FINAL REPORT
Electrokinetic-Enhanced (EK-Enhanced) Amendment Delivery for Remediation of Low Permeability and Heterogeneous Materials

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This project demonstrated and validated electrokinetic (EK)-enhanced amendment delivery for in-situ bioremediation (EK-BIO) via enhanced reductive dechlorination (ERD) of a tetrachloroethene source area in clay. The EK-enhanced amendment delivery technology entails the establishment of an electric field in the subsurface using a network of electrodes. The electrical current and voltage gradient established across a direct-current electric field provide the driving force to transport remediation amendments, including electron donors, chemical oxidants, and even bacteria, through the subsurface. This project showed that EK could achieve relatively uniform transport in low-permeability materials. This technology also represents a remedial alternative with excellent environmental performance.
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# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>SECTION</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXECUTIVE SUMMARY</td>
<td>ES-1</td>
</tr>
<tr>
<td>1.0 INTRODUCTION</td>
<td></td>
</tr>
<tr>
<td>1.1 BACKGROUND</td>
<td>1</td>
</tr>
<tr>
<td>1.2 OBJECTIVE OF THE DEMONSTRATION</td>
<td>1</td>
</tr>
<tr>
<td>1.3 REGULATORY/TECHNICAL/COST DRIVERS</td>
<td>2</td>
</tr>
<tr>
<td>2.0 TECHNOLOGY</td>
<td>3</td>
</tr>
<tr>
<td>2.1 TECHNOLOGY DESCRIPTION</td>
<td>3</td>
</tr>
<tr>
<td>2.2 TECHNOLOGY DEVELOPMENT</td>
<td>5</td>
</tr>
<tr>
<td>2.3 ADVANTAGES AND LIMITATIONS OF THE TECHNOLOGY</td>
<td>6</td>
</tr>
<tr>
<td>3.0 PERFORMANCE OBJECTIVES</td>
<td>9</td>
</tr>
<tr>
<td>3.1 PERFORMANCE OBJECTIVE: DEMONSTRATE UNIFORM DISTRIBUTION OF AMENDMENT</td>
<td>10</td>
</tr>
<tr>
<td>3.1.1 Data Requirements</td>
<td>10</td>
</tr>
<tr>
<td>3.1.2 Success Criteria</td>
<td>10</td>
</tr>
<tr>
<td>3.1.3 Performance Objective Assessment</td>
<td>10</td>
</tr>
<tr>
<td>3.2 PERFORMANCE OBJECTIVE: PROMOTE AND SUSTAIN EFFECTIVE BIODEGRADATION</td>
<td>11</td>
</tr>
<tr>
<td>3.2.1 Data Requirements</td>
<td>11</td>
</tr>
<tr>
<td>3.2.2 Success Criteria</td>
<td>11</td>
</tr>
<tr>
<td>3.2.3 Performance Objective Assessment</td>
<td>11</td>
</tr>
<tr>
<td>3.3 PERFORMANCE OBJECTIVE: DEMONSTRATE SUITABILITY FOR FULL-SCALE IMPLEMENTATION</td>
<td>12</td>
</tr>
<tr>
<td>3.3.1 Data Requirements</td>
<td>12</td>
</tr>
<tr>
<td>3.3.2 Success Criteria</td>
<td>12</td>
</tr>
<tr>
<td>3.3.3 Performance Objective Assessment</td>
<td>12</td>
</tr>
<tr>
<td>3.4 QUALITATIVE PERFORMANCE OBJECTIVES: DEMONSTRATE SAFETY, RELIABILITY, EASE OF IMPLEMENTATION</td>
<td>13</td>
</tr>
<tr>
<td>3.4.1 Data Requirements</td>
<td>13</td>
</tr>
<tr>
<td>3.4.2 Success Criteria</td>
<td>13</td>
</tr>
<tr>
<td>3.4.3 Performance Objective Assessment</td>
<td>13</td>
</tr>
<tr>
<td>4.0 SITE DESCRIPTION</td>
<td>15</td>
</tr>
<tr>
<td>4.1 SITE LOCATION AND HISTORY</td>
<td>15</td>
</tr>
<tr>
<td>4.2 SITE GEOLOGY/HYDROGEOLOGY</td>
<td>15</td>
</tr>
<tr>
<td>4.3 CONTAMINANT DISTRIBUTION</td>
<td>19</td>
</tr>
<tr>
<td>5.0 TEST DESIGN</td>
<td>23</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>5.1 CONCEPTUAL EXPERIMENTAL DESIGN</td>
<td>23</td>
</tr>
<tr>
<td>5.2 TREATABILITY OR LABORATORY STUDY RESULTS</td>
<td>26</td>
</tr>
<tr>
<td>5.3 BASELINE CHARACTERIZATION</td>
<td>27</td>
</tr>
<tr>
<td>5.3.1 Baseline Groundwater Sampling</td>
<td>27</td>
</tr>
<tr>
<td>5.3.2 Baseline Soil Sampling</td>
<td>33</td>
</tr>
<tr>
<td>5.4 DESIGN AND LAYOUT OF TECHNOLOGY COMPONENTS</td>
<td>33</td>
</tr>
<tr>
<td>5.4.1 Electrode Wells</td>
<td>33</td>
</tr>
<tr>
<td>5.4.2 Supply Wells</td>
<td>36</td>
</tr>
<tr>
<td>5.4.3 Monitoring Wells</td>
<td>36</td>
</tr>
<tr>
<td>5.4.4 Power Supply and Electrodes</td>
<td>36</td>
</tr>
<tr>
<td>5.4.5 Amendment Supply System</td>
<td>36</td>
</tr>
<tr>
<td>5.4.6 Cross-Circulation and Electrode Well pH Control System</td>
<td>41</td>
</tr>
<tr>
<td>5.4.7 Process Monitoring and Controls</td>
<td>41</td>
</tr>
<tr>
<td>5.4.8 Conveyance Piping and Utilities</td>
<td>41</td>
</tr>
<tr>
<td>5.5 FIELD TESTING</td>
<td>41</td>
</tr>
<tr>
<td>5.5.1 System Start-Up</td>
<td>42</td>
</tr>
<tr>
<td>5.5.2 Stage 1 EK Operations and Monitoring</td>
<td>42</td>
</tr>
<tr>
<td>5.5.3 Post-Stage 1 Incubation</td>
<td>43</td>
</tr>
<tr>
<td>5.5.4 Stage 2 EK Operations and Monitoring</td>
<td>43</td>
</tr>
<tr>
<td>5.5.5 Post-Stage 2 Incubation</td>
<td>43</td>
</tr>
<tr>
<td>5.5.6 Decommissioning</td>
<td>44</td>
</tr>
<tr>
<td>5.6 SAMPLING METHODS</td>
<td>44</td>
</tr>
<tr>
<td>5.6.1 Sampling and Analytical Methods</td>
<td>44</td>
</tr>
<tr>
<td>6.0 SAMPLING RESULTS AND DISCUSSIONS</td>
<td>49</td>
</tr>
<tr>
<td>6.1 SYSTEM OPERATION MONITORING</td>
<td>49</td>
</tr>
<tr>
<td>6.2 GROUNDWATER SAMPLING RESULTS</td>
<td>53</td>
</tr>
<tr>
<td>6.2.1 Groundwater Geochemistry</td>
<td>53</td>
</tr>
<tr>
<td>6.2.2 Groundwater Chemical and Microbial Analytical Results</td>
<td>59</td>
</tr>
<tr>
<td>6.3 SOIL SAMPLING RESULTS</td>
<td>65</td>
</tr>
<tr>
<td>6.3.1 Soil Chemical Analyses Results</td>
<td>66</td>
</tr>
<tr>
<td>6.3.2 Soil Microbial Analytical Results</td>
<td>72</td>
</tr>
<tr>
<td>7.0 PERFORMANCE ASSESSMENT</td>
<td>75</td>
</tr>
<tr>
<td>7.1 DEMONSTRATE UNIFORM DISTRIBUTION</td>
<td>75</td>
</tr>
<tr>
<td>7.2 DEMONSTRATE TREATMENT EFFECTIVENESS</td>
<td>76</td>
</tr>
<tr>
<td>7.3 DEMONSTRATE SUITABILITY FOR FULL-SCALE IMPLEMENTATION</td>
<td>77</td>
</tr>
<tr>
<td>7.4 SAFE AND RELIABLE OPERATION</td>
<td>78</td>
</tr>
<tr>
<td>7.5 EASE OF IMPLEMENTATION</td>
<td>79</td>
</tr>
<tr>
<td>8.0 COST ASSESSMENT</td>
<td>81</td>
</tr>
<tr>
<td>8.1 COST MODEL</td>
<td>81</td>
</tr>
</tbody>
</table>
TABLE OF CONTENTS (Continued)

8.2 COST DRIVERS ........................................................................................................ 82
8.3 COST ANALYSIS...................................................................................................... 84
9.0 IMPLEMENTATION ISSUES ........................................................................................... 89
10.0 REFERENCES .................................................................................................................... 91
APPENDIX A POINTS OF CONTACT .............................................................................. A-1
APPENDIX B TREATABILITY TEST MEMORANDUM ................................................. B-1
APPENDIX C BORING LOGS AND WELL CONSTRUCTION LOGS ......................... C-1
APPENDIX D GROUNDWATER SAMPLING FORMS.................................................. D-1
APPENDIX E LABORATORY ANALYSES CHAIN OF CUSTODY FORMS............... E-1
APPENDIX F GROUNDWATER MONITORING DATA SUMMARY ..............................F-1
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-2</td>
<td>Schematic of EK-Enhanced Amendment Delivery Technology</td>
<td>5</td>
</tr>
<tr>
<td>4-1</td>
<td>Site Location</td>
<td>16</td>
</tr>
<tr>
<td>4-2</td>
<td>Target Dem/Val Area</td>
<td>17</td>
</tr>
<tr>
<td>4-3</td>
<td>Lithology of the Target Dem/Val Area</td>
<td>18</td>
</tr>
<tr>
<td>4-4</td>
<td>Total Chlorinated Ethenes in Select Groundwater Monitoring Wells in Shallow</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>Sand Aquifer</td>
<td></td>
</tr>
<tr>
<td>4-5</td>
<td>Profile of Groundwater CVOC Distribution</td>
<td>20</td>
</tr>
<tr>
<td>4-6</td>
<td>Profiles of Soil and Groundwater CVOC Concentrations at OU3-3</td>
<td>21</td>
</tr>
<tr>
<td>5-1</td>
<td>Well Network for Dem/Val</td>
<td>24</td>
</tr>
<tr>
<td>5-2</td>
<td>Stage 1 Conceptual Electric Field</td>
<td>25</td>
</tr>
<tr>
<td>5-3</td>
<td>Stage 2 Conceptual Electric Field</td>
<td>26</td>
</tr>
<tr>
<td>5-4</td>
<td>Baseline Characterization</td>
<td>32</td>
</tr>
<tr>
<td>5-5</td>
<td>Electrode Well Details</td>
<td>34</td>
</tr>
<tr>
<td>5-6</td>
<td>Electrode Well Vault Details</td>
<td>35</td>
</tr>
<tr>
<td>5-7</td>
<td>Supply Well Details</td>
<td>37</td>
</tr>
<tr>
<td>5-8</td>
<td>Supply Well Vault Details</td>
<td>38</td>
</tr>
<tr>
<td>5-9</td>
<td>Monitoring Well Details</td>
<td>39</td>
</tr>
<tr>
<td>5-10</td>
<td>Conduit Trench Details</td>
<td>40</td>
</tr>
<tr>
<td>5-11</td>
<td>Soil Sampling Locations (C1 through C11)</td>
<td>46</td>
</tr>
<tr>
<td>6-1</td>
<td>Power Usage During System Operation</td>
<td>50</td>
</tr>
<tr>
<td>6-2</td>
<td>Voltage Measurements (V) at Monitoring Wells Within TTA</td>
<td>51</td>
</tr>
<tr>
<td>6-3</td>
<td>Groundwater CVOC &amp; Biomarkers</td>
<td>62</td>
</tr>
<tr>
<td>6-4</td>
<td>Soil PCE Concentration vs. Soil Grain Size (Baseline; 18.5 ft bgs)</td>
<td>69</td>
</tr>
<tr>
<td>6-5</td>
<td>Soil CVOC Data – Comparisons Between Events</td>
<td>71</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 3-1. Performance Objectives ........................................................................................................... 9
Table 5-1. Major Project Milestones ........................................................................................................ 25
Table 5-2. Bromide Tracer Test Results ................................................................................................... 27
Table 5-3. Summary of Monitoring Program .......................................................................................... 28
Table 5-4a. Analytical Results in Groundwater-baseline Sampling Event ............................................. 30
Table 5-5. Dem/Val Field Testing Phases ................................................................................................. 42
Table 5-6. Analytical Methods for Sample Analysis .............................................................................. 45
Table 6-1. Electrical Current to Electrode Wells .................................................................................... 52
Table 6-2. EK System Operation Summary ............................................................................................ 52
Table 6-3. Groundwater Geochemistry Data Summary ......................................................................... 54
Table 6-4. Groundwater TOC and VFA Summary .................................................................................. 60
Table 6-5. Groundwater TOC at Select DPT Sampling Locations (from 21 ft bgs) ......................... 61
Table 6-6. Groundwater CVOC and Biomarker at Select DPT Sampling Locations ....................... 65
Table 6-7. Summary of Soil Chemical Analytical Results ..................................................................... 67
Table 6-8. Soil Grain Size Analysis (Baseline Event) ............................................................................ 69
Table 6-9. Soil Microbial Analytical Data (Post-Stage 2 Samples; 18.5 ft bgs) ................................... 72
Table 7-1. Changes of Groundwater CVOC and Ethene Concentrations* ........................................ 76
Table 8-1. Cost Model for EK-enhanced Amendment Delivery In-Situ Remediation ..................... 81
Table 8-2. Cost Model for Full-Scale Implementation of Select Source Area Remediation Technologies ........................................................................................................ 86
Page Intentionally Left Blank
# ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>amp</td>
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<tr>
<td>AC</td>
<td>alternate current</td>
</tr>
<tr>
<td>cm</td>
<td>centimeter</td>
</tr>
<tr>
<td>cm/sec</td>
<td>centimeter per second</td>
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<td>CVOC</td>
<td>chlorinated volatile organic compounds</td>
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<tr>
<td>cDCE</td>
<td>cis-1,2-dichloroethene</td>
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<tr>
<td>$k_e$</td>
<td>coefficient of electroosmotic permeability</td>
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<tr>
<td>Dhb</td>
<td>Dehalobacter</td>
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<tr>
<td>Dhc</td>
<td>Dehalococcoides</td>
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<tr>
<td>Dem/Val</td>
<td>Demonstration/Validation</td>
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<tr>
<td>DoD</td>
<td>Department of Defense</td>
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<tr>
<td>DO</td>
<td>dissolved oxygen</td>
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<tr>
<td>dc</td>
<td>direct-current</td>
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<tr>
<td>DPT</td>
<td>Direct Push Technology</td>
</tr>
<tr>
<td>EK-BIO</td>
<td>EK-enhanced amendment delivery for in situ bioremediation</td>
</tr>
<tr>
<td>EK</td>
<td>electrokinetic</td>
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<tr>
<td>$K_{eo}$</td>
<td>electroosmotic permeability</td>
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<td>ERH</td>
<td>electrical resistance heating</td>
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<td>ERDC</td>
<td>Engineer Research &amp; Development Center</td>
</tr>
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<td>EISB</td>
<td>enhanced in-situ bioremediation</td>
</tr>
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<td>ERD</td>
<td>enhanced reductive dechlorination</td>
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<tr>
<td>FS</td>
<td>Feasibility Study</td>
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<tr>
<td>ft</td>
<td>feet</td>
</tr>
<tr>
<td>ft bgs</td>
<td>feet below ground surface</td>
</tr>
<tr>
<td>gal</td>
<td>gallon</td>
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<tr>
<td>g/L</td>
<td>grams per Liter</td>
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<tr>
<td>$K_h$</td>
<td>hydraulic conductivity</td>
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<td>ISCO</td>
<td>in-situ chemical oxidation</td>
</tr>
<tr>
<td>kg</td>
<td>kilogram</td>
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<tr>
<td>kW-hr</td>
<td>kilowatt hour</td>
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<tr>
<td>L</td>
<td>Liter</td>
</tr>
</tbody>
</table>
low-K  low-permeability

µg/g  microgram per gram
µg/L  microgram per Liter
mg/kg  milligram per kilogram
mV  millivolts
m  minutes
MMO  mixed metal oxide

NAS  Naval Air Station
NAVFAC  Naval Facilities Engineering Command

OU3  Operable Unit 3
ORP  oxidation-reduction potential

POC  points of contact
PVC  Polyvinyl chloride
K₂CO₃  potassium carbonate
PSV  pressure safety valve
PLC  programmable logic controller

qPCR  quantitative polymerase chain reaction

cm²  square centimeter

TTA  target treatment area
PCE  tetrachloroethene
TCE  trichloroethene
TOC  total organic carbon

USACE  United States Army Corps of Engineers

VC  vinyl chloride
vcrA  vinyl chloride reductase
VFA  volatile fatty acid
VOC  volatile organic compound
V  volts
V/m  Volts per minute

w/w  weight per weight

XRD  X-Ray Diffraction
EXECUTIVE SUMMARY

This Demonstration/Validation (Dem/Val) project was conducted at Naval Air Station (NAS) Jacksonville, Florida, to assess and validate the performance of an electrokinetic (EK) technique to promote uniform and effective distribution of remediation amendments (e.g., electron donors, electron acceptors, chemical oxidants) in low-permeability (low-K) and heterogeneous subsurface materials. Recent advances in the understanding of mass distribution in subsurface environments has highlighted that in many cases a significant portion of the source mass is held in storage in low-K materials. The main limitation of current in situ remediation applications in low-K materials using conventional hydraulic recirculation or injection techniques is the inability to effectively deliver the required amendments to the target contaminant mass. The EK-enhanced amendment delivery technology entails the establishment of an electric field in the subsurface using a network of electrodes. The electrical current and voltage gradient established across a direct-current (dc) electric field provide the driving force to transport remediation amendments, including electron donors, chemical oxidants, and even bacteria, through the subsurface.

