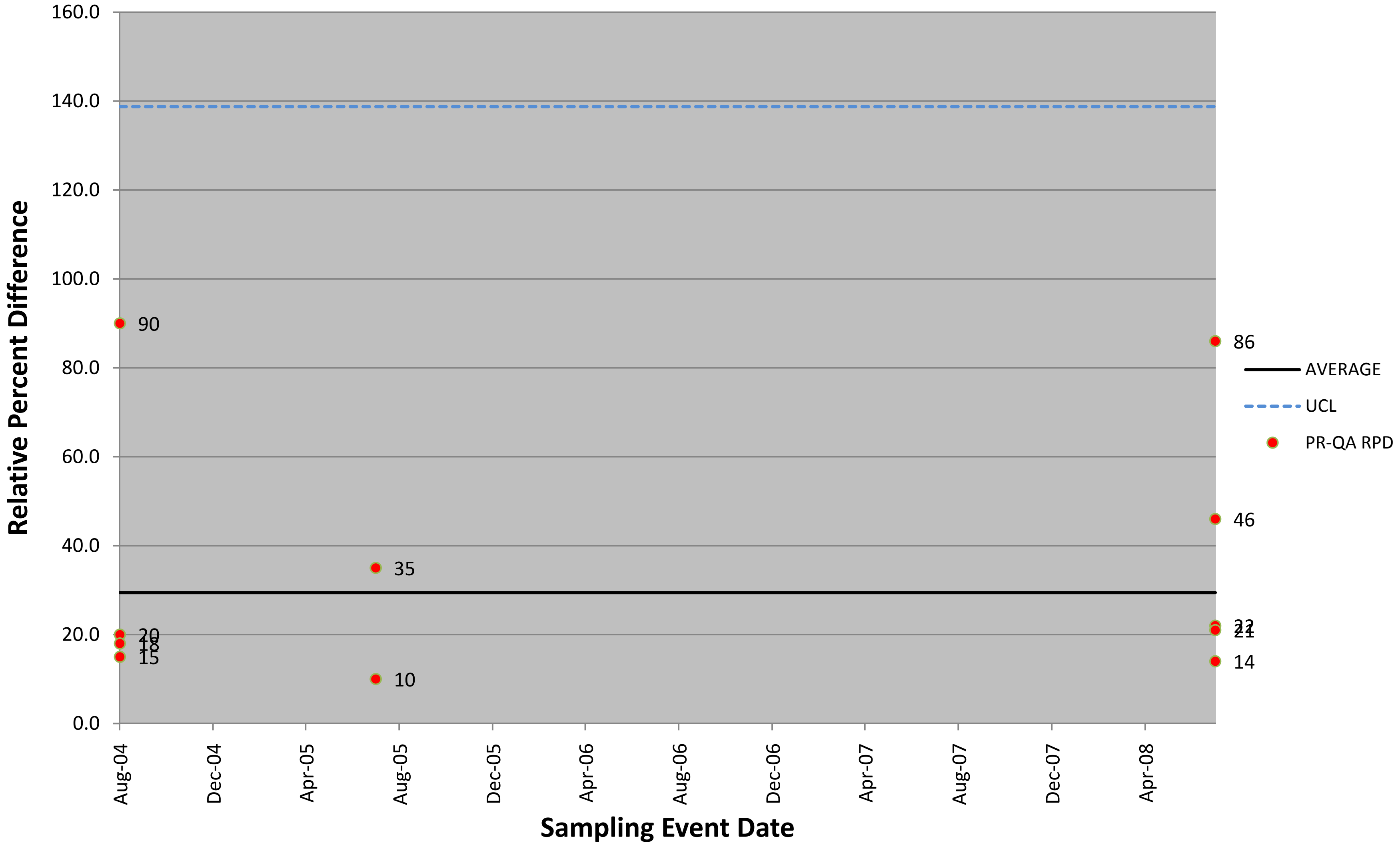


Chart A-245: Potassium Control Chart for 2004-2005 Marine Sediment

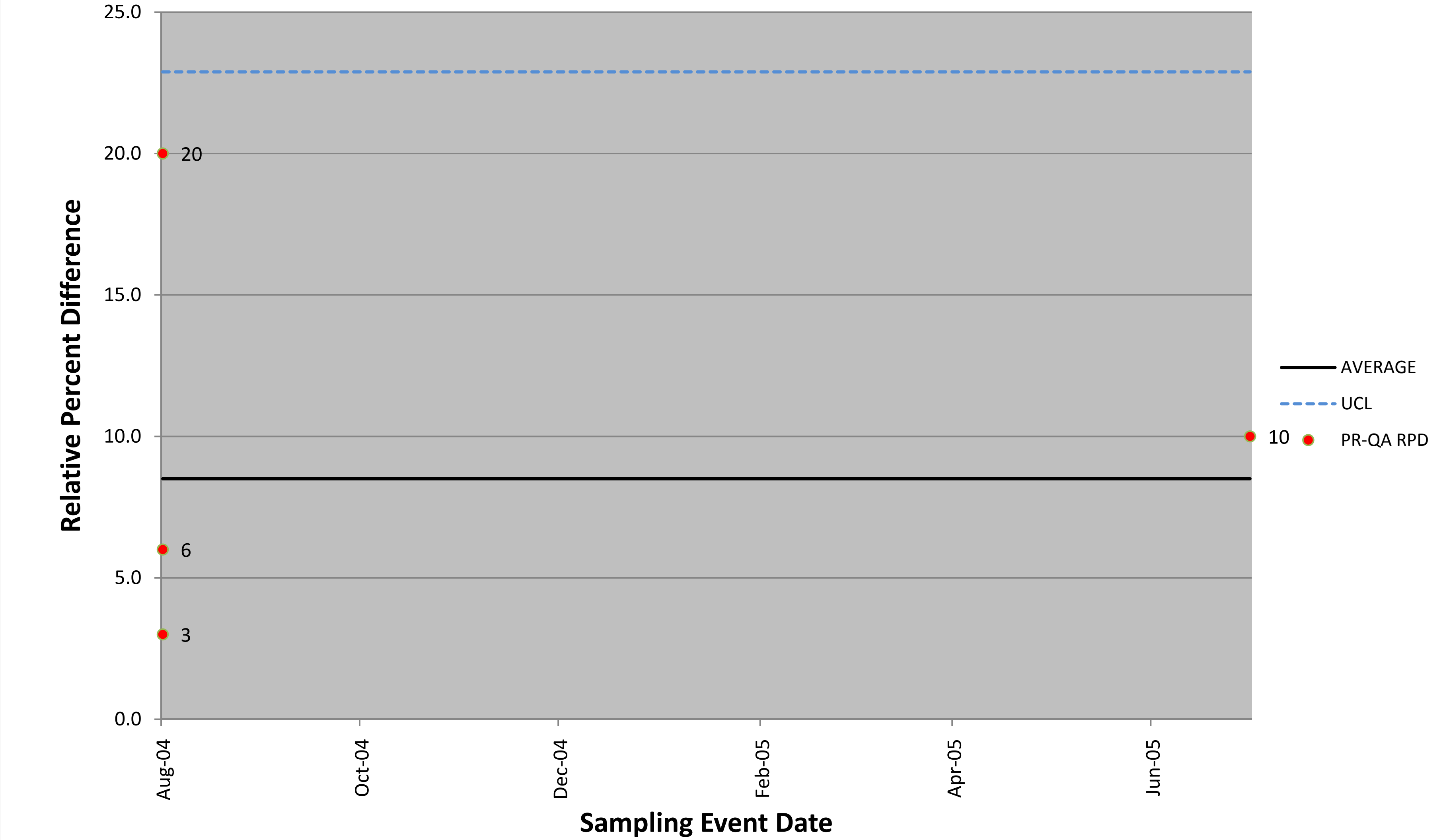
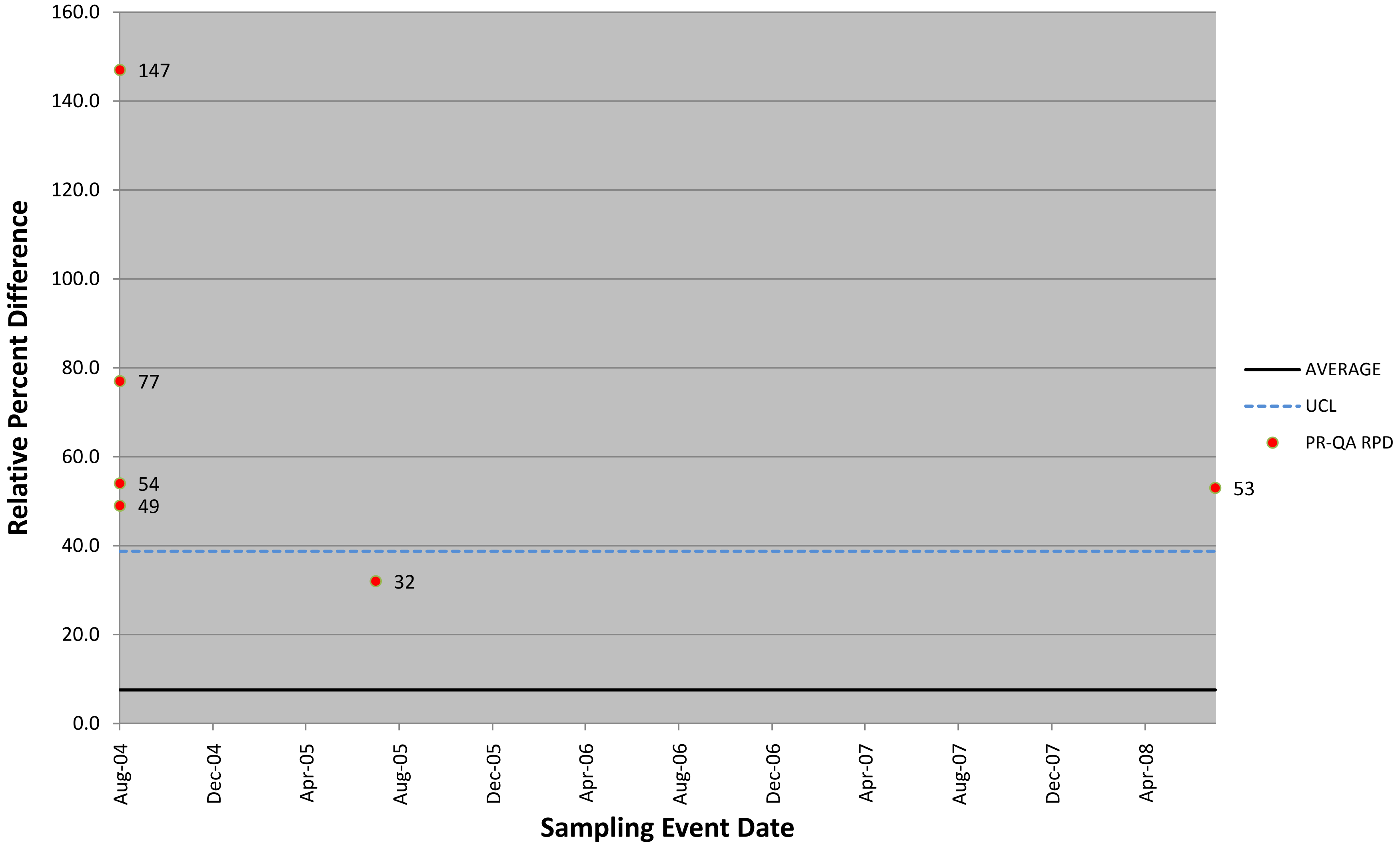


