



Jordan Water Quality Monitoring Split Sample Program

(First Round)

March 2011

Organized by

**The Accreditation Unit
Jordan Standards & Metrology
Organization**

2011AU®. This Publication was produced by Jordanian Accreditation Unit. This may not be used for any other purposes, reproduced in whole or in part, nor passed to any organization or person without the specific permission in writing of the AU®. 33 pages publication in addition to 10 tables and 15 figures.

Acting Accreditation Unit Director

Eng. Lana Marashdeh

SUMMARY

The current report aims to establish firm confidence on the national level using inter-laboratory comparison technique as a valuable tool for lab performance improvement in order to enhance and promote the participating laboratories' Quality Systems in Jordan. And improve the quality of results from water testing laboratories and the water quality monitoring activities in Jordan.

This can be achieved through conducting Split Sample Program (SSP). The SS Program was conducted under the supervision of Accreditation Unit/ JSMO of the Advisory Group of the Split Sample Program decided to make sampling frequency every six months. Ten laboratories participated in fifteen tests in the field of Chemical and Microbiological analyses of water (Potable water). The results have been evaluated on the basis of the requirements of ISO/IEC Guide 17073: 2010, ISO 13528:2005 and the accumulative experience of the Technical Expert. The results indicated that the participated laboratories have successfully completed all the tests within the scope of the First phase of Split sample Program with acceptable results; however some laboratories failed to achieve satisfactory results in one or more test.

The evaluation report consists of two parts

- Performance evaluation: Evaluation sheet for the relevant laboratory.
- Charts: graphical presentation of results. These graphs show the distribution of the participant's results from the mean after excluding the outliers. They show also methods of testing.
- Method key: methods of testing reported by participants and their relevant key abbreviations.

Advisory Group:

- Eng. Lana Marashdeh: Acting Accreditation Unit Director/JISM, Tel: 065658036, Fax: 065695721 E-mail: lmashdeh@jsmo.gov.jo, Amman-Jordan.
- Mr. Bashar Khalil: CDM, Tel: 065651918, Fax: 065652937 E-mail: khalilb@cdm.com.
- Eng. Tahani Tarawneh: (Coordinator) Accreditation Unit/ JSMO, Tel.: 065658037, Fax: 065695721 E-mail: ttarawneh@jsmo.gov.jo, Amman- Jordan.

Please read the following explanation of sample collection and data treatment before you read the evaluation:

Sample Collection

Sample was collected at an active water supply station which may vary from round to round in this case Wadi Esser Water Treatment Plant was the source. The sample location may vary from round to round. Participating laboratories were instructed to provide their own personnel and equipment (containers, preservatives, ice boxes, etc.). At the pre-arranged time window on a set date, from 10:30 am to 11:30 am, each laboratory collected their sample and returned them to their laboratory for testing using routine procedures. Sample test results were reported by each participating laboratory to AU/JSMO for compilation and evaluation.

Participating Laboratories and Identification

The following laboratories participated in this round (Listed in random Order):

- Ben Hayyan Aqaba International Laboratory /Aqaba Special Economic Zone Authority - (ASEZA)
- Institute of Earth and Environment Sciences / Al Beyt University – (AU)
- Aqaba Water Company – (AWC)
- Northern Governorates Water Authority – (NGWA)
- Miyahuna - Jordan Water Company – (MIYAHUNA)
- MOH Environmental Health Directorate – (EHD)
- Wadi Main Zara & Mujib Water Treatment Plant & Conveyance System Laboratory – (WMZM)
- Center of Environmental Studies / Hashemite University – (HU)
- Quality Laboratories/ Water Authority of Jordan – (WAJ)

Laboratory confidentiality is protected. Each laboratory is given a code number to maintain confidentiality by an AU representative. Only the concerned laboratory knows its code number.

AU/JSMO, acting as the present split sample program coordinator, is the only party that needs to know all laboratory identifications for evaluation purposes. Other

laboratories are invited to participate in the split sample program, as additional results help providing more robust statistical evaluation and improve Jordan laboratory analytical standards.

Evaluation of Data and Results Report

Sample results were analyzed as reported. Potential outliers were assessed using Grubb's Test with a 5% risk factor. Confirmed outliers were excluded from the statistical work-up of the data. The distribution of results was characterized by the F-pseudo sigma statistic. A z-value for each result was determined using the median value of the data set and the F-pseudo sigma statistic. Z-values ≤ 2 were deemed acceptable. Z-values > 3 were deemed unacceptable. Z-values > 2 and ≤ 3 were deemed check for error, which means that the result is in the acceptable range, however it is highly recommended to start preventive action. In order to provide supervisors in the laboratories with objective tool to evaluate the performance of their laboratories, the percentage of acceptable results are presented in the individual laboratory evaluation sheet.

Other notes pertinent to the data analysis are:

- Results not reported from the participant laboratory for a particular test were annotated as N and are not evaluated.
- Evaluation of microbiology results are based on the logarithmic value of the reported counts.
- Chemistry results that were reported by the participating laboratories as a less than ($<$) value, were considered in the evaluation. The study coordinator used $1/2$ the reported value in the assessment calculation.
- Microbiology results reported as " $>$ value" or " \geq value" were considered in the evaluation and included in the calculation as the laboratory result.
- Results where a less than or greater than value was outside the range of acceptable results were deemed unacceptable.

- Analysis for the parameter results reported by 50% of the participants or less will not be reported in the final evaluation report as it will affect robustness and reliability of the analysis. Analysis results will be available separately from the final evaluation report for the participants who would like to know their results.
- Some results were reported as less than (<), or greater than (>) were evaluated while the mean of the results indicates that the limits set are not appropriate (i.e. result was reported as < 3 mg/l and the mean of results is 1.5) these results were not evaluated, and annotated as Unacceptable-reporting limit.
- Laboratory technical directors and managers are encouraged to evaluate all parameters with a z-value greater than 2, and apply preventive action.
- Laboratory technical directors and managers are encouraged to evaluate all parameters with a z-value greater than 3 and initiate a corrective action process consistent with their quality management system.
- The acceptable results percentage is calculated based on the number of the parameters evaluated. The parameters not reported by the laboratory or not evaluated are not considered.
- Acceptable Results % = [number of acceptable results/number of results evaluated]X100

Graphical Presentation of Results

The reported results for each parameter are plotted with the mean of all reported values (not including outliers).

Analysis methods in the graphs are given short names. Attached in this report is a list of the full names of analysis methods and the correspondence short names and the method number according to the Standard Methods for the Examination of Water and Wastewater edition 21st.

| Analysis Method | | | | |
|--|---------------------------|---|--------------------------|--------------|
| Method Name | Common name | Analyte | Standard method number # | Reference ## |
| Multiple Tube Fermentation | MTF | Total Coliform E.coli | 9221 | MTF |
| Membrane Filtration | MF | Total Coliform E.coli | 9222 | MF |
| Enzyme Substrate (Colilert or IDEXX) | Colilert | Total Coliform E.coli | 9223 | ENZ |
| Flame Emission Photometric | Flame | Na ⁺ | 3500-Na B | Flame |
| Flame Emission Photometric | Flame | K ⁺ | 3500-K B | Flame |
| Ion Selective Electrode | ISE | K ⁺ | 3500-K C | ISE-K |
| Flame Atomic Absorption | Flame, AAS | K ⁺ , Na ⁺ , Ca ⁺² , Mg ⁺² | 3111 | AAS |
| EDTA Titrametric Method | EDTA Titration, Titration | Ca ⁺² | 3500-Ca B | EDTA-Ca |
| Ion Chromatography | IC | NO ₃ ⁻ , SO ₄ ⁻² , Cl ⁻ , F ⁻ , Br ⁻ | 4110 | IC |
| Calculation | | Mg ⁺² | 3500-Mg B | Cal-Mg |
| Argentometric Method | Titration | Cl ⁻ | 4500-Cl B | Ti-Cl |
| Potentiometric Method | | Cl ⁻ | 4500-Cl D | Pot-Cl |
| Ultraviolet Spectrophotometric Screening | Screening, UV | NO ₃ ⁻ | 4500 NO3 B | UV |
| Turbidimetric | Gravimetric | SO ₄ ⁻² | 4500 SO4 E | Tur-S |
| Ion Selective Electrode | ISE | F ⁻ | 4500 F C | ISE-F |
| Phenol Red Colorimetric | Colorimetric | Br ⁻ | 4500 Br B | Col-Br |
| Electrometric Method | Electrode | pH | 4500 H B | Elect |
| Nephelometric Method | | Turbidity | 2130 B | Neph |
| Laboratory Method | | EC | 2510 B | Lab |
| Total Dissolved Solids Dried at 180°C | Gravimetric | TDS | 2540 C | TDS-1 |
| EDTA Titrimetric Method | Titration, EDTA | Total Hardness (TH) | 2340 C | EDTA-TH |
| Titration Method | Titration | Alkalinity | 2320 B | Ti-Alk |
| Hardness by Calculation | Calculation | Total Hardness (TH) | 2340 B | Cal-TH |
| TDS By Calculation | Calculation | TDS | 2510 A | TDS-2 |

According to Standard Methods for the Examination of Water and Wastewater, edition 21st

Method name that will appear beside test result in the graphs

Performance Evaluation

| | |
|--------------|-----------------------------------|
| Sample: | PT//2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 01

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-------------------------------|------------------------|-----------------|---------|-----------------|-------|--------|----------------|------------------------|
| A. Microbiology | | | | | | | | |
| Total Coliforms | MPN/100 mL | 130 | 0.2 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 49 | 0.6 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |
| B. Cations | | | | | | | | |
| K ⁺ | mg/L | N | | Not Reported | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 30.6 | 1.30 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | N | | Not Reported | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | N | | Not Reported | 102.0 | 102.1 | 4.0 | 7 |
| C. Anions | | | | | | | | |
| NO ₃ ⁻ | mg/L | 34.77 | 2.23 | Check for Error | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | 29.07 | 1.32 | Acceptable | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 67 | 2.44 | Check for Error | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | 0.19 | 1.87 | Acceptable | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |
| D. Chemistry/others | | | | | | | | |
| pH | Unit | 7.22 | 0.00 | Acceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | 0.11 | 0.59 | Acceptable | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 340 | 0.60 | Acceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 810 | 0.78 | Acceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | 461 | 1.13 | Acceptable | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | N | | Not Reported | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|------|
| No. reported results | 12 |
| No. acceptable results | 12 |
| No. unacceptable results | 0 |
| No. evaluated results | 12 |
| Acceptable results % | 100% |