The EK Dem/Val system consists of nine (9) electrode wells and eight (8) supply wells located within a target treatment area (TTA) measuring approximately 40 feet by 40 feet. The remediation amendments distributed by the EK remediation system included electron donor (lactate provided as potassium lactate), pH control reagents (potassium carbonate), and a dechlorinating microbial consortium (KB-1®) containing *Dehalococcoides* (*Dhc*). Following the system startup, initial site conditioning, and bioaugmentation of the site, the Dem/Val included two (2) separate stages, 5-month each, of active operation with a 6-month incubation period between the two active stages.

The overall goal of this Dem/Val is to demonstrate and validate EK-enhanced amendment delivery for in-situ bioremediation (EK-BIO) via enhanced reductive dechlorination (ERD) of a tetrachloroethene (PCE) source area in clay. Several performance objectives were identified and assessed based on the performance monitoring data collected:

I. *Demonstrate uniform distribution of the amendments and relative uniformity of the established electrical field.*

This Dem/Val met this objective by meeting the success criteria, including:

- At groundwater monitoring locations within the TTA after the completion of active EK operation, post-EK concentration of total organic carbon (TOC) was at least 5x baseline; and
- No local focusing of electric field was observed within the TTA.

II. *Demonstrate effectiveness of treatment established by EK-BIO operation within the TTA.*

This Dem/Val met this objective by meeting the success criteria, including:

- >60% reduction in average PCE concentrations was achieved in soil and groundwater within the TTA. While groundwater data also showed coupled and comparable increases of dechlorination daughter and end products, no such apparent increases of degradation products were observed in soil samples;
- Ethene was detected at 100% of groundwater monitoring wells within the TTA; and
• >10x increases of $Dhc$ from baseline was observed at >60% of soil and groundwater samples collected from within the TTA.

**III. Demonstrate suitability of this technology for full-scale implementation.**

This Dem/Val met this objective by meeting the success criteria, including:

- System operation conditions (voltage and current) were maintained within ± 50% of the designed target conditions;
- Amendment supply up-time was >75% of target; and
- Energy consumption was within ± 30% of design estimates.

This Dem/Val showed that a critical and distinct advantage of the EK-enhanced amendment delivery over other conventional advective flow-based approaches is that EK can achieve relatively uniform transport in low-K materials. EK-enhanced delivery is a safe and relatively more controllable approach compared to high-pressure/fracturing injection and thermal approaches. This technology also represents a remedial alternative with excellent environmental performance. The electrical energy consumed during the active EK operation period in this Dem/Val was equivalent to operating two 100-W lightbulbs over the same time interval.

Based on the information and experience obtained from this Dem/Val, there are three main cost drivers to consider when evaluating implementation costs in future projects, including: (1) footprint, depth interval, and volume of target treatment zone and contaminant mass; (2) presence and location of above-ground and subsurface utilities; and (3) site geochemistry, particularly pH and iron. These are also the same cost drivers for many other in-situ remediation technologies and not unique to EK technology implementation.

A cost comparison was developed and showed that EK-BIO could be potentially more cost favorable to an in situ thermal treatment approach, electrical resistance heating (ERH). It is also noted that the significant difference in the electrical energy needed for these two technologies indicating a much more favorable environmental performance of EK-BIO over ERH. The cost comparison also showed that EK-BIO approach is slightly more cost favorable to direct-injection enhanced in situ bioremediation (EISB) and fracturing enhanced zero-valent iron (ZVI) direct injection. However, at sites where low-K material and/or high-degree of heterogeneity likely preclude the consideration for direct injection, EK-BIO provides a cost-effective solution for implementing in situ bioremediation.

While EK-BIO is mainly a variation on standard EISB whereby EK is used to more effectively deliver the required amendments through low-K materials, some areas where additional attention, beyond those typically considered for EISB, may be required on a site-specific basis include:

- Safety considerations related to potential stray current/voltage to surface. To address this question, we checked the current and voltage at the manhole steel cover located within the treatment area while the EK system was in operation to confirm that there was no safety concern. Depending on project site, and for sensitive and active facilities with dedicated safety departments, additional design and explanation effort may be required for project approvals.
• Iron fouling of filters and valves along the catholyte (well water from cathode wells) extraction line. In this Dem/Val, we re-plumbed the system to minimize potential flow restriction points. Scaling of the cathodes also required maintenance actions to clean the cathode surface. As indicated above, this issue diminished over the course of the Dem/Val.

• Corrosion of metallic parts in the manifold system & wellhead fittings due to elevated chloride concentrations. In this Dem/Val, we replaced most metallic contacting parts with plastic parts upon discovering that chloride levels were far higher than initially known.

• The technology implementation did not require specialized/proprietary equipment. We used only standard commercial off-the-shelf equipment. We designed the manifold and control system and had a remediation system vendor assemble the system per design, but the overall system was similar to other “typical” in-situ remediation systems.

• If the technology is to be implemented near (laterally and/or vertically) utilities that are “sensitive” to electric interference or corrosion concerns, some protection measures, such as cathodic protection, may be considered.

• No special regulatory requirements or permits beyond what are typical for other EISB or ISCO projects such as UIC permit. Depending on the locality-/facility-specific requirements, local or facility power/electrical departments should be consulted.
1.0 INTRODUCTION

This Draft Final Report summarizes the approach, methodology and results of a field Demonstration / Validation (Dem/Val) project conducted to assess and validate the performance of an electrokinetic (EK) technique to promote uniform and effective distribution of remediation amendments (e.g., electron donors, electron acceptors, chemical oxidants) in low-permeability (low-K) and heterogeneous subsurface materials, for the purposes of improving remediation success at low-K sites. This project was conducted in collaboration with Naval Facilities Engineering Command (NAVFAC) and the United States Army Corps of Engineers (USACE) Engineer Research & Development Center (ERDC).

1.1 BACKGROUND

Decades of remediation experience have shown that in-situ remediation approaches are more successful and cost effective than most ex-situ remediation methods. However, in-situ remedies, such as enhanced in-situ bioremediation (EISB) and in-situ chemical oxidation (ISCO), while capable of treating various contaminants in permeable sandy aquifers, often fail to effectively target contaminants in silt and clay materials, or combinations of sand and low-K materials. Recent advances in the understanding of mass distribution in subsurface environments has highlighted that in many cases a significant portion of the source mass is held in storage in low-K materials, and that the release rate from low-K storage is many times slower than the original contaminant loading rate. The main limitation of EISB and ISCO applications in low-K materials is the inability to effectively deliver the required amendments to the target contaminant mass contained within the low-K material using conventional hydraulic recirculation or injection techniques.

While hydraulic fracturing has shown some promise in improving amendment distribution in low-K materials, the success of this approach has been limited by site access constraints, surface structure impact concerns, high cost, and consistency and predictability of induced fractures. Other technologies such as large diameter auger mixing and thermal treatment have shown promise in low-K materials. However, these approaches have been expensive and are also limited by site access and re-use limitations. Conventional thermal remediation approaches also face the challenges of removing and treating gaseous phase contaminants. Lower cost, and ideally more environmentally-sustainable remediation approaches or improvements to existing technologies are required to reduce overall remediation costs at Department of Defense (DoD) and defense contractor sites.

The EK-enhanced amendment delivery technology entails the establishment of an electric field in the subsurface using a network of electrodes. The electrical current and voltage gradient established across a direct-current (dc) electric field provide the driving force to transport remediation amendments, including electron donors, chemical oxidants, and even bacteria, through the subsurface. One reason why EK represents a fundamentally more effective delivery technique compared to an advective hydraulic approach is the relatively uniform electrical property of various soil materials. As a result, EK-enhanced amendment delivery technology can achieve effective and uniform amendment distribution at sites where heterogeneous subsurface materials often limit the applications of hydraulic methods.
1.2 OBJECTIVE OF THE DEMONSTRATION

The overall goal of this project is to Dem/Val the use of EK-enhanced amendment delivery to achieve uniform and effective distribution of remediation amendments into and through low-K and heterogeneous materials in the subsurface, thereby improving the effectiveness of in-situ remediation (in this case, EISB) and reducing the costs of remediation at DoD sites impacted by chlorinated and recalcitrant contaminants. The specific technical objectives for this Dem/Val project are as follows:

i) demonstrate and quantify the ability to uniformly distribute remediation amendments (in this case, lactate and *Dehalococcoides* (*Dhc*) microorganisms) across a target treatment area (TTA) using a dc electric field;

ii) demonstrate the ability to promote and sustain effective biodegradation within the TTA as a result of amendment delivery by EK;

iii) evaluate EK system operational parameters and resolve potential operational issues (e.g., scaling of electrodes) to allow engineering design and implementation of full-scale EK systems; and

iv) develop costing information for technology evaluation by DoD and remediation practitioners.

1.3 REGULATORY/TECHNICAL/COST DRIVERS

In 2011, a SERDP/ESTCP-sponored workshop on *Investment Strategies to Optimize Research and Demonstration Impacts in Support of DoD Restoration Goals* identified treatment of contaminants in low-K subsurface materials (i.e. silts, clays, and bedrock) as a high-priority area for additional investment. The workshop participants noted that treatment of low-K zones would require adoption of cost-effective techniques that can target delivery of remedial agents to these regions and prevent continued back-diffusion of contaminants.

Estimated costs to DoD for adopting hydraulic containment at more than 3,000 chlorinated hydrocarbon sites could surpass $100 million annually, with estimated life-cycle costs of more than $2 billion (SERDP/ESTCP, 2006). EISB has generally been considered as one of the more cost-effective remedial options available for chlorinated solvent sites. However, there are sites where the effectiveness of EISB is limited by the presence of low-K zones, or sites where more expensive alternatives are the presumed options due to the concerns of low-K materials. Improved delivery of remediation amendments can reduce the overall duration and cost of EISB, as well as allow the consideration of lower cost EISB options at more DoD sites where low-K zones represent a limiting factor in remedy selection and success.
2.0 TECHNOLOGY

This section provides an overview of the EK-enhanced amendment delivery technology that was demonstrated in this project. Advantages and potential limitations associated with this technology are also discussed.

2.1 TECHNOLOGY DESCRIPTION

The EK-enhanced amendment delivery technology entails the use of electrodes and dc electrical power to establish an electric field in the subsurface. The voltage gradient established across the dc electric field is then the driving force for transporting remediation reagents, including electron donors for microorganisms, chemical oxidants, and even bacteria, through low-K soils or uniformly through heterogeneous formations. The EK transport process relies on three mechanisms which occur with the application of the electric field:

- **Electromigration (or ion migration)** – the movement of charged dissolved ions through an aqueous medium in response to the applied electric field. The direction of ion migration is toward the electrode with a polarity opposite of the ion’s charge;
- **Electroosmosis** – the movement of pore fluid (and dissolved constituents) within a porous medium in response to the applied electric field. The direction of electroosmotic flow is usually from the anode toward the cathode; and
- **Electrophoresis** – the movement of charged particles, such as clay particles or bacteria, through an aqueous medium in response to the applied electric field. Similar to electromigration, the direction of ion migration is toward the electrode with a polarity opposite to that of a particle’s net charge.

This Dem/Val project focused on the amendment transport facilitated by electromigration and electroosmosis. While ion migration phenomenon is readily apparent and understandable as it reflects basic electrochemistry, electroosmosis is a more complex EK phenomenon. Certain subsurface materials, such as clays, have a negative surface charge due to their mineral contents and crystal lattice structures. Porewater surrounding these soil particles, containing mixtures of cations and anions, forms a boundary layer system (i.e., double layer) around these negatively charged soil particles consisting of an inner immobile zone (Stern layer) and an outer mobile zone (Diffuse layer). The electrical potential at the interface between the two zones is known as the zeta potential. Upon the application of a voltage gradient, the surface of the Stern layer (positively charged layer in this case) allows the movement of cations drawing along the surrounding water molecules toward the negatively charged electrode (i.e., cathode). The value of the zeta potential is dependent on the pore fluid’s ionic strength and pH.

The rate of electroosmotic flow is proportional to the coefficient of electroosmotic permeability ($k_e$), which is a measure of the rate of fluid flow per unit area under a unit voltage gradient. The value of $k_e$ is a function of the zeta potential of the soil particle surface, viscosity of the pore fluid, porosity, and electrical permittivity of the medium.
One reason why EK represents a fundamentally more effective delivery technique for low-K and heterogeneous soils compared to an advective hydraulic approach is the relatively uniform electrical property of various soil materials. For example, as presented in Figure 2-1, while the hydraulic conductivity of fine sand and kaoline materials can vary by several orders of magnitude, the coefficient of electroosmotic permeability of fine sand (4.1E-05 cm²/sec-V) is comparable to that of kaoline (5.7E-05 cm²/sec-V) and clayey till (5.0E-05 cm²/sec-V). Therefore, the EK-enhanced amendment delivery technology can achieve effective and uniform amendment distribution at sites where heterogeneous subsurface materials often limit the applications of hydraulic methods.

![Figure 2-1. Hydraulic and Electrical Properties of Various Soils (rev. Mitchell, 1993)](image)

The application of electric current will also result in electrolytic reactions at the electrodes. If inert electrodes (such as graphite or ceramic-coated electrodes) are used, water oxidation produces oxygen gas and acid (H₃O⁺) at the anode (positively charged electrode), while water reduction produces hydrogen gas and base (OH⁻) at the cathode (negatively charged electrode). Electrolytic reactions of water are shown below in Equations 1 and 2,

$$
2H₂O \rightarrow 4e^- + 4H^+ + O_2 \quad \text{(at Anode)} \\
2H₂O + 2e^- \rightarrow 2OH^- + H_2 \quad \text{(at Cathode)}
$$

Faraday’s law for equivalence of mass and charge can be used to calculate the rate of redox reactions that will occur at the electrodes (Koryta and Dvorak, 1987). Therefore, it is possible to engineer and control the electrolytic processes at the electrodes to produce hydrogen (H₂) and oxygen (O₂) or to control pH conditions, depending on the system design objectives.
To implement the EK-enhanced delivery technology in the field, remediation amendments
are added to electrode wells and potentially additional supply wells located intermediary to the
electrode wells, mainly to shorten amendment travel distance versus consumption rate (Figure 2-2).
Electrodes of selected inert materials are installed in electrode wells and connected to a dc
power source. The power supply unit will supply electrical energy to electrodes at designed
settings of voltage and/or current. The electrical field will transport the amendments from the
electrode wells and supply wells into and through the formation materials to achieve a relatively
uniform transport and distribution. Cross-circulation and pH-balancing can be employed at the
electrode wells to overcome the effects of water electrolysis, and retain the natural in-situ pH of
the system (as required). Slight subsurface heating may occur with application of the electrical
field. However, results from field trials have shown that temperature increases are minor (less than
10°C). A modest increase in temperature often results in an improvement in the bioremediation
process, as has been shown for Dhc during trichloroethene (TCE) dechlorination, where
dechlorination was faster at 30°C than 15°C (Friis et al., 2007).

Figure 2-2. Schematic of EK-Enhanced Amendment Delivery Technology

2.2 TECHNOLOGY DEVELOPMENT

Results from many studies conducted at both bench-scale and field-pilot scale have shown the potential
of EK-enhanced amendment transport (Mao et al., 2012; Gent, 2001; Wu et al., 2007; Reynolds et al.,
2008; Hodges et al., 2011; SERDP ER-1204). Bench-scale studies conducted at ERDC effectively
delivered acetate through loess soil (K=10^{-7} \text{ cm/s}) and vertically deposited clay (K=10^{-9} \text{ cm/s}) at
rates of 2.1 and 2.5 cm/day, respectively, with a voltage gradient near 0.5 V/cm (Gent, 2001).
An average lactate transport rate of 3.4 cm/day under a unit voltage gradient of 1 V/cm was achieved in a bench-scale study conducted using a silty clay (K=10^{-7} cm/s) (SERDP ER-1204). The observed EK-enhanced transport rate in that SERDP study was more than 120 times higher than the transport rate achievable in the same type of soil but under a unit hydraulic gradient. The use of EK-enhancement for ISCO has also been demonstrated at the bench scale in both column and sandbox experiments (Roach et al., 2006; Reynolds et al., 2008; Robertson, 2009; Hodges et al., 2011). Common oxidants such as permanganate and persulfate are charged compounds, and will migrate under the driving force of the imposed electric gradient. Migration rates of monovalent and divalent oxidants have been measured in the laboratory at levels in excess of 500 times higher than that achievable through diffusion alone.

Geosyntec, in collaboration with ERDC, completed a field pilot test of EK-enhanced delivery for in-situ bioremediation (EK-BIO) at a site in Denmark, which achieved a lactate transport rate between 2.5 and 5 cm/day through clay materials. The pilot test involved simultaneous biostimulation (using lactate) and bioaugmentation (using dechlorinating culture KB-1®) targeting a PCE source area. Active EK operation for lactate distribution was conducted for approximately 8 weeks, followed by 16 weeks of post-EK monitoring. Results from the pilot test (both groundwater samples and clay cores) indicated general uniformity of distribution of electron donor, rapid establishment and growth of the bioaugmented Dhc within the clay, and rapid dechlorination of PCE, TCE, and cis-1,2-dichloroethene (cDCE) to vinyl chloride (VC) and ethene. Results from both laboratory studies and the field pilot test for this site showed that the applied electrical field had no deleterious impacts on the microorganisms or subsurface conditions. During the EK field pilot test, the average groundwater temperature in the demonstration area increased from 17ºC to 25ºC, which was believed to provide improved conditions for PCE dechlorination by the introduced Dhc.

