## Gunter, Jason

**From:** Seabourne, Rocky <rseabourne@doerun.com>
**Sent:** Monday, August 31, 2015 3:43 PM
**To:** Gunter, Jason
**Cc:** Yingling, Mark; Neaville, Chris; Montgomery, Michael; Ty Morris
**Subject:** Federal July 2015 Progress Report
**Attachments:** Federal_ProgressReport_07-31.pdf; 6 - Remediation Air Report - June 2015.pdf

**Categories:** Red Category

Jason,
Please find the attached progress report for the Federal Mine Tailings site for the reporting period of July 1, 2015-July 31, 2015. If you should have any questions please let me know.

Sincerely,

**ROCKY SEABOURNE**
General Supervisor Land & Remediation
Office: 573-244-8136
Cell: 573-325-5425
Fax: 573-244-8179

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THE
DOE RUN
COMPANY
Remediation Group

**Rocky Seabourne**
**General Supervisor Land & Remediation rseabourne@doerun.com**

August 31, 2015

Mr. Jason Gunter Remedial Project Manager U.S. Environmental Protection Agency
Region 7 - Superfund Branch 11201 Renner Blvd.
Lenexa, KS 66219

**Re: The Doe Run Company - Federal Mine Tailings Site Monthly Progress Report**

Dear Mr. Gunter:

As required by Article XVII, Paragraph 73 of the Administrative Order on Consent (Docket No.VII- 97-F-0009) for the referenced project and on behalf of The Doe Run Company, the progress report for the period July 1, 2015 through July 31, 2015 is enclosed. If you have any questions or comments, please call me at 573-244-8136.

Sincerely,

Rocky Seabourne

General Supervisor Land & Remediation

c: Mark Yingling - TDRC (electronic only)
Chris Neaville - TDRC (electronic only) Michael Montgomery - TDRC (electronic only) Martin Kator - MDNR DSP Brandon Wiles - MDNR HWP Ty Morris - Barr Engineering

**35 Iron County Rd. #1, Viburnum, MO 65566**
**Telephone: (573) 244-8136**

Federal Mine Tailings Site
Park Hills, Missouri
Monthly Progress Report
Period: July 1, 2015 – July 31, 2015

1. Actions Performed or Completed This Period:
   a. Work continued on the development of the Removal Action Report.
   b. Work continued on the design modifications to improve drainage in the northwest section of the Off Road Vehicle (ORV) Riding Area.
   c. Given the nature of the work remaining at the site, The Doe Run Company would like to request a reduction in the frequency of the progress reports to quarterly. The next progress report that would be submitted for this site would be for July, August, and September.

2. Data and Results Received This Period:
   a. During this period, the ambient air monitoring samples for June were processed and the Ambient Air Monitoring Report for June 2015 was completed and is attached.

3. Planned Activities for Next Period:
   a. Address any comments received from MDNR-DSP to the Post-Removal Site Control Plan for the site.
   b. Continue developing the Removal Action Report.
   c. Continue the development of the design modifications to improve drainage in the northwest section of the ORV Riding Area.

4. Issues or Problems Encountered and the Resolution:
   a. None.

# Monthly Ambient Air Monitoring Report

The Doe Run Company
Old Lead Belt Sites:
Federal, Rivermines, National, and Leadwood

## June-2015

SUITE 300
1801 PARK 270 DRIVE
ST. LOUIS, MO 63146

## Federal Site

Sample Results for **June-2015**

| | St. Joe (Ballfields) | | Big River#4 | | Water Treatment Plant | |
|---|---|---|---|---|---|---|
| Sample Date | **TSP** ug/m3 | **Lead** ug/m3 | **TSP** ug/m3 | **Lead** ug/m3 | **TSP** ug/m3 | **Lead** ug/m3 |
| 6/1/15 | 23 | 0.007 | 28 | 0.007 | 25 | 0.007 |
| 6/2/15 | invalid | invalid | 15 | 0.007 | 12 | 0.048 |
| 6/3/15 | 22 | 0.007 | 17 | 0.007 | 19 | 0.007 |
| 6/4/15 | 19 | 0.007 | 16 | 0.007 | 20 | 0.000 |
| 6/5/15 | 19 | 0.007 | 19 | 0.007 | 23 | 0.007 |
| 6/8/15 | 23 | 0.007 | 22 | 0.007 | 20 | 0.021 |
| 6/9/15 | 30 | 0.007 | 30 | 0.007 | invalid | invalid |
| 6/10/15 | 32 | 0.007 | 26 | 0.007 | 34 | 0.007 |
| 6/11/15 | 40 | 0.007 | 34 | 0.007 | 39 | 0.007 |
| 6/12/15 | 30 | 0.014 | 18 | 0.007 | 35 | 0.028 |
| 6/15/15 | 16 | 0.007 | 14 | 0.007 | 19 | 0.000 |
| 6/16/15 | 19 | 0.007 | 15 | 0.027 | 5 | 0.021 |
| 6/17/15 | 45 | 0.007 | 30 | 0.007 | 35 | 0.007 |
| 6/18/15 | 32 | 0.007 | 31 | 0.000 | 32 | 0.007 |
| 6/19/15 | 17 | 0.000 | 17 | 0.007 | 15 | 0.000 |
| 6/22/15 | 72 | 0.007 | 73 | 0.007 | 76 | 0.014 |
| 6/23/15 | 46 | 0.021 | 44 | 0.021 | 49 | 0.056 |
| 6/24/15 | 70 | 0.007 | 61 | 0.007 | 63 | 0.021 |
| 6/25/15 | 44 | 0.049 | 31 | 0.007 | 35 | 0.014 |
| 6/26/15 | 16 | 0.007 | 13 | 0.007 | 14 | 0.007 |
| 6/29/15 | 34 | 0.021 | 22 | 0.021 | 56 | 0.056 |
| 6/30/15 | 48 | 0.014 | 51 | 0.020 | 49 | 0.021 |

| | | | |
|---|---|---|---|
| Monthly Avg. TSP | 33 | 28 | 32 |
| Monthly Avg. Pb | 0.011 | 0.009 | 0.017 |
| May-15 | 0.008 | 0.009 | 0.011 |
| Apr-15 | 0.011 | 0.035 | 0.027 |
| **Rolling 3-Month** | **0.010** | **0.018** | **0.018** |