Notes:

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or "≥value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT//2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 02

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-------------------------------|------------------------|-----------------|---------|-----------------|-------|--------|----------------|------------------------|
| A. Microbiology | | | | | | | | |
| Total Coliforms | MPN/100 mL | 80 | 1.1 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | N | | Not Reported | 37.4 | 40.7 | 1.4 | 8 |
| B. Cations | | | | | | | | |
| K ⁺ | mg/L | 0.84 | 1.69 | Acceptable | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 31.2 | 1.09 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | 35.04 | 6.60 | Unacceptable | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | 94.95 | 1.80 | Acceptable | 102.0 | 102.1 | 4.0 | 7 |
| C. Anions | | | | | | | | |
| NO ₃ ⁻ | mg/L | N | | Not Reported | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | N | | Not Reported | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 65.6 | 2.64 | Check for Error | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | N | | Not Reported | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |
| D. Chemistry/others | | | | | | | | |
| pH | Unit | 7.19 | 0.37 | Acceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | N | | Not Reported | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 381.1 | 4.33 | Unacceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 729.2 | 4.30 | Unacceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | 430.2 | 1.73 | Acceptable | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | 196.3 | 0.00 | ## | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|-----|
| No. reported results | 11 |
| No. acceptable results | 7 |
| No. unacceptable results | 3 |
| No. evaluated results | 10 |
| Acceptable results % | 70% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or ">=value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT/I/2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 03

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|

A. Microbiology

| | | | | | | | | |
|-----------------|------------|-------|-----|------------|-------|-------|-----|---|
| Total Coliforms | MPN/100 mL | 151.5 | 0.0 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 39.9 | 0.1 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |

B. Cations

| | | | | | | | | |
|------------------|------|------|------|-----------------|-------|-------|-----|---|
| K ⁺ | mg/L | 1.55 | 0.17 | Acceptable | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 34.5 | 0.08 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | 17.5 | 2.03 | Check for Error | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | 105 | 0.73 | Acceptable | 102.0 | 102.1 | 4.0 | 7 |

C. Anions

| | | | | | | | | |
|-------------------------------|------|------|------|------------|------|------|-----|---|
| NO ₃ ⁻ | mg/L | 41.5 | 1.79 | Acceptable | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | 36 | 1.24 | Acceptable | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 94.2 | 1.63 | Acceptable | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | 0.27 | 0.21 | Acceptable | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | 0.13 | 1.35 | ## | 0.1 | 0.1 | 0.0 | 2 |

D. Chemistry/others

| | | | | | | | | |
|----------------|------------------------|------|------|--------------|-------|-------|------|----|
| pH | Unit | 7.31 | 1.10 | Acceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | 0.26 | 0.00 | Acceptable | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 335 | 1.20 | Acceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 824 | 0.17 | Acceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | N | | Not Reported | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | N | | Not Reported | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|------|
| No. reported results | 15 |
| No. acceptable results | 14 |
| No. unacceptable results | 0 |
| No. evaluated results | 14 |
| Acceptable results % | 100% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or ">=value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT/I/2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 04

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-------------------------------|------------------------|-----------------|---------|-----------------|-------|--------|----------------|------------------------|
| A. Microbiology | | | | | | | | |
| Total Coliforms | MPN/100 mL | 70 | 1.4 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 23 | 1.7 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |
| B. Cations | | | | | | | | |
| K ⁺ | mg/L | 1.35 | 0.60 | Acceptable | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 34.07 | 0.08 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | 21.88 | 0.12 | Acceptable | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | 100.1 | 0.50 | Acceptable | 102.0 | 102.1 | 4.0 | 7 |
| C. Anions | | | | | | | | |
| NO ₃ ⁻ | mg/L | 40.61 | 1.26 | Acceptable | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | 34.38 | 0.64 | Acceptable | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 80.08 | 0.48 | Acceptable | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | 0.29 | 0.21 | Acceptable | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | 0.075 | 1.35 | ## | 0.1 | 0.1 | 0.0 | 2 |
| D. Chemistry/others | | | | | | | | |
| pH | Unit | 7.33 | 1.35 | Acceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | 0.95 | 2.72 | Check for Error | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 357 | 1.44 | Acceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 841 | 0.57 | Acceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | N | | Not Reported | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | N | | Not Reported | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|------|
| No. reported results | 15 |
| No. acceptable results | 14 |
| No. unacceptable results | 0 |
| No. evaluated results | 14 |
| Acceptable results % | 100% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or ">=value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT/I/2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 05

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|

A. Microbiology

| | | | | | | | | |
|-----------------|------------|-----|-----|------------|-------|-------|-----|---|
| Total Coliforms | MPN/100 mL | 166 | 0.2 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 35 | 0.5 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |

B. Cations

| | | | | | | | | |
|------------------|------|------|------|--------------|-------|-------|-----|---|
| K ⁺ | mg/L | N | | Not Reported | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | N | | Not Reported | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | 22.6 | 0.48 | Acceptable | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | 99.2 | 0.73 | Acceptable | 102.0 | 102.1 | 4.0 | 7 |

C. Anions

| | | | | | | | | |
|-------------------------------|------|------|------|-----------------|------|------|-----|---|
| NO ₃ ⁻ | mg/L | 38.5 | 0.00 | Acceptable | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | 33 | 0.13 | Acceptable | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 89 | 0.85 | Acceptable | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | 0.39 | 2.28 | Check for Error | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |

D. Chemistry/others

| | | | | | | | | |
|----------------|------------------------|------|------|--------------|-------|-------|------|----|
| pH | Unit | 7.2 | 0.25 | Acceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | 0.15 | 0.43 | Acceptable | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 344 | 0.12 | Acceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 830 | 0.09 | Acceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | N | | Not Reported | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | N | | Not Reported | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|------|
| No. reported results | 12 |
| No. acceptable results | 12 |
| No. unacceptable results | 0 |
| No. evaluated results | 12 |
| Acceptable results % | 100% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or ">=value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT//2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 06

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|

A. Microbiology

| | | | | | | | | |
|-----------------|------------|-----|-----|------------|-------|-------|-----|---|
| Total Coliforms | MPN/100 mL | 148 | 0.0 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 52 | 0.7 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |

B. Cations

| | | | | | | | | |
|------------------|------|--------|------|------------|-------|-------|-----|---|
| K ⁺ | mg/L | 1.81 | 0.39 | Acceptable | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 35.16 | 0.31 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | 21.38 | 0.12 | Acceptable | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | 104.08 | 0.50 | Acceptable | 102.0 | 102.1 | 4.0 | 7 |

C. Anions

| | | | | | | | | |
|-------------------------------|------|-------|------|--------------|------|------|-----|---|
| NO ₃ ⁻ | mg/L | 39.01 | 0.30 | Acceptable | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | 30.89 | 0.65 | Acceptable | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 83.3 | 0.00 | Acceptable | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | 0.33 | 1.04 | Acceptable | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |

D. Chemistry/others

| | | | | | | | | |
|----------------|------------------------|--------|------|--------------|-------|-------|------|----|
| pH | Unit | 7.29 | 0.86 | Acceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | 0.2 | 0.24 | Acceptable | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 347.67 | 0.32 | Acceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 854 | 1.13 | Acceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | N | | Not Reported | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | N | | Not Reported | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|------|
| No. reported results | 14 |
| No. acceptable results | 14 |
| No. unacceptable results | 0 |
| No. evaluated results | 14 |
| Acceptable results % | 100% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or ">=value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT//2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 07

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|
|-----------|------|-----------------|---------|------------|------|--------|----------------|------------------------|

A. Microbiology

| | | | | | | | | |
|-----------------|------------|---|--|--------------|-------|-------|-----|---|
| Total Coliforms | MPN/100 mL | N | | Not Reported | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | N | | Not Reported | 37.4 | 40.7 | 1.4 | 8 |

B. Cations

| | | | | | | | | |
|------------------|------|-------|------|--------------|-------|-------|-----|---|
| K ⁺ | mg/L | 1.63 | 0.00 | Acceptable | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 31.7 | 0.91 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | 24.5 | 1.41 | Acceptable | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | 134.5 | 8.18 | Unacceptable | 102.0 | 102.1 | 4.0 | 7 |

C. Anions

| | | | | | | | | |
|-------------------------------|------|------|------|--------------|------|------|-----|---|
| NO ₃ ⁻ | mg/L | N | | Not Reported | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | 29.2 | 1.27 | Acceptable | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 82.5 | 0.12 | Acceptable | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | N | | Not Reported | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |

D. Chemistry/others

| | | | | | | | | |
|----------------|------------------------|-------|-------|--------------|-------|-------|------|----|
| pH | Unit | 6.6 | 7.60 | Unacceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | 0.68 | 1.66 | Acceptable | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 436.7 | 10.99 | Unacceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 916 | 3.83 | Unacceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | 746.6 | 4.46 | Unacceptable | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | 163.2 | 0.65 | ## | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|-----|
| No. reported results | 12 |
| No. acceptable results | 6 |
| No. unacceptable results | 5 |
| No. evaluated results | 11 |
| Acceptable results % | 55% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or "≥value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT//2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 08

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratories reporting |
|-------------------------------|------------------------|-----------------|---------|-----------------|-------|--------|----------------|------------------------|
| A. Microbiology | | | | | | | | |
| Total Coliforms | MPN/100 mL | 79 | 1.2 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 23 | 1.7 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |
| B. Cations | | | | | | | | |
| K ⁺ | mg/L | 2.35 | 1.54 | Acceptable | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 37.26 | 1.05 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | 19.11 | 1.24 | Acceptable | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | 108.42 | 1.60 | Acceptable | 102.0 | 102.1 | 4.0 | 7 |
| C. Anions | | | | | | | | |
| NO ₃ ⁻ | mg/L | 37.6 | 0.54 | Acceptable | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | 32.64 | 0.00 | Acceptable | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 89.11 | 0.87 | Acceptable | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | 0.25 | 0.62 | Acceptable | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |
| D. Chemistry/others | | | | | | | | |
| pH | Unit | 7.41 | 2.33 | Check for Error | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | N | | Not Reported | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 346 | 0.12 | Acceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 828 | 0.00 | Acceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | 529.9 | 0.22 | Acceptable | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | 230 | 0.66 | ## | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|------|
| No. reported results | 15 |
| No. acceptable results | 14 |
| No. unacceptable results | 0 |
| No. evaluated results | 14 |
| Acceptable results % | 100% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or ">=value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|---------------------|-----------------------------------|
| Sample: | PT/I/2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 09