2.3 ADVANTAGES AND LIMITATIONS OF THE TECHNOLOGY

A critical and distinct advantage of the EK technology over most other approaches is that EK can achieve relatively uniform transport in inter-bedded clays and sands, even when the hydraulic conductivities of the subsurface materials vary by orders of magnitude. EK-enhanced transport, which relies primarily on the electrical properties of aquifer materials instead of the hydraulic properties, represents a solution to the limitations of preferential pathways facing conventional advective-based hydraulic technologies.

EK-enhanced delivery is a safer, and more controllable approach compared to current high-pressure/fracturing injection and thermal approaches. The migration of remediation reagents is directed by the electrical field established between electrodes, and no high injection pressures are involved.

EK-enhanced delivery also represents a remediation technology with good environmental performance. Unlike other technologies that repeatedly deliver/flush amendments through a small number of preferential pathways in the subsurface, the EK technology can uniformly deliver the amendments, maximizing treatment effectiveness and reducing treatment cost and duration. When coupled with existing in situ remediation technologies (i.e., EISB and ISCO), EK-BIO and EK-ISCO can achieve direct treatment and destruction of target contaminants in situ instead of transferring contaminants to the gas phase, which requires additional containment/collection and treatment.
The electrical energy usage of EK-enhanced delivery is relatively low compared to current thermal remediation technologies. The EK-BIO field pilot test conducted by Geosyntec in Denmark required less than 100 volts (V) and 15 amp (A) of electrical power to sustain the EK operation. The energy usage of the EK-BIO pilot test was equivalent to the energy needed to power approximately ten 100-watt light bulbs, reflecting the small carbon footprint and excellent environmental performance of this technology. As discussed in Section 6.1 of this report, the electrical power used in this Dem/Val (maintained at <30V and <10A) also demonstrated the excellent energy efficiency of this technology.

There are several aspects of this technology that will require appropriate considerations and control measures:

- Safety considerations related to potential stray current/voltage to ground surface.
- If the technology is to be implemented near (laterally and/or vertically) utilities that are sensitive to electric interference or corrosion concerns, some protection measures, such as cathodic (grounding) protection, may be required. Depending on the locality / facility-specific requirements, local or facility power/electrical departments should be consulted.
- Although conceptually there is no depth limit for this technology, shallow treatment zones too close to the ground surface and/or utilities, or in a vadose zone, can limit the feasibility of this technology.
- Certain site hydrogeology or geochemical conditions may limit the applications or impact the costs of this technology, including
  - Very high levels of sulfate or nitrate that challenge the supply of electron donors for promoting and sustaining reductive dechlorination. This limitation is not specific to EK amendment delivery, instead, it is a limitation for anaerobic in situ bioremediation.
  - High natural groundwater flow velocity in the permeable portion of a target treatment zone may potentially limit the EK transport in the direction against the natural groundwater flow.
  - High levels of chloride and/or iron that require particular engineering control measures (e.g., corrosion protection) or more operational maintenance efforts for fouling controls. Iron fouling is also a common challenge to other in situ remediation technologies.
3.0 PERFORMANCE OBJECTIVES

The overall goal of this Dem/Val is to demonstrate and validate EK-enhanced amendment delivery for in-situ bioremediation via enhanced reductive dechlorination (ERD) of a PCE source area in clay. Performance objectives were identified and approved by ESTCP to provide the basis for evaluating the performance and costs of the Dem/Val technology. Table 3-1 presents a summary of the quantitative and qualitative performance objectives, which are further discussed in the following subsections.

Table 3-1. Performance Objectives

<table>
<thead>
<tr>
<th>Performance Objective</th>
<th>Data Requirements</th>
<th>Success Criteria</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantitative Performance Objectives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I. Demonstrate uniform distribution of the amendments and relative uniformity of the established electrical field</td>
<td>Pre- and post-EK monitoring of the concentrations of amendments, Monitoring of voltage and electrical current within the EK system during operation</td>
<td>At groundwater monitoring locations within the TTA after the completion of active EK operation: post-EK concentration of TOC is 5x baseline, or 10x detection limit if baseline is below detection limit. No local focusing of electric field within the TTA: no electrical potential gradient between any individual pair of cathode-anode is 5x the average electrical gradient between all pairs of electrodes. Electrical potential gradient between electrode pairs maintained at level no more than 5x target gradient at design current.</td>
<td>Objective Met (see Section 3.1)</td>
</tr>
<tr>
<td>II. Demonstrate effectiveness of treatment established by EK-BIO operation within the TTA</td>
<td>Pre- and post-EK concentrations of chlorinated ethenes in soil and groundwater, Pre- and post-EK concentrations of ethene in groundwater, Pre- and post-EK concentrations of biomarker (qPCR analysis of Dhc and/or vinyl chloride reductase [vcrA]) in soil and groundwater</td>
<td>&gt; 60% reduction in average PCE concentrations in soil and groundwater within the TTA, with coupled and comparable molar concentration increases of dechlorination daughter and end products. Ethene/ethane detected at &gt; 75% of groundwater monitoring wells within the TTA before the completion of post-EK monitoring. &gt; 10x increases of Dhc from baseline at &gt; 50% of soil and groundwater samples collected from within the TTA before the completion of post-EK monitoring.</td>
<td>Objective Met (see Section 3.2)</td>
</tr>
<tr>
<td>III. Demonstrate suitability of this technology for full-scale implementation</td>
<td>EK system operational parameters, amendment usage, and energy consumption</td>
<td>System operation conditions (voltage and current) within ± 50% of the designed target conditions. Amendment supply up-time &gt; 75% of target. Energy consumption within ± 30% of design estimates</td>
<td>Objective Met (see Section 3.3)</td>
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<tr>
<td>Qualitative Performance Objectives</td>
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</tr>
<tr>
<td>IV. Safe and reliable operation</td>
<td>Monitoring of system operational parameters</td>
<td>Operation conditions remain stable within the normal designed ranges over the course of the demonstration period. No lost-time incidents.</td>
<td>Objective Met (see Section 3.4)</td>
</tr>
<tr>
<td>V. Ease of implementation</td>
<td>Feedback from field personnel on installation and operation of technology and system</td>
<td>Ability to construct using conventional techniques and contractors. A single field technician able to effectively monitor and maintain normal system operation.</td>
<td>Objective Met (see Section 3.4)</td>
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</table>
3.1 PERFORMANCE OBJECTIVE: DEMONSTRATE UNIFORM DISTRIBUTION OF AMENDMENT

The main objective of the EK technology is to achieve uniform distribution of the remediation amendments in the subsurface upon injection under the established electric field conditions. The effective distribution of the amendments (electron donor and \( Dhc_c \)) is essential to the success of the technology (EISB via ERD in this project).

3.1.1 Data Requirements

Uniform distribution of remediation amendments was determined by measuring concentrations of remedial reagents at all monitoring locations in the TTA. Groundwater and soil core samples were collected and analyzed in accordance with the sampling plan. Additionally, measurements of electric current and voltage were taken during system operation to assess the uniformity of the electrical field.

3.1.2 Success Criteria

This objective is considered achieved upon observing evidence of amendment (represented by TOC) transport at monitoring locations (5x baseline or 10x detection limit if baseline is below detection). Potential variability associated with the baseline data was assessed through calculating the arithmetic average and standard deviation.

For successful achievement of a uniform electric field at design levels, the electrical gradient between any individual pair of cathode-anode should not be more than 5 times the average electrical gradient between all pairs of electrodes. Moreover, the electrical potential gradient between electrode pairs should be maintained at a level no more than 5 times the target gradient.

3.1.3 Performance Objective Assessment

As presented in Table 6-4, every monitoring well within the TTA had TOC concentrations >8x baseline levels (for each well) during Stage 1 and/or Stage 2 operation, with the exception of EKMW-04 where the maximum TOC detected was 1.8x of the baseline. However, at EKMW-04 the maximum VFA detected was >9x its baseline. With respect to VFAs, all but one monitoring well (EKMW-05) had concentrations >9x baseline levels. As such, the Dem/Val has met this criterion in the EK was able to substantially increase electron donor concentrations across the entire TTA.

As presented in Figure 6-2, the voltage measured at discrete locations within the TTA were between 5.3V and 6.2V, with a standard deviation of 0.31V (5%). Voltage gradients were calculated between locations of closest pairs shown in Figure 6-2 and range between 0.1 to 0.26 V/m. The calculated voltage gradients between these pairs are within 3x of each other and within 2x of the average gradients (0.13 V/m) indicating no local focusing of electric field within TTA. The Dem/Val has met this criterion.

The EK system was designed and operated at a constant current, determined after the start-up period, during the Dem/Val. As presented in Figure 6-1, during Stage 1 and Stage 2 operation, the voltage required of the power supply unit was generally consistent at between 15V and 30V, except for a few occasions when electrodes were in need of replacement. The electrical current supplied to individual wells during each stage of operation was generally steady (variation within 37% of average).
Given that (1) soil electrical resistivity is a soil property not expected to vary over the course of Dem/Val, and (2) the voltage output by the power supply unit and the current supplied to individual electrodes were generally steady, the electrical potential between electrode pairs within the TTA should maintain within 5x of target during operation. The Dem/Val has met this criterion.

3.2 PERFORMANCE OBJECTIVE: PROMOTE AND SUSTAIN EFFECTIVE BIODEGRADATION

The success of biodegradation depends on a sustained supply of remediation amendments such as electron donor. The benefit of the EK technology is its ability to facilitate transport of the remediation agents into hard-to-reach contaminant storage (low-K) areas/zones, thereby creating conditions that stimulate microbial activity and accomplish contaminant degradation.

3.2.1 Data Requirements

The effectiveness of EK in promoting biodegradation in the TTA was evaluated on the basis of concentrations of chlorinated ethenes in groundwater and soil, and ethene/ethane concentrations in groundwater in the TTA. Pre- and post-EK groundwater and soil core samples were collected and analyzed to assess the changes in chlorinated ethenes and ethene concentrations in the TTA. A baseline characterization event was performed to assess the pre-EK concentrations and establish the baseline conditions within the TTA.

3.2.2 Success Criteria

This objective is considered achieved through the observation of a 60% average reduction in PCE concentrations in groundwater and soil, coupled with comparable molar concentration increases of dechlorination daughter and end products at monitoring locations in the TTA. In addition, detection of ethene/ethane in more than 75% of groundwater monitoring wells within the TTA is indicative of successful attainment of this objective. Sustained biodegradation was successfully demonstrated by observing an increasing trend, or sustained elevated levels, of degradation intermediates and end products in the groundwater monitoring wells within the TTA for as long as sufficient (e.g., greater than 5 times the baseline concentration) electron donor was present.

3.2.3 Performance Objective Assessment

For each of the six monitoring wells located within the TTA, decreases of >80% in PCE concentration were achieved at the end of either Stage 1 and/or Stage 2. Also presented in Figure 6-3 and Table 7-1, the decreases of PCE from baseline at each well within the TTA were coupled with evident increases of dechlorination daughter products and/or ethene. The Dem/Val has met this criterion for groundwater.

Figure 6-5 presents a comparison of soil chlorinated volatile organic compounds (CVOC) at corresponding locations between the three (3) sampling events. The data presented in Figure 6-5 are arranged per individual locations and sampling depths. Overall, soil PCE concentrations of all samples collected from 18.5 feet below ground surface (ft bgs) at the nine (9) locations within the TTA decreased by 78% (C6) to 99% (C3) from baseline to post-Stage 2, with an average decrease of 88%.
It was also noted that while C6 was the only location with evident baseline PCE concentration at 21 ft bgs (5.5 mg/kg), the PCE concentration at this depth and location decreased to 0.21 mg/kg (96% reduction) and below in subsequent post-operation sampling events. As such, the Dem/Val met the PCE soil reduction criterion.

As presented in Figure 6-3 and Table 7-1, every (100%) monitoring well within the TTA showed increased concentrations of ethene (up to >1,000 µg/L) during the Dem/Val. The Dem/Val has met this criterion. Figure 6-3 also shows that every monitoring well within the TTA showed significant increases (several orders of magnitude) of Dhc and vcrA. The Dem/Val has met this criterion for groundwater.

As presented in Table 6-9, among the nine post-Stage 2 soil samples collected from within the TAA, six samples were reported with quantifiable levels, plus one with estimated level, of Dhc, while all baseline soil samples did not contain detectable levels of Dhc. Of the seven samples with detected Dhc, five samples (C2, C3, C5, C7, and C9) showed functional genes for VC dechlorination. Thus, while not as impressive as the groundwater results, the Dem/Val has met this criterion for soil.

3.3 PERFORMANCE OBJECTIVE: DEMONSTRATE SUITABILITY FOR FULL-SCALE IMPLEMENTATION

For this project, the application of EK technology is focused on and limited to the TTA. The information obtained from this Dem/Val was used to assess the suitability of EK for full-scale operation at this and other sites.

3.3.1 Data Requirements

The suitability of the EK technology for full-scale implementation was assessed by measuring the electrical input (voltage/current) to achieve and maintain the desired electric field, by measuring operational parameters for maintaining consistent operation, and by determining the overall energy consumption within the TTA.

3.3.2 Success Criteria

This objective is considered achieved if system operational conditions are within ± 50% of the designed target voltage and current. Additionally, successful accomplishment of this objective includes amendment supply up-time to be greater than 75% of target and the energy consumption to be within ± 30% of the design estimate.

3.3.3 Performance Objective Assessment

The EK system was designed and operated at a constant current, determined after the start-up period, during the Dem/Val. As discussed in Section 7.1 (criterion related to electrical gradient) and presented in Figure 6-1, the operating voltage and current remained relatively steady except when electrodes were in need of replacement. There were three occasions when different electrodes needed to be replaced: late October/early November 2015 and late January/early February 2016 during Stage 1 operation; and December 2016 during Stage 2 operation. Prior to electrode replacement, the system voltage readings would indicate the operating conditions were becoming unsteady.
As discussed in Section 6.1, excluding the temporary unstable readings during the three periods shortly before the electrode replacement, the overall system operation conditions were steady and within 50% of the average during each normal operation period. The Dem/Val has met this criterion.

Other than the scheduled major O&M events between the two stages of operation, there were only three occasions when the system was shut down to allow replacement of electrodes. Overall, the system up-time was well >75% during the Dem/Val. The Dem/Val has met this criterion.

Figure 6-1 presents cumulative energy consumption during each stage of operation. Given that the energy consumption is a function of voltage and current and as discussed above regarding the steady system operation condition criterion, excluding the temporary unstable voltage conditions during the three short periods before the electrode replacement, the overall system operations were steady within ± 30% and, thus, the energy usage as well. The Dem/Val has met the energy consumption criterion.

3.4 QUALITATIVE PERFORMANCE OBJECTIVES: DEMONSTRATE SAFETY, RELIABILITY, EASE OF IMPLEMENTATION

In addition to quantitative objectives discussed above, qualitative objectives are also identified for this Dem/Val and include demonstrations of the safety, reliability, and ease of technology implementation.

3.4.1 Data Requirements

The suitability of the EK technology for full-scale implementation should include the considerations of safety and reliability of technology implementation. Operation records, including system operation monitoring records and field operators’ notes, are the primary data for assessing the safety and reliability. For ease of implementation criterion, field operation logs and records documented the utilization of field technician efforts for system operation and maintenance.

3.4.2 Success Criteria

This objective will be considered achieved if operational conditions remain stable over the course of the demonstration period and no lost-time incidents occur. The ease of technology implementation will be demonstrated if a single field technician is able to effectively monitor and maintain normal system operation.

3.4.3 Performance Objective Assessment

As discussed in Sections 7.1 and 7.3 above, the overall operation conditions remained relatively steady over the course of system operation. The Dem/Val has met this criterion. There were no safety-related lost-time incidents. The Dem/Val has met the safety criterion.

The Dem/Val involved only conventional field construction techniques, including well drilling, well installation, and trenching and piping, as well as remediation system assembly performed by regular, qualified subcontractors. The Dem/Val has met this criterion.
During the operation, one field technician performed routine system O&M tasks twice per week with approximately 2 to 3 hours per visit. During the routine O&M visit, the tasks primarily included system visual inspections, recording the system operational parameters (voltage, current, amendment flow and pressure), and replenishing amendment solutions as needed. Other than sampling groundwater, there were fewer than 5 scheduled O&M events that involved two field technicians. The Dem/Val has met this criterion.
4.0 SITE DESCRIPTION

The target area for this Dem/Val is located within Operable Unit 3 (OU3) at Naval Air Station (NAS) Jacksonville in Duval County, Florida (Figures 4-1 and 4-2). The Site Selection Memorandum was accepted by ESTCP on 27 November 2013. This section provides a summary of site information most relevant to this technology Dem/Val.

4.1 SITE LOCATION AND HISTORY

The EK-BIO Dem/Val was conducted at NAS Jacksonville, which is located on the west bank of the St. Johns River in Duval County, Florida (Figure 4-1). The Dem/Val area is in OU3 in the vicinity of former Building 106, where the station’s dry-cleaning facility once existed (Figure 4-2). The results of previous site characterizations in OU3 indicate that a PCE source zone exists in this area above and partially into a clay unit underneath the shallow sand unit.

NAS Jacksonville was commissioned in October 1940 to provide facilities for pilot training and a Navy Aviation Trades School for ground crewmen. The buildings in OU3 are industrial, consisting of administrative space, workshops, storage, and aircraft hangars. The majority of the buildings were constructed in the 1940s with several additions and re-fabrications taking place since then. Over 90 percent of OU3 is covered with buildings and thick (greater than 1 foot) concrete pavement.