*Three month rolling average must be less than 0.15 ug/m3*

| | Big River QA | |
|---|---|---|
| Sample Date | **TSP** ug/m3 | **Lead** ug/m3 |
| 6/2/15 | 15 | 0.007 |
| 6/5/15 | 18 | 0.007 |
| 6/9/15 | 30 | 0.007 |
| 6/11/15 | 37 | 0.007 |
| 6/16/15 | 13 | 0.007 |
| 6/18/15 | 32 | 0.007 |
| 6/23/15 | 44 | 0.021 |
| 6/25/15 | 33 | 0.007 |
| 6/30/15 | 37 | 0.021 |

**Notes**

St. Joe:
6/2, <23hr run time.

Water Treatment Plant:
6/9, <23hr run time, GFI shorted out.

# Rivermines

Sample Results for **June-2015**

| | Big River #4 | | Rivermines South #1 | | Rivermines North #2 | | Rivermines East #3 | |
|---|---|---|---|---|---|---|---|---|
| Sample Date | **TSP** ug/m3 | **Lead** ug/m3 | **TSP** ug/m3 | **Lead** ug/m3 | **TSP** ug/m3 | **Lead** ug/m3 | **TSP** ug/m3 | **Lead** ug/m3 |
| 6/1/15 | 28 | 0.007 | 35 | 0.098 | 16 | 0.007 | 25 | 0.007 |
| 6/2/15 | 15 | 0.007 | 16 | 0.027 | 11 | 0.000 | 12 | 0.048 |
| 6/3/15 | 17 | 0.007 | 17 | 0.007 | 14 | 0.014 | 19 | 0.007 |
| 6/4/15 | 16 | 0.007 | invalid | invalid | 20 | 0.028 | 20 | 0.000 |
| 6/5/15 | 19 | 0.007 | invalid | invalid | 19 | 0.007 | 23 | 0.007 |
| 6/8/15 | 22 | 0.007 | 16 | 0.007 | 22 | 0.050 | 20 | 0.021 |
| 6/9/15 | 30 | 0.007 | 37 | 0.095 | 26 | 0.021 | invalid | invalid |
| 6/10/15 | 26 | 0.007 | 22 | 0.007 | 34 | 0.113 | 34 | 0.007 |
| 6/11/15 | 34 | 0.007 | 35 | 0.007 | 33 | 0.057 | 39 | 0.007 |
| 6/12/15 | 18 | 0.007 | invalid | invalid | 26 | 0.021 | 35 | 0.028 |
| 6/15/15 | 14 | 0.007 | 15 | 0.007 | 18 | 0.057 | 19 | 0.000 |
| 6/16/15 | 15 | 0.027 | 18 | 0.034 | 20 | 0.014 | 5 | 0.021 |
| 6/17/15 | 30 | 0.007 | 31 | 0.007 | 36 | 0.007 | 35 | 0.007 |
| 6/18/15 | 31 | 0.000 | 30 | 0.007 | 30 | 0.007 | 32 | 0.007 |
| 6/19/15 | 17 | 0.007 | invalid | invalid | 16 | 0.000 | 15 | 0.000 |
| 6/22/15 | 73 | 0.007 | 74 | 0.007 | 69 | 0.014 | 76 | 0.014 |
| 6/23/15 | 44 | 0.021 | 55 | 0.118 | 34 | 0.007 | 49 | 0.056 |
| 6/24/15 | 61 | 0.007 | 69 | 0.083 | 55 | 0.028 | 63 | 0.021 |
| 6/25/15 | 31 | 0.007 | invalid | invalid | invalid | invalid | 35 | 0.014 |
| 6/26/15 | 13 | 0.007 | invalid | invalid | invalid | invalid | 14 | 0.007 |
| 6/29/15 | 22 | 0.021 | 46 | 0.082 | 18 | 0.014 | 56 | 0.056 |
| 6/30/15 | 51 | 0.020 | 48 | 0.014 | 40 | 0.014 | 49 | 0.021 |

| | | | | |
|---|---|---|---|---|
| Monthly Avg. TSP | 28 | 35 | 28 | 32 |
| Monthly Avg. Pb | 0.009 | 0.038 | 0.024 | 0.017 |
| May-15 | 0.009 | 0.049 | 0.033 | 0.011 |
| Apr-15 | 0.035 | 0.060 | 0.019 | 0.027 |
| **Rolling 3-Month** | **0.018** | **0.049** | **0.025** | **0.018** |

*Three month rolling average must be less than 0.15 ug/m3*

| | Big River QA | |
|---|---|---|
| Sample Date | **TSP** ug/m3 | **Lead** ug/m3 |
| 6/2/15 | 15 | 0.007 |
| 6/5/15 | 18 | 0.007 |
| 6/9/15 | 30 | 0.007 |
| 6/11/15 | 37 | 0.007 |
| 6/16/15 | 13 | 0.007 |
| 6/18/15 | 32 | 0.007 |
| 6/23/15 | 44 | 0.021 |
| 6/25/15 | 33 | 0.007 |
| 6/30/15 | 37 | 0.021 |

**Notes**

Rivermines South:
6/4, 6/5, 6/12, 6/19, 6/26, >25hr run time.
6/25, <23hr run time.

