**MEMORANDUM** **(LABORATORY DATA REPORT)**

**SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.**
**Contract No. EP-C-08-034**

| | | | |
|---|---|---|---|
| | | **In reply refer to:** | 11-FL05 |
| **To:** | Cindy Paul<br>Rick Wilkin | **From:**<br>**Lab:** | Feng Lu<br>IRMS |
| **Thru:** | Sujith Kumar | **Date:** | 6/29/2011 |
| **Technical Directive No.:**<br>**Task No.:** | 7IR214SF<br>23993 | **Originator:**<br>**Copies:** | Rick Wilkin<br>Rick Wilkin<br>Feng Lu |

| | | | |
|---|---|---|---|
| **Date Collected:** | 4/18-21/2011 | | |
| **Date Received:** | 4/21-22/2011 | **Shaw Sample Set No:** | 6030/6032 |
| **Date Analyzed:** | 6/6-9/2011 | **Sample Matrix:** | Water |
| **No. Samples Analyzed:** | 15 | **Analysis Type:** | IRMS |
| **Method Used:** | RSKSOP-296v1* | | |

***RSKSOP-296v1:**
Determination of Hydrogen and Oxygen Isotope Ratios in Water Samples Using A High Temperature Conversion Elemental Analyzer (TC/EA), A Continuous Flow Unit, and An Isotope Ratio Mass Spectrometer (IRMS).

**Comments:**
Six replicates for each of fifteen water samples were analyzed for $\delta^2$H and $\delta^{18}$O. Along with these samples, two standards were analyzed as working standards to calibrate the $\delta^2$H and $\delta^{18}$O values of samples. One additional standard was analyzed as a check standard to monitor the analytical accuracy and precision.

**SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.**



**Analytical Report - Analytical Results**

Laboratory: IRMS

Report Date: 06/29/11

Tech Dir: 7IR214SF

Date Analyzed: 6/6-9/2011

Method: RSKSOP-296v1

Analyst: Feng Lu

| | | | 1000 $\delta^2H_{VSMOW}$ | | | 1000 $\delta^{18}O_{VSMOW}$ | | |
|---|---|---|---|---|---|---|---|---|
| Field Sample ID | IRMS Tracking ID | Sample ID | Results | Mean | Stdev | Results | Mean | Stdev |
| PGDW20-0411 | 6030-29 | #6030- 1 | *No data* | | | *No data* | | |
| (4/18/2011) | 6030-30 | 1D | *-107.88* | | | *-12.04* | | |
| | 6030-31 | 1D | *-108.43* | | | *-13.31* | | |
| | 6030-32 | 1D | *-108.63* | | | *-13.35* | | |
| | 6030-33 | 1D | **-108.35** | | | **-13.30** | | |
| | 6030-34 | 1D | **-108.34** | -108.35 | 0.00 | **-13.32** | -13.31 | 0.01 |
| PGDW26-0411 | 6030-35 | 2 | *-129.94* | | | *-15.44* | | |
| (4/18/2011) | 6030-36 | 2D | *-129.72* | | | *-16.75* | | |
| | 6030-37 | 2D | *-129.46* | | | *-16.80* | | |
| | 6030-38 | 2D | *-129.52* | | | *-16.48* | | |
| | 6030-39 | 2D | **-129.33** | | | **-16.43** | | |
| | 6030-40 | 2D | **-129.13** | -129.23 | 0.14 | **-16.51** | -16.47 | 0.05 |
| PGDW30-0411 | 6030-41 | 3 | *-108.38* | | | *-13.50* | | |
| (4/18/2011) | 6030-42 | 3D | *-108.61* | | | *-13.19* | | |
| | 6030-43 | 3D | *-109.30* | | | *-13.11* | | |
| | 6030-44 | 3D | *-108.63* | | | *-13.40* | | |
| | 6030-45 | 3D | **-108.14** | | | **-13.22** | | |
| | 6030-46 | 3D | **-108.08** | -108.11 | 0.04 | **-13.24** | -13.23 | 0.01 |
| PGDW32-0411 | 6030-47 | 4 | *-109.59* | | | *-13.38* | | |
| (4/18/2011) | 6030-48 | 4D | *-108.29* | | | *-13.35* | | |
| | 6030-49 | 4D | *-108.87* | | | *-13.37* | | |
| | 6030-50 | 4D | *-108.56* | | | *-13.13* | | |
| | 6030-51 | 4D | **-108.17** | | | **-13.26** | | |
| | 6030-52 | 4D | **-108.31** | -108.24 | 0.10 | **-13.30** | -13.28 | 0.03 |
| PGDW32d-0411 | 6030-53 | 5 | -109.28 | | | -13.31 | | |
| (4/18/2011) | 6030-54 | 5D | -108.13 | | | -13.39 | | |
| | 6030-55 | 5D | -108.48 | | | -13.46 | | |
| | 6030-56 | 5D | -108.85 | | | -13.33 | | |
| | 6030-57 | 5D | **-108.13** | | | **-13.33** | | |
| | 6030-58 | 5D | **-108.07** | -108.10 | 0.04 | **-13.32** | -13.33 | 0.01 |
| EPAMW02-0411 | 6030-59 | 6 | -113.53 | | | -14.26 | | |
| (4/19/2011) | 6030-60 | 6D | -112.84 | | | -14.53 | | |
| | 6030-61 | 6D | -114.11 | | | -14.36 | | |
| | 6030-62 | 6D | -113.71 | | | -14.25 | | |
| | 6030-63 | 6D | **-113.63** | | | **-14.21** | | |

**SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.**

**Analytical Report - Analytical Results**

Laboratory: IRMS

Report Date: 06/29/11

Tech Dir: 7IR214SF

Date Analyzed: 6/6-9/2011

Method: RSKSOP-296v1

Analyst: Feng Lu

| | | | 1000 $\delta^2H_{VSMOW}$ | | | 1000 $\delta^{18}O_{VSMOW}$ | | |
|---|---|---|---|---|---|---|---|---|
| Field Sample ID | IRMS Tracking ID | Sample ID | Results | Mean | Stdev | Results | Mean | Stdev |
| | 6030-64 | 6D | **-113.22** | -113.42 | 0.29 | **-14.28** | -14.24 | 0.05 |
| EPAMW02d-0411 | 6030-65 | 7 | -113.50 | | | -14.37 | | |
| (4/19/2011) | 6030-66 | 7D | -113.34 | | | -14.49 | | |
| | 6030-67 | 7D | -114.18 | | | -14.36 | | |
| | 6030-68 | 7D | -113.78 | | | -14.11 | | |
| | 6030-69 | 7D | **-113.02** | | | **-14.25** | | |
| | 6030-70 | 7D | **-113.89** | -113.46 | 0.61 | **-14.29** | -14.27 | 0.03 |
| PGDW05-0411 | 6030-77 | 11 | -109.84 | | | -13.48 | | |
| (4/19/2011) | 6030-78 | 11D | -108.72 | | | -13.13 | | |
| | 6030-79 | 11D | -108.55 | | | -13.23 | | |
| | 6030-80 | 11D | -109.74 | | | -13.10 | | |
| | 6030-81 | 11D | **-109.69** | | | **-13.12** | | |
| | 6030-82 | 11D | **-109.59** | -109.64 | 0.08 | **-13.10** | -13.11 | 0.02 |
| PGDW45-0411 | 6030-83 | 12 | -127.17 | | | -16.46 | | |
| (4/19/2011) | 6030-84 | 12D | -128.48 | | | -16.77 | | |
| | 6030-85 | 12D | -127.56 | | | -16.68 | | |
| | 6030-86 | 12D | -127.73 | | | -16.56 | | |
| | 6030-87 | 12D | **-127.85** | | | **-16.51** | | |
| | 6030-88 | 12D | **-128.51** | -128.18 | 0.47 | **-16.67** | -16.59 | 0.11 |
| EPAMW01-0411 | 6030-89 | 13 | -110.87 | | | -13.74 | | |
| (4/20/2011) | 6030-90 | 13D | -107.58 | | | -13.36 | | |
| | 6030-91 | 13D | -109.26 | | | -13.28 | | |
| | 6030-92 | 13D | -110.35 | | | -13.40 | | |
| | 6030-93 | 13D | **-109.60** | | | **-13.27** | | |
| | 6030-94 | 13D | **-109.46** | -109.53 | 0.10 | **-13.25** | -13.26 | 0.02 |
| PGDW41-0411 | 6030-95 | 14 | -121.29 | | | -15.82 | | |
| (4/20/2011) | 6030-96 | 14D | -122.13 | | | -15.93 | | |
| | 6030-97 | 14D | -121.15 | | | -16.07 | | |
| | 6030-98 | 14D | -121.40 | | | -15.89 | | |
| | 6030-99 | 14D | **-121.94** | | | **-15.87** | | |
| | 6030-100 | 14D | **-121.92** | -121.93 | 0.02 | **-15.95** | -15.91 | 0.06 |
| PDGW14-0411 | 6030-107 | #6032-01 | -125.33 | | | -15.21 | | |
| (4/20/2011) | 6030-108 | 1D | -126.03 | | | -15.62 | | |
| | 6030-109 | 1D | -125.66 | | | -15.61 | | |
| | 6030-110 | 1D | -125.64 | | | -15.91 | | |

**SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.**

**Analytical Report - Analytical Results**

| | | | |
|---|---|---|---|
| Laboratory: | IRMS | Report Date: | 06/29/11 |
| Tech Dir: | 7IR214SF | Date Analyzed: | 6/6-9/2011 |
| Method: | RSKSOP-296v1 | Analyst: | Feng Lu |

| | | | 1000 $\delta^2H_{VSMOW}$ | | | 1000 $\delta^{18}O_{VSMOW}$ | | |
|---|---|---|---|---|---|---|---|---|
| Field Sample ID | IRMS Tracking ID | Sample ID | Results | Mean | Stdev | Results | Mean | Stdev |
| | 6030-111 | 1D | **-125.88** | | | **-15.79** | | |
| | 6030-112 | 1D | **-126.19** | -126.04 | 0.22 | **-15.79** | -15.79 | 0.00 |
| PDGW49-0411 | 6030-113 | 2 | -125.22 | | | -16.01 | | |
| (4/20/2011) | 6030-114 | 2D | -122.28 | | | -15.60 | | |
| | 6030-115 | 2D | -122.71 | | | -15.62 | | |
| | 6030-116 | 2D | -122.52 | | | -15.52 | | |
| | 6030-117 | 2D | **-122.42** | | | **-15.62** | | |
| | 6030-118 | 2D | **-121.96** | -122.19 | 0.33 | **-15.51** | -15.57 | 0.08 |
| PDGW23-0411 | 6030-119 | 3 | *-102.90* | | | *-13.32* | | |
| (4/21/2011) | 6030-120 | 3D | *-99.46* | | | *-12.53* | | |
| | 6030-121 | 3D | *-98.08* | | | *-12.74* | | |
| | 6030-122 | 3D | *-97.69* | | | *-12.56* | | |
| | 6030-123 | 3D | **-97.30** | | | **-12.33** | | |
| | 6030-124 | 3D | **-97.40** | -97.35 | 0.07 | **-12.47** | -12.40 | 0.09 |
| PDGW44-0411 | 6030-125 | 4 | *-98.35* | | | *-13.84* | | |
| (4/21/2011) | 6030-126 | 4D | *-100.28* | | | *-13.48* | | |
| | 6030-127 | 4D | *-98.92* | | | *-13.39* | | |
| | 6030-128 | 4D | *-99.14* | | | *-13.24* | | |
| | 6030-129 | 4D | **-100.26** | | | **-13.33** | | |
| | 6030-130 | 4D | **-100.33** | -100.29 | 0.05 | **-13.25** | -13.29 | 0.06 |

**Comments:**
Due to memory effect, typically the first four replicates (italic) of each sample were excluded from the calculations for the average (mean) and the standard deviation (stdev).

**SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.**

**Analytical Report - Quality Control Data Summary**



Laboratory: IRMS

Report Date: 6/29/2011

Tech Dir: 7IR214SF

Date Analyzed: 6/6-9/2011

Method: RSKSOP-296v1

Analyst: Feng Lu

| | | | 1000 $\delta^2H_{VSMOW}$ | | | 1000 $\delta^{18}O_{VSMOW}$ | | |
|---|---|---|---|---|---|---|---|---|
| QC Sample | IRMS Tracking ID | Lab ID | Instrument Reading | Calibrated | True | Instrument Reading | Calibrated | True |
| Calibration Standards | | | | | | | | |
| AW | 6030-17 | | *-83.28* | | | *-14.27* | | |
| | 6030-18 | | *-81.61* | | | *-13.87* | | |
| | 6030-19 | | **-82.43** | | | **-13.69** | | |
| | 6030-20 | | **-82.61** | | | **-13.59** | | |
| | 6030-21 | | **-81.80** | | | **-13.67** | | |
| | 6030-22 | | **-82.14** | | | **-13.54** | | |
| | 6030-149 | | *-82.31* | | | *-13.09* | | |
| | 6030-150 | | *-81.97* | | | *-13.38* | | |
| | 6030-151 | | **-81.90** | | | **-13.46** | | |
| | 6030-152 | | **-82.32** | | | **-13.61** | | |
| | 6030-153 | | **-82.02** | | | **-13.41** | | |
| | 6030-154 | | **-82.09** | | | **-13.66** | | |
| average | | | -82.16 | | -65.59 | -13.58 | | -9.40 |
| std dev | | | 0.27 | | | 0.10 | | |
| S1 | 6030-11 | | *-138.02* | | | *-38.29* | | |
| | 6030-12 | | *-137.95* | | | *-37.68* | | |
| | 6030-13 | | -138.24 | | | -38.13 | | |
| | 6030-14 | | **-138.46** | | | **-38.44** | | |
| | 6030-15 | | **-138.70** | | | **-38.33** | | |
| | 6030-16 | | **-138.33** | | | **-38.52** | | |
| | 6030-71 | | *-137.58* | | | *-37.83* | | |
| | 6030-72 | | *-137.11* | | | *-38.27* | | |
| | 6030-73 | | *-137.56* | | | *-38.35* | | |
| | 6030-74 | | **-138.50** | | | **-38.40** | | |
| | 6030-75 | | **-138.69** | | | **-38.53** | | |
| | 6030-76 | | **-138.54** | | | **-38.42** | | |
| | 6030-155 | | *-137.02* | | | *-37.03* | | |
| | 6030-156 | | *-137.50* | | | *-38.32* | | |
| | 6030-157 | | *-138.95* | | | *-38.19* | | |
| | 6030-158 | | **-138.76** | | | **-38.52** | | |

**SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.**

**Analytical Report - Quality Control Data Summary**



Laboratory: IRMS

Report Date: 6/29/2011

Tech Dir: 7IR214SF

Date Analyzed: 6/6-9/2011

Method: RSKSOP-296v1

Analyst: Feng Lu

| | | | 1000 $\delta^2H_{VSMOW}$ | | | 1000 $\delta^{18}O_{VSMOW}$ | | |
|---|---|---|---|---|---|---|---|---|
| QC Sample | IRMS Tracking ID | Lab ID | Instrument Reading | Calibrated | True | Instrument Reading | Calibrated | True |
| | 6030-159 | | **-138.60** | | | **-38.60** | | |
| | 6030-160 | | **-138.38** | | | **-38.65** | | |
| average | | | -138.55 | | -122.44 | -38.49 | | -34.93 |
| std dev | | | 0.15 | | | 0.10 | | |
| Check Standard | | | | | | | | |
| HW | 6030-23 | | *10.32* | *27.64* | | *1.70* | *6.26* | |
| | 6030-24 | | *15.01* | *32.38* | | *2.10* | *6.67* | |
| | 6030-25 | | *16.51* | *33.89* | | *2.09* | *6.66* | |
| | 6030-26 | | *16.06* | *33.44* | | *1.98* | *6.54* | |
| | 6030-27 | | 15.98 | **33.36** | | 1.99 | **6.55** | |
| | 6030-28 | | 16.49 | **33.87** | | 2.09 | **6.66** | |
| | 6030-101 | | *14.41* | *31.77* | | *0.98* | *5.52* | |
| | 6030-102 | | *14.90* | *32.27* | | *1.88* | *6.45* | |
| | 6030-103 | | *15.73* | *33.10* | | *2.00* | *6.57* | |
| | 6030-104 | | *16.16* | *33.53* | | 2.05 | *6.62* | |
| | 6030-105 | | 16.05 | **33.42** | | 2.00 | **6.57** | |
| | 6030-106 | | 16.17 | **33.55** | | *2.09* | **6.66** | |
| | 6030-143 | | *9.21* | *26.53* | | *1.72* | *6.28* | |
| | 6030-144 | | *14.74* | *32.10* | | *1.73* | *6.29* | |
| | 6030-145 | | *16.29* | *33.66* | | *1.94* | *6.50* | |
| | 6030-146 | | *16.56* | *33.94* | | *2.18* | *6.75* | |
| | 6030-147 | | 16.04 | **33.42** | | 2.06 | **6.63** | |
| | 6030-148 | | 15.99 | **33.36** | | 2.04 | **6.61** | |
| average | | | | 33.50 | 33.88 | | 6.61 | 6.59 |
| std dev | | | | 0.20 | | | 0.05 | |

**Comments**:
Standards AW and S1 were analyzed at the start, middle and end of the sample sequence to calibrate the measured results of the samples. An additional standard HW was analyzed as a check standard to monitor the accuracy and precision for $\delta^2H$ and $\delta^{18}O$ analyses. The average and standard deviation were calculated from the bold replicates excluding the italic values, which had memory effect.