The contamination within OU3 that is the focus of this Dem/Val is associated with PSC 48, the former station’s dry-cleaning facility located in former Building 106. PSC 48 encompasses the footprint and immediate surrounding area of former Building 106. PCE was released at former Building 106 through occasional spills and leaks, resulting in contamination of the shallow aquifer. PCE and its dechlorination daughter products, including TCE, cDCE, and VC, have been detected in this area in permeable sand layers within the shallow aquifer (5 to 16.5 ft bgs). Moreover, site characterization results also indicate that CVOC mass present in the low-K clay layer beneath the shallow sand aquifer can serve as a long-term source of contamination to the shallow aquifer (EISB Workplan, Geosyntec, 2013). This low-K clay layer beneath the shallow sand aquifer is the target for this EK technology Dem/Val.

4.2 SITE GEOLOGY/HYDROGEOLOGY

Site geology was characterized as part of a previous ESTCP Project (ER-0705), as described in the Data Analysis Report for Field Event 4: NAS Jacksonville (ESTCP, 2012b). Lithology at OU3 consists of inter-bedded layers of sand, clayey sand, sandy clay, and clay. Soil cores collected and logged at OU3 (ESTCP, 2012a) indicate that the site lithology generally consists of:

- 0.5 to 5 ft bgs: Fine sand with gravel and silt/clay;
- 5 to 7.5 ft bgs: Clay with trace sand and organic matter;
- 7.5 to 16.5 ft bgs: Fine sand/silt to fine sand with silt/clay;
- 16.5 to 18.5 ft bgs: Clay/silt with trace fine sand;
- 18.5 to 25 ft bgs: Clay with trace sand; and
- 25 to 30 ft bgs: Fine sand with silt/clay to fine sand.
Figure 4-1. Site Location
Figure 4-2. Target Dem/Val Area
A transition layer between the shallow sand and clay layers has been observed in some soil cores, generally between 13 and 16.5 ft bgs. A soil core, OU3-4 (location shown in Figure 4-2), exhibiting the lithology representative of the target area is presented below in Figure 4-3. The same lithology was again observed during this Dem/Val with a representative soil core collected from within the TTA during monitoring well installation (EKMW-02) also presented in Figure 4-3. The EK-BIO Dem/Val specifically targeted the CVOCs (predominately PCE) in the clay layer between approximately 16.5 to 24 ft bgs underneath the shallow sand unit in this area.

![Figure 4-3. Lithology of the Target Dem/Val Area](OU3-4 from ESTCP ER-201032; EKMW-02 from this Dem/Val)

Prior to the Dem/Val, depth to groundwater measurements local to the test area were collected in August 2009, January 2011, June 2011, and September 2011. Groundwater in this area was first encountered approximately 5 ft bgs, and flows towards the east with gradients ranging from 0.005 to 0.02 (ESTCP, 2012b). Past hydraulic testing estimated the mid-range hydraulic conductivity of the shallow sand aquifer at 5x10^{-3} cm/s (ESTCP, 2012b). The linear groundwater velocity was estimated as high as 101 ft/year (using a gradient of 0.005 and the mid-range conductivity).

ESTCP Project ER-0705 conducted depth-discrete, aquifer specific-capacity tests at various locations in this area, including along a transect from ASU-2 through ASU-7 shown in Figure 4-2. Depth-discrete hydraulic conductivity estimates for the clay unit beneath the shallow sand aquifer showed that at approximately 17 ft bgs the average K was 4x10^{-5} cm/sec (September 2011 data); however, there was not enough water at 6 of the 7 locations tested at the depth of 22 ft bgs to provide steady-state flow rates needed for the specific-capacity testing. Based on the soil core lithology observation and the orders of magnitude decrease of K from the shallow sand (5x10^{-3} cm/s) to the clay at a depth of 17 ft (4x10^{-5} cm/sec), it is believed that the clay material below 17 ft bgs has a hydraulic conductivity lower than 10^{-5} cm/sec.
4.3 CONTAMINANT DISTRIBUTION

Site investigations prior to the Dem/Val showed that PCE and degradation daughter products (TCE, cDCE, and VC) were present in permeable sand layers within the shallow aquifer (5 to 16.5 ft bgs). Chlorinated ethenes have also migrated, in part through molecular diffusion, into the clay layer (generally from 16.5 to 24 ft bgs) present beneath the shallow sandy aquifer. PCE is the dominant groundwater CVOC in this area, with TCE, cDCE and VC detected at lower concentrations. The groundwater quality data collected in January 2013 before this Dem/Val (Tetra Tech, 2013) indicate that groundwater monitoring wells screened in the shallow aquifer within the target area have total chlorinated ethene concentrations ranging from 194 µg/L in well PZ-04 to 51,000 µg/L in well PZ-02 (Figure 4-4).

Figure 4-4. Total Chlorinated Ethenes in Select Groundwater Monitoring Wells in Shallow Sand Aquifer
(January 2013; concentration unit: µg/L)

Previous SERDP/ESTCP projects have profiled the distribution of CVOCs across both the sand and clay units in the target Dem/Val area (Figures 4-5 and 4-6). Figure 4-5 presents the distribution of CVOCs in groundwater along a north-south cross section just to the east (downgradient) of the target Dem/Val area (transect along ASU2 through ASU7 shown in Figure 4-2).
Figure 4-5. Profile of Groundwater CVOC Distribution
As shown in Figures 4-2 and 4-5, previous sampling location OU3-3 is located within the target Dem/Val footprint. Figure 4-6 presents a conceptualized geologic cross section derived from high-resolution coring conducted at OU3-3 (ESTCP project ER-201032). At OU3-3, the vertical distribution of PCE, TCE, and cDCE in soil and groundwater at depths above, within, and below the clay unit depicts a classic PCE diffusion profile, with PCE penetration into approximately the upper 5 feet of the clay unit. Porewater PCE concentrations detected at OU3-3 at various depths across the clay unit ranged from 15,000 to 40,000 µg/L, indicating significant contamination within the depth interval targeted by the Dem/Val (~16.5 to 24 ft bgs).

![Figure 4-6. Profiles of Soil and Groundwater CVOC Concentrations at OU3-3](Source: ESTCP Project ER-201032)

Based on the site characterization results discussed above, the CVOCs residing in the clay unit in the proximity of OU3-3 represent a long-term continuing source for groundwater CVOC contamination in this area. Previous efforts to obtain water samples from the clay unit using conventional approaches were reported to be difficult, highlighting the expected limitations that would be encountered in an attempt to hydraulically migrate remediation amendments into this clay unit. Therefore, the Dem/Val footprint (as shown in Figure 4-2) and the target depth interval of 16.5 ft bgs to 24 ft bgs are deemed appropriate for this Dem/Val. Subsequent characterization data collected during the Dem/Val baseline characterization are presented in Section 5.3.
5.0 TEST DESIGN

This section provides the details pertaining to the design, installation, and implementation of the EK-BIO technology in the target Dem/Val area.

5.1 CONCEPTUAL EXPERIMENTAL DESIGN

As presented in Figure 5-1, the overall EK system consists of nine (9) electrode wells [E1 through E9] and eight (8) supply wells [S1 through S8] located within a TTA measuring approximately 40 feet by 40 feet. Also presented in Figure 5-1, are seven (7) monitoring wells [EKMW1 through EKMW-7] located within the TTA and four (4) located outside the TTA.

The remediation amendments distributed by the EK system included electron donor (lactate provided as potassium lactate), pH control reagents (potassium carbonate), and a dechlorinating microbial consortium (KB-1®) containing $Dhc$. The power supply unit, amendment supply units and manifolds, and system operation monitoring and control unit were housed in a shed located adjacent to an existing utility building approximately 35 feet south of the TTA. Amendment conveyance tubing and electrical wiring conduit were installed along a trenched corridor to connect the EK control/amendment supply system to the well network in the TTA.

Table 5-1 presents a summary of major project milestones for this Dem/Val. To support the Dem/Val design, a bench-scale EK column test was conducted. The bench test and test results are discussed in Section 5.2. A baseline characterization event was conducted prior to the system construction and installation. Baseline characterization results are presented in Section 5.3. After the completion of system construction/installation and system startup, the overall Dem/Val involved two separate stages of EK operations. Each stage was operated with varying anode and cathode configurations to alter the primary direction of electric fields. Figures 5-2 and 5-3 present conceptual orientations of the electric field established during each EK operational stage. Bioaugmentation of the TTA with reductive dechlorination culture (KB-1®) was conducted during Stage 1 operation. There was an incubation period of approximately 6 months between the two stages of active operation. Following the completion of the second EK operation stage in March 2017 and a subsequent incubation period of 3 months, a post-EK performance monitoring event was conducted in June 2017 to complete the Dem/Val.

During each stage of operation, the EK system was operated to achieve and maintain a constant current supplied to the overall electrode network. The voltage that was required to achieve and sustain this constant current is a site-specific characteristic related to the electrical resistance of the subsurface materials.
Figure 5-1. Well Network for Dem/Val
Table 5-1. Major Project Milestones

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Well Installation</td>
<td>September 2014</td>
</tr>
<tr>
<td>Baseline Characterization</td>
<td>October 2014</td>
</tr>
<tr>
<td>System Fabrication / Field Construction / System Installation &amp; Shakedown</td>
<td>October 2014 – June 2015</td>
</tr>
<tr>
<td>System Startup &amp; Initial Field Conditioning</td>
<td>June – August 2015</td>
</tr>
<tr>
<td>Stage 1 Operation Period</td>
<td>August 2015 – Mach 2016</td>
</tr>
<tr>
<td>Bioaugmentation (Supply Wells and Electrode Wells)</td>
<td>October 29, 2015</td>
</tr>
<tr>
<td>End-of-Stage 1 Monitoring Event</td>
<td>March 2016</td>
</tr>
<tr>
<td>Post-Stage 1 Incubation Period</td>
<td>March – September 2016</td>
</tr>
<tr>
<td>Stage 2 Operation Period</td>
<td>October 2016 – March 2017</td>
</tr>
<tr>
<td>End-of-Stage 2 Monitoring Event</td>
<td>March 2017</td>
</tr>
<tr>
<td>Post-Stage 2 Incubation Period</td>
<td>March – June 2017</td>
</tr>
<tr>
<td>Final Sampling Event</td>
<td>June 2017</td>
</tr>
</tbody>
</table>

Figure 5-2. Stage 1 Conceptual Electric Field
Potassium lactate was used to provide electron donor for ERD of CVOCs. Lactate was supplied to all electrode wells and all supply wells during the system operation. In addition to lactate, potassium carbonate (K₂CO₃) was added to all supply wells during EK operation as a pH buffer due to the low baseline pH (<6) in the TTA (which is not optimal for ERD). The EK system would also cross-circulate electrolytes (fluids in electrode wells) between cathodes and anodes, as well as provide supplemental acid or base, as needed, to individual electrode wells for overall pH control. The following sections provide specific details of individual phases completed under this Dem/Val.

5.2 TREATABILITY OR LABORATORY STUDY RESULTS

Preliminary characterization of the aquifer materials from the target Dem/Val area was performed to support design of the EK system. The descriptions of testing are provided in Appendix B. Approximately 24 feet of soil core was obtained from the vicinity of the target area with direct push approaches. Mineralogical analysis of the core through X-Ray Diffraction (XRD) indicated that the clay is predominantly kaolinite (61%), with smaller amounts of illite (1.4%), chlorite (11.9%), and smectite (15.3%). These fractions are within the range of soils encountered at other EK field sites.

Zeta potential measurements were conducted on samples from the soil cores by the University of Toronto. Zeta potential is a soil characteristic affecting electroosmosis of bulk water through soil pores under an applied electric potential. Two sets of testing were performed at various pH values. A flat zeta potential curve was measured, with values of approximately -25 mV above a pH of 4.5, suggesting that the EK system design should target pH control in electrode wells to levels above pH 5 to maintain operational efficiency. The zeta potential of the site soil is similar to that of the materials from sites previously tested for other EK projects.
A bench-scale EK column test was also conducted using the core material from the site to estimate the migration rate of amendments. Three 10-cm sections of the core materials were individually compacted using a piston into a 10-cm PVC column (3-inch diameter). A filter assembly was used at each end of the PVC column to connect the soil column to the electrode cells. A conservative bromide tracer (1 g/L of sodium bromide solution) was added to the cathode cell reservoir. Sodium phosphate solution (1.3 g/L) was added to both cathode and anode cells as electrolyte and buffer. The electrodes were connected to a dc power supply unit. A constant current of 25 mA was applied during the EK column test. The voltage needed to sustain this target current varied from the initial reading of 69.8 V after 29 hours to a lower reading of 54.3 V after 72 hours indicating the core material in the column became more electrically conductive.

At the completion of 72 hours of testing, the column was detached from the electrode cells and frozen. The frozen core was subsequently cut into a total of eight 1-cm sections along the direction from anode toward cathode. These samples, plus a background soil sample, were analyzed for bromide concentrations. The results presented in Table 5-2 show that bromide migrated across the entire length of the 10-cm column from the cathode to the anode within 72 hours. These results suggest a minimum electromigration rate of 3.3 cm/day.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Background Soil</th>
<th>3-cm from cathode</th>
<th>5-cm from cathode</th>
<th>7-cm from cathode</th>
<th>10-cm from cathode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromide (mg/kg)</td>
<td>&lt;1</td>
<td>295</td>
<td>158</td>
<td>157</td>
<td>284</td>
</tr>
</tbody>
</table>

### 5.3 BASELINE CHARACTERIZATION

As discussed in Section 4, several previous SERDP/ESTCP projects (ER-0705, ER-1740, and ER-201032) have characterized the geology, hydrogeology, and contaminant distribution in the area that encompasses the target Dem/Val area. To establish the baseline geochemical conditions, microbial conditions, and contaminant distribution specifically within the Dem/Val footprint, a baseline characterization event was performed in October 2014 following the completion of well installation. Table 5-3 presents a summary of the overall monitoring program for the Dem/Val, including the baseline characterization discussed in this section. Specific activities and details for the monitoring activities performed during system operation are discussed in Section 5.5.

#### 5.3.1 Baseline Groundwater Sampling

Groundwater samples were collected from the 11 groundwater monitoring wells (EKMW-01 through EKMW-11; seven within and four outside the TTA) shown on Figure 5-1. Baseline geochemical characterization of groundwater included measurements of field parameters (dissolved oxygen [DO], oxidation-reduction potential [ORP], conductivity, and temperature) and laboratory analyses for metals, inorganic anions (chloride, sulfate and nitrate), CVOCs, total organic carbon (TOC), volatile fatty acids (VFAs), and dissolved hydrocarbon gases (DHGs: methane, ethene and ethane). Baseline measurement of various carbon indicators, such as TOC and VFAs, allowed the subsequent tracking of electron donor distribution.
Baseline groundwater microbial characterization included quantitative analysis of \textit{Dhc} and \textit{Dehalobacter (Dhb)}, as well as the key biomarker, \textit{vcrA}. These microbial characterization data were collected to establish the baseline conditions regarding the specific microbiological capacity within the Dem/Val footprint.

Field sampling and laboratory analyses were performed in accordance with the sampling and analysis methods presented in Section 5.6. Field sampling forms are provided in Appendix D. The baseline groundwater sampling results of select key parameters are summarized in Table 5-4a and presented in Figure 5-4a and 5-4b. Baseline data indicated that groundwater within the TTA was generally acidic and slightly oxidizing with low DO between 0.2 to 0.6 mg/L. Baseline TOC and VFAs were relatively low (mostly below 6 mg/L), and, with the exceptions of EKMW-01 and EKMW-05, there was no detectable levels of \textit{Dhc}, \textit{Dhb}, and \textit{vcrA}. Additional detailed discussions of groundwater baseline characterization results are presented in Section 6.3.