Rivermines North #2:
6/25, >25hr run time, 6/26, <23hr run time.

Rivermines East #3:
6/9, <23hr run time, GFI shorted out.

## Federal Site

Sample Results for **June-2015**

| | St. Joe (Ballfields) | Big River#4 | Water Treatment |
|---|---|---|---|
| Sample Date | **PM10** (ug/m3) | **PM10** (ug/m3) | **PM10** (ug/m3) |
| 6/2/15 | 12 | 13 | 11 |
| 6/5/15 | 12 | 13 | 29 |
| 6/8/15 | 16 | 16 | 17 |
| 6/11/15 | 21 | 21 | 20 |
| 6/14/15 | 14 | 17 | 12 |
| 6/17/15 | 30 | 56 | 21 |
| 6/20/15 | 13 | 21 | 7 |
| 6/23/15 | 45 | 39 | 41 |
| 6/26/15 | 15 | 10 | 8 |
| 6/29/15 | 28 | 30 | 27 |

*Compliance with NAAQS is less than 150 ug/m3*

| | | | |
|---|---|---|---|
| **Monthly Avg. PM10** | 21 | 23 | 19 |

| | Big River QA |
|---|---|
| Sample Date | **PM10** (ug/m3) |
| 6/5/15 | 9 |
| 6/11/15 | 1 |
| 6/17/15 | 19 |
| 6/23/15 | 38 |
| 6/29/15 | 15 |

**Notes:**

# Rivermines

Sample Results for **June-2015**

| Sample Date | Big River #4 **PM10** (ug/m3) | Rivermines South #1 **PM10** (ug/m3) | Rivermines North #2 **PM10** (ug/m3) | Rivermines East #3 **PM10** (ug/m3) |
|---|---|---|---|---|
| 6/2/15 | 13 | 40 | 12 | 11 |
| 6/5/15 | 13 | 24 | 7 | 29 |
| 6/8/15 | 16 | 42 | 16 | 17 |
| 6/11/15 | 21 | 20 | 19 | 20 |
| 6/14/15 | 17 | 19 | 11 | 12 |
| 6/17/15 | 56 | 21 | 16 | 21 |
| 6/20/15 | 21 | invalid | 15 | 7 |
| 6/23/15 | 39 | 45 | 35 | 41 |
| 6/26/15 | 10 | 11 | 8 | 8 |
| 6/29/15 | 30 | 55 | 25 | 27 |

*Compliance with NAAQS is less than 150 ug/m3*

| | | | | |
|---|---|---|---|---|
| **Monthly Avg. PM10** | 23 | 31 | 17 | 19 |

| Sample Date | Big River QA **PM10** (ug/m3) |
|---|---|
| 6/5/15 | 9 |
| 6/11/15 | 1 |
| 6/17/15 | 19 |
| 6/23/15 | 38 |
| 6/29/15 | 15 |

**Notes:**

Rivermines South #1:

6/20, <23hr run time, did not run.

# Meterological Data - Old Lead Belt
# June-2015

24hr average

| Date | Wind Speed (MPH) | Wind Direction | Sigma-Theta | Temperature ( C ) | Air Pressure (mmHg) | Rain (Inches) | Power Supply (Volts) |
|---|---|---|---|---|---|---|---|
| 01-Jun-15 | 2.5 | 359 | 22.70 | 14.5 | 748 | 0 | 13.37 |
| 02-Jun-15 | 1.8 | 60 | 31.12 | 16.3 | 747 | 0 | 13.35 |
| 03-Jun-15 | 2.7 | 178 | 35.11 | 19.1 | 745 | 0 | 13.28 |
| 04-Jun-15 | 1.4 | 209 | 30.86 | 20.2 | 745 | 0.27 | 13.27 |
| 05-Jun-15 | 1.8 | 260 | 34.85 | 22.7 | 745 | 0.03 | 13.23 |
| 06-Jun-15 | 1.9 | 38 | 33.80 | 23.2 | 745 | 0 | 13.20 |
| 07-Jun-15 | 4.8 | 207 | 22.69 | 26.5 | 741 | 0 | 13.17 |
| 08-Jun-15 | 2.7 | 240 | 34.69 | 23.9 | 741 | 1.05 | 13.20 |
| 09-Jun-15 | 1.5 | 231 | 31.47 | 24.5 | 741 | 0 | 13.18 |
| 10-Jun-15 | 2.4 | 203 | 31.01 | 25.8 | 741 | 0 | 13.16 |
| 11-Jun-15 | 3.9 | 201 | 23.33 | 26.6 | 741 | 0 | 13.15 |
| 12-Jun-15 | 4.6 | 209 | 32.19 | 27.1 | 741 | 0.07 | 13.14 |
| 13-Jun-15 | 5.7 | 195 | 23.28 | 25.7 | 744 | 0 | 13.17 |
| 14-Jun-15 | 4.5 | 205 | 24.98 | 24.6 | 744 | 0.78 | 13.19 |
| 15-Jun-15 | 3.9 | 215 | 26.63 | 25.5 | 745 | 0.8 | 13.17 |
| 16-Jun-15 | 1.8 | 248 | 41.22 | 23.9 | 746 | 2.74 | 13.19 |
| 17-Jun-15 | 1.9 | 211 | 29.13 | 24.3 | 745 | 0.12 | 13.19 |
| 18-Jun-15 | 2.2 | 177 | 25.74 | 23.2 | 745 | 0.07 | 13.22 |
| 19-Jun-15 | 4.5 | 20 | 30.42 | 22.1 | 741 | 2.8 | 13.25 |
| 20-Jun-15 | 3.3 | 234 | 36.66 | 26.1 | 742 | 0 | 13.17 |
| 21-Jun-15 | 2.7 | 218 | 32.34 | 27.5 | 744 | 0 | 13.14 |
| 22-Jun-15 | 4.2 | 219 | 27.39 | 28.1 | 744 | 0 | 13.14 |
| 23-Jun-15 | 2.4 | 289 | 35.71 | 26.4 | 746 | 0 | 13.15 |
| 24-Jun-15 | 3.4 | 172 | 29.72 | 26.0 | 747 | 0 | 13.15 |
| 25-Jun-15 | 3.7 | 234 | 32.79 | 28.6 | 744 | 0.05 | 13.12 |
| 26-Jun-15 | 3.0 | 279 | 36.75 | 23.3 | 742 | 0 | 13.18 |
| 27-Jun-15 | 4.0 | 327 | 25.78 | 21.3 | 744 | 0.02 | 13.19 |
| 28-Jun-15 | 2.8 | 225 | 30.40 | 22.4 | 743 | 0.02 | 13.21 |
| 29-Jun-15 | 2.4 | 265.6 | 33.14 | 24.5 | 740 | 0 | 13.17 |
| 30-Jun-15 | 1.3 | 242.1 | 32.19 | 23.9 | 742 | 0 | 13.19 |