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratory reporting |
|-----------|------|-----------------|---------|------------|------|--------|----------------|----------------------|
|-----------|------|-----------------|---------|------------|------|--------|----------------|----------------------|

A. Microbiology

| | | | | | | | | |
|------------------------|-------------------|--------------|------------|-------------------|--------------|--------------|------------|----------|
| Total Coliforms | MPN/100 mL | 172.3 | 0.3 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 41.6 | 0.1 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |

B. Cations

| | | | | | | | | |
|------------------------|-------------|----------|--|---------------------|--------------|--------------|------------|----------|
| K⁺ | mg/L | N | | Not Reported | 1.7 | 2.2 | 0.5 | 7 |
| Na⁺ | mg/L | N | | Not Reported | 33.8 | 34.3 | 2.8 | 8 |
| Mg²⁺ | mg/L | N | | Not Reported | 21.2 | 21.6 | 2.0 | 7 |
| Ca²⁺ | mg/L | N | | Not Reported | 102.0 | 102.1 | 4.0 | 7 |

C. Anions

| | | | | | | | | |
|------------------------------------|-------------|----------|--|---------------------|-------------|-------------|------------|----------|
| NO₃⁻ | mg/L | N | | Not Reported | 38.5 | 38.5 | 1.7 | 7 |
| SO₄²⁻ | mg/L | N | | Not Reported | 32.2 | 32.6 | 2.7 | 7 |
| Cl⁻ | mg/L | N | | Not Reported | 82.5 | 83.3 | 6.7 | 9 |
| F⁻ | mg/L | N | | Not Reported | 0.3 | 0.3 | 0.0 | 6 |
| Br⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |

D. Chemistry/others

| | | | | | | | | |
|-----------------------|------------------------------|--------------|-------------|---------------------|--------------|--------------|-------------|-----------|
| pH | Unit | 7.22 | 0.00 | Acceptable | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | N | | Not Reported | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO₃ | N | | Not Reported | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | N | | Not Reported | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | 518.8 | 0.00 | Acceptable | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO₃ | N | | Not Reported | 196.5 | 196.3 | 51.1 | 3 |

| | |
|--------------------------|------|
| No. reported results | 4 |
| No. acceptable results | 4 |
| No. unacceptable results | 0 |
| No. evaluated results | 4 |
| Acceptable results % | 100% |

Notes

1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or "≥value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

| | |
|--------------|-----------------------------------|
| Sample: | PT//2011 |
| Sample Date: | 21-Mar-2011 |
| Site: | Wadi Essier Water Treatment Plant |

Laboratory Code: 10

| Parameter | Unit | Reported result | z value | Evaluation | Mean | Median | F-pseudo sigma | Laboratory reporting limit |
|-------------------------------|------------------------|-----------------|---------|-----------------|-------|--------|----------------|----------------------------|
| A. Microbiology | | | | | | | | |
| Total Coliforms | MPN/100 mL | 220 | 0.7 | Acceptable | 126.2 | 148.0 | 1.7 | 9 |
| E. Coli | MPN/100 mL | 49 | 0.6 | Acceptable | 37.4 | 40.7 | 1.4 | 8 |
| B. Cations | | | | | | | | |
| K ⁺ | mg/L | 2.4 | 1.65 | Acceptable | 1.7 | 2.2 | 0.5 | 7 |
| Na ⁺ | mg/L | 36.1 | 0.64 | Acceptable | 33.8 | 34.3 | 2.8 | 8 |
| Mg ²⁺ | mg/L | N | | Not Reported | 21.2 | 21.6 | 2.0 | 7 |
| Ca ²⁺ | mg/L | N | | Not Reported | 102.0 | 102.1 | 4.0 | 7 |
| C. Anions | | | | | | | | |
| NO ₃ ⁻ | mg/L | 37.5 | 0.60 | Acceptable | 38.5 | 38.5 | 1.7 | 7 |
| SO ₄ ²⁻ | mg/L | N | | Not Reported | 32.2 | 32.6 | 2.7 | 7 |
| Cl ⁻ | mg/L | 91.7 | 1.25 | Acceptable | 82.5 | 83.3 | 6.7 | 9 |
| F ⁻ | mg/L | N | | Not Reported | 0.3 | 0.3 | 0.0 | 6 |
| Br ⁻ | mg/L | N | | Not Reported | 0.1 | 0.1 | 0.0 | 2 |
| D. Chemistry/others | | | | | | | | |
| pH | Unit | 7.02 | 2.45 | Check for Error | 7.24 | 7.22 | 0.08 | 10 |
| Turbidity | NTU | 0.354 | 0.37 | Acceptable | 0.39 | 0.26 | 0.25 | 7 |
| Total Hardness | mg/L CaCO ₃ | 330 | 1.80 | Acceptable | 347.6 | 345.0 | 8.3 | 9 |
| EC | µs/cm at 25 °C | 689 | 6.05 | Unacceptable | 813.5 | 828.0 | 23.0 | 9 |
| TDS | mg/L | N | | Not Reported | 537.3 | 518.8 | 51.1 | 5 |
| Alkalinity | mg/L CaCO ₃ | N | | Not Reported | 196.5 | 196.3 | 51.1 | 3 |

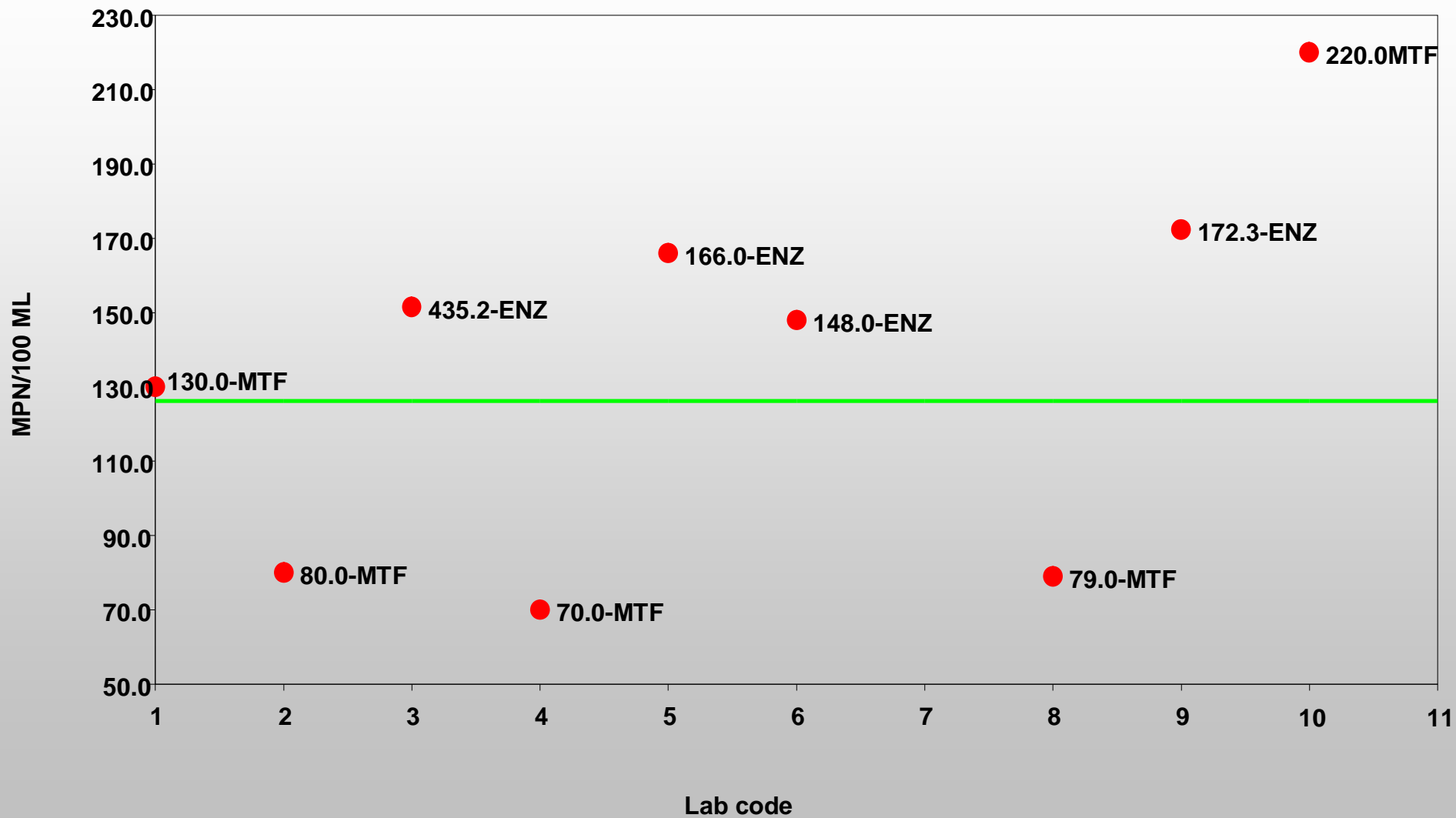
| | |
|--------------------------|-----|
| No. reported results | 10 |
| No. acceptable results | 9 |
| No. unacceptable results | 1 |
| No. evaluated results | 10 |
| Acceptable results % | 90% |