Chart A-246: Selenium Control Chart for 2004-2008 Marine Sediment



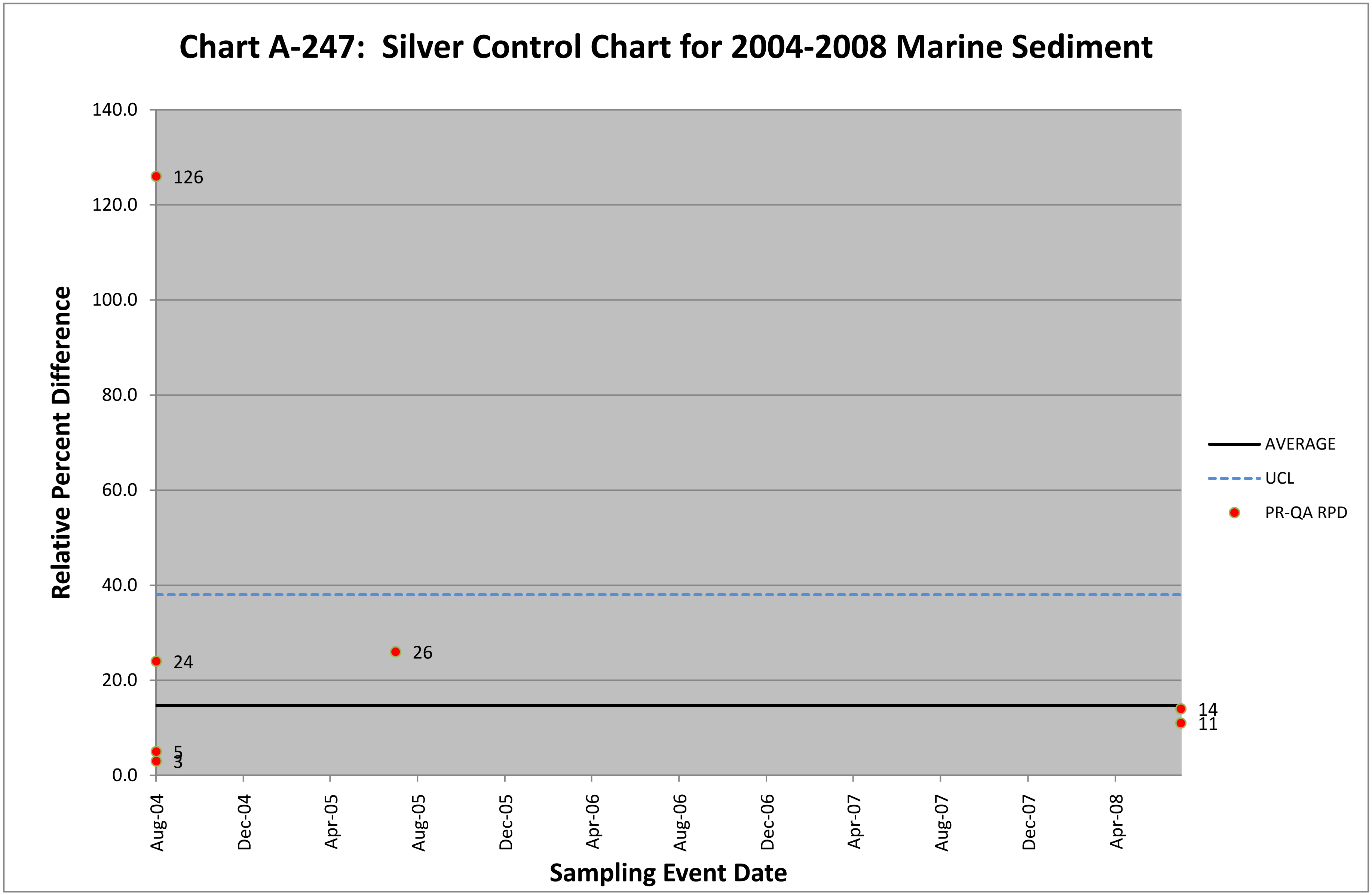
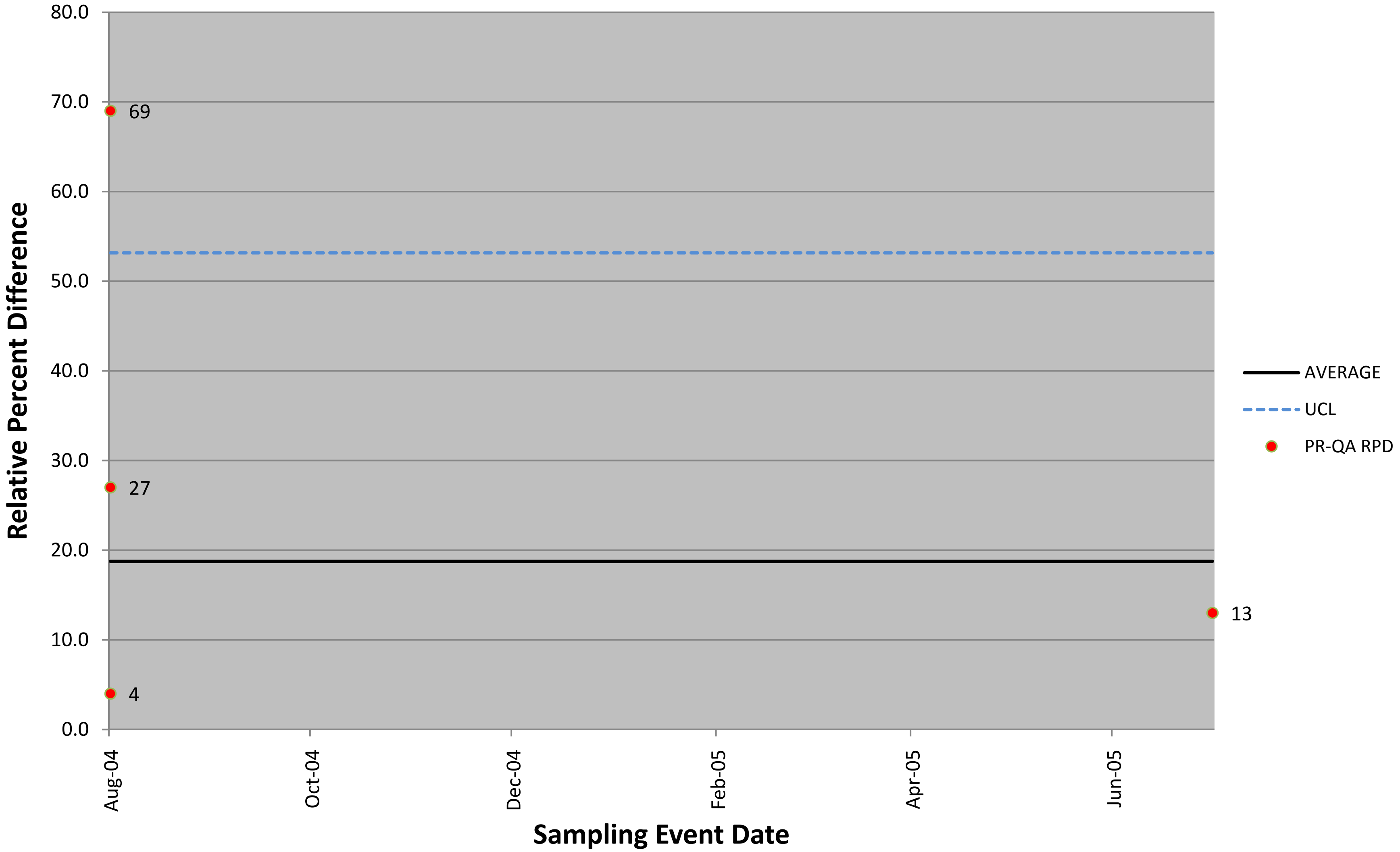


Chart A-247: Silver Control Chart for 2004-2008 Marine Sediment
Relative Percent Difference
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
126
24
26
5
3
14
11
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-248: Sodium Control Chart for 2004-2005 Marine Sediment



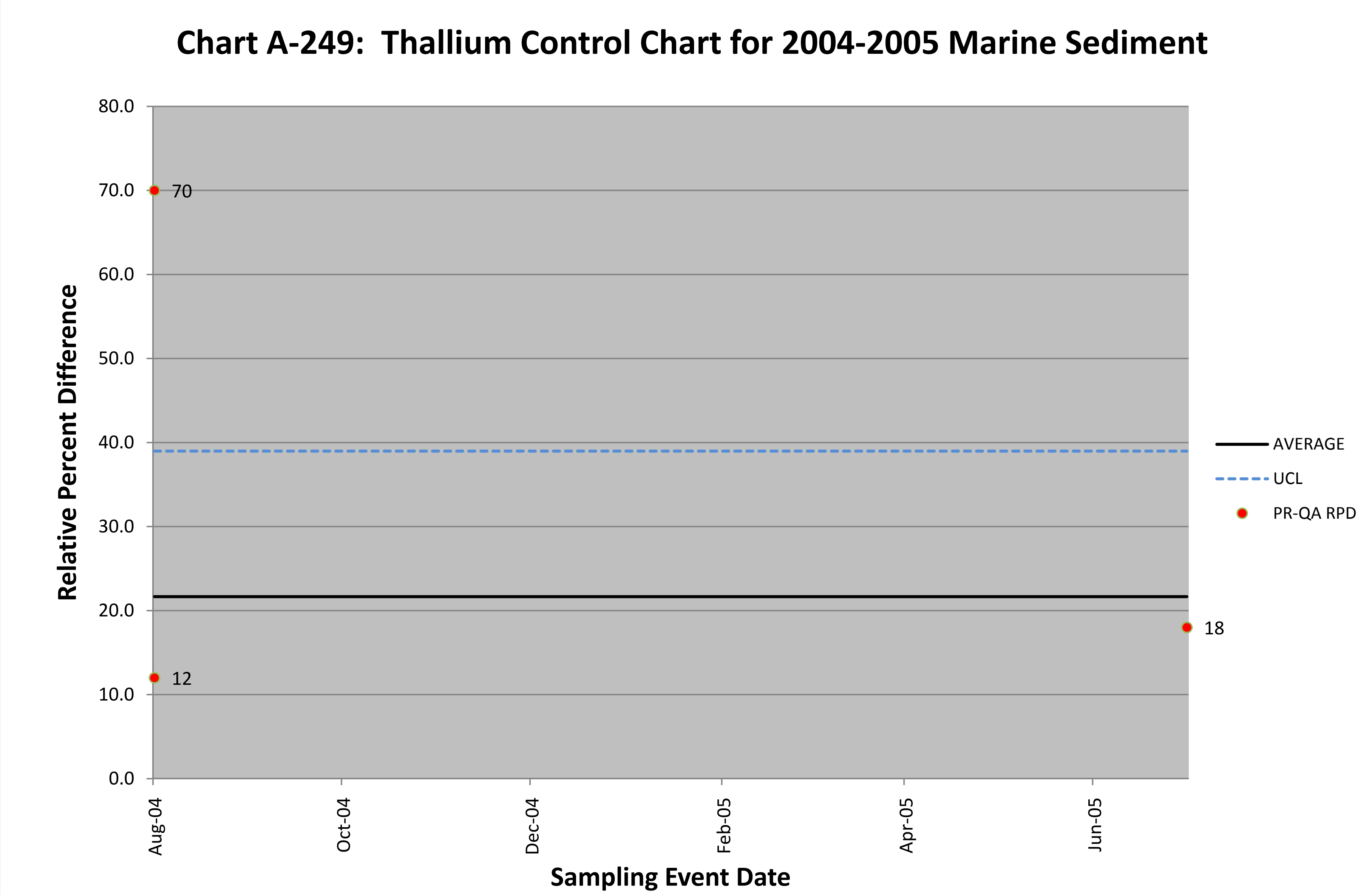


Chart A-249: Thallium Control Chart for 2004-2005 Marine Sediment
Relative Percent Difference
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
70
12
18
Aug-04
Oct-04
Dec-04
Feb-05
Apr-05
Jun-05
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-250: Tin Control Chart for 2004-2008 Marine Sediment