**INQUEST**
ENVIRONMENTAL INC.

3609 Mojave Ct., Ste E ◆ COLUMBIA, MO 65202
(573) 474-8110 ◆ FAX: (573) 474-8371

April 15, 2015

Mr. Greg Henson
Chemist
The Doe Run Company
881 Main Street
Herculaneum, Missouri 63048

RE: 2nd Quarter 2015 Lead/PM10 Samplers Performance Audit Report.

Dear Mr. Henson,

Please find enclosed the worksheets detailing the Lead/PM10 sampler's one-point flow verifications and multi-point flow calibrations that were recently performed on the Doe Run Park Hills Monitoring Network. A copy of the current certifications for the audit device that was used has also been enclosed.

All of the flow checks and calibrations were found to be within expected guidelines.

After reviewing the enclosed information, please feel free to call with any comments or questions. Thank you for your business.

Sincerely,

John A. Kunkel
Inquest Environmental, Inc.

# PM10 Sampler Verifications

**INQUEST**
**Environmental, Inc.**

# PM10 Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 7, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Big River | Intercept (Qa) | -0.00876 |
| Sampler | #4 Primary PM10 | Temperature | 21.9 °C 295.1 °K |
| Flow Controller | P2952 | Station Pressure | 29.13 "Hg 739.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.20 | 1.094 | 25.10 | 46.88 | 0.937 | 1.129 | **3.20** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 25.00 | 46.69 | 0.937 | 1.129 | 1.093 | **-3.27** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.00 | 1.059 | 35.50 | 66.30 | 0.910 | 1.095 | **3.40** | ± 4% |
| 3.05 | 1.068 | 32.30 | 60.33 | 0.918 | 1.105 | **3.46** | ± 4% |
| 3.15 | 1.085 | 26.00 | 48.56 | 0.934 | 1.125 | **3.69** | ± 4% |
| 3.20 | 1.094 | 25.10 | 46.88 | 0.937 | 1.129 | **3.20** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

**INQUEST**
**Environmental, Inc.**

# PM10 Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 7, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Big River | Intercept (Qa) | -0.00876 |
| Sampler | #4 QA PM10 | Temperature | 21.9 °C 295.1 °K |
| Flow Controller | P1019 | Station Pressure | 29.13 "Hg 739.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.30 | 1.111 | 25.20 | 47.06 | 0.936 | 1.143 | **2.88** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 25.30 | 47.25 | 0.936 | 1.143 | 1.110 | **-1.77** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.30 | 1.111 | 25.20 | 47.06 | 0.936 | 1.143 | **2.88** | ± 4% |
| 3.40 | 1.127 | 24.90 | 46.50 | 0.937 | 1.148 | **1.86** | ± 4% |
| 3.45 | 1.135 | 21.70 | 40.53 | 0.945 | 1.155 | **1.76** | ± 4% |
| 3.50 | 1.143 | 19.70 | 36.79 | 0.950 | 1.161 | **1.57** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

**INQUEST**
**Environmental, Inc.**

# PM10 Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Leadwood (South) | Intercept (Qa) | -0.00876 |
| Sampler | #1 PM10 | Temperature | 23.7 °C 296.9 °K |
| Flow Controller | P1500 | Station Pressure | 29.04 "Hg 737.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.35 | 1.124 | 25.50 | 47.63 | 0.935 | 1.141 | **1.51** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 25.40 | 47.44 | 0.936 | 1.143 | 1.126 | **-0.35** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.25 | 1.107 | 34.90 | 65.18 | 0.912 | 1.127 | **1.81** | ± 4% |
| 3.30 | 1.116 | 29.70 | 55.47 | 1.130 | 1.145 | **2.60** | ± 4% |
| 3.35 | 1.124 | 25.50 | 47.63 | 0.935 | 1.141 | **1.51** | ± 4% |
| 3.50 | 1.149 | 19.30 | 36.05 | 0.951 | 1.162 | **1.13** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