Notes

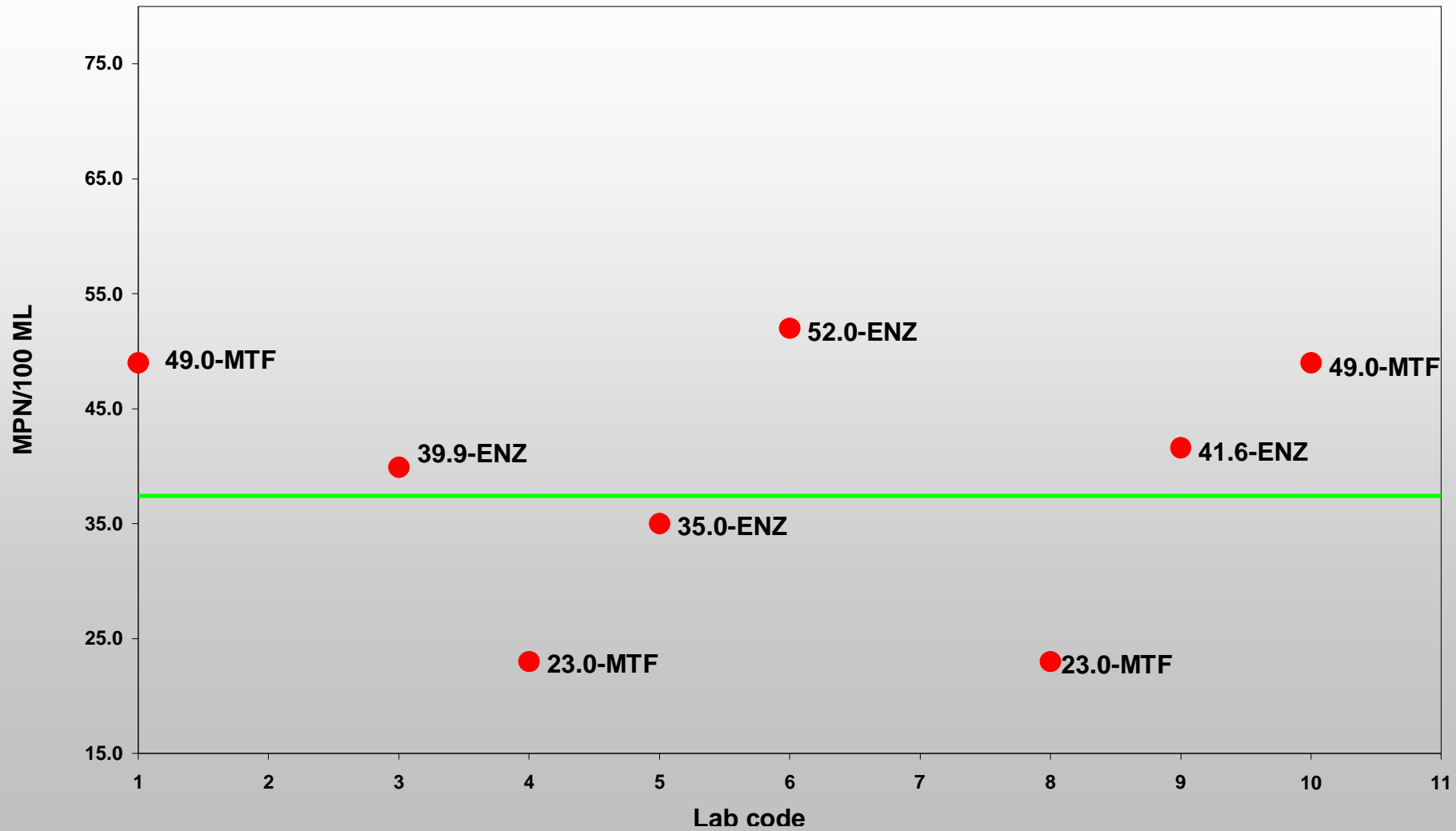
1. N: Not Reported
2. Statistical analysis performed excluding outliers (Grubbs test 5% risk) and less than values carried at 1/2 the reporting limit.
3. Microbiology results reported as ">value" or ">=value" were considered in the evaluation and included in the calculation as the laboratory result.
4. Limits for microbiology calculated using log transformed data values
5. Acceptable results % calculated by dividing the number of acceptable results by the number of evaluated results

CHARTS

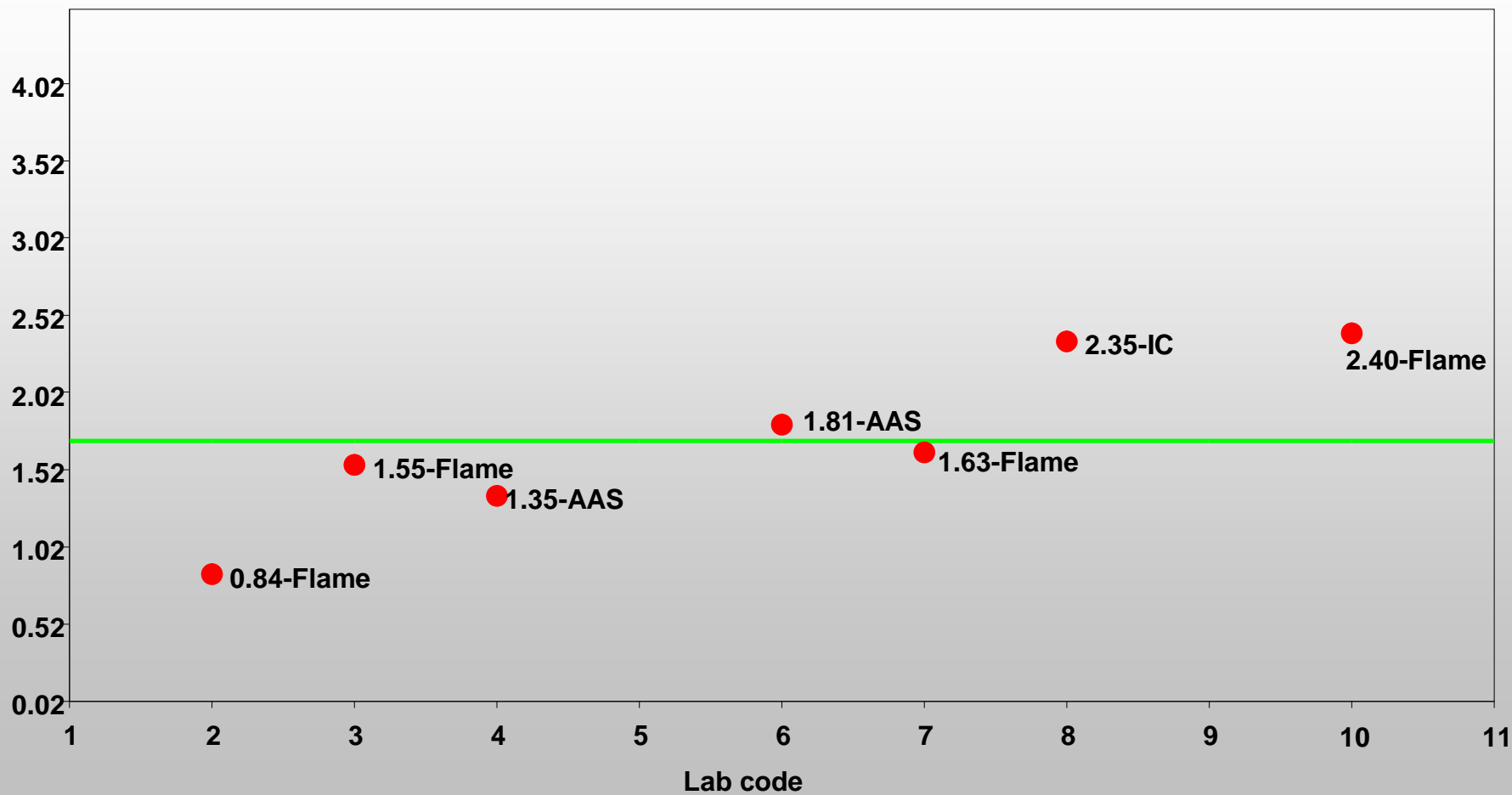
Jordan Split Sample Program
PT/1/2011 - March 2011
Total Coliforms



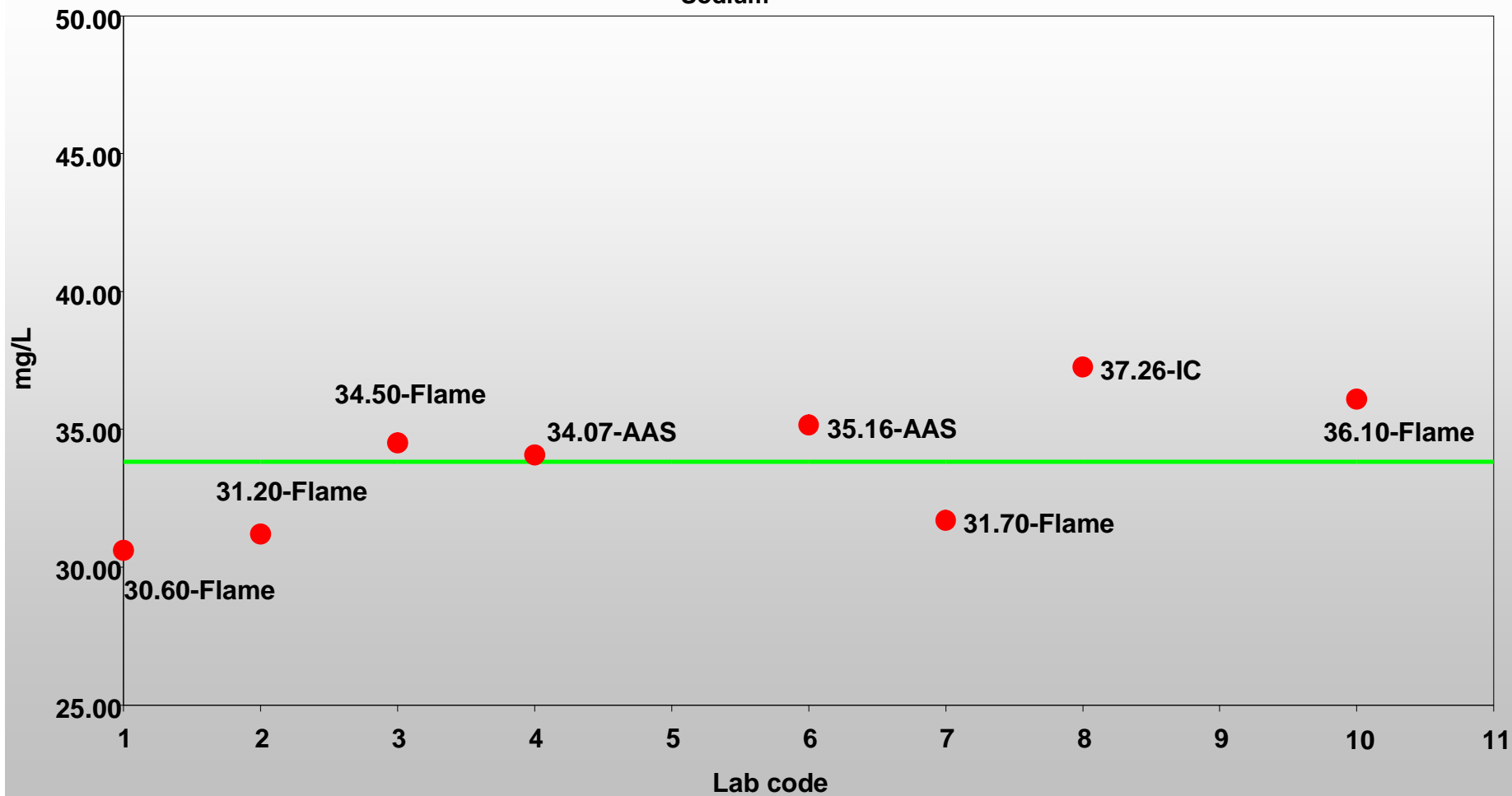
Jordan Split Sample Program
PT/1/2011 - March 2011
E. Coli