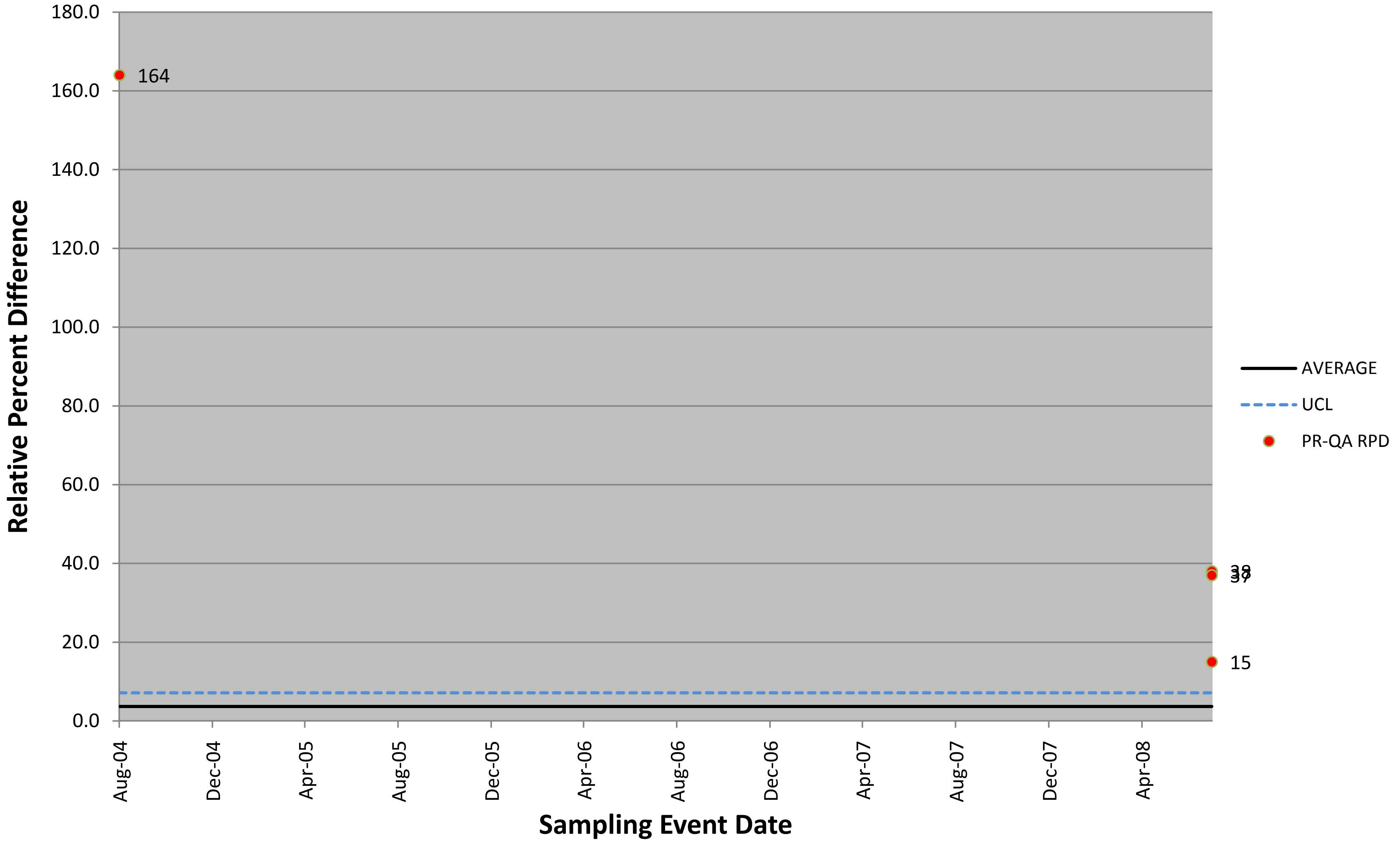


Chart A-251: Vanadium Control Chart for 2004-2005 Marine Sediment

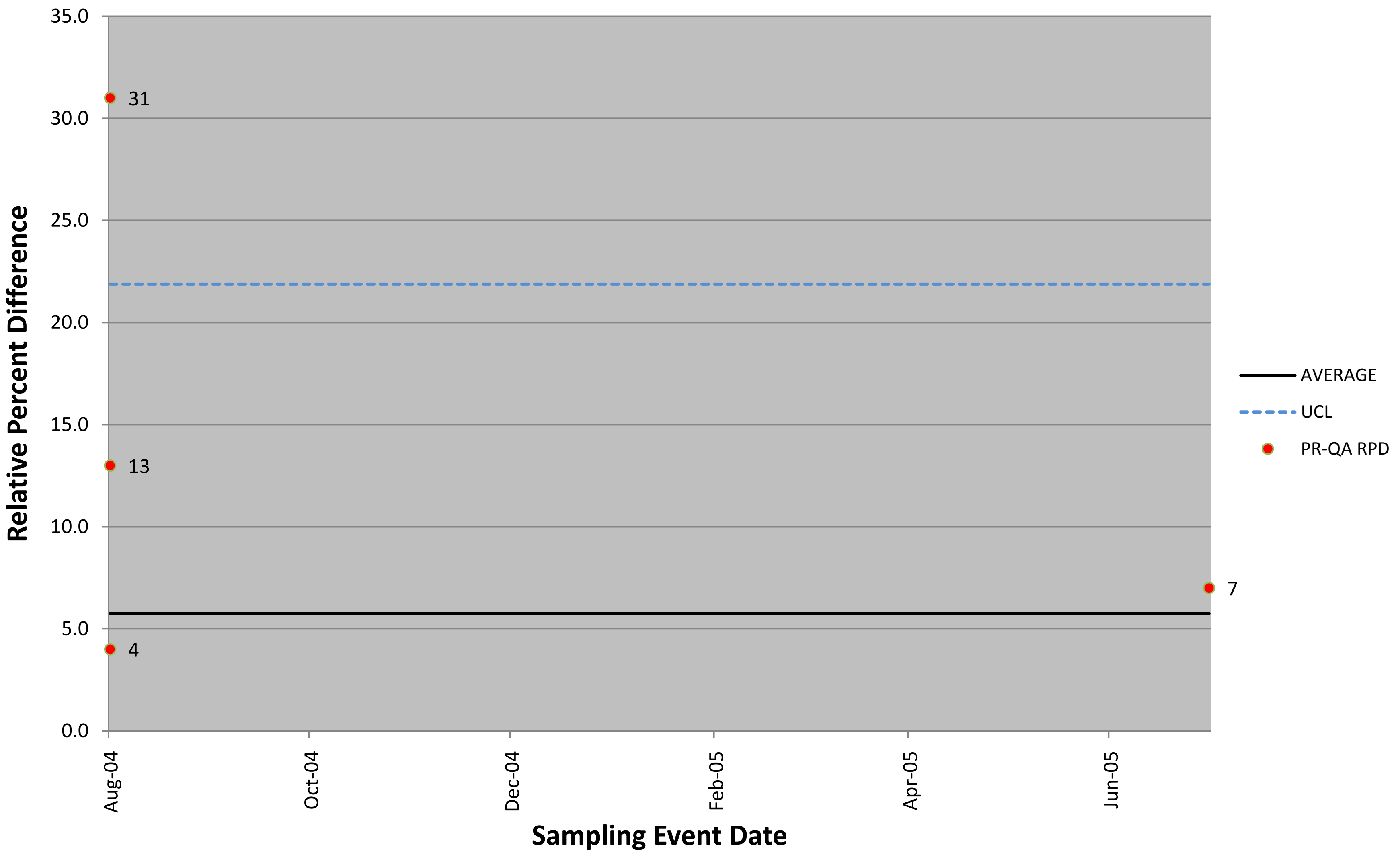


Chart A-252: Zinc Control Chart for 2004-2008 Marine Sediment

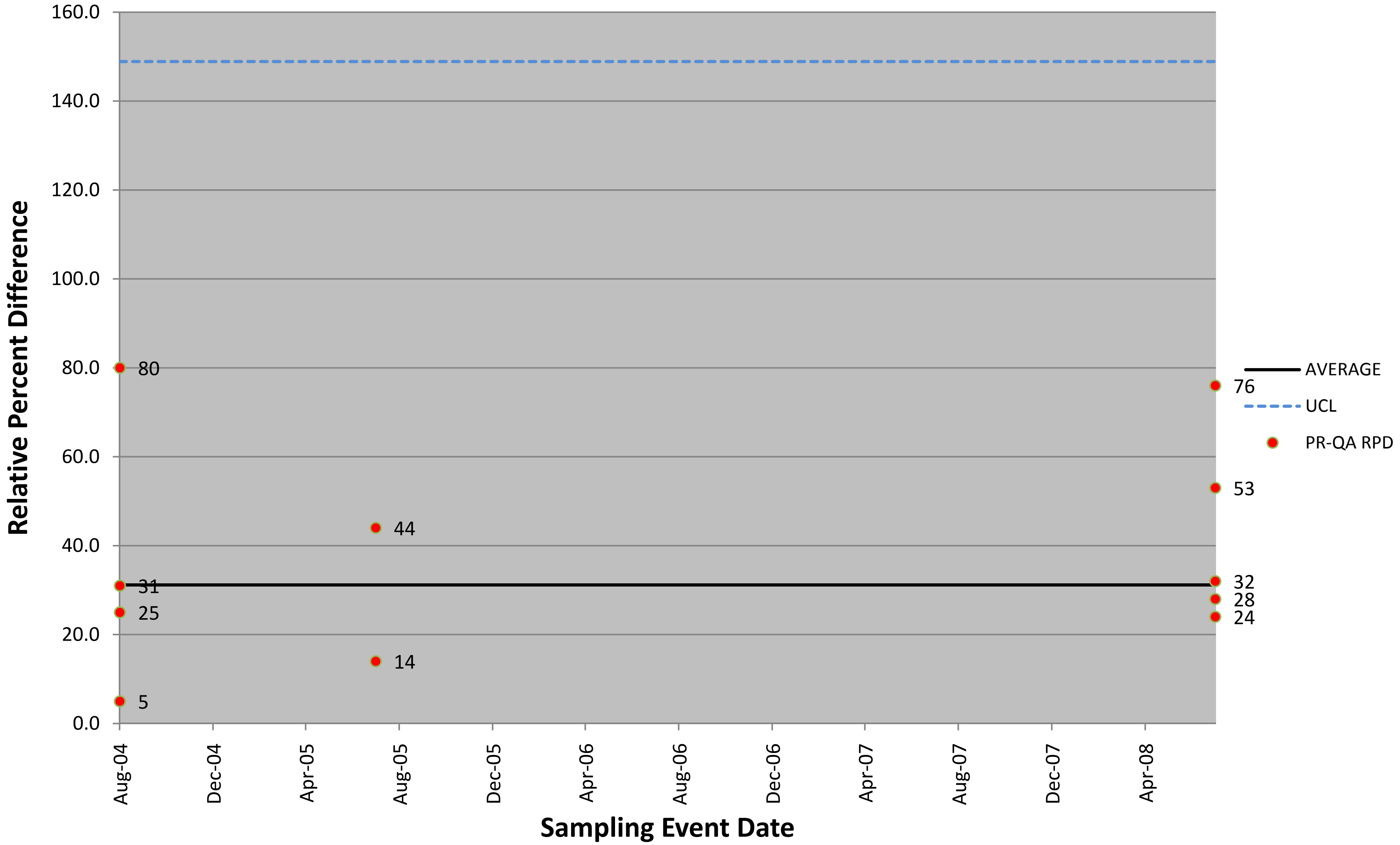


Chart A-253: SEM Zinc Control Chart for 2008 Marine Sediment

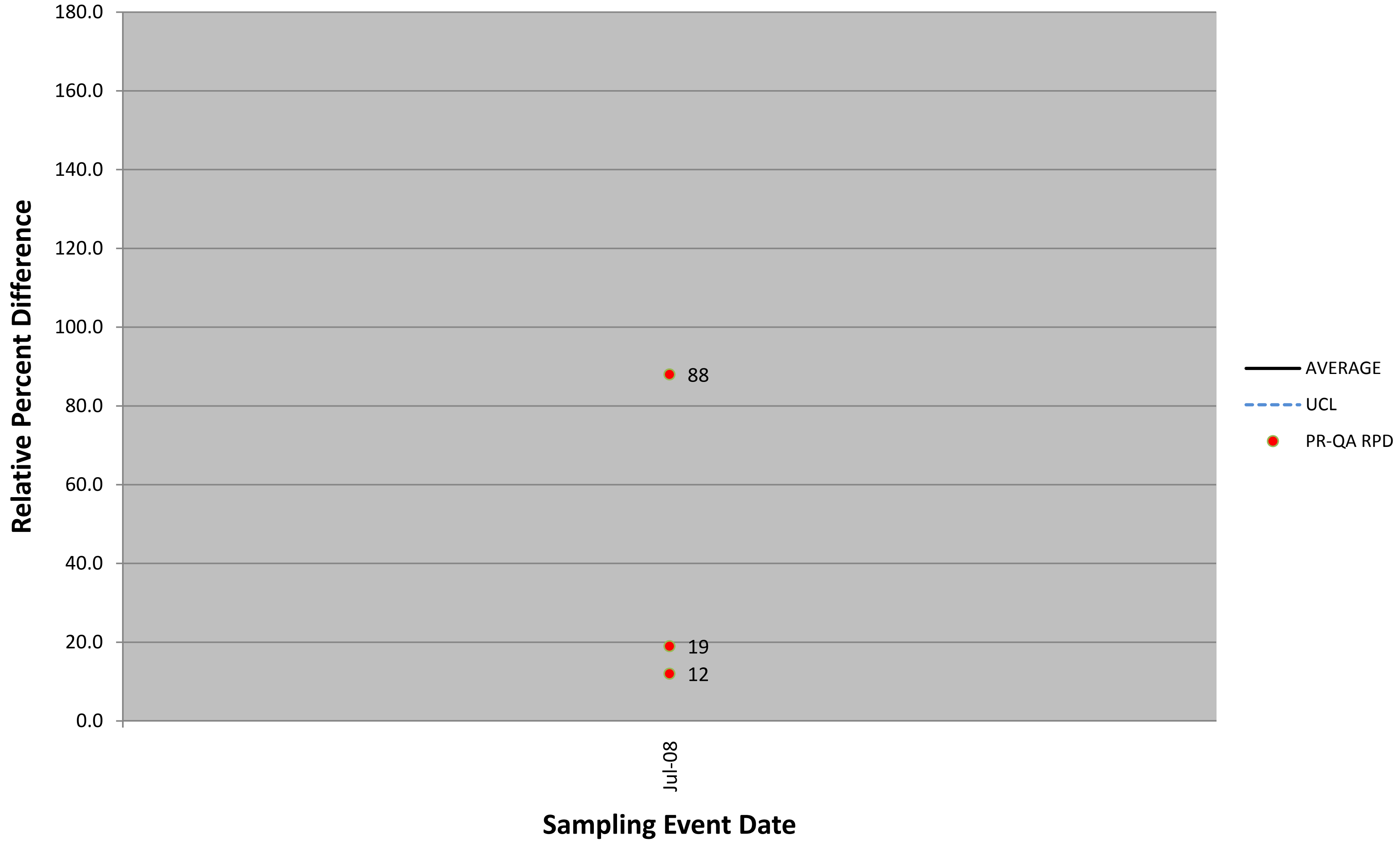
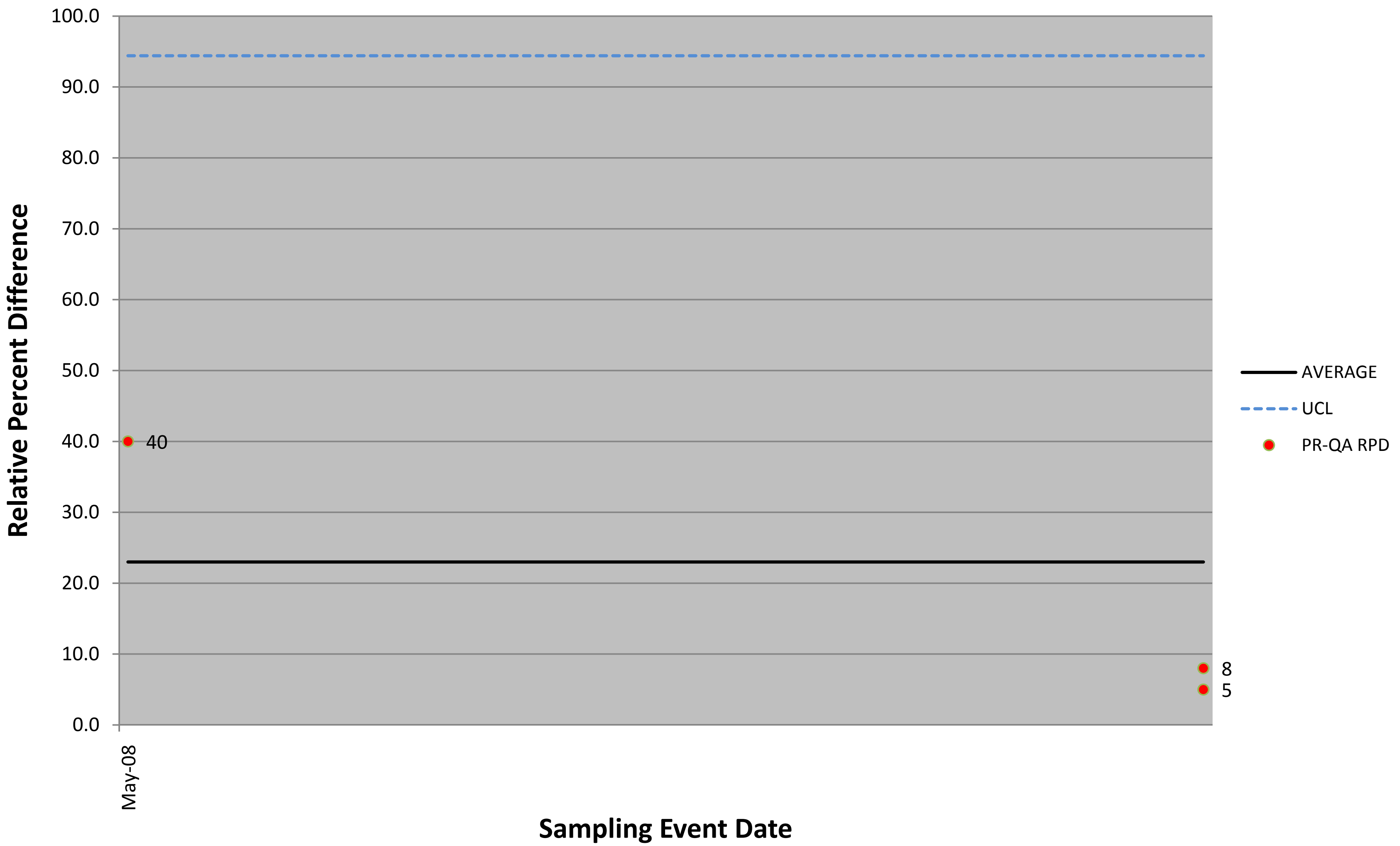