**INQUEST**
**Environmental, Inc.**

# PM10 Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Leadwood (School) | Intercept (Qa) | -0.00876 |
| Sampler | #2 PM10 | Temperature | 23.7 °C 296.9 °K |
| Flow Controller | P6071 | Station Pressure | 29.04 "Hg 737.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.30 | 1.116 | 23.60 | 44.08 | 0.940 | 1.159 | **3.85** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 23.80 | 44.45 | 0.940 | 1.159 | 1.114 | **-1.42** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.15 | 1.090 | 30.90 | 57.71 | 0.922 | 1.138 | **4.40** | ± 4% |
| 3.25 | 1.107 | 27.90 | 52.11 | 0.929 | 1.145 | **3.43** | ± 4% |
| 3.30 | 1.116 | 23.60 | 44.08 | 0.940 | 1.159 | **3.85** | ± 4% |
| 3.40 | 1.132 | 19.80 | 36.98 | 0.950 | 1.172 | **3.53** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

**INQUEST**
**Environmental, Inc.**

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| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Leadwood (Mill St) | Intercept (Qa) | -0.00876 |
| Sampler | #3 PM10 | Temperature | 23.7 °C 296.9 °K |
| Flow Controller | P1018 | Station Pressure | 29.04 "Hg 737.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.30 | 1.116 | 23.60 | 44.08 | 0.940 | 1.149 | **2.96** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 23.90 | 44.64 | 0.939 | 1.148 | 1.114 | **-1.42** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.10 | 1.082 | 32.60 | 60.89 | 0.917 | 1.145 | **5.82** | ± 4% |
| 3.20 | 1.099 | 28.50 | 53.23 | 0.928 | 1.134 | **3.18** | ± 4% |
| 3.30 | 1.116 | 23.60 | 44.08 | 0.940 | 1.149 | **2.96** | ± 4% |
| 3.40 | 1.132 | 20.80 | 38.85 | 0.947 | 1.158 | **2.30** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

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## Volumetric Flow Control

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| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Rivermines (Quarry) | Intercept (Qa) | -0.00876 |
| Sampler | #1 PM10 | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P4601 | Station Pressure | 29.05 "Hg 737.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.10 | 1.084 | 24.80 | 46.32 | 0.937 | 1.104 | **1.85** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 24.50 | 45.76 | 0.938 | 1.104 | 1.084 | **-4.07** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 2.90 | 1.048 | 32.30 | 60.33 | 0.918 | 1.079 | **2.96** | ± 4% |
| 3.00 | 1.066 | 25.60 | 47.81 | 0.935 | 1.102 | **3.38** | ± 4% |
| 3.20 | 1.101 | 22.80 | 42.58 | 0.942 | 1.110 | **0.82** | ± 4% |
| 3.30 | 1.118 | 19.00 | 35.49 | 0.952 | 1.123 | **0.45** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

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# PM10 Sampler Audit
## Volumetric Flow Control

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| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Rivermines (Wood St) | Intercept (Qa) | -0.00876 |
| Sampler | #2 PM10 | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P4507 | Station Pressure | 29.05 "Hg 737.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.20 | 1.101 | 25.20 | 47.06 | 0.936 | 1.123 | **2.00** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 25.40 | 47.44 | 0.936 | 1.123 | 1.101 | **-2.57** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.00 | 1.066 | 31.90 | 59.58 | 0.919 | 1.103 | **3.47** | ± 4% |
| 3.10 | 1.084 | 29.40 | 54.91 | 0.926 | 1.110 | **2.40** | ± 4% |
| 3.20 | 1.101 | 25.20 | 47.06 | 0.936 | 1.123 | **2.00** | ± 4% |
| 3.30 | 1.118 | 20.20 | 37.73 | 0.949 | 1.139 | **1.88** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

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## Volumetric Flow Control

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| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Rivermines (Wtr Plnt) | Intercept (Qa) | -0.00876 |
| Sampler | #3 PM10 | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P2951 | Station Pressure | 29.08 "Hg 738.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.20 | 1.100 | 24.20 | 45.20 | 0.939 | 1.135 | **3.18** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 24.20 | 45.20 | 0.939 | 1.135 | 1.099 | **-2.74** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.10 | 1.083 | 28.20 | 52.67 | 0.929 | 1.121 | **3.51** | ± 4% |
| 3.20 | 1.100 | 24.40 | 45.57 | 0.938 | 1.135 | **3.18** | ± 4% |
| 3.30 | 1.117 | 19.30 | 36.05 | 0.951 | 1.150 | **2.95** | ± 4% |
| 3.40 | 1.134 | 15.90 | 29.70 | 0.960 | 1.162 | **2.47** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

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# PM10 Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
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573-474-8110

| | | | |
|---|---|---|---|
| Date | April 7, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Ozark Insulation | Intercept (Qa) | -0.00876 |
| Sampler | #1 PM10 | Temperature | 21.9 °C 295.1 °K |
| Flow Controller | P2950 | Station Pressure | 29.13 "Hg 739.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.20 | 1.094 | 24.70 | 46.13 | 0.938 | 1.130 | **3.29** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 24.70 | 46.13 | 0.938 | 1.130 | 1.093 | **-3.27** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.10 | 1.077 | 34.20 | 63.87 | 0.914 | 1.100 | **2.14** | ± 4% |
| 3.20 | 1.094 | 24.70 | 46.13 | 0.938 | 1.130 | **3.29** | ± 4% |
| 3.30 | 1.111 | 24.30 | 45.38 | 0.939 | 1.131 | **1.80** | ± 4% |
| 3.40 | 1.127 | 21.40 | 39.97 | 0.946 | 1.140 | **1.15** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