### Table 5-3. Summary of Monitoring Program

<table>
<thead>
<tr>
<th>Phase</th>
<th>Matrix</th>
<th>Frequency</th>
<th>Analyses</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline Characterization</td>
<td>Soil</td>
<td>Three depths(^{(1)}) per boring</td>
<td>VOCs(^{(2)}), Metals(^{(3)}), Microbial (\textit{Dhc}, \textit{Dhb} &amp; \textit{vcrA}), Grain-size</td>
<td>9 locations within the target treatment area (TTA) and 2 locations outside the TTA</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>One Time</td>
<td>VOCs, DHGs(^{(4)}), VFAs(^{(5)}), Metals, Anions(^{(6)}), TOC, Field Geochemistry(^{(7)}), Microbial (\textit{Dhc}, \textit{Dhb} &amp; \textit{vcrA})</td>
<td>All 11 monitoring wells (EKMW-01 through EKMW-11)</td>
</tr>
<tr>
<td>System Start-up Phase</td>
<td>Groundwater</td>
<td>Weekly</td>
<td>Field Geochemistry, Electric Field (^{(8)})</td>
<td>7 Monitoring wells within TTA</td>
</tr>
<tr>
<td>Stage 1 Operations</td>
<td>Groundwater</td>
<td>Weekly</td>
<td>Electric Field</td>
<td>6 Monitoring wells within the TTA (EKMW-01 through EKMW-07 except EKMW-06)</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>Monthly</td>
<td>TOC, VFAs</td>
<td></td>
</tr>
<tr>
<td>End of Stage 1 Operation &amp; End of Incubation Period between Stage 1 and Stage 2 Operations</td>
<td>Soil</td>
<td>Two depths (^{(1)}) per boring</td>
<td>VOCs, Microbial (\textit{Dhc}, \textit{Dhb} &amp; \textit{vcrA})</td>
<td>9 select locations within the TTA and 1 location outside the TTA</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>One Time</td>
<td>VOCs, DHGs, VFAs, Metals, Anions, TOC, Field Geochemistry, Microbial (\textit{Dhc}, \textit{Dhb} &amp; \textit{vcrA})</td>
<td>All 10 monitoring wells (EKMW-01 through EKMW-11 except EKMW-06)</td>
</tr>
<tr>
<td>Stage 2 Operations</td>
<td>Groundwater</td>
<td>Weekly</td>
<td>Electric Field</td>
<td>6 Monitoring wells within TTA (EKMW-01 through EKMW-07 except EKMW-06)</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>Monthly</td>
<td>TOC, VFAs</td>
<td></td>
</tr>
<tr>
<td>Post-Operation Final Monitoring (3 months)</td>
<td>Soil</td>
<td>End of 3-month post-operation incubation period; Two depths(^{(1)}) per boring</td>
<td>VOCs, Microbial (\textit{Dhc}, \textit{Dhb} &amp; \textit{vcrA}); and Metals</td>
<td>9 locations within TTA and 1 location outside TTA</td>
</tr>
<tr>
<td></td>
<td>Groundwater</td>
<td>End of 3-month post-operation incubation period</td>
<td>Field Geochemistry; TOC, VOCs, DHGs Metals, Microbial (\textit{Dhc}, \textit{Dhb} &amp; \textit{vcrA})</td>
<td>All 10 monitoring wells, including 6 Monitoring wells in TTA</td>
</tr>
</tbody>
</table>
(1) Baseline event: discrete soil samples collected from approximately 18.5, 21, and 23 ft bgs. Subsequent events: two sampling depths per location at 18.5 and 21 ft bgs.
(2) VOCs: PCE, TCE, cDCE, and VC.
(3) Iron, Manganese, Calcium, and Magnesium.
(4) Methane, Ethene, and Ethane.
(5) Lactate, Acetate, Propionate, Formate, Butyrate, and Pyruvate.
(6) Nitrate, Sulfate, and Chloride.
(7) Conductivity, Temperature, Redox, pH, and Dissolved Oxygen.
(8) Voltage measurements taken at select wells. Readings of electric currents to individual electrodes recorded at wellhead using portable current clamp.
Table 5-4a. Analytical Results in Groundwater-baseline Sampling Event

OU3, NAS Jacksonville

<table>
<thead>
<tr>
<th>Analyte</th>
<th>Units</th>
<th>EKMW-01</th>
<th>EKMW-02</th>
<th>EKMW-03</th>
<th>EKMW-04</th>
<th>EKMW-05</th>
<th>EKMW-06</th>
<th>EKMW-07</th>
<th>EKMW-08</th>
<th>EKMW-09</th>
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<th>EKMW-11</th>
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<tr>
<td><strong>Volatile Organic Compounds</strong></td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1,1-DCE</td>
<td></td>
<td>25 U</td>
<td>41</td>
<td>21</td>
<td>11</td>
<td>5 U</td>
<td>11</td>
<td>2 U</td>
<td>2 U</td>
<td>25 U</td>
<td>2</td>
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<tr>
<td>cis-1,2-DCE</td>
<td>μg/L</td>
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<td>950</td>
<td>760</td>
<td>380</td>
<td>773</td>
<td>120</td>
<td>970</td>
<td>90</td>
<td>288</td>
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<td>PCE</td>
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<td>190</td>
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<td>trans-1,2-DCE</td>
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<td>VC</td>
<td>μg/L</td>
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<tr>
<td>Dbc</td>
<td>cell/L</td>
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<td>3.0E+03</td>
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<tr>
<td>vcrA</td>
<td>gene cop/L</td>
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<tr>
<td><strong>Volatile Fatty Acids</strong></td>
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<tr>
<td>Lactate</td>
<td>mg/L</td>
<td>0.96</td>
<td>0.39 U</td>
<td>0.52</td>
<td>0.29 U</td>
<td>0.39 U</td>
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<td>1.6 U</td>
<td>0.54 U</td>
<td>1.9</td>
<td>1.8</td>
<td>4.6</td>
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<td>1.3</td>
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<td>0.31 U</td>
<td>0.74</td>
<td>0.31 U</td>
<td>0.31 U</td>
<td>0.31 U</td>
<td>0.31 U</td>
<td>0.31 U</td>
<td>0.31 U</td>
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<td>0.22 U</td>
<td>0.22 U</td>
<td>0.22 U</td>
<td>0.22 U</td>
<td>0.22 U</td>
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<td>Pyruvate</td>
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<td>0.69 U</td>
<td>0.69 U</td>
<td>0.69 U</td>
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<td>520</td>
<td>570</td>
<td>1900</td>
<td>1700</td>
<td>790</td>
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<td>2800</td>
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<td>170</td>
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<td>Nitrate (as Nitrogen)</td>
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<td>0.17 U</td>
<td>0.17 U</td>
<td>0.17 U</td>
<td>0.17 U</td>
<td>0.05 U</td>
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<td>50</td>
<td>23</td>
<td>140</td>
<td>36</td>
<td>21</td>
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<td>16 I</td>
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<td>150</td>
<td>150</td>
<td>400</td>
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<td>130</td>
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<td>58</td>
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<td>160</td>
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<td>23</td>
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<td>ORP</td>
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<td>-21</td>
<td>42</td>
<td>64</td>
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<td>34</td>
<td>12</td>
<td>100</td>
<td>-27</td>
<td>-9</td>
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<td>DO</td>
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<td>0.4</td>
<td>1.2</td>
<td>0.6</td>
<td>0.1</td>
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Notes:
- PCE - Tetrachloroethene
- TCE - Trichloroethene
- 1,1-DCE - 1,1-Dichloroethene
- cis-1,2-DCE - cis-1,2-Dichloroethene
- trans-1,2-DCE - trans-1,2-Dichloroethene
- VC - Vinyl Chloride
- L - liter
- DO - dissolved oxygen
- μg/L - microgram per liter
- mg/L - milligram per liter
- mV - millivolt
- vcrA - vinyl chloride reductase
- U - The compound was analyzed for but not detected
- I - The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit
- (a) gene copy per liter is generally equivalent to cell per liter
Table 5-4b. Analytical Results in Soil – Baseline Sampling Event
OU3, NAS Jacksonville

<table>
<thead>
<tr>
<th>Soil Boring</th>
<th>Sample Depth (ft/ft)</th>
<th>Volatile Organic Compounds (mg/kg)</th>
<th>Inorganics</th>
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<td></td>
<td></td>
<td>PCE</td>
<td>TCE</td>
<td>cis-1,2-DCE</td>
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<td>C1</td>
<td>18.5</td>
<td>16</td>
<td>0.42</td>
<td>0.38</td>
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<td></td>
<td>21</td>
<td>0.029</td>
<td>0.032</td>
<td>0.006</td>
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<td></td>
<td>23</td>
<td>0.04</td>
<td>0.061</td>
<td>0.0077</td>
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<td>18.5</td>
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<td>0.27</td>
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<td>21</td>
<td>0.028</td>
<td>0.017</td>
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<td>0.0083</td>
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<td>6.9</td>
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<td>0.077</td>
<td>0.999 I</td>
</tr>
<tr>
<td></td>
<td>23</td>
<td>0.084 U</td>
<td>0.077</td>
<td>0.97 I</td>
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<td>0.14</td>
<td>0.12 I</td>
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<td>0.0048 I</td>
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<td>0.0067 I</td>
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<td>10</td>
<td>0.27 I</td>
<td>0.16</td>
</tr>
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<td>5.5</td>
<td>0.18</td>
<td>0.12</td>
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<td>23</td>
<td>3.1</td>
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<td>21</td>
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<td>C9</td>
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<td>0.31</td>
<td>0.22 I</td>
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<tr>
<td></td>
<td>23</td>
<td>0.0013 U</td>
<td>0.03</td>
<td>0.0066</td>
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<td>45</td>
<td>1.0</td>
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<td></td>
<td>21</td>
<td>11</td>
<td>0.015</td>
<td>0.004 I</td>
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<td>2.6</td>
<td>0.0067</td>
<td>0.0016 I</td>
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<tr>
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<td>0.084</td>
<td>0.0014 U</td>
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<td>23</td>
<td>0.087 U</td>
<td>0.081 U</td>
<td>0.013 U</td>
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</table>

Notes:
PCE - Tetrachloroethene
TCE - Trichloroethene
cis-1,2-DCE - cis-1,2-Dichloroethene
VC - Vinyl Chloride
Dhc - dehalococcoides
mg/kg - milligram per kilogram
U - The compound was analyzed for but not detected
I - The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit
-- - not analyzed
(a) Sampling locations C10 and C11 are outside the target treatment area.
Figure 5-4. Baseline Characterization
5.3.2 Baseline Soil Sampling

Soil cores were collected from nine (9) locations within the TTA and two (2) locations outside the TTA (Figure 5-4c). At each location, a soil core was collected using Direct Push Technology (DPT) to a target depth of 24 feet. With each collected soil core, three (3) discrete soil samples were collected from approximately 18.5, 21, and 23 ft bgs.

Baseline soil characterization included laboratory analyses for metals and CVOCs, as well as quantitative analyses of Dhc, Dhb, and verA. In addition, the baseline soil characterization included soil grain size analysis.

Field sampling and laboratory analyses were performed in accordance with the sampling and analysis methods presented in Section 5.6. Field sampling forms and chain of custody forms are provided in Appendices D & E. The baseline soil sampling results of select key parameters are summarized in Table 5-4b and the soil PCE data are presented in Figure 5-4c. The baseline soil characterization data indicated that there was very little apparent reductive dechlorination activities within the TTA prior to the Dem/Val. The data also suggested that the majority of soil PCE within the TTA appeared to be present above the depth of 21 ft. Additional detailed discussions of soil baseline characterization results are presented in Section 6.2.

5.4 DESIGN AND LAYOUT OF TECHNOLOGY COMPONENTS

The locations of the electrode wells, supply wells, and monitoring wells are shown in Figure 5-1. System components and equipment for amendment supply and cross-circulation were housed in an equipment enclosure located adjacent to an existing utility building to the south of the TTA. Given the operational needs of NAS Jacksonville, the wellhead components and the connections between electrode/supply wells and the equipment enclosure (conveyance piping, electrical wiring, instrumentation wiring) were installed below ground. Prior to field construction and installation, a comprehensive utility locate and survey was conducted in the proposed Dem/Val area. The Dem/Val system design and well network was adjusted based on the results of these surveys. The following sections describe the specifics of individual system components.

5.4.1 Electrode Wells

A total of nine (9) electrode wells (E1 through E9) were installed by hollow-stem auger drilling in the treatment area. Electrode well construction details are provided in Figure 5-5. Each electrode well was constructed with 4-inch diameter PVC casing and 0.01-inch slotted screen. The screened interval was generally between 19 and 23 ft bgs across the clay unit (which was expected to be observed between approximately 16.5 to 25 ft bgs). A medium sand filter pack was placed around the screen from the bottom of the borehole up to the top of the screen and topped by a fine sand filter pack up to 1/2 foot above the screened interval. A 2-foot thick (~16.5 to 18.5 ft bgs) bentonite seal was installed above the sand pack by placing bentonite chips and hydrating for at least one hour. Grout, consisting of cement and bentonite powder, was then added to fill the remaining annulus up to the bottom of the well vault.

Figure 5-6 presents the details of the electrode well vault. Locking well vaults (traffic-rated, 2-ft x 2-ft x 2-ft) were installed with concrete protection around the vault and a gravel base. The electrode well casing was completed at the top with the installation of a PVC flange.
Figure 5-5. Electrode Well Details
Figure 5-6. Electrode Well Vault Details
Access ports were installed in the flange for installation of the electrode, electrical cable, tubing, and a pressure safety valve (PSV). Additional descriptions of the conveyance system and control instrumentation are provided in Sections 5.4.5 through 5.4.8.

5.4.2 Supply Wells

A total of eight (8) supply wells (S1 through S8) were installed by hollow-stem auger drilling in the treatment area. Supply well construction details are provided in Figure 5-7. Each supply well was constructed with 4-inch diameter PVC casing and 0.01-inch slotted screen. The screened interval was across the clay unit at depths between 19 and 23 ft bgs. Construction details for supply wells are the same as electrode wells. Figure 5-8 presents the details of the supply well vaults. Additional descriptions of the conveyance system and control instrumentation are provided in Sections 5.4.5 through 5.4.8.

5.4.3 Monitoring Wells

A total of 11 monitoring wells were installed by hollow-stem auger drilling within and around the treatment area (Figure 5-1). Monitoring wells were constructed as double-casing wells each with a 6-inch PVC surface casing installed to 18 ft bgs and grouted in place (Figure 5-9). Each 2-inch diameter monitoring well was then constructed by drilling through the bottom of grouted 6-inch casing to install 0.01-inch slotted screen section at depths between 19 and 23 ft bgs. A medium (20/30) sand filter pack was placed around the screen from the bottom of the borehole up to 1/2 ft above the top of the screened interval. A 2-foot thick bentonite seal was installed above the sand pack by placing bentonite chips and hydrating for at least one hour. Grout, consisting of cement and bentonite powder was then added to fill the remaining annulus up to the bottom of the well vault.

5.4.4 Power Supply and Electrodes

The power supply unit for the EK system was a Magna XR250-24/240 dc power supply unit with input power from 3-phase alternate current (AC) 240V. This 6kW unit has a capacity to output 0 to 250V and 0 to 24A. The power supply was operated in constant current mode with varying voltage automatically adjusted to the changes in soil conductivity.

During each EK operational stage, six (6) electrode wells were used as cathodes and three (3) electrode wells as anodes. The electrode arrangements for Stage 1 and Stage 2 operations are shown in Figures 5-2 and 5-3, respectively. The electrodes consisted of a titanium rod (¼-inch diameter; 4-ft long) with mixed metal oxide (MMO) coating (TELPRO tubular anodes manufactured by Titanium Electrode Products, Inc., Stafford, TX). The coating consists of IrO2/Ta2O5 and is suitable for use in soils, carbonaceous backfill, fresh and brackish water, and seawater.

5.4.5 Amendment Supply System

Electron donor solution was prepared by adding 60% (w/w) potassium lactate (WILCLEAR®) to 250-gallon totes for transfer to supply wells and electrode wells by the amendment supply system. Buffer solution was prepared by adding potassium carbonate (anhydrous power, 99%) to 250-gallon totes for transfer to supply wells by the amendment supply system. The amendment supply was performed as short-duration pulsed injections using feed pumps controlled by timers. The duration and flow rate of each pulse injection cycle were programmed so that each injection event generally introduced less than ½ gallon of solution to each well.
Figure 5-7. Supply Well Details
Figure 5-8. Supply Well Vault Details
Figure 5-9. Monitoring Well Details
CONDUIT TRENCH DETAILS

NOTES:
1. SURFACE TO BE REPAIRED TO PRE-CONSTRUCTION CONDITIONS. WHERE GRASS IS REQUIRED, SEED TO BE USED.

Figure 5-10. Conduit Trench Details
5.4.6 Cross-Circulation and Electrode Well pH Control System

Electrolysis of water in electrode wells produces acid (anode) and base (cathode) resulting in pH changes in the wells. Cross-circulation of electrolytes between anodes and cathodes can balance pH to an extent and reduce the amount of supplemental pH-adjusting reagents needed. Cross-circulation between cathode wells and anode wells was achieved by transferring electrolyte from individual cathode wells to individual anode wells and vice versa. During a given programmed cross-circulation event, the system extracted catholyte from a cathode well to a catholyte holding tank, while at the same time extracting anolyte from an anode well to an anolyte holding tank. Extraction was performed by peristaltic pumps controlled by timers. In-line monitoring stations monitored the pH of the extracted electrolytes. Following the extraction event, the system pumped the extracted electrolyte in the holding tank back to the electrode well of opposite polarity (i.e., catholyte to anode well and vice versa). Depending on the pH reading of the extracted electrolyte, supplemental lactic acid solution (for cathode well) or sodium hydroxide solution (for anode well) was added to the electrolyte injection tubing during the re-injection cycle when electrolyte was pumped from the holding tank back to an electrode well.

5.4.7 Process Monitoring and Controls

The EK system was constructed with instrumentation and controls to monitor and operate the system automatically using a programmable logic controller (PLC). Overall operation of the pumps for amendment supply and electrolyte cross-circulation was controlled by timers in the PLC. The PLC also controlled solenoid valves at the central manifold in the equipment shed to direct flows from and to individual wells.

In-line water quality stations installed on the electrolyte extraction lines monitored the pH of the electrolyte coming from an individual electrode well. A data acquisition system was used to record the pH monitoring data collected.

5.4.8 Conveyance Piping and Utilities

Dedicated conveyance piping was run between the system equipment enclosure and the well network through a combined conduit. The conduit was installed in shallow trenches as shown in a typical trench detail (Figure 5-10). Additional conduits were placed in the trenches for the installation of electrical wires to electrodes.

5.5 FIELD TESTING

This section provides a description of each significant phase of operation and the activities conducted during that phase. A schedule illustrating the sequence and duration of individual phases of operation is presented in Table 5-5.
### Table 5-5. Dem/Val Field Testing Phases

<table>
<thead>
<tr>
<th>Phase</th>
<th>Time Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Startup &amp; Initial Field Conditioning</td>
<td>June 2015 – August 2015</td>
</tr>
<tr>
<td>Stage 1 Operation</td>
<td>August 2015 – March 2016</td>
</tr>
<tr>
<td>* During Stage 1 Operation – Bioaugmentation (Supply Wells and Electrode Wells)</td>
<td>* October 29, 2015</td>
</tr>
<tr>
<td>* End-of-Stage 1</td>
<td>* March 2016</td>
</tr>
<tr>
<td>Post-Stage 1 Incubation Period (no operation)</td>
<td>March 2016 – September 2016</td>
</tr>
<tr>
<td>Stage 2 Operation</td>
<td>October 2016 – March 2017</td>
</tr>
<tr>
<td>* End-of-Stage 2</td>
<td>* March 2017</td>
</tr>
<tr>
<td>Post-Stage 2 Incubation Period (no operation)</td>
<td>March 2017 – June 2017</td>
</tr>
</tbody>
</table>

#### 5.5.1 System Start-Up

EK system Start-Up commenced following the installation and shakedown of the system components described above in Section 5.4. During the start-up, carbonate (Na₂CO₃) solution was delivered to the supply wells in order to condition the pH in the formation around the supply wells prior to the addition of electron donor in the next phase. The duration of the start-up period for buffer addition was approximately 60 days. Buffer addition continued during the subsequent two active EK operational phases (Stage 1 and Stage 2) together with lactate amendment supply.