Chart A-254: Arsenic Control Chart for 2008 Marine Vegetation



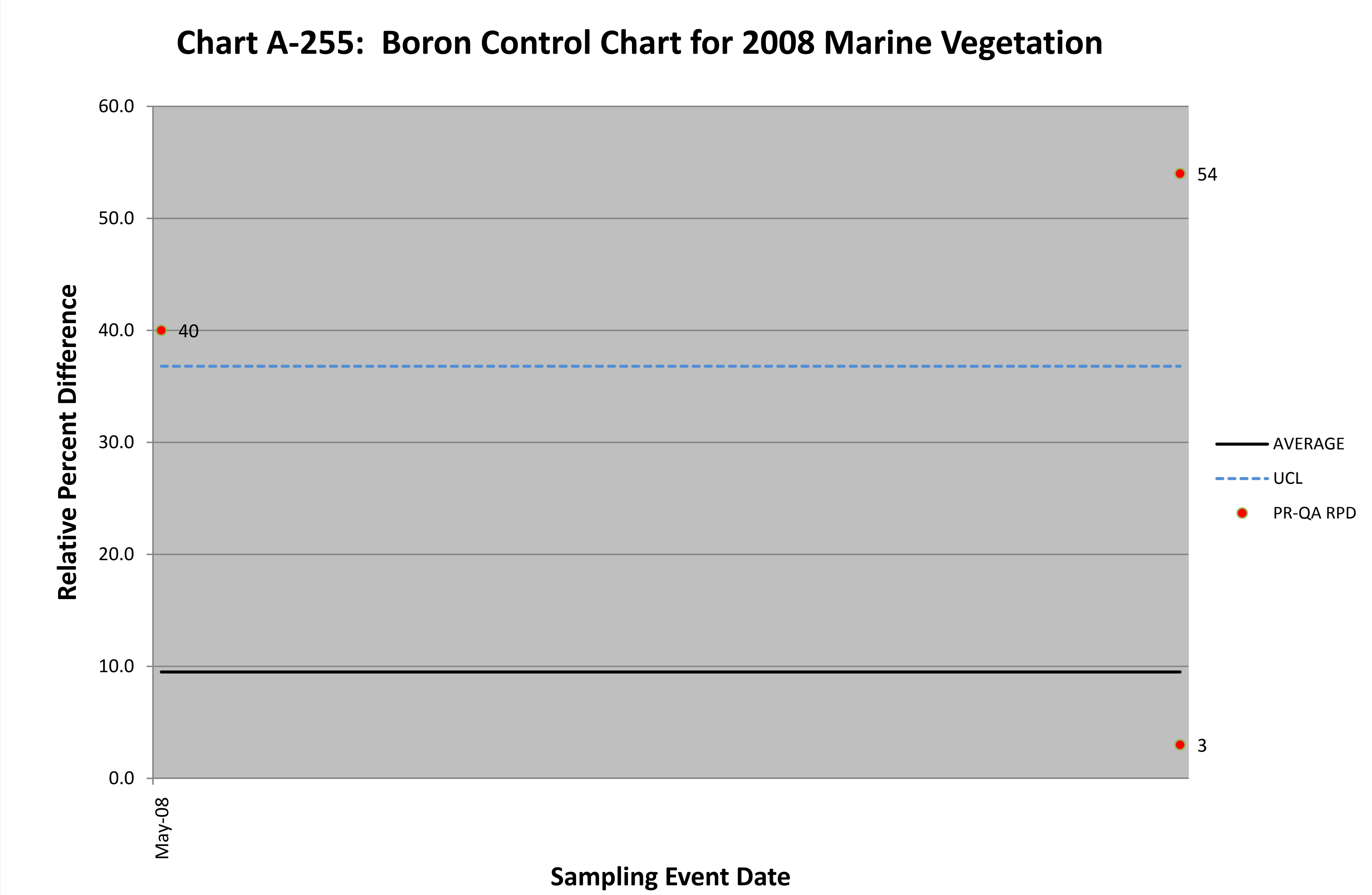
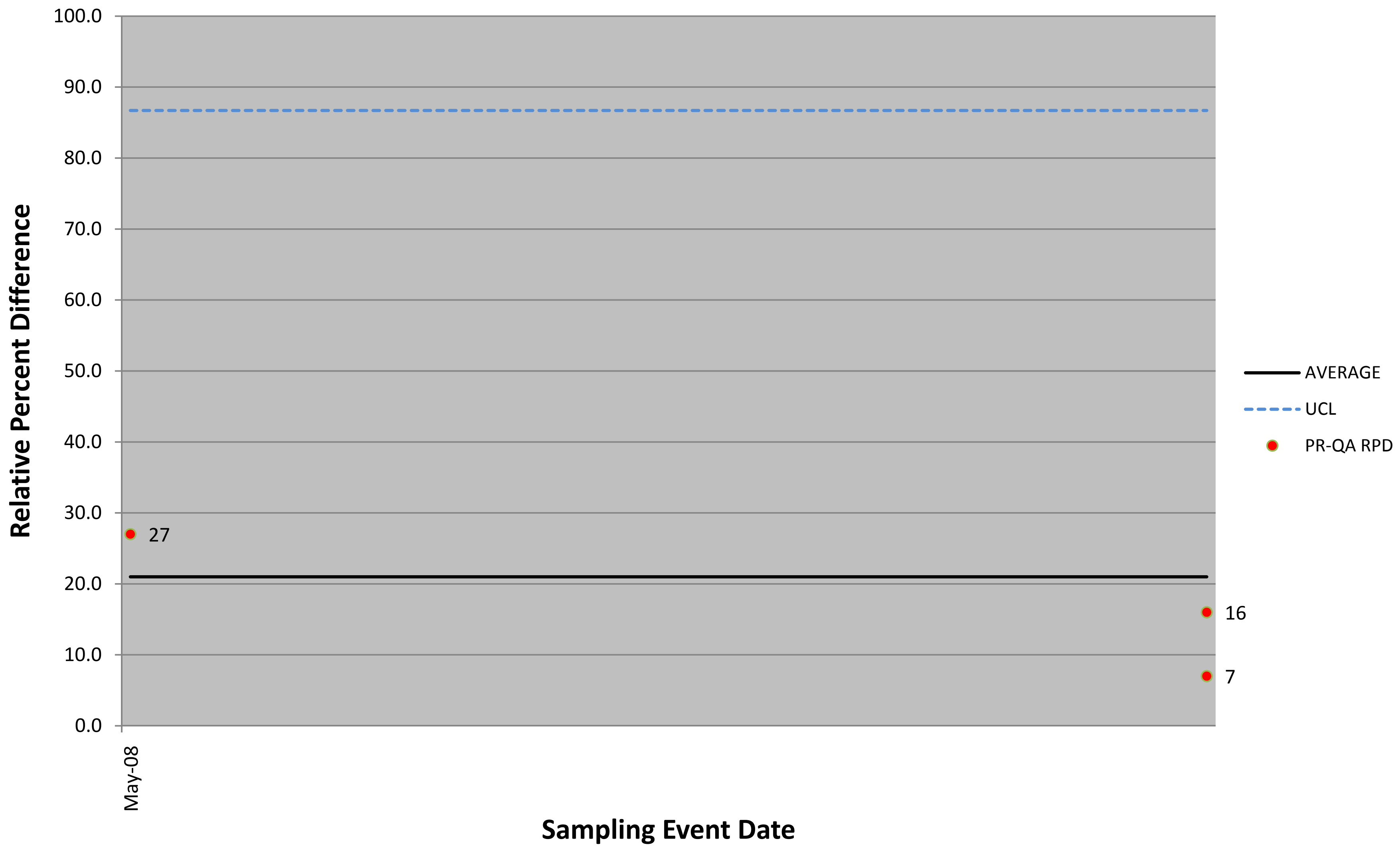


Chart A-255: Boron Control Chart for 2008 Marine Vegetation
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Relative Percent Difference
54
40
3
May-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-256: Cadmium Control Chart for 2008 Marine Vegetation



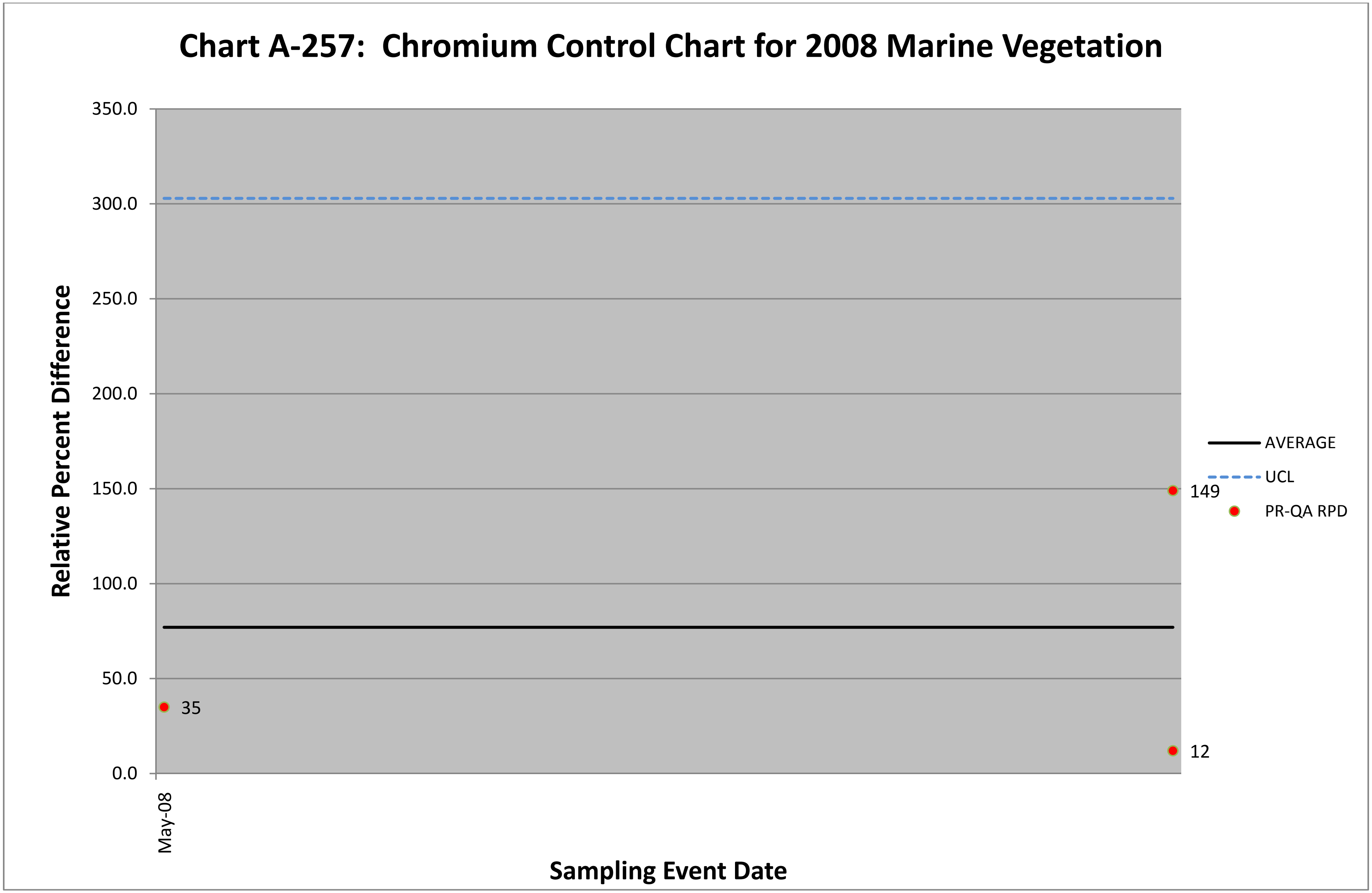


Chart A-257: Chromium Control Chart for 2008 Marine Vegetation
Relative Percent Difference
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
May-08
Sampling Event Date
35
149
12
AVERAGE
UCL
PR-QA RPD

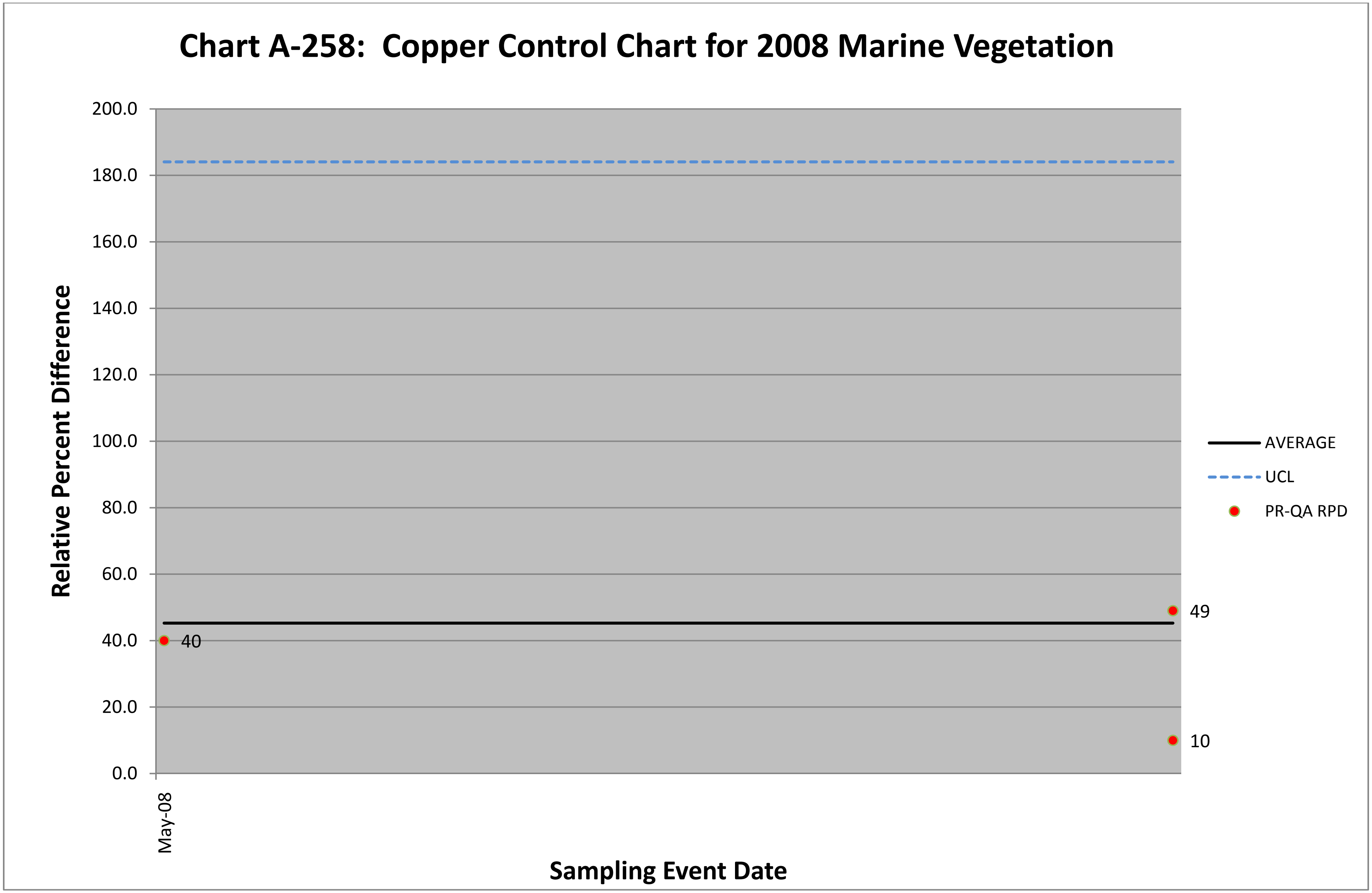


Chart A-258: Copper Control Chart for 2008 Marine Vegetation
Relative Percent Difference
200.0
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
40
49
10
May-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