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## Volumetric Flow Control

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| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Hanley Park | Intercept (Qa) | -0.00876 |
| Sampler | #2 PM10 | Temperature | 25.0 °C / 298.2 °K |
| Flow Controller | P2949 | Station Pressure | 29.08 "Hg / 738.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.15 | 1.092 | 24.60 | 45.94 | 0.938 | 1.127 | **3.21** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 24.60 | 45.94 | 0.938 | 1.127 | 1.091 | **-3.45** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.00 | 1.066 | 32.80 | 61.26 | 0.917 | 1.103 | **3.47** | ± 4% |
| 3.15 | 1.092 | 24.60 | 45.94 | 0.938 | 1.127 | **3.21** | ± 4% |
| 3.20 | 1.100 | 21.40 | 39.97 | 0.946 | 1.137 | **3.36** | ± 4% |
| 3.30 | 1.117 | 17.80 | 33.24 | 0.955 | 1.149 | **2.86** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

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# PM10 Sampler Audit
## Volumetric Flow Control

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| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | St Joe Park | Intercept (Qa) | -0.00876 |
| Sampler | #4 PM10 | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P4353 | Station Pressure | 29.08 "Hg 738.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.10 | 1.083 | 24.90 | 46.50 | 0.937 | 1.120 | **3.42** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Design % Difference | Acceptable Range |
|---|---|---|---|---|---|---|
| 25.00 | 46.69 | 0.937 | 1.120 | 1.082 | **-4.25** | ± 10% |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Flow Rate Percent Difference | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate* $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 2.95 | 1.057 | 33.00 | 61.63 | 0.917 | 1.096 | **3.69** | ± 4% |
| 3.10 | 1.083 | 24.90 | 46.50 | 0.937 | 1.120 | **3.42** | ± 4% |
| 3.20 | 1.100 | 21.00 | 39.22 | 0.947 | 1.132 | **2.91** | ± 4% |
| 3.30 | 1.117 | 19.00 | 35.49 | 0.952 | 1.139 | **1.97** | ± 4% |

*At least 3 of 4 orifice flow rates must be between 1.13 ± 10% (1.02 and 1.24)

**Calculations:**

Pressure mmHg (Pf) - ("$H_2O$/13.6) * 25.4

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Flow Rate Percent Difference- (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Percent Difference)/100)