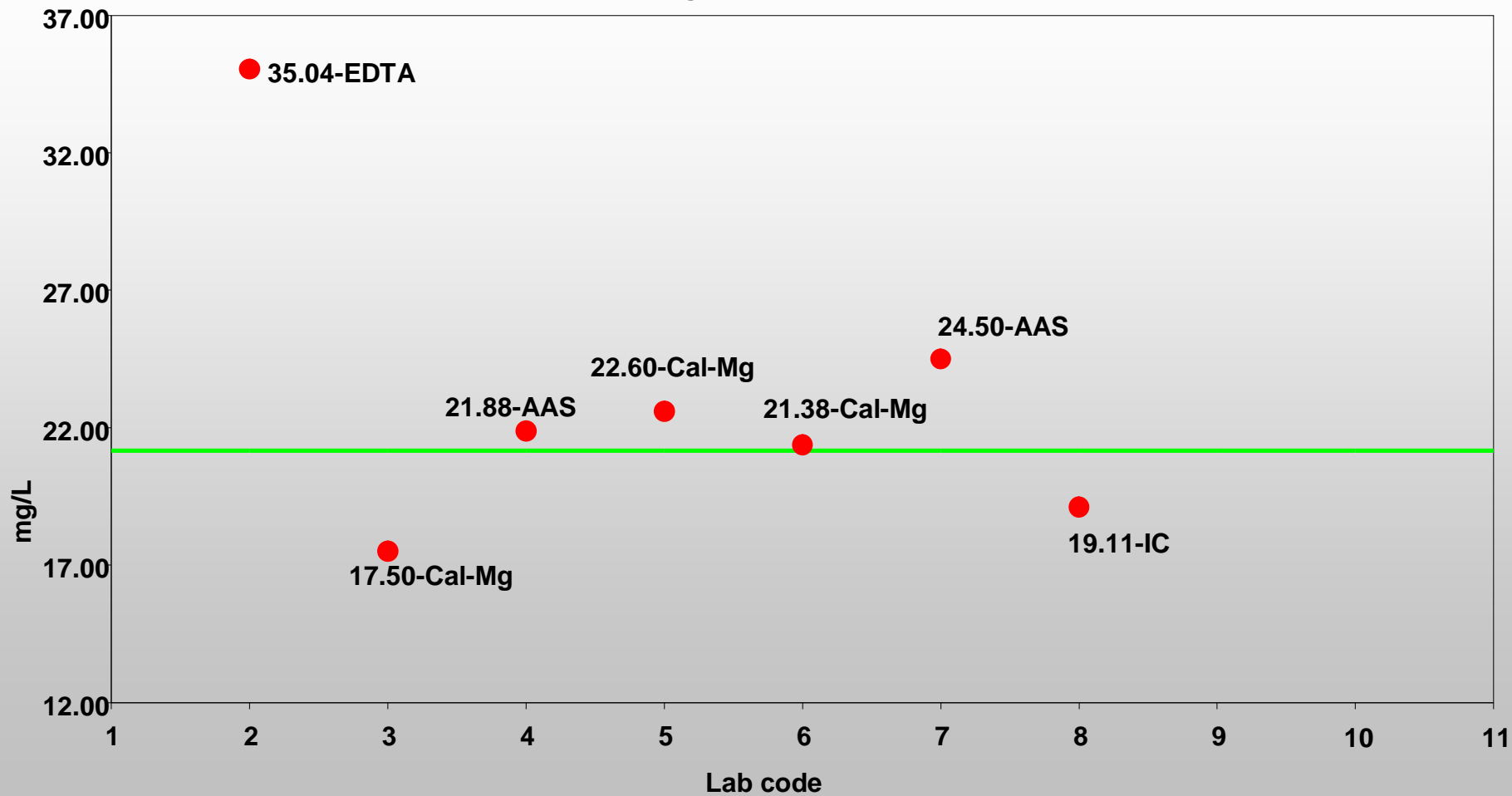
Jordan Split Sample Program
PT/1/2011 - March 2011
Potassium



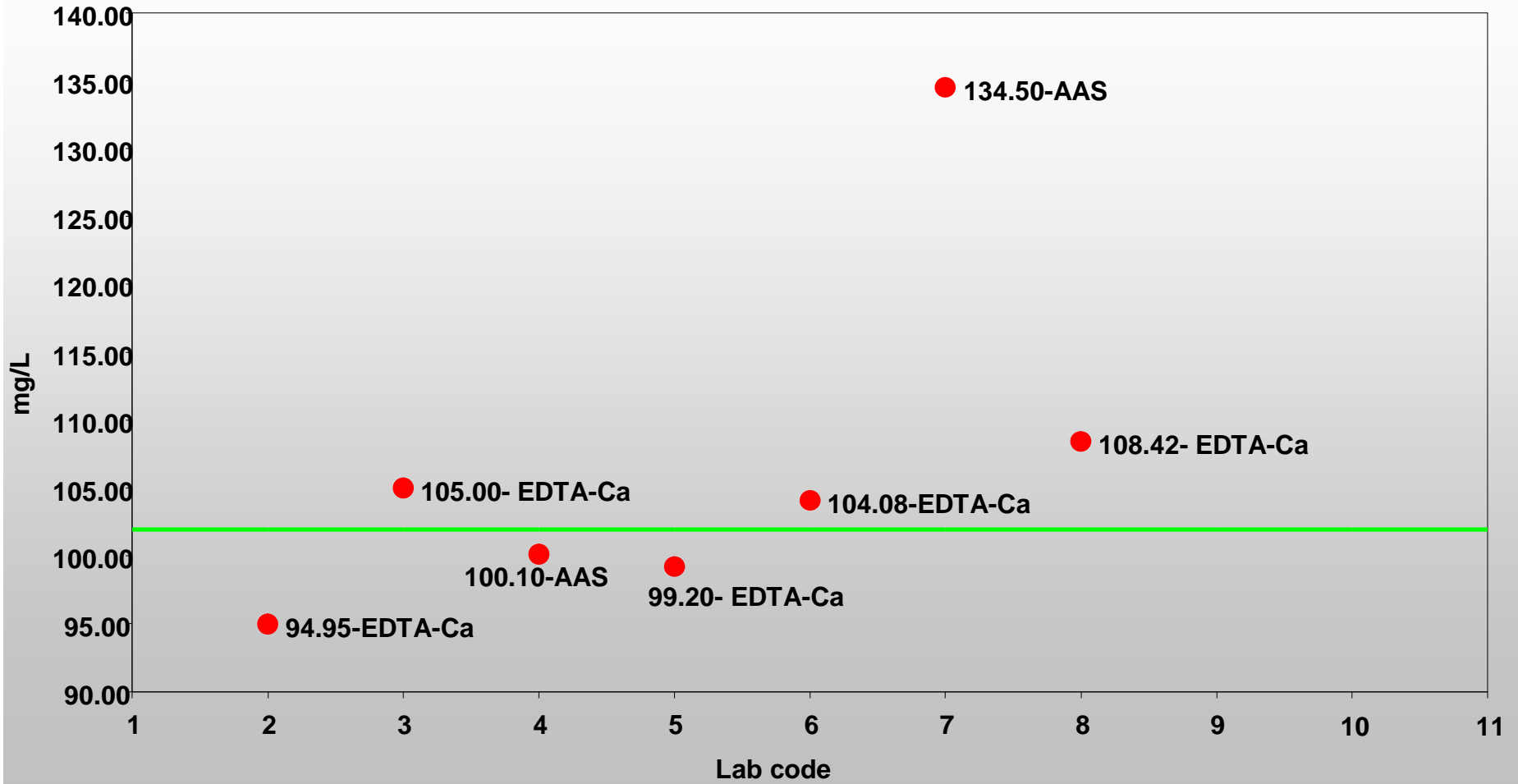
Jordan Split Sample Program
PT/1/2011 - March 2011
Sodium