During the start-up operation, daily remote-monitoring of PLC data and weekly system field inspections were conducted to monitor system operations. The distribution of the electric field within the TTA was confirmed by lowering an insulated reference electrode into a given monitoring well and using a hand-held voltage meter to measure the voltage difference between that location and a universal reference cathode, which in our case was the power supply unit in the system shed. The field personnel wore rubber boots and rubber gloves when performing this task. As discussed in Section 6.1, relatively uniform electric field was confirmed based on the voltage measurements taken at all monitoring wells within the TTA.

#### 5.5.2 Stage 1 EK Operations and Monitoring

Following system start-up, electron donor (lactate solution) was added to the TTA during Stage 1 EK operation. This operational stage included 2 segments – before bioaugmentation and after. The electrode polarity arrangement for Stage 1 operation is shown in Figure 5-2 with E2, E5, and E8 as anodes.

Lactate solution was supplied to all electrode wells and all supply wells as individual short pulses several times a day. Other system operation activities included buffer amendment to supply wells, cross-circulation between electrodes, and supplemental acid and base addition, as needed, to electrode wells.
Bioaugmentation

Bioaugmentation of the TTA with dechlorination microbial culture containing \( Dhc \) was performed to establish adequate reductive dechlorinating populations. After approximately 75 days of active operation when geochemistry monitoring data indicated anaerobic and reducing conditions at supply wells and monitoring wells within the TTA, the system was shut down 48 hours prior to the bioaugmentation event, which occurred on 29 October 2015. To bioaugment the TTA, 4 liters of KB-1\(^{®}\) culture (SiREM Laboratory, Ontario, Canada) was added to each supply well, and 1.5 liters to each electrode well. The KB-1\(^{®}\) culture selected for this project contain \( Dhc \) that are capable of fully degrading chlorinated ethenes under mildly acidic (i.e., pH <6.0) conditions. The system operation resumed 48 hours after the bioaugmentation event.

The Stage 1 operation continued for approximately 5 months following bioaugmentation and was completed in March 2016. During the operation, system inspections were conducted generally twice a week by a field operator to monitor and record system operational conditions and perform routine maintenance, mainly related to filter cleaning/replacement and amendment stock solution replenishment. The distribution of electric field within the TTA was confirmed by measuring voltages at monitoring wells as described above. Groundwater sampling and analysis for performance monitoring was conducted in accordance with Table 5-3 and the sampling methods presented in Section 5.6.

5.5.3 Post-Stage 1 Incubation

Following the completion of Stage 1 operations, the system was shut down and the project entered a 6-month post-Stage 1 incubation period. An end-of-Stage 1 monitoring event was completed in March 2016 immediately following the system shut down. An end-of-post Stage 1 incubation monitoring event was completed in September 2016. Sampling and analysis for these monitoring events were performed in accordance with Table 5-3 and the methods presented in Section 5.6.

5.5.4 Stage 2 EK Operations and Monitoring

After the 6-month post-Stage 1 incubation, the electrode polarity arrangement was adjusted to start Stage 2 operation (Figure 5-3) with E4, E5, and E6 as anodes. The system operational program for electron donor amendment, buffer addition, cross-circulation between electrodes, and supplemental acid and base addition essentially followed the same approach as that of Stage 1 operation. There was no bioaugmentation in Stage 2 operation.

The Stage 2 operation continued for approximately 5 months from October 2016 through March 2017. During the operation period, system inspections and maintenance, as well as field measurements, were conducted following the same program and procedures as described above for the Stage 1 operation.

5.5.5 Post-Stage 2 Incubation

Following the completion of Stage 2 operations, the system was shut down and the project entered a 3-month post-Stage 2 incubation period. An end-of-Stage 2 monitoring event was completed in March 2017 immediately following the system shut down. An end-of-post Stage 2 incubation monitoring event (also as the final performance monitoring event) was completed in June 2017.
Sampling and analysis for these monitoring events were performed in accordance with Table 5-3 and the methods presented in Section 5.6.

5.5.6 Decommissioning

NAS Jacksonville and NAVFAC are currently in the process of preparing a Feasibility Study (FS) for remediation of the OU3 area, which encompasses the Dem/Val TTA. It is anticipated that EK-BIO will be retained in the FS as a technology in consideration for treatment of impacts in the clay layer outside of the Dem/Val TTA. As such, the Dem/Val infrastructure will remain in place until the FS is completed, and a decision rendered on remedy, in the event that the decision is to expand the EK-BIO remedy to the wider source zone. Should EK-BIO not proceed further, Geosyntec will then remove the surface infrastructure (i.e., EK Control Center and solution tanks) from the site, while NAS Jacksonville will complete final disposition of the wells. Details will be provided in a separate letter.

5.6 SAMPLING METHODS

In addition to operational data related to the system (i.e., electrical current and voltage, flow rates of amendments and cross-circulation), an overall field monitoring and sampling program for the Dem/Val is presented in Table 5-3. Table 5-3 presents the sample matrix (i.e., soil and groundwater), the locations and frequencies, and the analytical parameters performed during each phase of this Dem/Val.

5.6.1 Sampling and Analytical Methods

As presented in Table 5-3, the Dem/Val monitoring program included both measurements of field parameters and collection of environmental samples (soil and groundwater) for laboratory analyses. Table 5-6 summarizes the laboratory analytical methods. The methods for field sample collection and field parameter measurements are described in this section.
<table>
<thead>
<tr>
<th>Matrix</th>
<th>Analyte</th>
<th>Method</th>
<th>Container</th>
<th>Preservative$^1$</th>
<th>Holding Time</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Soil</strong></td>
<td>VOCs</td>
<td>8260B</td>
<td>3x 10-gram</td>
<td>2 with NaHSO4;</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Terra Cores</td>
<td>1 with methanol;</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 ± 2°C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Metals (Ca, Fe, Mn, Mg)</td>
<td>6010B</td>
<td>2-oz glass jar</td>
<td>4 ± 2°C</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td>Tracer (Br$^-$)</td>
<td>300.0</td>
<td>2-oz glass jar</td>
<td>4 ± 2°C</td>
<td>28 days</td>
</tr>
<tr>
<td></td>
<td>Biomarkers ($Dhc$, $Dhb$, and $vcrA$)</td>
<td>Gene-Trac® Method</td>
<td>50 mL conical tube provided by laboratory</td>
<td>4 ± 2°C</td>
<td>14 days</td>
</tr>
<tr>
<td><strong>Groundwater</strong></td>
<td>VOCs</td>
<td>8260B</td>
<td>40 mL VOA vial</td>
<td>HC1; 4 ± 2°C</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>VFAs</td>
<td>Ion Chromatography</td>
<td>40 mL VOA vial</td>
<td>4 ± 2°C</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>DHGs (methane, ethane, ethane)</td>
<td>RSK-175</td>
<td>40 mL VOA vial</td>
<td>HC1; 4 ± 2°C</td>
<td>14 days</td>
</tr>
<tr>
<td></td>
<td>Total Metals (Ca, Fe, Mn, Mg)</td>
<td>6010B</td>
<td>250 mL polyethylene</td>
<td>HNO3; 4 ± 2°C</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td>Anions (NO$_3^-$, SO$_4^{2-}$, Cl$^-$) and Tracer (Br$^-$)</td>
<td>300.0</td>
<td>250 mL polyethylene</td>
<td>4 ± 2°C</td>
<td>28 days (except NO$_3^-$ at 48 hours)</td>
</tr>
<tr>
<td></td>
<td>TOC</td>
<td>9060A</td>
<td>125 mL amber glass</td>
<td>HC1, 4 ± 2°C</td>
<td>28 days</td>
</tr>
<tr>
<td></td>
<td>Biomarkers ($Dhc$, $Dhb$, and $vcrA$)</td>
<td>Gene-Trac® Method</td>
<td>500 mL polyethylene</td>
<td>4 ± 2°C</td>
<td>14 days</td>
</tr>
</tbody>
</table>
For soil sampling, soil cores were collected using DPT tooling. For each soil sampling event, one continuous core from ground surface to approximately 24 feet bgs was collected from each of the 11 soil sampling locations (C1 through C11) shown in Figure 5-11. Soil cores were collected in acetate sleeves for observation and sampling. Discrete soil samples were collected for laboratory analyses from the selected depths. For the baseline event, samples were collected at each location from approximately 18.5, 21, and 23 ft bgs. The field personnel documented that clay was the predominant geologic material at all the locations and all these sampling depths. As discussed in Section 6.2, based on the baseline soil sampling results, subsequent soil sampling events only collected samples from 18.5 and 21 ft bgs, since CVOCs were not typically present below 21 ft bgs. For VOC analysis, Terra Core samplers were used to minimize volatilization loss. Upon completion of soil sampling, each borehole was backfilled with bentonite chips and surface repaired in accordance with NAS Jacksonville requirements.

Figure 5-11. Soil Sampling Locations (C1 through C11)

The groundwater monitoring well network for the Dem/Val is presented in Figure 5-1. Groundwater elevation was measured for each monitoring well prior to sampling. After opening each well, the groundwater elevation was allowed to equilibrate with atmospheric conditions before taking a water level measurement. The depth to groundwater was measured using a Solinst interface meter (or equivalent) in 0.01-foot increments, relative to a permanently marked survey point located at the top of the well casing and recorded on the purge log field form. The water level meter was decontaminated between wells.
Groundwater sampling was conducted following low-flow purging protocols with the use of a peristaltic pump and dedicated tubing. With the low-flow sampling, the intake of the sampling tube was placed mid-way between the top and bottom of the well screen. The water level was monitored during purging to measure drawdown and determine the appropriate flow rate for the well. During purging, in-line water quality parameters were monitored continuously in a flow-through cell for temperature, pH, specific conductance, DO, and ORP. Purging was considered complete when a minimum of one casing volume of water had been removed with collection of at least three sets of field measurements spaced at two (2) to three (3) minute intervals, or when groundwater field parameters stabilized. The indicator parameters were considered stabilized when three consecutive readings met the following criteria:

- Temperature ± 0.2°C
  (i.e., the second and third reading must be within 0.2°C of the first reading);
- pH ± 0.2 pH units;
- Specific Conductance ± 5% units; and
- DO ± 0.2 mg/L or ±10% (whichever is greater).

Readings of stabilized parameters were recorded on the field sampling log forms. Following stabilization of indicator parameters, groundwater samples were collected into the appropriate laboratory prepared and preserved sample containers. Sampling containers, holding times, and preservation methods associated with each method are presented in Table 5-6. The sample containers were clearly labeled and placed in an insulated cooler with ice for shipping to laboratories following proper chain-of-custody protocols.
6.0  SAMPLING RESULTS AND DISCUSSIONS

This section presents a detailed summary and discussions of all monitoring/sampling results. While baseline characterization results have already been presented in Section 5.2, select baseline characterization data are incorporated in this section, as appropriate, with other performance monitoring data to support analyses and discussions related to changes of soil and groundwater conditions during the Dem/Val.

6.1  SYSTEM OPERATION MONITORING

Figure 6-1 presents the power usage over the course of Stage 1 and Stage 2 operations. The voltage (V) and current (A) readings recorded at the power supply unit over the duration of operation are used to calculate the electrical power usage (kilowatt-hour [kW-hr]). The system was designed and operated to supply a constant current, determined after the start-up phase, and the power supply unit would then operate at a voltage level that was required in response to field electrical resistivity in order to maintain the supply of constant current.

Figure 6-1 shows that the power supply unit’s voltage output remained generally steady between approximately 18V and 28V (Stage 1) and 12V and 20V (Stage 2). There were three occasions when different electrodes needed to be replaced, including late October/early November 2015 and late January/early February 2016 during Stage 1 operation, as well as December 2016 during Stage 2 operation. Prior to the electrode replacement, the system voltage readings would indicate the operating conditions were becoming unsteady. By inspecting the electrodes, it was determined that the initial shakedown/start-up operations at the start of Stage 1 operation, particularly an initial conservative electrode polarity reversal program, overly stressed the anode leading to damage of the electrode surface coatings. The polarity reversal program was corrected after the start-up operation in June/July 2015, however, the initial damages to the electrodes shortened the life-span of the anodes leading to the need to replace them during the operation. Other than the periods when electrodes were in need of replacement, the power supply unit operating conditions were relatively steady.

The total power consumption was calculated for Stage 1 at 1,037 kW-hr and Stage 2 at 548 kW-hr. Calculations for Stage 1 include the initial start-up operation (June-July 2015) and the initial buffering/conditioning operation (July-October 2015) preceding the 5-month Stage 1 full EK-BIO operation (October 2015-March 2016) counting after the TTA bioaugmented with the dechlorination culture. Stage 2 operation included only the 5-month full operation (October 2016-March 2017). As a comparison, the total energy usage by the EK system during the 14 active months of the Dem/Val (1,585 kW-hr) is equivalent to operating two 100-W lightbulbs over the same time interval, or operating a single 100-W lightbulb for approximately 660 days (22 months).
In addition to monitoring the power supply unit, field measurements were taken to confirm the establishment of electric field within the TTA. Figure 6-2 presents the field measurements made in October 2015 when electrode wells, E2, E5, and E8 were anodes.
The voltage measurements taken at individual monitoring wells were used to assess if a uniform electric field was established within the TTA. Voltage measurements at individual wells relative to a common cathode reference at the EK control system were between 5.3V and 6.2V with an average of 5.6V and a standard deviation of 0.31V (5% variation from the average) indicating that an electric field was established in the area between electrode wells. Voltage gradients between discrete locations of closest pairs are also calculated and summarized below.

<table>
<thead>
<tr>
<th>Well Pairs</th>
<th>MW-1 &amp; MW-3</th>
<th>MW-2 &amp; MW-3</th>
<th>MW-4 &amp; MW-6</th>
<th>MW-5 &amp; MW-6</th>
<th>MW-5 &amp; MW-7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Gradient (V/m)</td>
<td>0.12</td>
<td>0.26</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

The calculated voltage gradients between these pairs are within 2x of the average gradients (0.13 V/m) measured also suggesting no local focusing of electric field within TTA.

**Table 6-1** below presents the average and standard deviation calculated for the electrical current to individual wells during each stage of operation. The data show that the current supply to individual electrode well was generally steady (variation within 37% of average). Given that (1) soil electrical resistivity is a soil property not expected to vary over the course of Dem/Val, and (2) the voltage output by the power supply unit and the current supplied to individual electrodes were generally steady, the electrical potential between electrode pairs within the TTA should maintain within 5x of target during operation.
Table 6-1. Electrical Current to Electrode Wells

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Cathodes</th>
<th>Anodes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E1</td>
<td>E3</td>
</tr>
<tr>
<td>Avg</td>
<td>1.5</td>
<td>1.0</td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.2</td>
<td>0.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Stage 2</th>
<th>Cathodes</th>
<th>Anodes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>E1</td>
<td>E2</td>
</tr>
<tr>
<td>Avg</td>
<td>1.4</td>
<td>1.7</td>
</tr>
<tr>
<td>Std Dev</td>
<td>0.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Table 6-2 summarizes the amendment supplied to the TTA and the energy usage throughout the Dem/Val. The duration and quantity reported for Stage 1 operation include the initial start-up operation and buffering/conditioning operation prior to bioaugmentation of the field when the 5-month full EK-BIO remediation operation was considered to start.

Table 6-2. EK System Operation Summary

<table>
<thead>
<tr>
<th>Stage 1 Operation</th>
<th>Lactate to 8 Supply Wells</th>
<th>Lactate to 9 Electrode Wells</th>
<th>K-Carbonate to All Wells</th>
<th>Energy Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2015 – March 2016</td>
<td>80 kg via 370 gal</td>
<td>158 kg via 620 gal</td>
<td>35 kg via 655 gal</td>
<td>985 kW-hr</td>
</tr>
<tr>
<td></td>
<td>10 kg/well via 47 gal/well</td>
<td>17.5 kg/well via 69 gal/well</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 2 Operation</td>
<td>Lactate to 8 Supply Wells</td>
<td>Lactate to 9 Electrode Wells</td>
<td>K-Carbonate to All Wells</td>
<td>Energy Usage</td>
</tr>
<tr>
<td>October 2016 – March 2017</td>
<td>105 kg via 520 gal</td>
<td>212 kg via 1,038 gal</td>
<td>16 kg via 305 gal</td>
<td>548 kW-hr</td>
</tr>
<tr>
<td></td>
<td>13.1 kg/well via 65 gal/well</td>
<td>23.5 kg/well via 115 gal/well</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dem / Val Total</td>
<td>Lactate to 8 Supply Wells</td>
<td>Lactate to 9 Electrode Wells</td>
<td>K-Carbonate to All Wells</td>
<td>Total Energy Usage</td>
</tr>
<tr>
<td></td>
<td>185 kg / 890 gal (23 kg/well via 112 gal/well)</td>
<td>370 kg / 1,658 gal (41 kg/well via 184 gal/well)</td>
<td>51 kg / 960 gal</td>
<td>1,533 kW-hr</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It should be noted that in this Dem/Val, amendment delivery was driven by electric field and not hydraulic pressure. The total volume of lactate amendment solution delivered throughout the Dem/Val was approximately 2,550 gallons. This accounts for only 16% to 22% of the total pore volume within a treatment zone of 35 ft x 35 ft x 5 ft at 25% to 35% total porosity.
Therefore, amendment distribution and the resulted biotreatment achieved within the TTA, as discussed below based on the monitoring data collected, should be recognized as the results of enhanced amendment delivery beyond diffusion mechanism.