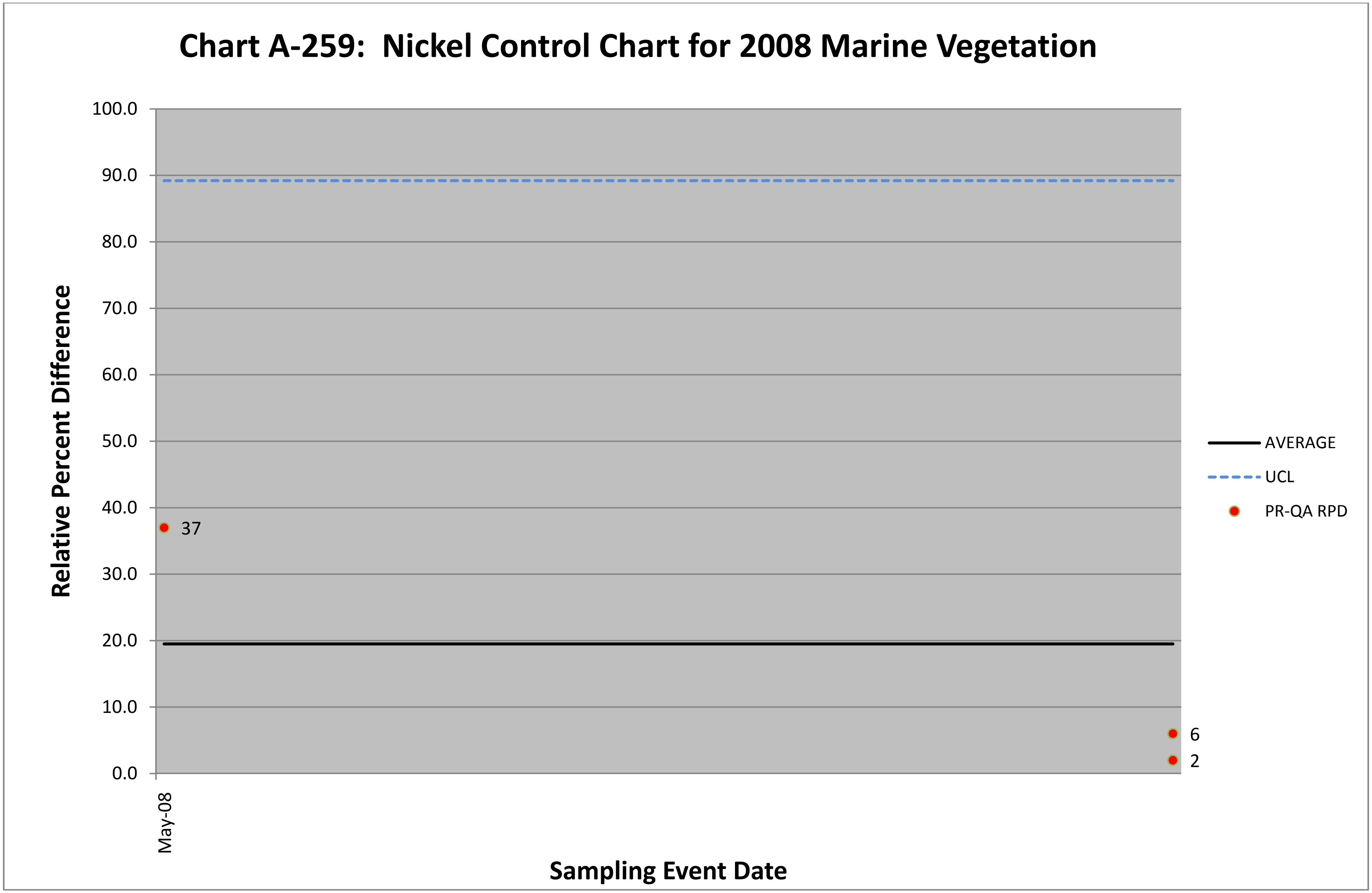


Chart A-259: Nickel Control Chart for 2008 Marine Vegetation
Relative Percent Difference
100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
37
6
2
May-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-260: Zinc Control Chart for 2008 Marine Vegetation