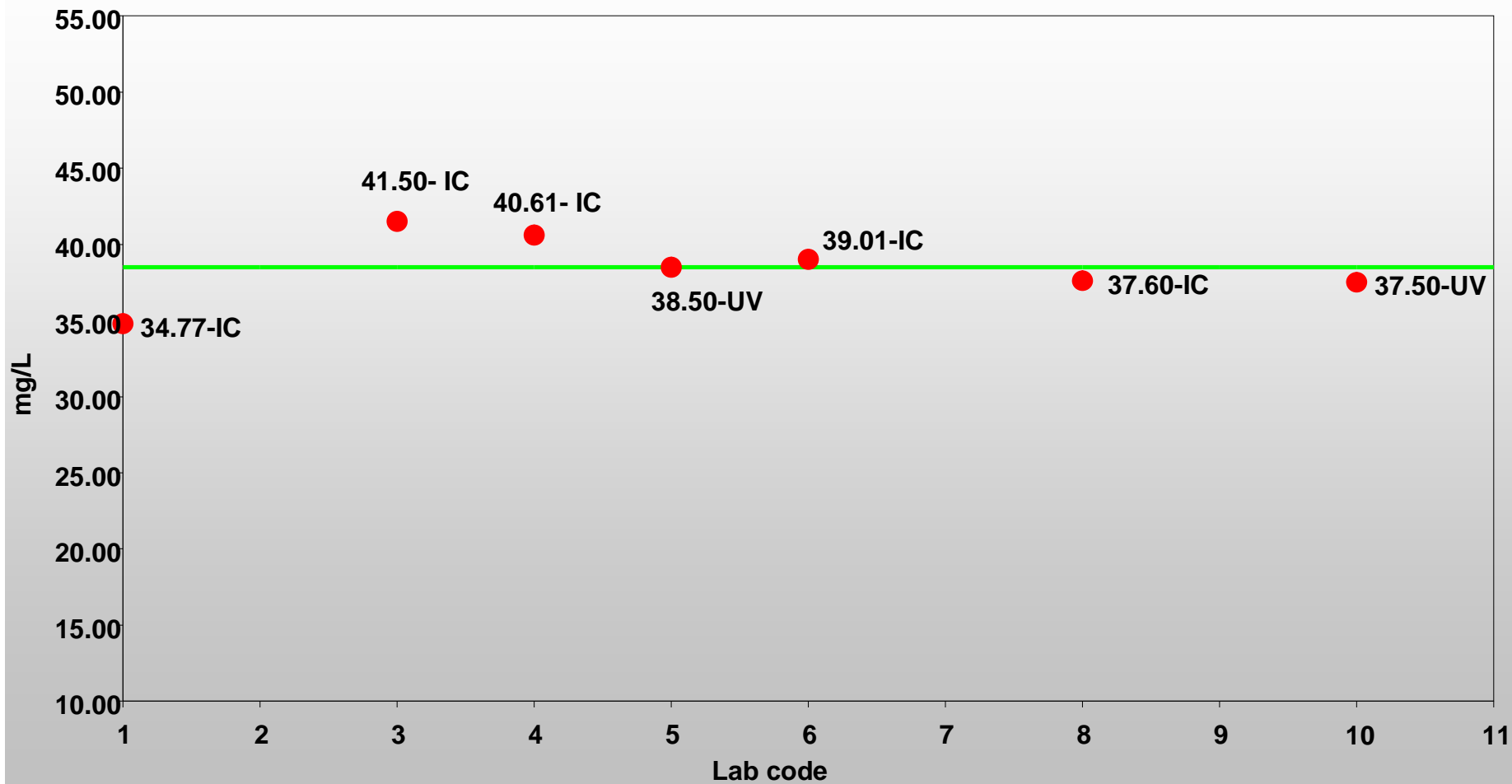
Jordan Split Sample Program
PT/1/2011 - March 2011
Magnesium



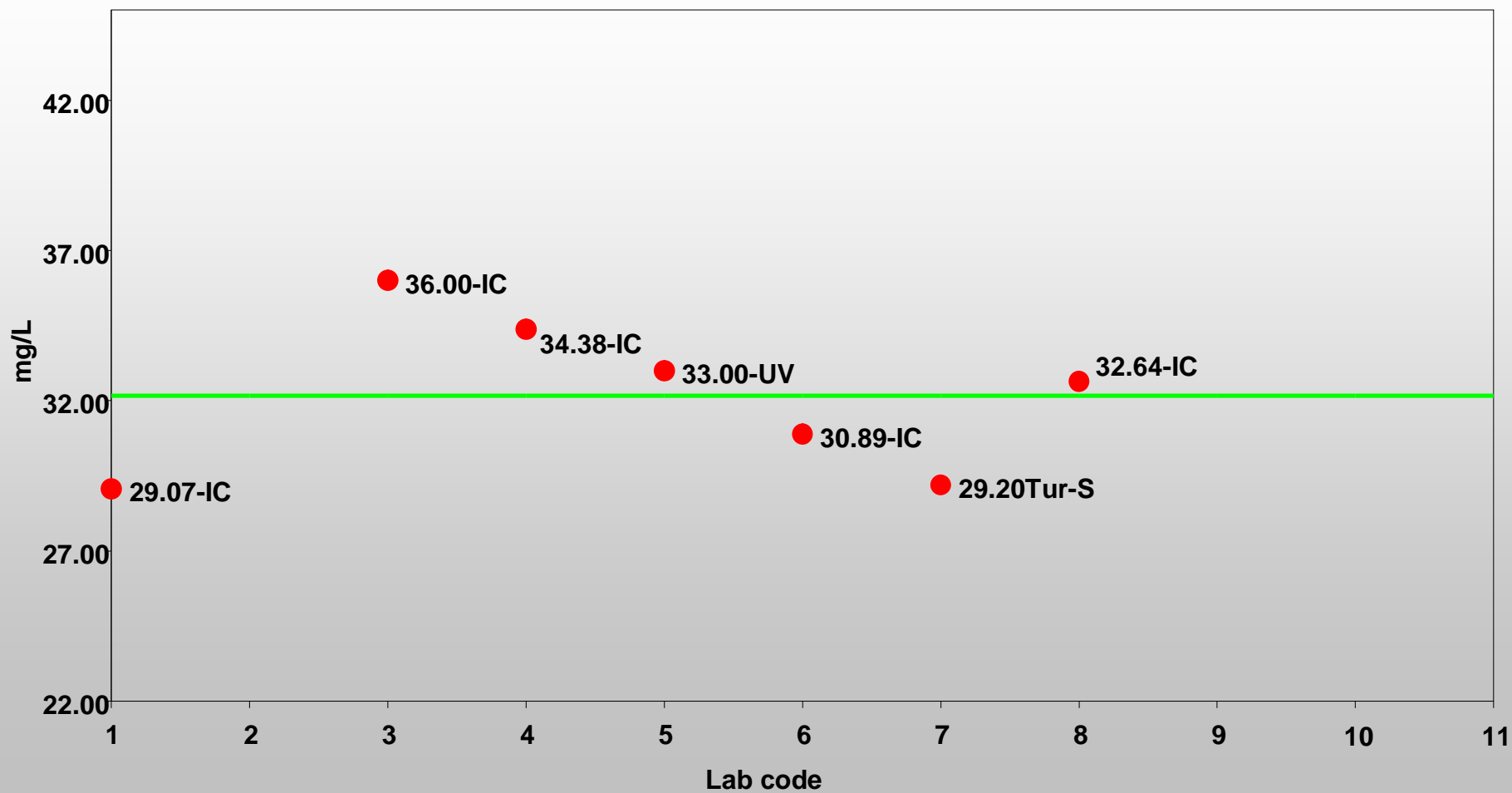
Jordan Split Sample Program
PT/1/2011 - March 2011
Calcium



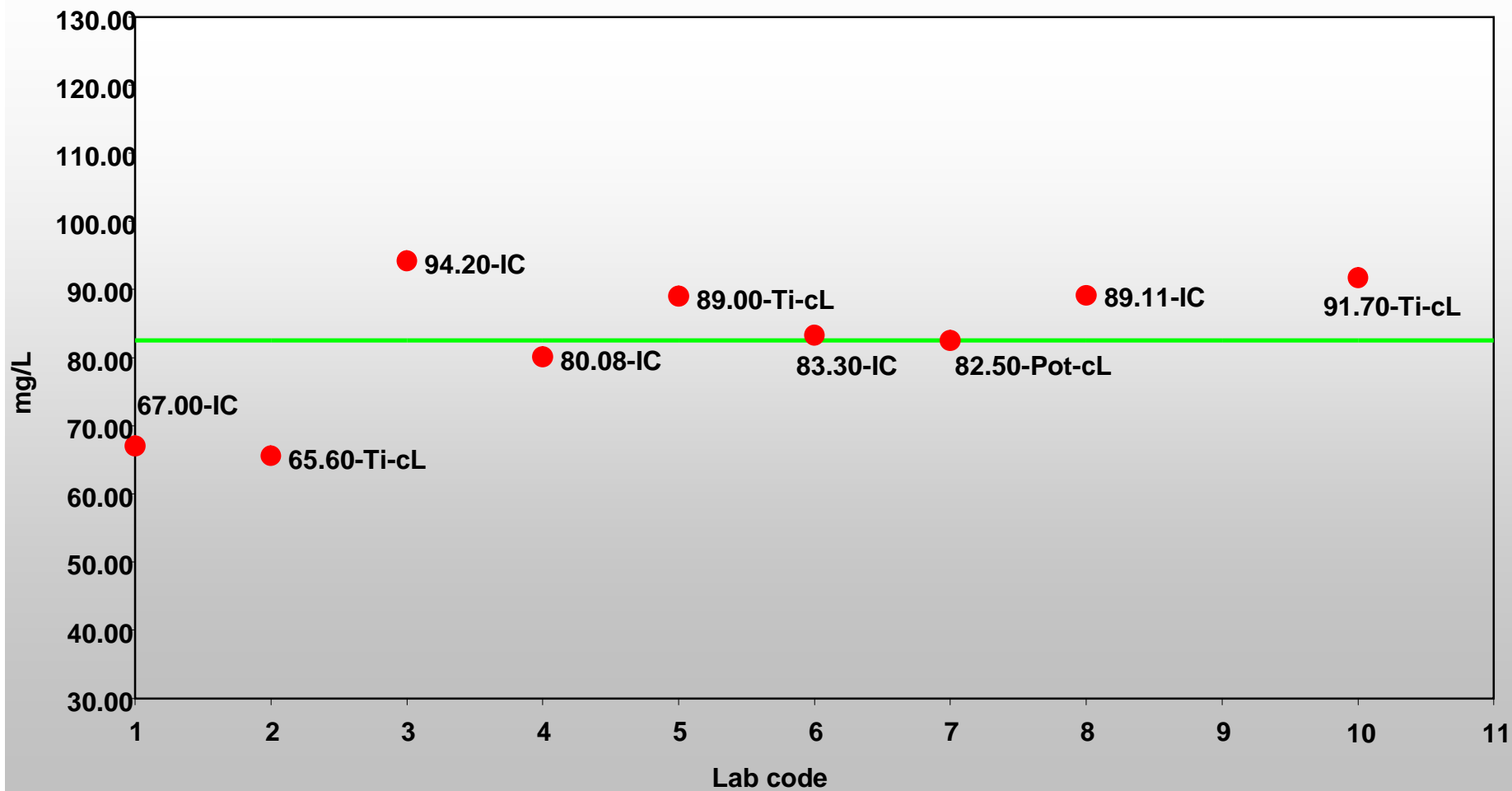
Jordan Split Sample Program
PT/1/2011 - March 2011
Nitrate