6.2 GROUNDWATER SAMPLING RESULTS

Groundwater monitoring data are summarized, per sampling event, and provided in Appendix F. The locations of groundwater monitoring wells are presented in Figure 5-1. One monitoring well within the TTA, EKMW-06, was later found to not produce sufficient groundwater volume for sampling likely due to blockage. Therefore, EKMW-06 was not included in the monitoring program.

6.2.1 Groundwater Geochemistry

Groundwater geochemistry data, including the baseline characterization results, are summarized in Table 6-3. The baseline groundwater geochemistry data are also presented in Figure 5-4. The discussion in this section is organized by three separate areas – upgradient of the TTA, within the TTA, and downgradient of the TTA. For each area, data collected from the baseline event and subsequent performance monitoring events are discussed.

Monitoring well EKMW-09 is located upgradient of the TTA. Baseline data indicated that groundwater in this area was acidic (pH at 5), oxidizing (ORP at 100 mV and DO at 1.2 mg/L), with high chloride (2,800 mg/L), and high iron (130 mg/L). Throughout the Dem/Val, groundwater remained acidic (pH below 5.2) and slightly oxidizing (ORP above 60 mV with low DO). The chloride concentration decreased from baseline to below 1,800 mg/L post-Stage 2, the reasons for the decline are unknown. Iron concentrations decreased from baseline to below 80 mg/L.

Within the TTA, baseline characterization data showed that groundwater was acidic (pH 4.7 at EKMW-01 to pH 5.8 at EKMW-02 and EKMW-03), slightly oxidizing (ORP at 34 to 64 mV, except -21 mV at EKMW-02 and EKMW-03) with low DO at 0.2 to 0.6 mg/L. Other notable baseline geochemical conditions included:

- Three relatively distinct baseline chloride levels – EKMW-01 at 3,400 mg/L; EKMW-05 and EKMW-07 at 1,900 and 790 mg/L, respectively; and EKMW-02, -03, and -04 at 520 – 570 mg/L.
- Sulfate at 140 mg/L at EKMW-07, while at 24 to 57 mg/L at all other wells.
- Relatively high iron at EKMW-01 (130 mg/L) and EKMW-05 (160 mg/L), while generally at 60 mg/L for iron at other wells.

Based on baseline chloride, and iron concentrations, groundwater at EKMW-01 and EKMW-05 seemed to have similar geochemistry as that of upgradient well EKMW-09. While EKMW-01 is located near the upgradient edge of the TTA, EKMW-05 is near the down-/side-gradient edge of the TTA.
### Table 6-3. Groundwater Geochemistry Data Summary

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>pH</strong></td>
<td>S.U.</td>
<td>4.7</td>
<td>5.1</td>
<td>5.0</td>
<td>6.4</td>
<td>5.6</td>
<td>5.74</td>
<td>5.9</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>ORP</strong></td>
<td>mV</td>
<td>54</td>
<td>130</td>
<td>-170</td>
<td>-50</td>
<td>-103</td>
<td>-120</td>
<td>-76</td>
<td>-79</td>
</tr>
<tr>
<td><strong>Dissolved Oxygen</strong></td>
<td>mg/L</td>
<td>0.6</td>
<td>2.1</td>
<td>0.1</td>
<td>0.6</td>
<td>0.2</td>
<td>0.13</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Analyte</strong></td>
<td>Units</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
</tr>
<tr>
<td><strong>Bromide</strong></td>
<td>mg/L</td>
<td>40 I</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>2.3</td>
<td>NA</td>
<td>NA</td>
<td>4.5 I</td>
</tr>
<tr>
<td><strong>Chloride</strong></td>
<td>mg/L</td>
<td>3400</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>1450</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Nitrate (as N)</strong></td>
<td>mg/L</td>
<td>0.17 U</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.1</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Sulfate</strong></td>
<td>mg/L</td>
<td>57</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>13.2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Calcium</strong></td>
<td>mg/L</td>
<td>350</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>210</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Iron</strong></td>
<td>mg/L</td>
<td>130</td>
<td>100</td>
<td>NA</td>
<td>NA</td>
<td>87.4</td>
<td>NA</td>
<td>NA</td>
<td>93.4</td>
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<tr>
<td><strong>Magnesium</strong></td>
<td>mg/L</td>
<td>98</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>61.9</td>
<td>NA</td>
<td>NA</td>
<td>57.7</td>
</tr>
<tr>
<td><strong>Manganese</strong></td>
<td>mg/L</td>
<td>2.8</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>196</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td><strong>Potassium</strong></td>
<td>mg/L</td>
<td>8.1</td>
<td>5.7</td>
<td>5.2</td>
<td>5.43 I</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>5.9 I</td>
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</thead>
<tbody>
<tr>
<td><strong>pH</strong></td>
<td>S.U.</td>
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<td>NA</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>150</td>
<td>NA</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
<td>67</td>
<td>NA</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>45</td>
<td>NA</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/L</td>
<td>1.1</td>
<td>NA</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/L</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>S.U.</td>
<td>5.0</td>
<td>4.5</td>
<td>4.5</td>
<td>4.8</td>
<td>4.9</td>
<td>3.8</td>
</tr>
<tr>
<td>ORP</td>
<td>mV</td>
<td>100</td>
<td>163</td>
<td>201</td>
<td>102</td>
<td>74</td>
<td>62</td>
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<tr>
<td>Dissolved Oxygen</td>
<td>mg/L</td>
<td>12</td>
<td>0.8</td>
<td>4.1</td>
<td>0.1</td>
<td>1.7</td>
<td>1.4</td>
</tr>
<tr>
<td><strong>Analyte</strong></td>
<td>Units</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
<td>Result</td>
</tr>
<tr>
<td>Bromide</td>
<td>mg/L</td>
<td>60 U</td>
<td>NA</td>
<td>0.38 I</td>
<td>NA</td>
<td>NA</td>
<td>3.0 U</td>
</tr>
<tr>
<td>Chloride</td>
<td>mg/L</td>
<td>2800</td>
<td>NA</td>
<td>2190</td>
<td>NA</td>
<td>NA</td>
<td>1790</td>
</tr>
<tr>
<td>Nitrate (as N)</td>
<td>mg/L</td>
<td>0.17 U</td>
<td>NA</td>
<td>18.4</td>
<td>NA</td>
<td>NA</td>
<td>22.8 I</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>36</td>
<td>NA</td>
<td>431</td>
<td>NA</td>
<td>NA</td>
<td>295</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/L</td>
<td>130</td>
<td>NA</td>
<td>125</td>
<td>NA</td>
<td>NA</td>
<td>79.2</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/L</td>
<td>130</td>
<td>NA</td>
<td>128</td>
<td>NA</td>
<td>NA</td>
<td>85.3</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/L</td>
<td>4.1</td>
<td>NA</td>
<td>4.48</td>
<td>NA</td>
<td>NA</td>
<td>2.9</td>
</tr>
<tr>
<td>Manganese</td>
<td>mg/L</td>
<td>9.4</td>
<td>9</td>
<td>8.55 I</td>
<td>10.3</td>
<td>7.4 I</td>
<td>6.3 I</td>
</tr>
<tr>
<td>Potassium</td>
<td>mg/L</td>
<td>5700</td>
<td>6900</td>
<td>5760</td>
<td>6190</td>
<td>4400</td>
<td>2950</td>
</tr>
</tbody>
</table>

**Total Dissolved Solids (Filterable)**
Table 6-3. Groundwater Geochemistry Data Summary (Continued)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>pH</td>
<td>S.U.</td>
<td>6.0</td>
<td>6.0</td>
<td>5.8</td>
<td>7.2</td>
<td>5.7</td>
<td>5.3</td>
<td>6.3</td>
</tr>
<tr>
<td>ORP</td>
<td>mV</td>
<td>-27</td>
<td>10</td>
<td>-5.9</td>
<td>-630</td>
<td>-92</td>
<td>30</td>
<td>-101</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>mg/L</td>
<td>0.6</td>
<td>0.6</td>
<td>3.6</td>
<td>0.1</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
</tr>
</tbody>
</table>

Notes:
S.U. Standard Units  NA Not analyzed.
mV millivolts  U The compound was analyzed for but not detected.
mg/L milligrams per Liter  I The reported value is between the laboratory method detection limit and the laboratory practical quantitation limit.
NTU Nephelometric Turbidity Unit
Geochemistry data collected from within the TTA in October 2015 following approximately 3 months of system operation adding buffering reagent showed pH increases at all wells from baseline to between pH 5.5 and pH 6, except at EKMW-01 where pH increased from baseline pH 4.7 to pH 5. The data showed negative ORP at all wells, except at EKMW-05 where ORP changed from 64 mV baseline to 17 mV. DO was at or below 0.2 mg/L at all wells. Bioaugmentation with low-pH KB-1® dechlorination culture was conducted at the end of October 2015.

Within the TTA following bioaugmentation and through Stage 1 and Stage 2 operations, groundwater pH generally remained between 5.5 and 6.6 and ORP was mostly negative after the Stage 1 and Stage 2 operations. Notable changes of certain geochemical conditions over the duration of Dem/Val include:

- **Chloride** – At EKMW-01, the concentration decreased from a baseline of 3,400 mg/L to 1,950 mg/L post-Stage 2, and at EKMW-05 from 1,900 to 1,570 mg/L. However, at EKMW-02 and -03, concentrations increased from baseline levels of 520–550 mg/L to 717–750 mg/L, and at EKMW-07 from 790 to 1,670 mg/L. Relatively smaller changes were observed at EKMW-04 (570 to 465 mg/L). These data suggest that some migration and redistribution of chloride (and likely other anions) might have occurred within the TTA as a result of the EK application.

- **Sulfate** – concentrations at all wells decreased from baseline levels of around 50 mg/L (except 140 mg/L baseline at EKMW-07) to 9 to 15 mg/L, including at EKMW-07, at end of Stage 1 operation. Sulfate concentrations generally remained low thereafter. These data are indicative of sulfate reduction in the TTA.

- **Iron** – concentrations decreased from baseline at EKMW-01 and EKMW-05, the two wells with the highest baseline iron, to approximately 90 mg/L at post-Stage 2 incubation. However, at EKMW-02, -03, and -07, iron concentrations doubled or more from their baseline levels to 85–100 mg/L. These data suggest that some migration and redistribution of iron (and likely other cations) occurred within the TTA as a result of the EK application.

At downgradient well EKMW-10, baseline conditions were slightly acidic (pH at 6) and reducing (ORP at -27 mV and DO at 0.6 mg/L). Baseline chloride (570 mg/L), sulfate (21 mg/L), and iron (49 mg/L) concentrations were consistent with those observed in most of the wells in the TTA. Over the duration of Dem/Val, groundwater pH generally remained close to pH 6, while ORP became more reducing (-101 mV post-Stage 2). Chloride increased from 570 mg/L baseline to over 780 mg/L post-operation. Sulfate decreased after Stage 1 operation, but increased to baseline level after Stage 2. Relatively minimum changes (less than 8 mg/L in changes) in iron concentrations occurred throughout the Dem/Val.

### 6.2.2 Groundwater Chemical and Microbial Analytical Results

The discussion of groundwater sampling results is organized in this section with respect to assessment of (1) amendment distribution and (2) reductive dechlorination of CVOCs.
**Amendment Distribution**

Groundwater TOC and VFA concentrations at monitoring wells provided an assessment of amendment distribution across the TTA. While lactate was provided as the amendment, it was expected that lactate would biodegrade as it was transported in the subsurface. Therefore, total VFAs were considered as an appropriate indicator of amendment distribution. **Table 6-4** presents a summary comparing the baseline TOC and VFA concentrations detected at individual monitoring wells to the maximum concentrations of each detected during the Dem/Val.

**Table 6-4. Groundwater TOC and VFA Summary**

*Baseline vs. Maximum During Stage 1 / Stage 2*

<table>
<thead>
<tr>
<th>Well ID</th>
<th>TOC (baseline)</th>
<th>TOC (max S1/S2)</th>
<th>VFA* (baseline)</th>
<th>VFA* (max S1/S2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EKMW-01</td>
<td>2.5</td>
<td>12.8 / 20.1</td>
<td>3.2</td>
<td>60.7 / 57.6</td>
</tr>
<tr>
<td>EKMW-02</td>
<td>2.5</td>
<td>36.2 / 4.30</td>
<td>1.6</td>
<td>141 / 2.50</td>
</tr>
<tr>
<td>EKMW-03</td>
<td>2.5</td>
<td>57.9 / 4.60</td>
<td>1.2</td>
<td>233 / 11.3</td>
</tr>
<tr>
<td>EKMW-04</td>
<td>3.6</td>
<td>6.70 / 3.50</td>
<td>1.9</td>
<td>18.3 / 8.20</td>
</tr>
<tr>
<td>EKMW-05</td>
<td>1.7</td>
<td>15.9 / 2.30</td>
<td>1.8</td>
<td>6.60 / 1.00</td>
</tr>
<tr>
<td>EKMW-07</td>
<td>6.8</td>
<td>12.5 / 57.0</td>
<td>2.2</td>
<td>21.7 / 204.7</td>
</tr>
<tr>
<td>EKMW-09</td>
<td>1.6</td>
<td>1.40 / 1.90</td>
<td>2.3</td>
<td>1.40 / NA</td>
</tr>
<tr>
<td>EKMW-10</td>
<td>1.9</td>
<td>1.50 / 10.1</td>
<td>2.1</td>
<td>1.40 / NA</td>
</tr>
</tbody>
</table>

* VFA = total of lactate, acetate, propionate, formate, butyrate, and pyruvate.

Units: mg/L.

With respect to TOC data, every monitoring well within the TTA saw an increase in TOC concentration >8x baseline levels, with the exception of EKMW-04 where the maximum TOC detected was 1.8x the baseline. With respect to VFA data, every monitoring well within the TTA saw an increase in VFA concentration >9x baseline levels, with the exception of EKMW-05 where the maximum VFA detected was 4x the baseline. These data show substantial increase in TOC and VFA concentrations across the TTA affected by EK application.

TOC and VFA concentrations at the two background monitoring wells, EKMW-09 and EKMW-10, did not show apparent increases from their baseline levels, with the exception of TOC detected at 10.1 mg/L at EKMW-10 during the final post-Stage 2 sampling event. EKMW-10 is located downgradient of the TTA approximately 20 ft from electrode well E6. It is possible that some migration of TOC from the TTA occurred to affect this well in its final sampling event.

It is recognized that concentrations of TOC and VFA at certain locations within the TTA may be dynamic in nature given the microbial activities occurring in the subsurface. While it is apparent that amendment provided from the supply wells and electrode wells was distributed to all the monitoring well locations during the Dem/Val, the data suggest that certain monitoring well locations received different amounts of amendment between Stage 1 and Stage 2 operations.
For example, EKMW-02 and EKMW-03 appeared to receive more amendment in Stage 1 than in Stage 2, while EKMW-07 received more in Stage 2 than in Stage 1. This is likely due to the different orientations of electric fields established during the two stages of operations affecting the amendment transport patterns within the TTA. This observation suggests that future design should consider electrode network arrangements that will allow operations of various electric field orientations to enhance amendment delivery efficiency.

Noting that there was not a monitoring well located between the supply well network and electrode well E5, which was an anode during both Stage 1 and Stage 2 (i.e., electron donor would have always been migrating from the supply wells towards E5 in each stage), grab groundwater samples were collected during the final post-Stage 2 sampling event at several DPT soil sampling locations (C2, C3, C6, C7, and C9 in Figure 5-11). These samples were collected at each location generally from the depth of 21 ft, which approximately corresponded to the mid-screen interval of the monitoring wells within the TTA. The TOC results of these grab groundwater samples are presented in Table 6-5 below.

Table 6-5. Groundwater TOC at Select DPT Sampling Locations (from 21 ft bgs)

<table>
<thead>
<tr>
<th>Location</th>
<th>C2</th>
<th>C3</th>
<th>C6</th>
<th>C7</th>
<th>C9</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOC (mg/L)</td>
<td>950</td>
<td>160</td>
<td>3.4</td>
<td>820</td>
<td>790</td>
</tr>
</tbody>
</table>

Significant TOC concentrations (160 to 950 mg/L) were detected at all three sample locations (C2, C3, and C7) between the supply wells and electrode well E5. These data confirmed that significant amendment had been distributed to this interior area. As a comparison, location C6 at the upgradient edge of the TTA did not appear to receive much amendment, likely due to its exterior position relative to supply wells and electric field orientation.

TOC concentrations in the sample collected from C9, located in the vicinity of unused monitoring well EKMW-06, indicate that the area received substantial electron donor. Thus, while EKMW-06 failed to provide data, C9 provided valuable replacement data confirming the amendment distribution to this portion of the TTA.

Enhanced Reductive Dechlorination

Figure 6-3 presents a comparison of groundwater CVOC and biomarker monitoring results at six monitoring wells within the TTA and two outside the TTA. The overall tabulated groundwater monitoring data are provided in Appendix F. Figure 6-3 presents the data collected from five (5) milestone events: baseline event in October 2014; end of Stage 1 operation in March 2016; end of post-Stage 1 incubation in September 2016; end of Stage 2 operation in March 2017; and end of post-Stage 2 incubation in June 2017.
Figure 6-3. Groundwater CVOC & Biomarkers
EKMW-09 and EKMW-10 are located outside the TTA (Figure 5-1). The upgradient well, EKMW-09, is in the general area of the suspected PCE source (the former Building 106 area). The PCE concentrations at EKMW-09 remained above the baseline level during the Dem/Val, with no apparent increase of reductive dechlorination intermediates, and no detectable levels of biomarkers (below 1E+03 cell/L) throughout the Dem/Val.