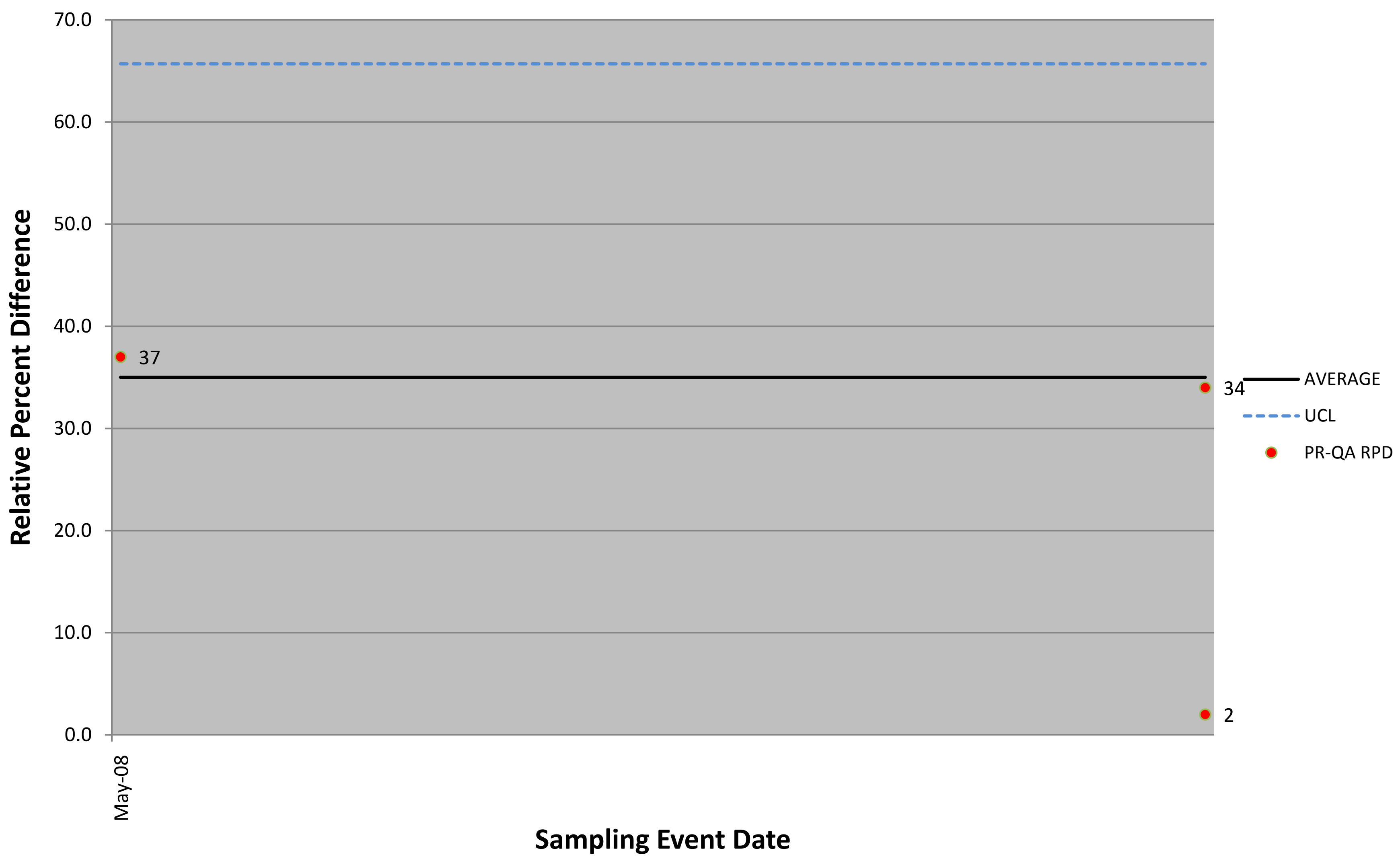


Chart A-261: Nitrogen: Ammonia (as N) Control Chart for 2004-2008 Marine Water

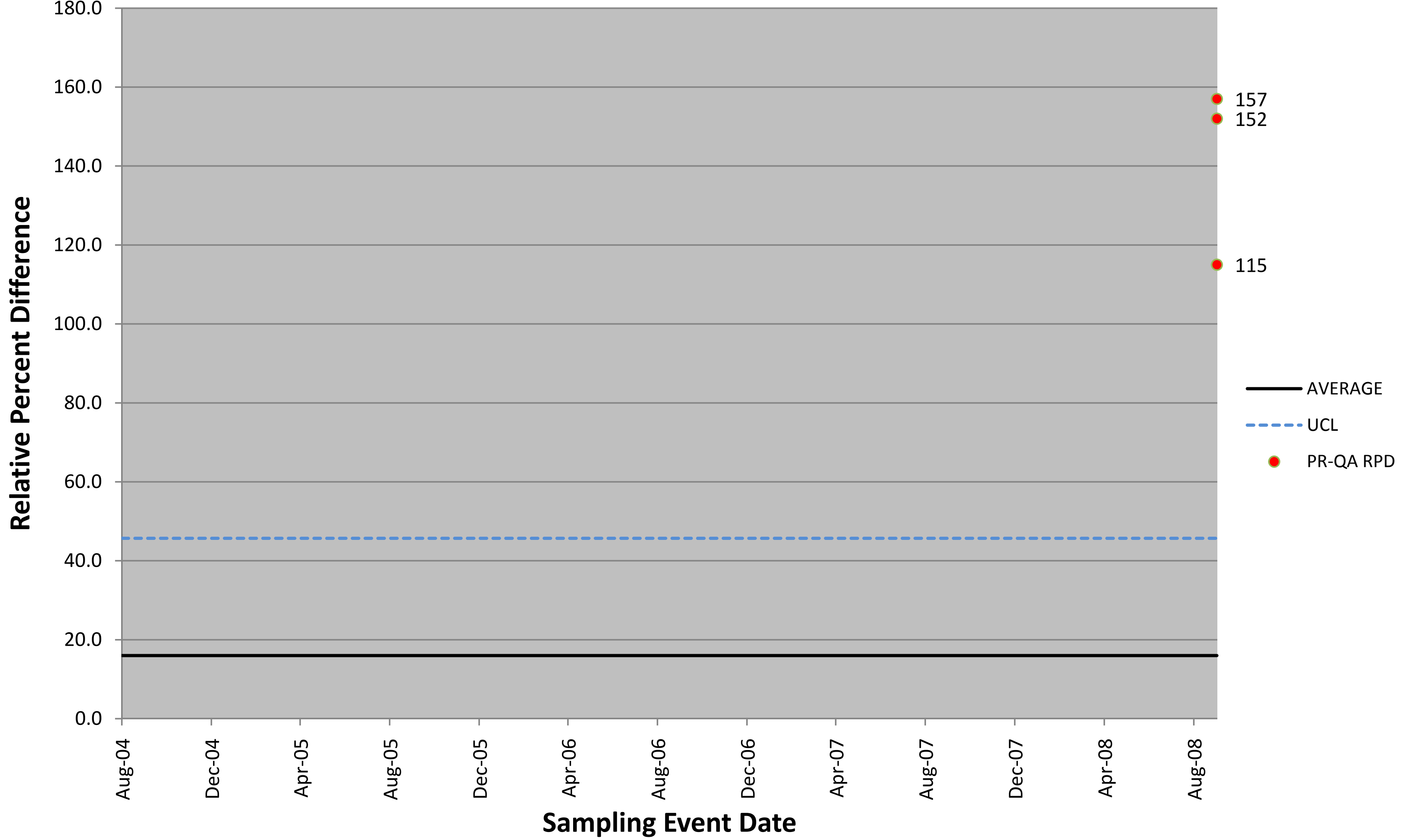


Chart A-262: Total Suspended Solids Control Chart for 2004-2008 Marine Water

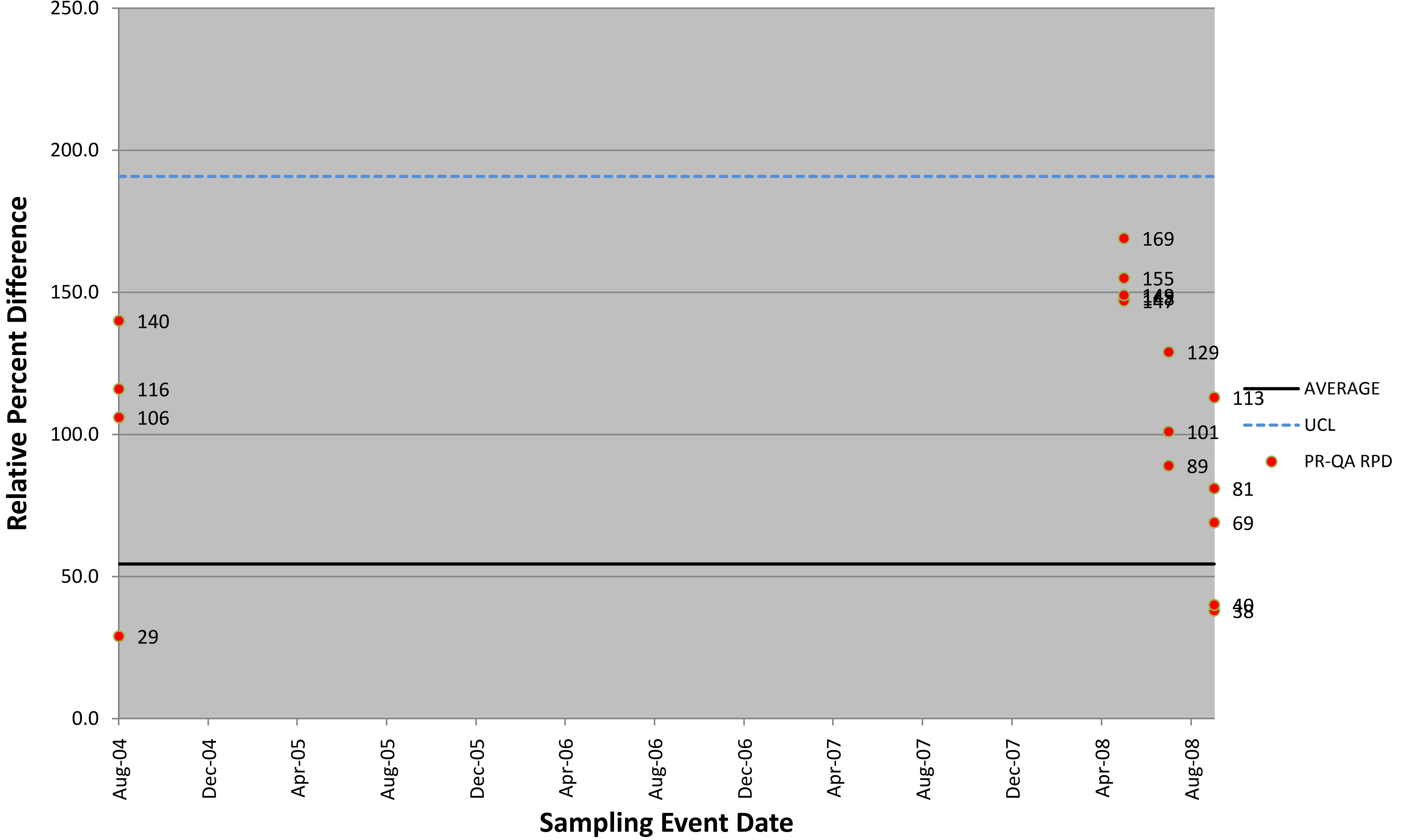


Chart A-263: Aluminum Control Chart for 2004-2008 Marine Water

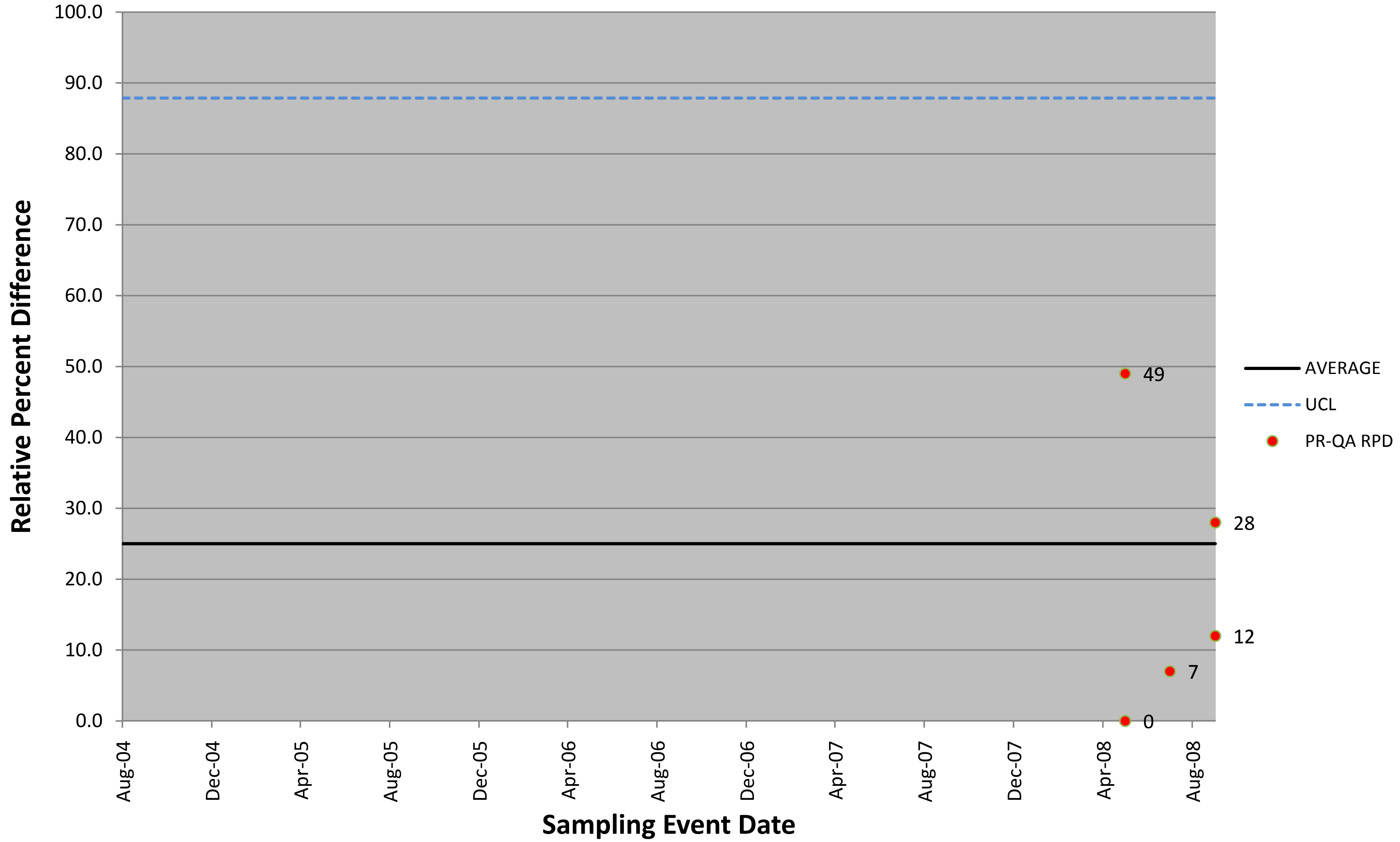


Chart A-264: Arsenic Control Chart for 2004-2008 Marine Water

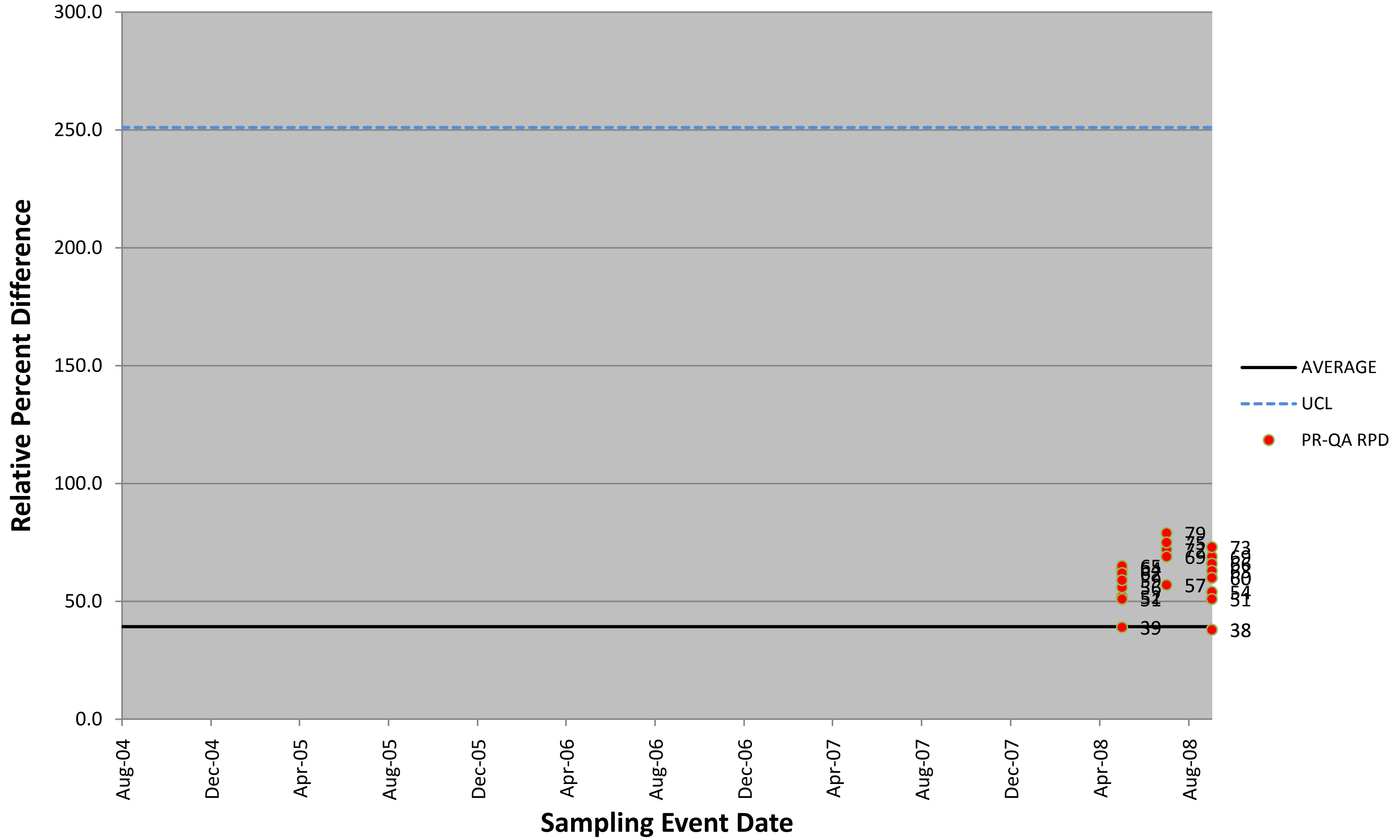


Chart A-265: Barium Control Chart for 2004-2008 Marine Water

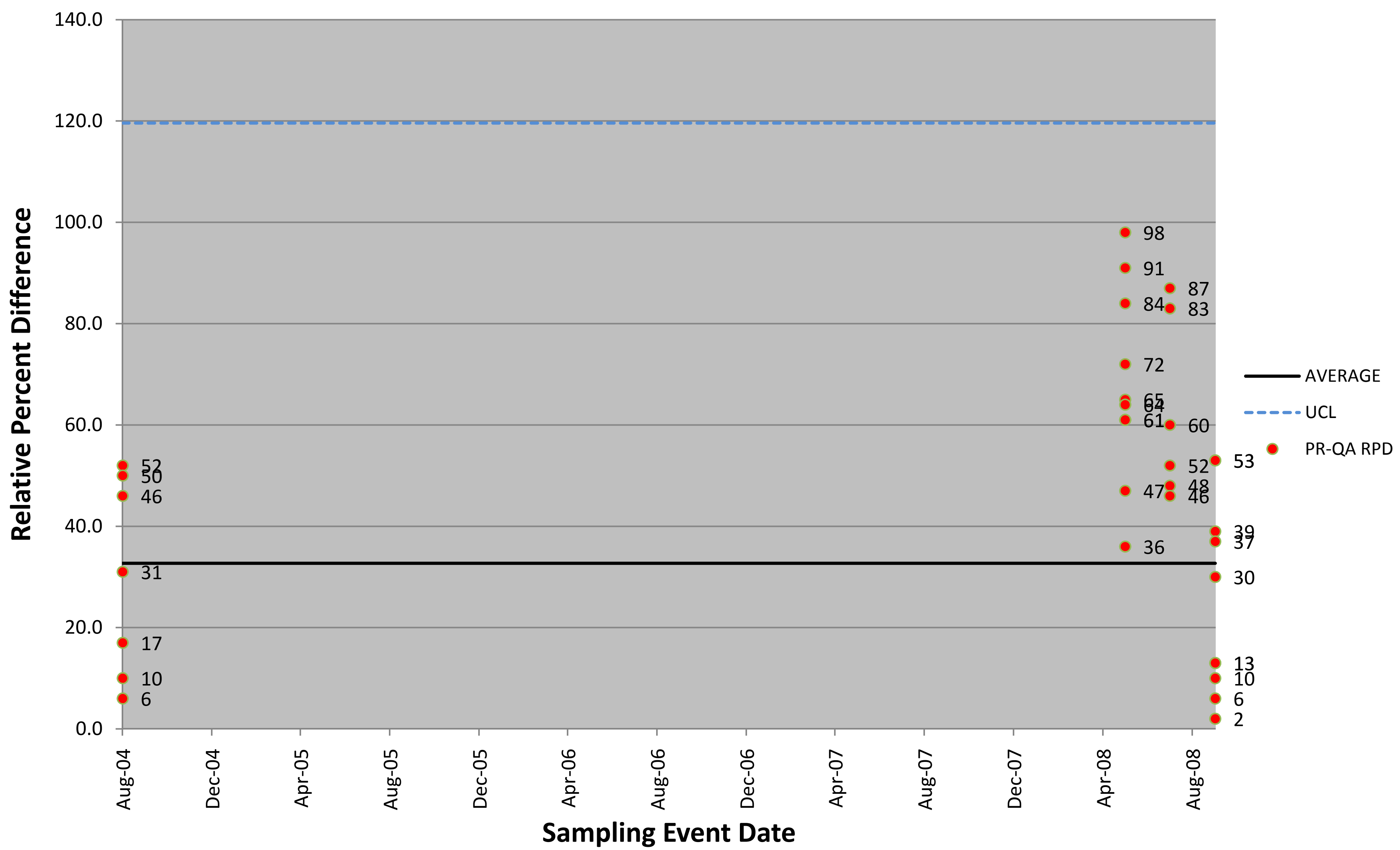
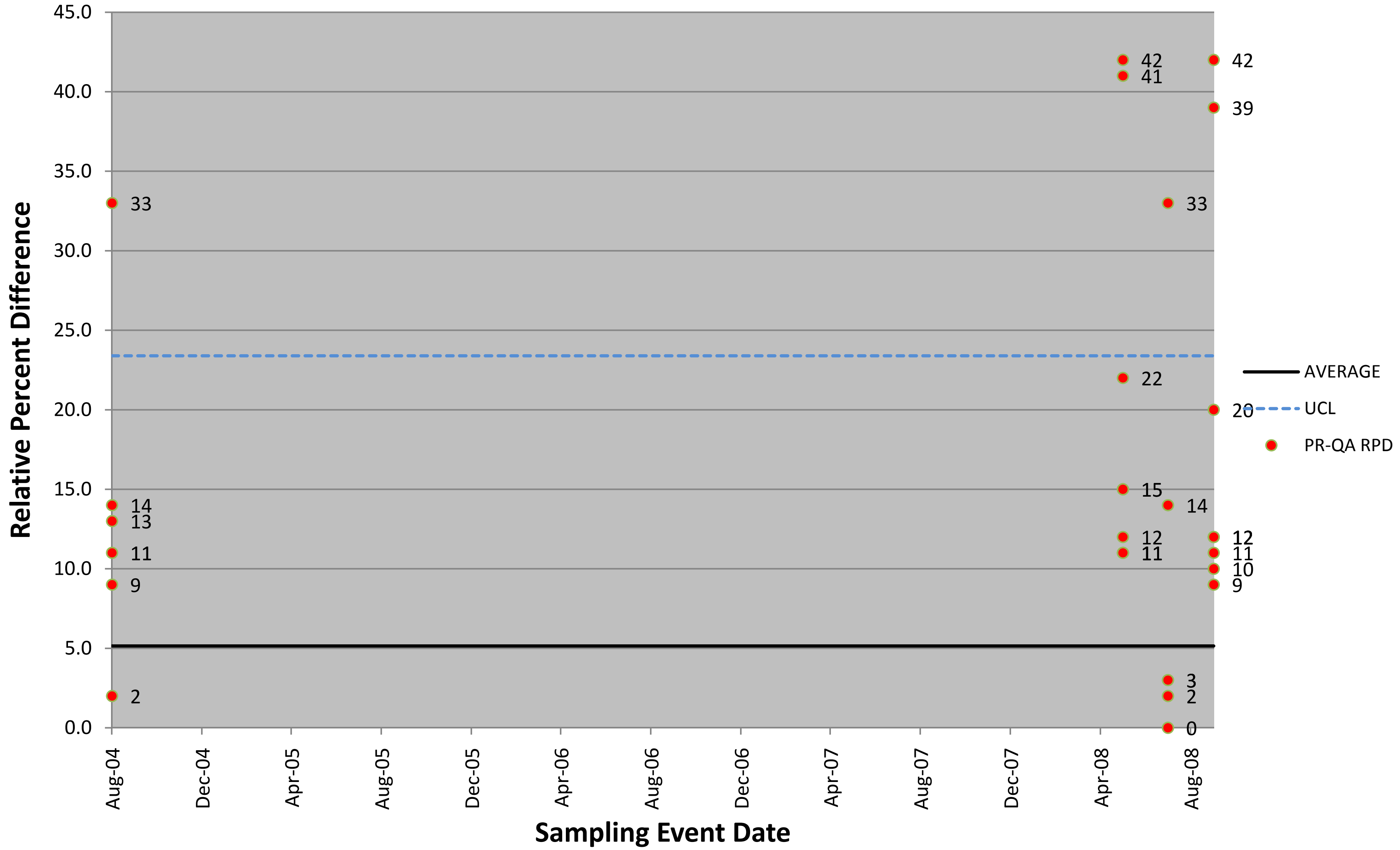