Design Percent Difference- (Corrected Flow Rate-1.13)/1.13*100

# Lead/TSP Sampler Verifications

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 7, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Big River #4 | Intercept (Qa) | -0.00876 |
| Sampler | QA TSP | Temperature | 21.9 °C 295.1 °K |
| Flow Controller | P4558 | Station Pressure | 29.13 "Hg 739.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.175 | 21.30 | 39.80 | 0.946 | 1.232 | **4.85** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 21.40 | 39.98 | 0.946 | 1.232 | **1.172** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.50 | 1.143 | 30.60 | 57.17 | 0.923 | 1.200 | **4.99** | ± 5% |
| 3.60 | 1.160 | 26.40 | 49.32 | 0.933 | 1.214 | **4.66** | ± 5% |
| 3.70 | 1.175 | 21.30 | 39.80 | 0.946 | 1.232 | **4.85** | ± 5% |
| 3.80 | 1.191 | 18.90 | 35.31 | 0.952 | 1.240 | **4.11** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
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| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Big River | Intercept (Qa) | -0.00876 |
| Sampler | #4 Primary TSP | Temperature | 21.9 °C 295.1 °K |
| Flow Controller | P4557 | Station Pressure | 29.13 "Hg 739.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.90 | 1.207 | 22.30 | 41.66 | 0.944 | 1.234 | **2.24** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 22.50 | 42.04 | 0.943 | 1.234 | **1.206** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.175 | 27.00 | 50.44 | 0.932 | 1.218 | **3.66** | ± 5% |
| 3.90 | 1.207 | 22.30 | 41.66 | 0.944 | 1.234 | **2.24** | ± 5% |
| 4.00 | 1.222 | 16.90 | 31.57 | 0.957 | 1.252 | **2.45** | ± 5% |
| 4.10 | 1.237 | 13.00 | 24.29 | 0.967 | 1.266 | **2.34** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Leadwood (South) | Intercept (Qa) | -0.00876 |
| Sampler | #1 TSP | Temperature | 23.7 °C 296.9 °K |
| Flow Controller | P4559 | Station Pressure | 29.04 "Hg 737.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.80 | 1.197 | 21.60 | 40.36 | 0.945 | 1.241 | **3.68** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 21.90 | 40.92 | 0.945 | 1.241 | **1.195** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.181 | 25.80 | 48.20 | 0.935 | 1.228 | **3.98** | ± 5% |
| 3.80 | 1.197 | 21.60 | 40.36 | 0.945 | 1.241 | **3.68** | ± 5% |
| 3.85 | 1.204 | 17.70 | 33.07 | 0.955 | 1.255 | **4.24** | ± 5% |
| 3.90 | 1.212 | 14.30 | 26.72 | 0.964 | 1.268 | **4.62** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Leadwood (School) | Intercept (Qa) | -0.00876 |
| Sampler | #2 TSP | Temperature | 23.7 °C / 296.9 °K |
| Flow Controller | P6793 | Station Pressure | 29.04 "Hg / 737.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.181 | 21.70 | 40.54 | 0.945 | 1.222 | **3.47** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 21.70 | 40.54 | 0.945 | 1.222 | **1.180** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.50 | 1.149 | 30.60 | 57.17 | 0.922 | 1.194 | **3.92** | ± 5% |
| 3.60 | 1.165 | 25.30 | 47.27 | 0.936 | 1.210 | **3.86** | ± 5% |
| 3.70 | 1.181 | 21.70 | 40.54 | 0.945 | 1.222 | **3.47** | ± 5% |
| 3.80 | 1.197 | 16.50 | 30.83 | 0.958 | 1.240 | **3.59** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Leadwood (Mill St) | Intercept (Qa) | -0.00876 |
| Sampler | #3 TSP | Temperature | 23.7 °C 296.9 °K |
| Flow Controller | P4476 | Station Pressure | 29.04 "Hg 737.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.80 | 1.197 | 21.10 | 39.42 | 0.947 | 1.233 | **3.01** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 21.30 | 39.80 | 0.946 | 1.230 | **1.193** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.60 | 1.165 | 29.80 | 55.68 | 0.925 | 1.199 | **2.92** | ± 5% |
| 3.70 | 1.181 | 25.80 | 48.20 | 0.935 | 1.211 | **2.54** | ± 5% |
| 3.80 | 1.197 | 21.10 | 39.42 | 0.947 | 1.227 | **2.51** | ± 5% |
| 3.90 | 1.212 | 16.80 | 31.39 | 0.957 | 1.241 | **2.39** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Rivermines (Quarry) | Intercept (Qa) | -0.00876 |
| Sampler | #1 TSP | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P2940 | Station Pressure | 29.05 "Hg 737.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.183 | 22.00 | 41.10 | 0.944 | 1.228 | **3.80** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 22.00 | 41.10 | 0.944 | 1.228 | **1.181** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.50 | 1.151 | 28.70 | 53.62 | 0.927 | 1.208 | **4.95** | ± 5% |
| 3.60 | 1.167 | 25.70 | 48.02 | 0.935 | 1.215 | **4.11** | ± 5% |
| 3.70 | 1.183 | 22.00 | 41.10 | 0.944 | 1.228 | **3.80** | ± 5% |
| 3.80 | 1.199 | 19.60 | 36.62 | 0.950 | 1.236 | **3.09** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Rivermines Wood St | Intercept (Qa) | -0.00876 |
| Sampler | #2 TSP | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P2941 | Station Pressure | 29.05 "Hg 737.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.183 | 22.30 | 41.66 | 0.944 | 1.229 | **3.89** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 22.00 | 41.10 | 0.944 | 1.229 | **1.181** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.60 | 1.167 | 31.90 | 59.60 | 0.919 | 1.195 | **2.40** | ± 5% |
| 3.65 | 1.175 | 27.10 | 50.63 | 0.931 | 1.212 | **3.15** | ± 5% |
| 3.70 | 1.183 | 22.30 | 41.66 | 0.944 | 1.229 | **3.89** | ± 5% |
| 3.80 | 1.199 | 19.00 | 35.50 | 0.952 | 1.240 | **3.42** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Rivermines Wtr Plnt | Intercept (Qa) | -0.00876 |
| Sampler | #3 TSP | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P4475 | Station Pressure | 29.08 "Hg 738.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.183 | 21.40 | 39.98 | 0.946 | 1.225 | **3.55** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 21.60 | 40.36 | 0.945 | 1.224 | **1.181** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.45 | 1.142 | 33.30 | 62.22 | 0.916 | 1.189 | **4.12** | ± 5% |
| 3.50 | 1.150 | 31.80 | 59.41 | 0.920 | 1.193 | **3.74** | ± 5% |
| 3.60 | 1.167 | 26.50 | 49.51 | 0.933 | 1.207 | **3.43** | ± 5% |
| 3.70 | 1.183 | 21.40 | 39.98 | 0.946 | 1.225 | **3.55** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 7, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Ozark Insulation | Intercept (Qa) | -0.00876 |
| Sampler | #1 TSP | Temperature | 21.9 °C 295.1 °K |
| Flow Controller | P2939 | Station Pressure | 29.13 "Hg 739.9 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.175 | 21.30 | 39.80 | 0.946 | 1.233 | **4.94** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 21.30 | 39.80 | 0.946 | 1.233 | **1.172** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.50 | 1.143 | 30.90 | 57.73 | 0.922 | 1.199 | **4.90** | ± 5% |
| 3.60 | 1.160 | 27.70 | 51.75 | 0.930 | 1.211 | **4.40** | ± 5% |
| 3.70 | 1.175 | 21.30 | 39.80 | 0.946 | 1.233 | **4.94** | ± 5% |
| 3.80 | 1.191 | 20.30 | 37.93 | 0.949 | 1.237 | **3.86** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | Hanley Park (Crane St.) | Intercept (Qa) | -0.00876 |
| Sampler | #2 TSP | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P4474 | Station Pressure | 29.08 "Hg 738.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.183 | 22.00 | 41.10 | 0.944 | 1.216 | **2.79** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 22.00 | 41.10 | 0.944 | 1.216 | **1.182** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.60 | 1.167 | 28.80 | 53.81 | 0.927 | 1.194 | **2.31** | ± 5% |
| 3.70 | 1.183 | 22.00 | 41.10 | 0.944 | 1.216 | **2.79** | ± 5% |
| 3.80 | 1.198 | 19.10 | 35.68 | 0.952 | 1.227 | **2.42** | ± 5% |
| 3.90 | 1.214 | 16.80 | 31.39 | 0.958 | 1.235 | **1.73** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