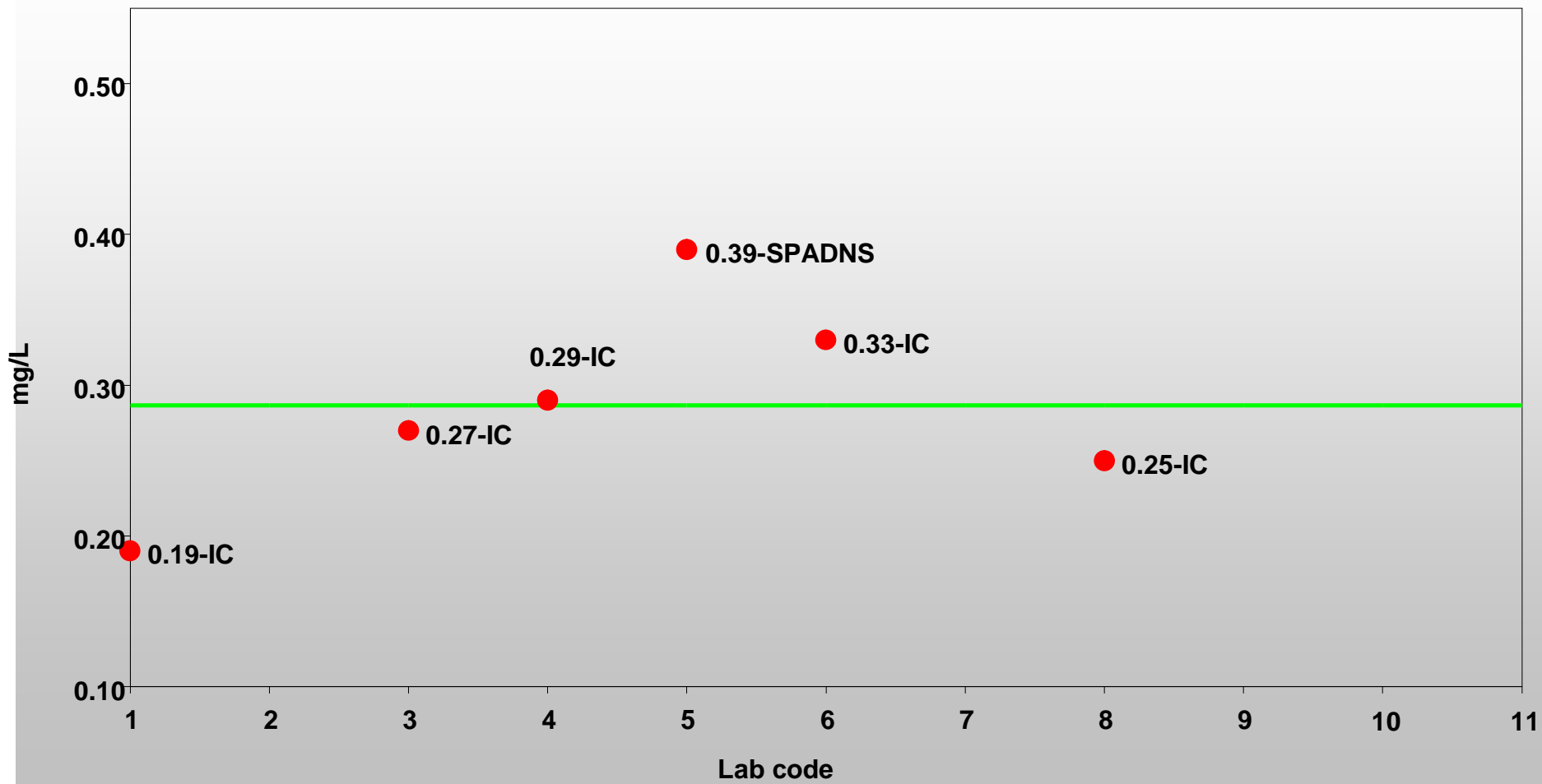
Jordan Split Sample Program
PT/1/2011 - March 2011
Sulfate



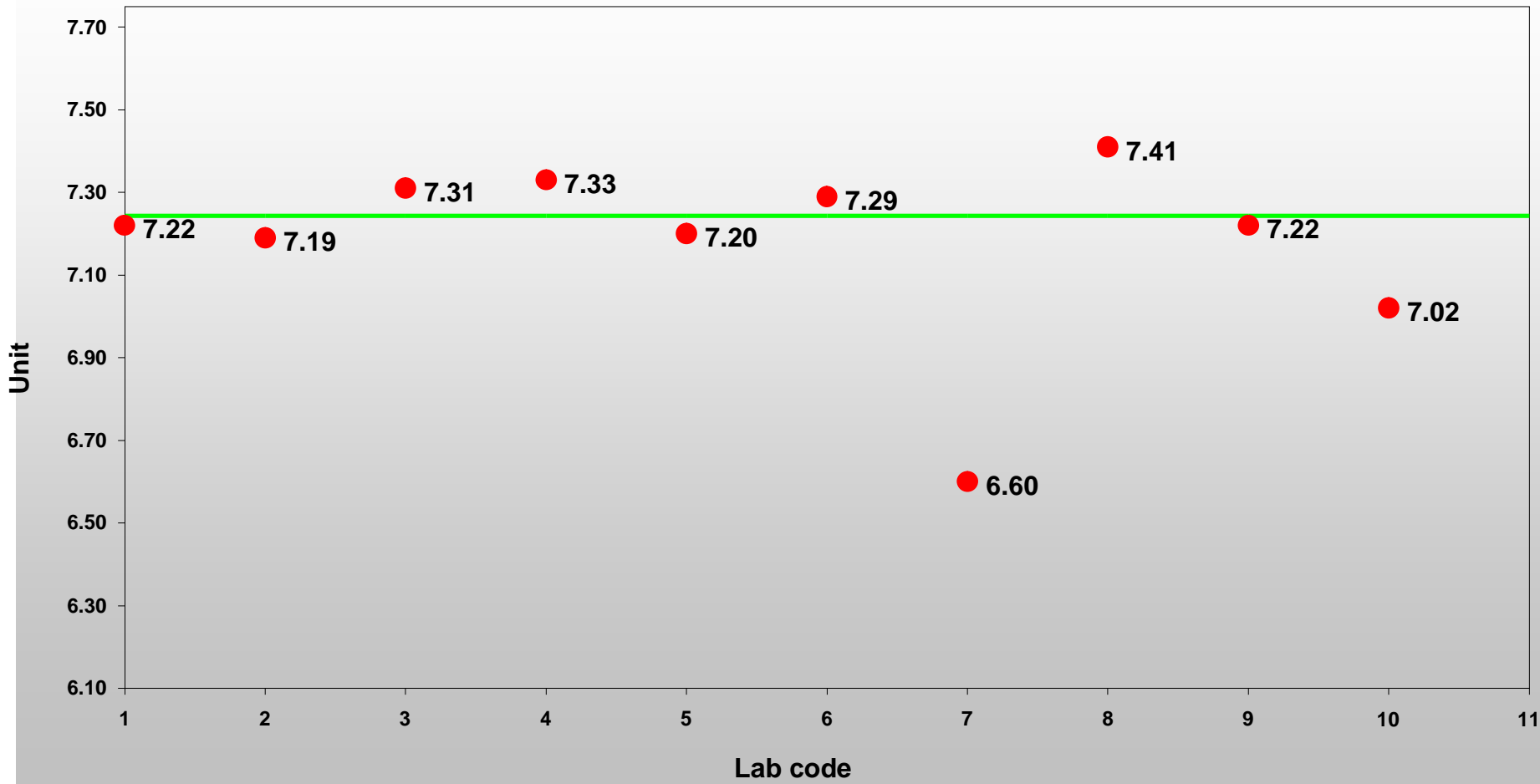
Jordan Split Sample Program
PT/1/2011 - March 2011
Chloride