Chart A-266: Boron Control Chart for 2004-2008 Marine Water



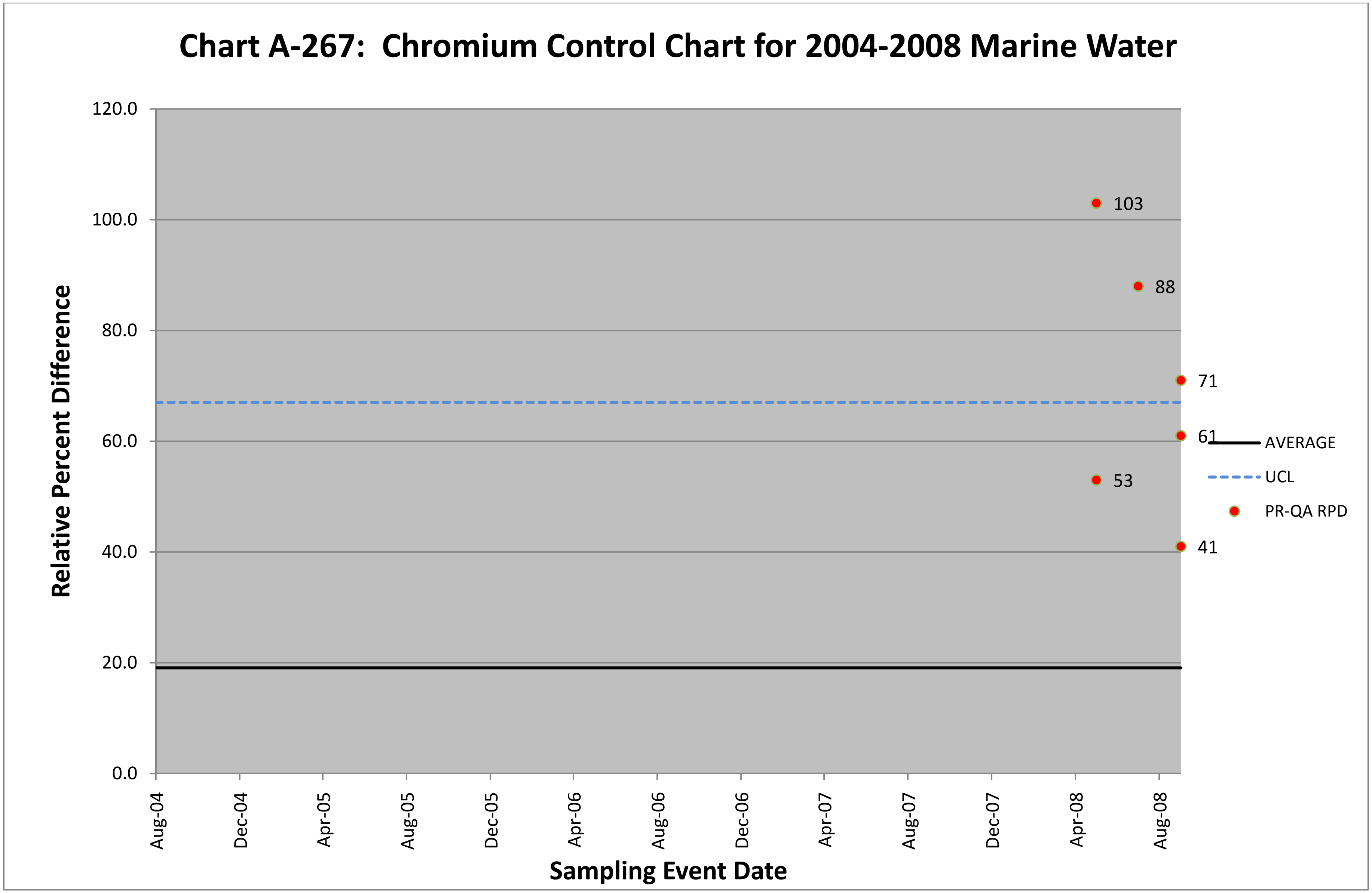


Chart A-267: Chromium Control Chart for 2004-2008 Marine Water
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
103
88
71
61
53
41
AVERAGE
UCL
PR-QA RPD
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Sampling Event Date

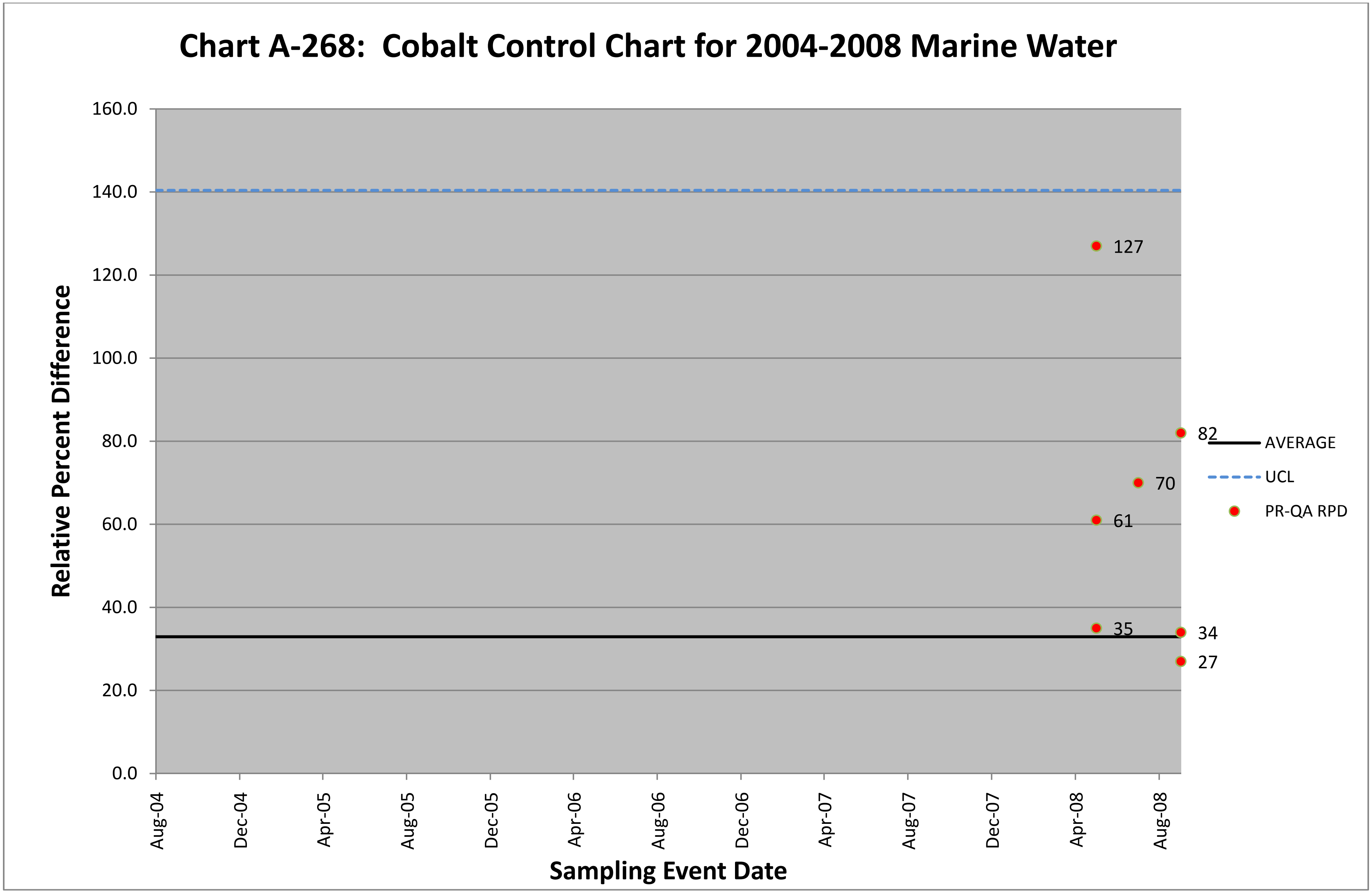


Chart A-268: Cobalt Control Chart for 2004-2008 Marine Water
Relative Percent Difference
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
127
82
70
61
35
34
27
AVERAGE
UCL
PR-QA RPD
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Sampling Event Date

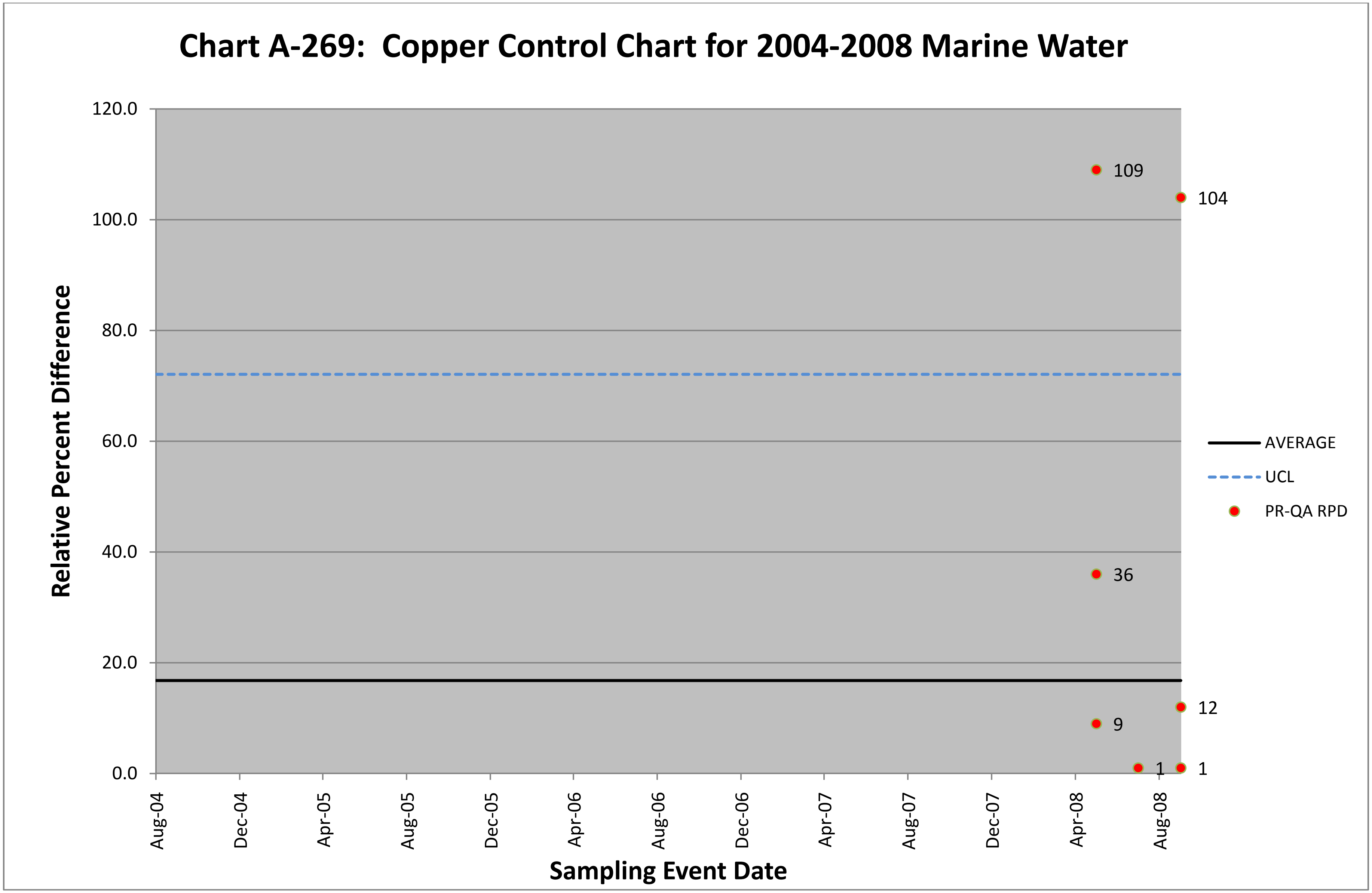


Chart A-269: Copper Control Chart for 2004-2008 Marine Water
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
109
104
36
12
9
1
1
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Sampling Event Date
AVERAGE
UCL
PR-QA RPD