**INQUEST**
**Environmental, Inc.**

# Lead Sampler Audit
## Volumetric Flow Control

3609 Mojave Court, Suite E
Columbia, Missouri 65202
573-474-8110

| | | | |
|---|---|---|---|
| Date | April 8, 2015 | Auditor | John Kunkel |
| Operator | The Doe Run Company | Transfer Orifice | 1882 |
| Location | Park Hills Network | Slope (Qa) | 1.04094 |
| Station | St Joe Park | Intercept (Qa) | -0.00876 |
| Sampler | #4 TSP | Temperature | 25.0 °C 298.2 °K |
| Flow Controller | P6792 | Station Pressure | 29.08 "Hg 738.6 mmHg |

**Flow Rate Audit**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.70 | 1.183 | 21.30 | 39.80 | 0.946 | 1.229 | **3.89** | ± 7% |

**Sampler Operating Flow Rate**

| Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | Corrected Flow Rate | Acceptable Range |
|---|---|---|---|---|---|
| 21.50 | 40.17 | 0.946 | 1.229 | **1.181** | 1.10 - 1.70 |

**Multi-point Flow Rate Verification**

| Transfer Orifice | | Sampler | | | | Calibration Error % | Acceptable Range |
|---|---|---|---|---|---|---|---|
| Manometer "$H_2O$ | Flow Rate $m^3$/min | Manometer "$H_2O$ | Pressure (Pf) | Press. Ratio (Po/Pa) | Flow Rate $m^3$/min | | |
| 3.60 | 1.167 | 26.40 | 49.32 | 0.933 | 1.211 | **3.77** | ± 5% |
| 3.70 | 1.183 | 21.30 | 39.80 | 0.946 | 1.229 | **3.89** | ± 5% |
| 3.75 | 1.190 | 18.30 | 34.19 | 0.954 | 1.239 | **4.12** | ± 5% |
| 3.80 | 1.198 | 14.90 | 27.84 | 0.962 | 1.250 | **4.34** | ± 5% |

**Calculations:**

Pressure mmHg (Pf) - "$H_2O$ * 1.86832

Pressure Ratio (Po/Pa) - 1-Pf/Pa

Orifice Flow Rate (Qa) - 1/Slope*( Sqrt("H2O*( Ta/Pa))-Intercept)

Sampler Flow Rate (Qa) - Taken from the look-up tables

Calibration Error - (Sampler Flow-Orifice Flow)/Orifice Flow*100

Corrected Flow Rate - Operating Flow*((100-Calibration Error)/100)

# Calibration Orifice Certification Worksheet

TISCH Environmental

TISCH ENVIRONMENTAL, INC.
145 SOUTH MIAMI AVE
VILLAGE OF CLEVES, OH
45002
513.467.9000
877.263.7610 TOLL FREE
513.467.9009 FAX

# ORIFICE TRANSFER STANDARD CERTIFICATION WORKSHEET TE-5028A

Date - Jan 13, 2015 Rootsmeter S/N 9833620 Ta (K) - 292
Operator Tisch Orifice I.D. - 1882 Pa (mm) - 765.81

| PLATE OR VDC # | VOLUME START (m3) | VOLUME STOP (m3) | DIFF VOLUME (m3) | DIFF TIME (min) | METER DIFF Hg (mm) | ORFICE DIFF H2O (in.) |
|---|---|---|---|---|---|---|
| 1 | NA | NA | 1.00 | 1.3360 | 4.3 | 1.50 |
| 2 | NA | NA | 1.00 | 1.0560 | 6.8 | 2.50 |
| 3 | NA | NA | 1.00 | 0.9570 | 8.2 | 3.00 |
| 4 | NA | NA | 1.00 | 0.8870 | 9.5 | 3.50 |
| 5 | NA | NA | 1.00 | 0.6670 | 16.5 | 6.00 |

## DATA TABULATION

| Vstd | (x axis) Qstd | (y axis) | | Va | (x axis) Qa | (y axis) |
|---|---|---|---|---|---|---|
| 1.0225 | 0.7654 | 1.2420 | | 0.9943 | 0.7443 | 0.7563 |
| 1.0191 | 0.9651 | 1.6034 | | 0.9910 | 0.9385 | 0.9763 |
| 1.0173 | 1.0630 | 1.7564 | | 0.9892 | 1.0337 | 1.0695 |
| 1.0155 | 1.1449 | 1.8972 | | 0.9875 | 1.1133 | 1.1552 |
| 1.0061 | 1.5084 | 2.4840 | | 0.9784 | 1.4668 | 1.5125 |

Qstd slope (m) = 1.66236
intercept (b) = -0.01438
coefficient (r) = 0.99927

y axis = SQRT[H2O(Pa/760)(298/Ta)]

Qa slope (m) = 1.04094
intercept (b) = -0.00876
coefficient (r) = 0.99927

y axis = SQRT[H2O(Ta/Pa)]

## CALCULATIONS

Vstd = Diff. Vol[(Pa-Diff. Hg)/760](298/Ta)
Qstd = Vstd/Time

Va = Diff Vol [(Pa-Diff Hg)/Pa]
Qa = Va/Time

For subsequent flow rate calculations:

Qstd = 1/m{[SQRT(H2O(Pa/760)(298/Ta))]- b}
Qa = 1/m{[SQRT H2O(Ta/Pa)]- b}