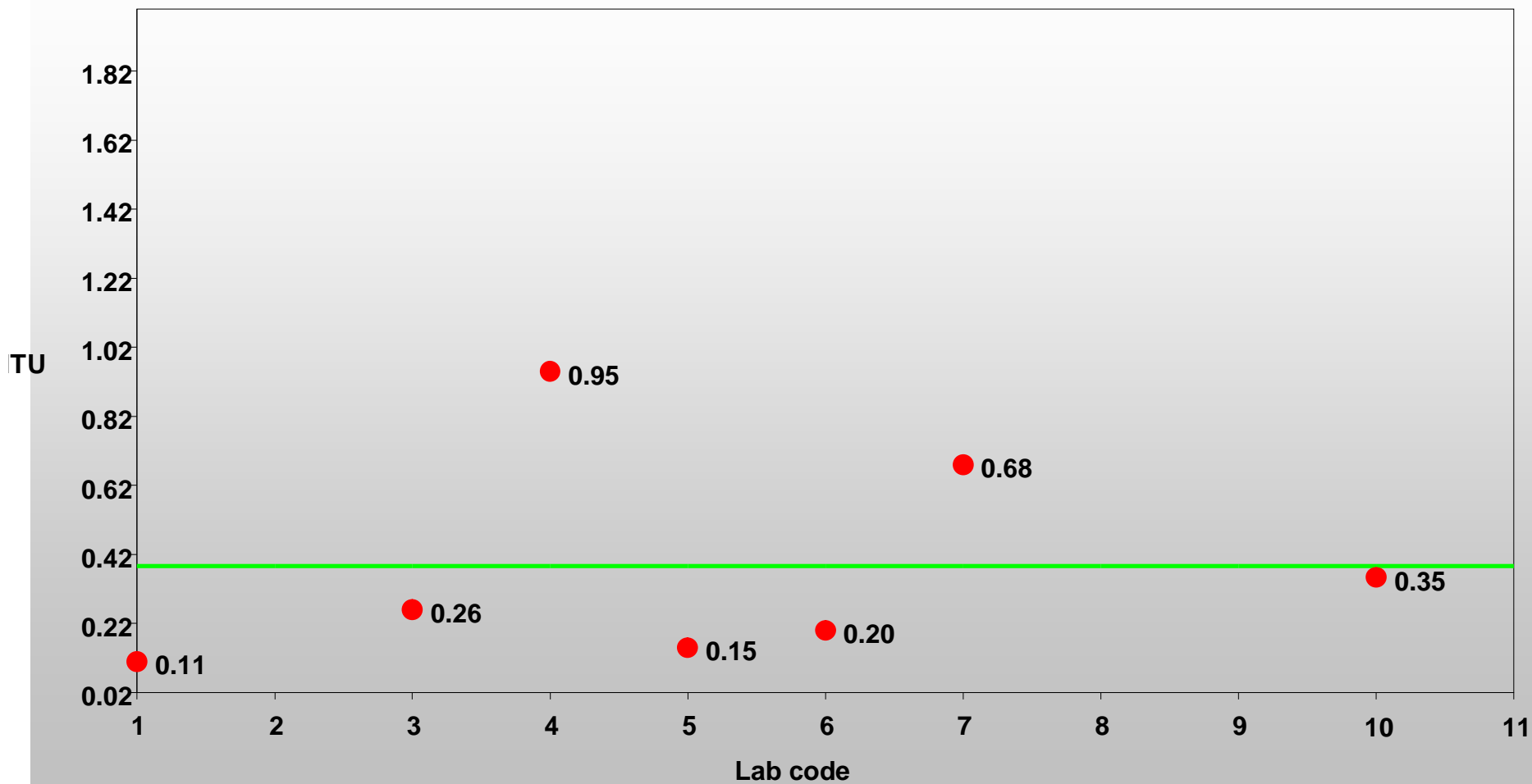
Jordan Split Sample Program
PT/1/2011 - March 2011
Fluoride



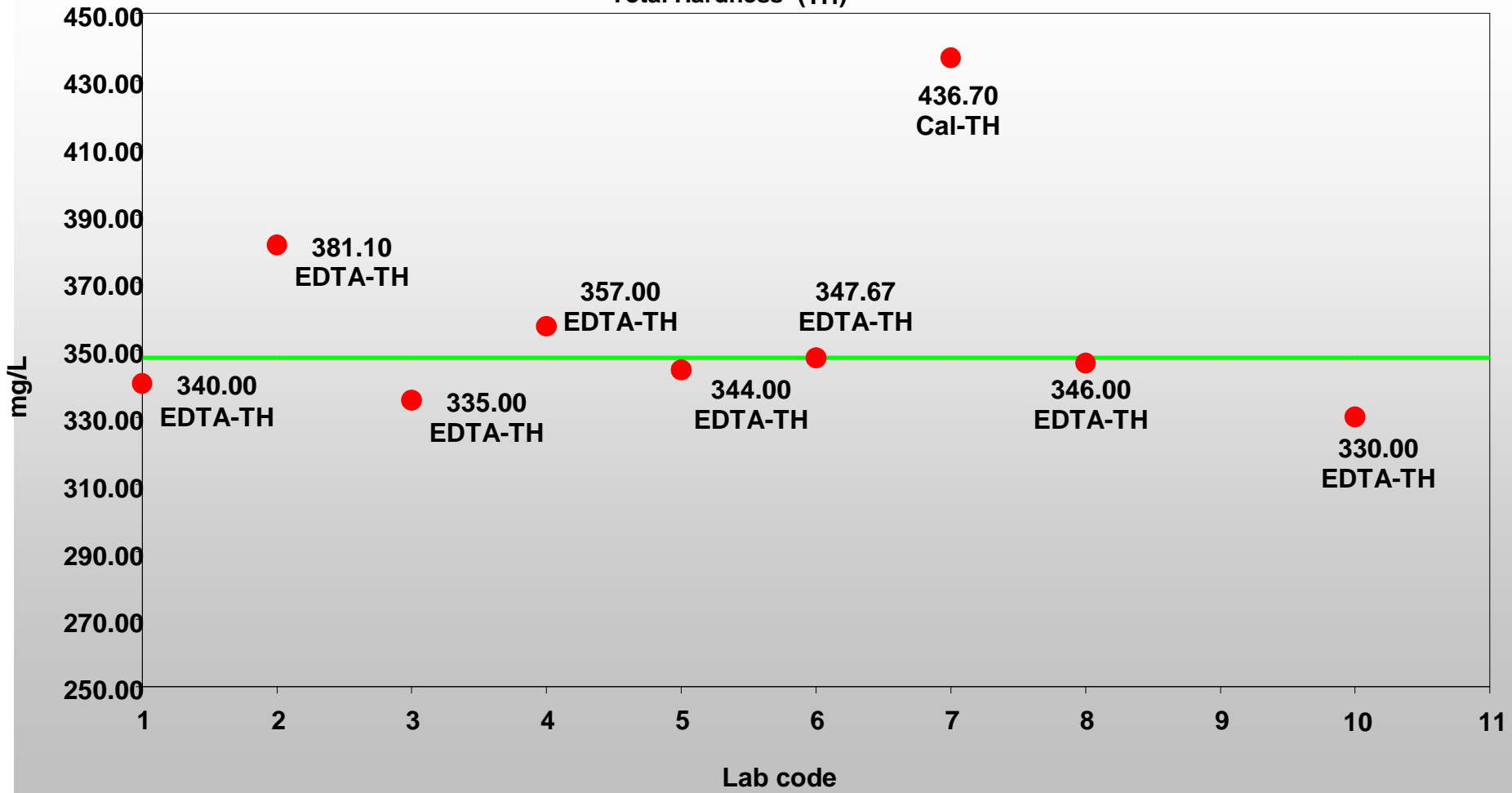
Jordan Split Sample Program
PT/1/2011 - March 2011
PH



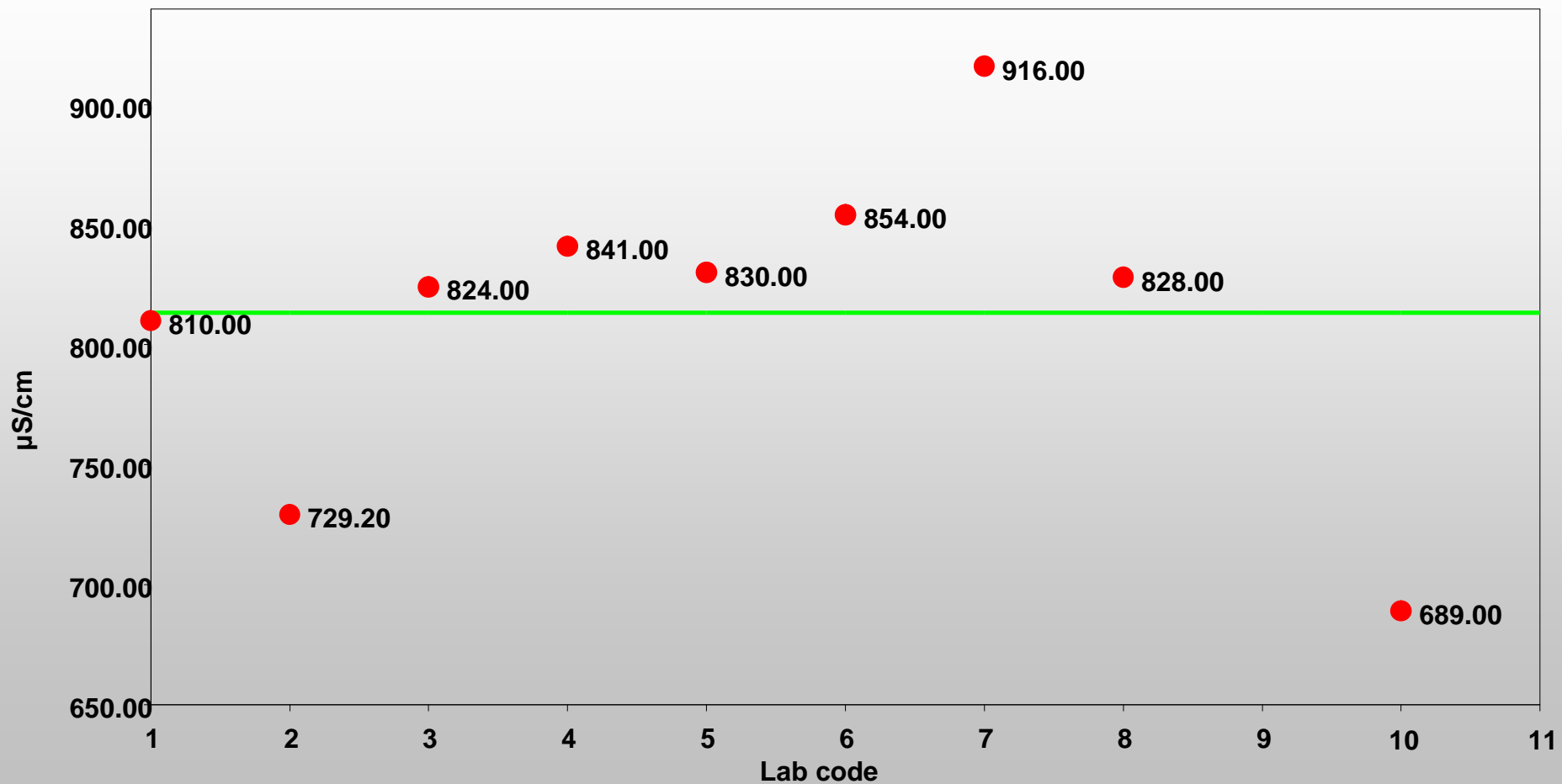
Jordan Split Sample Program
PT/1/2011 - March 2011
Turbidity



Jordan Split Sample Program
PT/1/2011 - March 2011
Total Hardness (TH)



Jordan Split Sample Program
PT/1/2011 - March 2011
Electrical Conductivity (EC)



Jordan Split Sample Program
PT/1/2011 - March 2011
Total Dissolved Solids (TDS)