Chart A-270: Iron Control Chart for 2004-2008 Marine Water

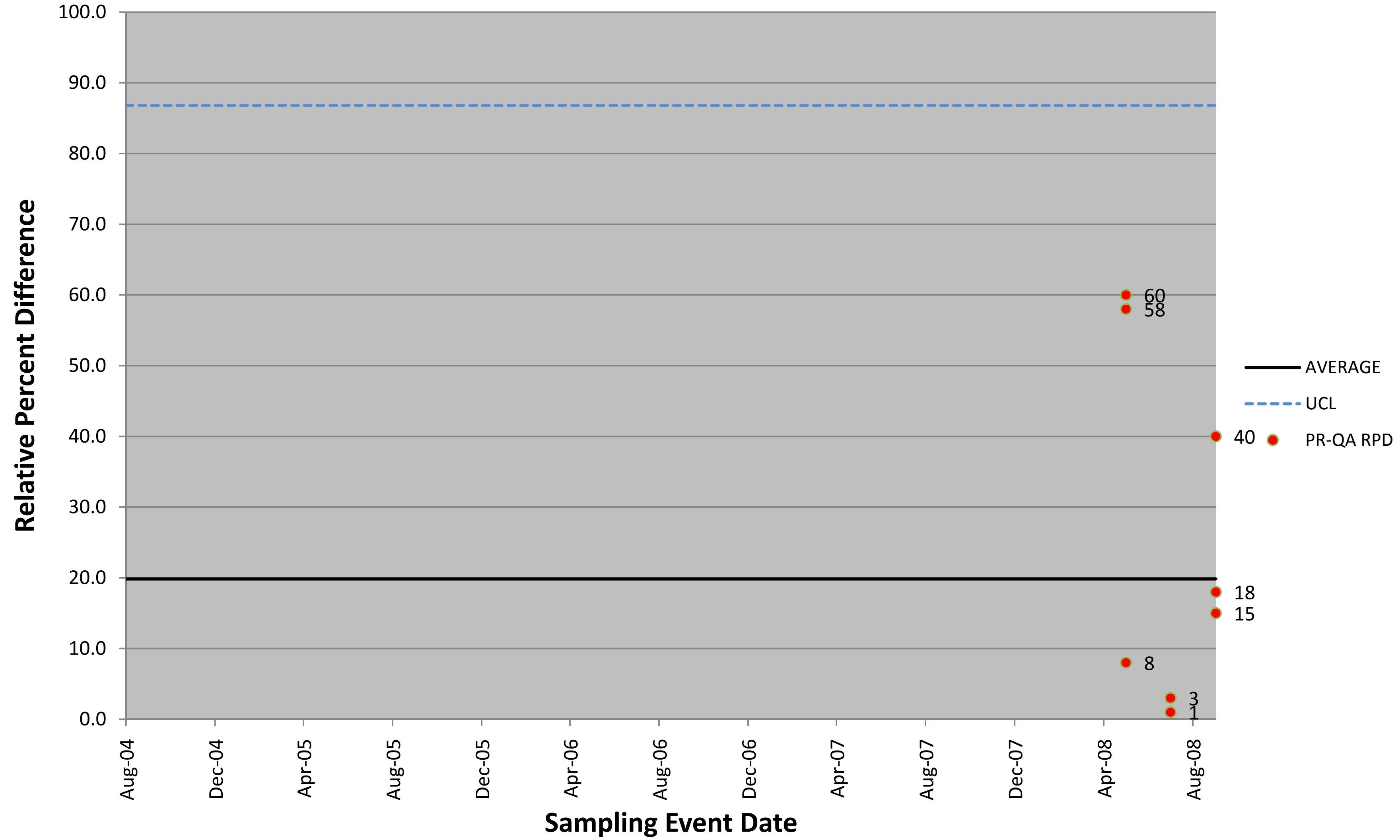
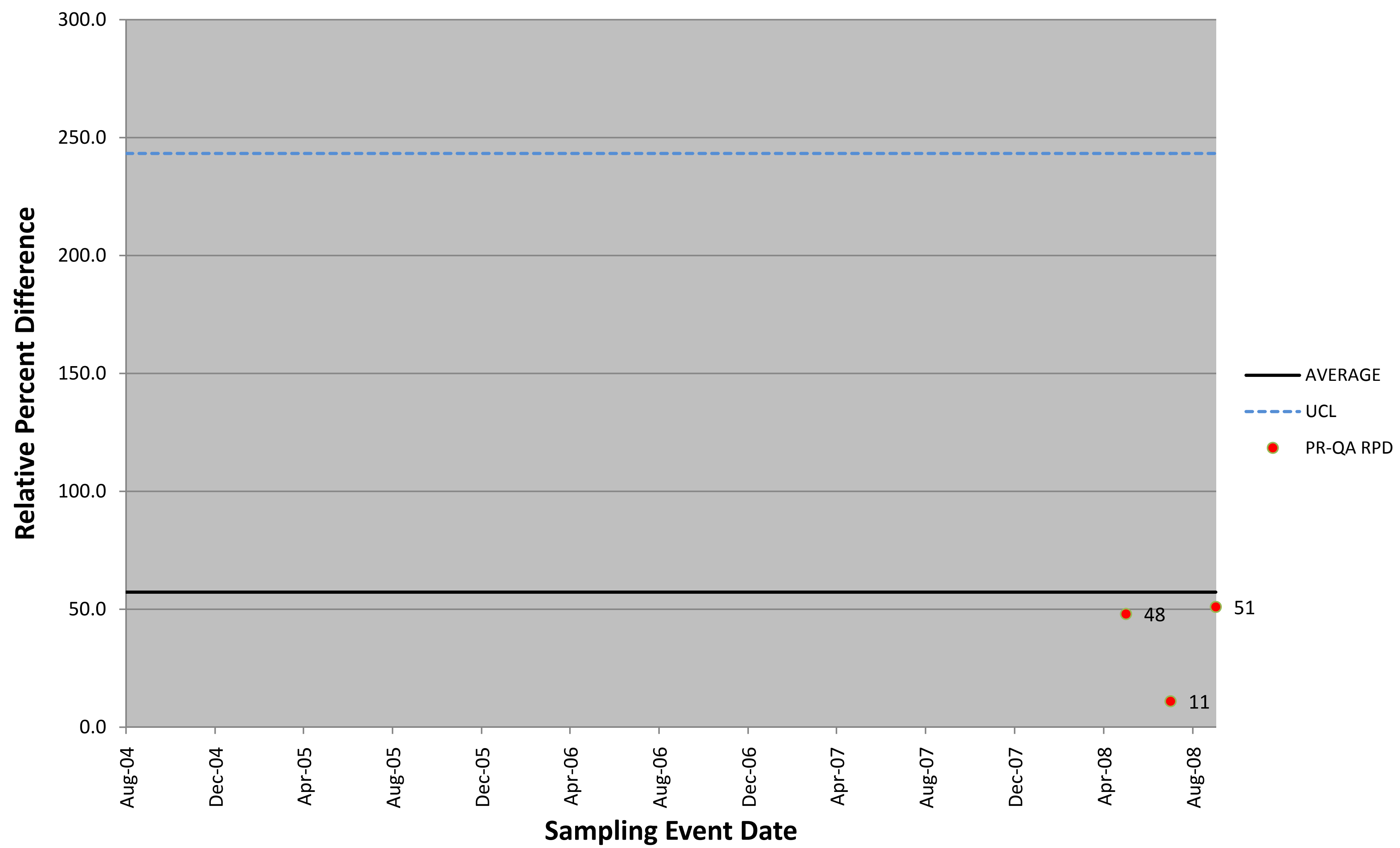


Chart A-271: Lead Control Chart for 2004-2008 Marine Water



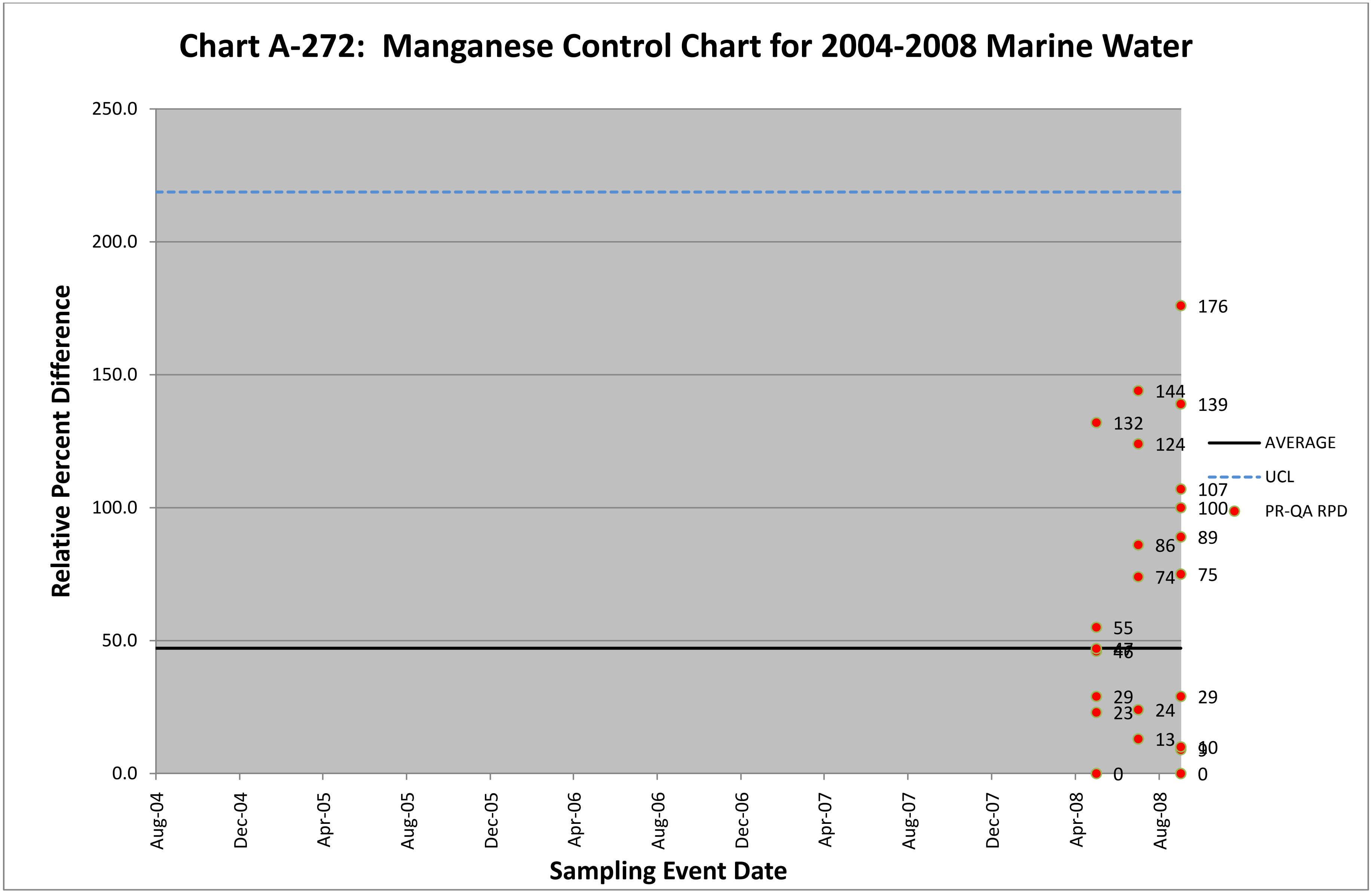


Chart A-272: Manganese Control Chart for 2004-2008 Marine Water
Relative Percent Difference
250.0
200.0
150.0
100.0
50.0
0.0
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Sampling Event Date
176
144
139
132
124
107
100
89
86
74
75
55
47
46
29
23
24
29
13
10
9
0
0
AVERAGE
UCL
PR-QA RPD

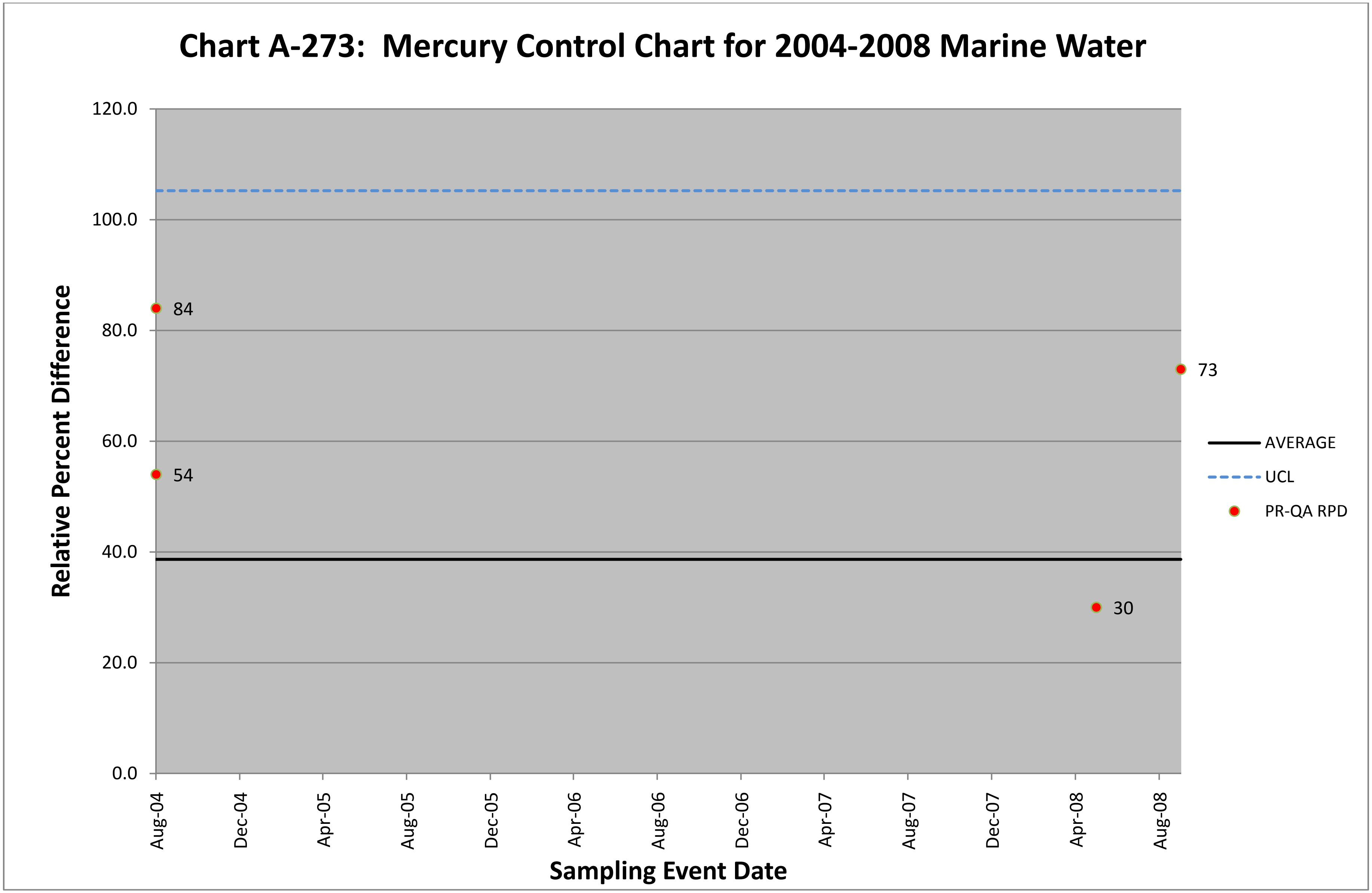


Chart A-273: Mercury Control Chart for 2004-2008 Marine Water
Relative Percent Difference
120.0
100.0
80.0
60.0
40.0
20.0
0.0
84
54
73
30
AVERAGE
UCL
PR-QA RPD
Aug-04
Dec-04
Apr-05
Aug-05
Dec-05
Apr-06
Aug-06
Dec-06
Apr-07
Aug-07
Dec-07
Apr-08
Aug-08
Sampling Event Date

Chart A-274: Silver Control Chart for 2004-2008 Marine Water