At downgradient well EKMW-10, the baseline cis-1,2-DCE concentration was 260 µg/L, while the baseline methane concentration was 1,300 µg/L, both indicative of some natural reductive biological activity in this area prior to the Dem/Val. Between the baseline event and the post-Stage 2 event, no significant changes in PCE and other PCE dechlorination intermediate concentrations were observed, with the exception of an increase in vinyl chloride from 5 µg/L to 157 µg/L. It is also noted that while biomarkers were below detection in the baseline event, a low level of \( Dhc \) (1.6E+03 cell per L) was detected at EKMW-10 in the post-Stage 2 event. This level of \( Dhc \) was close to the method detection limit, and \( vcrA \) in that sample was still below detection limit. Overall, the data at EKMW-10 appear to suggest slight influence from the operation in the TTA approximately 20 ft away (to electrode well E6). As a comparison, the upgradient well EKMW-09 is located approximately 25 ft away from the closest electrode well E4.

Among the monitoring wells within the TTA, EKMW-01, located closest to the upgradient edge of the TTA, contained the highest baseline PCE concentration at 7,640 µg/L. While there were baseline PCE dechlorination intermediates (cis-1,2-DCE >1,000 µg/L and VC at 33 µg/L) at EKMW-01, low levels of baseline methane (190 µg/L), ethene (15 µg/L), and VFAs (2.3 mg/L) suggested limited reductive dechlorination activities in the vicinity prior to the Dem/Val. It is noted that \( Dhc \) and \( vcrA \) were detected in the baseline event at 8E+05 cell/L and 3E+03 gene copies/L, respectively. As presented in Figure 6-3, significant PCE dechlorination at EKMW-01 was observed in both post-Stage 1 and post-Stage 2 monitoring events. PCE concentrations decreased from the baseline level by 90% and 95% in the two events, respectively, while dissolved ethene concentrations were 15x and 85x (228 µg/L and 1,280 µg/L, respectively) the baseline level. There was a transitory increase of cis-1,2-DCE from baseline to end of Stage 1 operation followed by its continuing decrease through the post-Stage 2 sampling event. Methane concentrations remained generally at a similar level as baseline throughout the Dem/Val (75 to 399 µg/L). Both biomarkers increased by 1,000x or more from the baseline levels to the post-Stage 1 detections (10⁷ and 10⁸ cell/gene copies per L), with continued increases through the post-Stage 2 event (10⁸ and 10⁹ cell/gene copies per L).

The data for monitoring wells EKMW-02, -03, and -04, were relatively similar, with baseline PCE concentrations ranging from 170 to 250 µg/L, and low to no detectable baseline VC (<6 µg/L), ethene (all below detection), and biomarkers (all below detection). While enhanced reductive dechlorination was evident at all these wells, one noticeable difference between this group of wells and EKMW-01 was the significant increases of methane throughout the Dem/Val (see below).

<table>
<thead>
<tr>
<th>Methane at</th>
<th>Baseline</th>
<th>End of Stage 1</th>
<th>Post-Stage 1</th>
<th>End of Stage 2</th>
<th>Post-Stage 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>EKMW-01</td>
<td>190</td>
<td>102</td>
<td>132</td>
<td>164</td>
<td>399</td>
</tr>
<tr>
<td>EKMW-02</td>
<td>1,200</td>
<td>1,850</td>
<td>6,380</td>
<td>7,890</td>
<td>8,740</td>
</tr>
<tr>
<td>EKMW-03</td>
<td>330</td>
<td>2,850</td>
<td>6,270</td>
<td>5,480</td>
<td>7,930</td>
</tr>
<tr>
<td>EKMW-04</td>
<td>54</td>
<td>401</td>
<td>1,930</td>
<td>4,100</td>
<td>5,010</td>
</tr>
</tbody>
</table>

Unit: µg/L
Both biomarkers at all these three wells increased by >1,000x from non-detect baseline levels to above 1E+06 at the end of Stage 1 operation, and were generally maintained at such levels throughout the Dem/Val. Dissolved ethene concentrations increased from non-detect baseline levels to the ranges of 120 to 170 µg/L at EKMW-02, 50 to 78 µg/L at EKMW-03, and up to 32 µg/L at EKMW-04. The sum of chlorinated ethenes decreased by 78% at EKMW-02, 54% at EKMW-03, and 46% at EKMW-04 over the course of Dem/Val.

EKMW-05 and EKMW-07 had relatively high baseline PCE concentrations at 1,800 and 1,300 µg/L, respectively. At EKMW-07 PCE concentrations significantly decreased from baseline to the end of Stage 1 operation (1,300 µg/L to 202 µg/L) and remained relatively stable during the 6-month post-Stage 1 incubation period (slight increase to 253 µg/L). In Stage 2, PCE concentrations decreased further (253 µg/L to 55 µg/L) during active EK, and rebounded slightly during post-Stage 2 incubation (up to to 92 µg/L). Methane concentrations at EKMW-07 increased significantly throughout the Dem/Val (110 µg/L baseline to over 7,000 µg/L post-Stage 1 and over 8,000 µg/L post-Stage 2), while *Dhc* and *vcrA* increased from non-detect levels to over 1E+08 cell/L and 1E+06 gene copies/L, respectively, and dissolved ethene continued to increase from baseline (11 µg/L) through post-Stage 1 incubation (161 µg/L) and again through post-Stage 2 incubation (260 µg/L).

At EKME-05, PCE concentrations significantly decreased from baseline (1,800 µg/L) to end of Stage 1 operation (180 µg/L) but then rebounded during the 6-month post-Stage 1 incubation period (to 2,280 µg/L). During the post-Stage 1 incubation (no active EK operation) when PCE rebounded, methane and ethene both increased from 210 to 587 µg/L and 144 to 255 µg/L, respectively, indicating continuing methanogenic and reductive dechlorination activities in the area. During Stage 2 operation, PCE concentrations decreased from 2,280 µg/L to 603 µg/L, but again rebounded (to 3,540 µg/L) during post-Stage 2 incubation. The reason for this rebound is unclear, but may indicate the presence of some residual PCE mass in this area. Methane concentrations further increased from post-Stage 1 incubation to post-Stage 2 incubation (from to 987 µg/L). Both biomarkers increased by almost 100x to 10,000x from baseline (1E+05 cell/gene copies per L) through Stage 1 operation, and remained above 1E+06 to 1E+07 cell/gene copies per L throughout the Dem/Val.

As presented in Table 6-6, DPT groundwater samples collected from select interior locations during the post-Stage 2 event were analyzed for CVOCs, dissolved gases, and biomarkers to supplement the monitoring data collected at monitoring wells. The three samples from the interior locations (C2, C3, and C7; see Figure 5-11) between the supply wells and anode E5 showed the most significant methanogenesis and reductive dechlorination. Methane concentrations were more than 2,400 µg/L, and dissolved ethene concentrations ranged between 474 and 1,880 µg/L. Biomarkers, *Dhc* and *vcrA*, were detected at levels between 1E+05 and 2E+07 cell/gene copies per liter. These observations are consistent with the soil sampling results for these three locations discussed in Section 6.3 below (see Figure 6-5 for soil CVOC and Table 6-9 for soil microbial analyses).
Table 6-6.  Groundwater CVOC and Biomarker at Select DPT Sampling Locations
(from 21 ft bgs)

<table>
<thead>
<tr>
<th>Location</th>
<th>C2</th>
<th>C3</th>
<th>C6</th>
<th>C7</th>
<th>C9</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCE</td>
<td>µg/L</td>
<td>11</td>
<td>160</td>
<td>1,400</td>
<td>28</td>
</tr>
<tr>
<td>TCE</td>
<td>µg/L</td>
<td>5</td>
<td>430</td>
<td>660</td>
<td>29</td>
</tr>
<tr>
<td>cis-1,2-DCE</td>
<td>µg/L</td>
<td>86</td>
<td>3,700</td>
<td>2,600</td>
<td>220</td>
</tr>
<tr>
<td>VC</td>
<td>µg/L</td>
<td>1,200</td>
<td>570</td>
<td>380</td>
<td>330</td>
</tr>
<tr>
<td>Methane</td>
<td>µg/L</td>
<td>2,490</td>
<td>3,840</td>
<td>634</td>
<td>4,090</td>
</tr>
<tr>
<td>Ethene</td>
<td>µg/L</td>
<td>1,710</td>
<td>474</td>
<td>100</td>
<td>1,880</td>
</tr>
<tr>
<td>Ethane</td>
<td>µg/L</td>
<td>18</td>
<td>12</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Dhc</td>
<td>cell / L</td>
<td>5.E+06</td>
<td>2.E+05</td>
<td>2.E+03</td>
<td>2.E+07</td>
</tr>
<tr>
<td>tce</td>
<td>gene copies / L</td>
<td>1.E+06</td>
<td>5.E+04</td>
<td>&lt;3E+04</td>
<td>4.E+06</td>
</tr>
<tr>
<td>bvc</td>
<td>gene copies / L</td>
<td>5.E+05</td>
<td>4.E+03</td>
<td>&lt;3E+04</td>
<td>1.E+06</td>
</tr>
<tr>
<td>ver</td>
<td>gene copies / L</td>
<td>4.E+06</td>
<td>1.E+05</td>
<td>&lt;3E+04</td>
<td>1.E+07</td>
</tr>
<tr>
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<td>cell / L</td>
<td>1.E+04</td>
<td>&lt;4E+03</td>
<td>&lt;3E+04</td>
<td>3.E+05</td>
</tr>
</tbody>
</table>

With the C6 sample, although methane concentrations over 600 µg/L, together with low levels of ethene (100 µg/L) and Dhc (2E+03 cell/L), were detected, overall the data suggest that the area near the upgradient edge of the TTA likely received less treatment due to the location relative to the supply well network and electric field orientation, which would move the amendment more effectively towards the interior of the TTA.

Location C9 was in the vicinity of a former monitoring well EKMW-06 which was not included in the monitoring program. The DPT groundwater data of C9 showed significant TOC concentration (790 mg/L) and evident reductive dechlorination with ethene concentration at 402 µg/L. As discussed below in Section 6.3, soil CVOC and soil microbial analyses of C9 also indicated reductive dechlorination activities in that area.

Collectively, with the evident reductive dechlorination observed in the groundwater samples collected from the interior portion of the TTA (C2, C3, and C7 locations) and the area of C9, as well as the network of Dem/Val monitoring wells, EK application clearly promoted substantial dichlorination and treatment within the overall TTA.

6.3 SOIL SAMPLING RESULTS

There were three (3) rounds of soil sampling over Dem/Val: baseline event (September 2014), post-Stage 1 event (April 2016), and post-Stage 2 event (June 2017). The 11 soil sampling locations are presented in Figure 5-11.
6.3.1 Soil Chemical Analyses Results

Table 6-7 presents a summary of soil chemical analytical results, including the baseline characterization results. For the baseline event, at each sampling location three (3) samples were collected each from discrete depths. The baseline data showed that within the TTA, PCE was the only chlorinated ethene detected at a concentration above 1 mg/kg, with the exception of cis-1,2-DCE at 1.9 mg/kg and 3.3 mg/kg at locations C3 (18.5 ft bgs) and C7 (18.5 ft bgs), respectively. The baseline data indicated that there was no apparent reductive dechlorination activity within the TTA soil prior to the Dem/Val. It was also noted that PCE concentrations decreased significantly with depth from 18.5 ft to 23 ft. PCE concentrations were below 0.08 mg/kg in all samples collected from the 21 and 23 ft bgs depths, with the exception of location C6 (5.5 mg/kg at 21 ft bgs and 3.1 mg/kg at 23 ft bgs) located on the upgradient limit of the TTA and closest to the expected PCE source in the general area of former Building 106 (Figure 5-11). Based on the finding that PCE was overwhelmingly present only at the 18.5 ft bgs sample interval, subsequent soil sampling events collected samples only from 18.5 ft bgs and 21 ft bgs.

The baseline soil sampling event also included soil grain size analysis to allow an assessment of whether the initial soil CVOC distribution was related to the heterogeneity of soil grain sizes. This was conducted, in response to a request by ESTCP during Demonstration Plan development, to assess whether CVOC concentrations, electron donor migration, and CVOC treatment could be correlated to grain size (a question related to uniformity of treatment). Table 6-8 presents the grain size analysis of the samples from within the TTA at 18.5 and 21 ft bgs.
## Table 6-7. Summary of Soil Chemical Analytical Results

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Tetrachloroethene</td>
<td>16</td>
<td>11</td>
<td>1.9</td>
<td>0.01</td>
<td>0.08</td>
<td>18</td>
<td>1.9</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
<td>0.03</td>
<td>0.06</td>
<td>0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>Trichloroethylene</td>
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<td>0.02</td>
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<td>0.47</td>
<td>0.31</td>
<td>0.02</td>
<td>0.08</td>
<td>0.47</td>
<td>0.31</td>
<td>0.02</td>
<td>0.08</td>
<td>0.47</td>
<td>0.31</td>
<td>0.02</td>
<td>0.08</td>
<td>0.47</td>
<td>0.31</td>
<td>0.02</td>
<td>0.08</td>
<td>0.47</td>
<td>0.31</td>
<td>0.02</td>
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<td>cis,1,2-Dichloroethene</td>
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<td>0.11</td>
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<td>0.07</td>
<td>0.11</td>
<td>0.06</td>
<td>0.11</td>
<td>0.07</td>
<td>0.11</td>
<td>0.06</td>
<td>0.11</td>
<td>0.07</td>
<td>0.11</td>
<td>0.06</td>
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<td>0.11</td>
<td>0.07</td>
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<td>Vinyl Chloride</td>
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<td>0.04</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.02</td>
<td>0.0004</td>
<td>0.0004</td>
<td>0.02</td>
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<td>0.02</td>
<td>0.0004</td>
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<tr>
<td>Iron</td>
<td>20000</td>
<td>19500</td>
<td>15000</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>20000</td>
<td>19500</td>
<td>15000</td>
<td>NA</td>
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<td>NA</td>
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<td>15000</td>
<td>12000</td>
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<td>NA</td>
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<td>15000</td>
<td>12000</td>
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<td>Total Organic Carbon</td>
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<td>520</td>
<td>91</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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Table 6-7. Summary of Soil Chemical Analytical Results (Continued)

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<td>Tetrachloroethene</td>
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<td>0.28</td>
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<td>0.039</td>
<td>0.13</td>
<td>0.0013 U</td>
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<td>Trichloroethene</td>
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<td>0.0064 U</td>
<td>0.086</td>
<td>0.0004</td>
<td>0.0019 U</td>
<td>0.019</td>
<td>0.03</td>
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<td>cis-1,2-Dichloroethene</td>
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<td>0.000052 U</td>
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<td>Calcium</td>
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<td>NA</td>
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<td>1500</td>
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<tr>
<td>Iron</td>
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<td>12000</td>
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<td>Manganese</td>
<td>42</td>
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<td>61</td>
<td>38</td>
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<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>510</td>
</tr>
</tbody>
</table>

Notes:

- mg/kg: milligrams per kilogram
- NA: Not analyzed
- U: Under detection limit
- The reported value is between the laboratory detection limit and the laboratory quantitation limit
- Estimated value
- Baseline (October 2014) C4 location corresponds to the C12 location in 2016 and 2017 events.
- [2] Sampling locations C10 and C11 are outside the target treatment area.
Table 6-8. Soil Grain Size Analysis (Baseline Event)

<table>
<thead>
<tr>
<th>Location / Depth</th>
<th>% Fines (Silt + Clay) 18.5 ft</th>
<th>% Fines 21 ft</th>
<th>% Silt 18.5 ft</th>
<th>% Silt 21 ft</th>
<th>% Clay 18.5 ft</th>
<th>% Clay 21 ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>61.0</td>
<td>76.8</td>
<td>16.2</td>
<td>31.2</td>
<td>44.8</td>
<td>45.6</td>
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<tr>
<td>C2</td>
<td>53.8</td>
<td>77.8</td>
<td>18.1</td>
<td>35.0</td>
<td>35.7</td>
<td>42.8</td>
</tr>
<tr>
<td>C3</td>
<td>80.7</td>
<td>80.5</td>
<td>26.4</td>
<td>30.1</td>
<td>54.3</td>
<td>50.4</td>
</tr>
<tr>
<td>C4</td>
<td>88.8</td>
<td>71.0</td>
<td>20.6</td>
<td>22.9</td>
<td>68.2</td>
<td>48.1</td>
</tr>
<tr>
<td>C5</td>
<td>77.5</td>
<td>84.5</td>
<td>22.1</td>
<td>34.3</td>
<td>55.4</td>
<td>50.2</td>
</tr>
<tr>
<td>C6</td>
<td>80.1</td>
<td>85.0</td>
<td>23.1</td>
<td>35.9</td>
<td>57.0</td>
<td>49.1</td>
</tr>
<tr>
<td>C7</td>
<td>76.5</td>
<td>75.4</td>
<td>21.3</td>
<td>24.7</td>
<td>55.2</td>
<td>50.7</td>
</tr>
<tr>
<td>C8</td>
<td>75.0</td>
<td>90.0</td>
<td>18.8</td>
<td>30.2</td>
<td>56.2</td>
<td>59.8</td>
</tr>
<tr>
<td>C9</td>
<td>80.2</td>
<td>88.4</td>
<td>19.7</td>
<td>36.0</td>
<td>60.5</td>
<td>52.4</td>
</tr>
<tr>
<td>Avg.</td>
<td>74.6</td>
<td>81.0</td>
<td>20.6</td>
<td>31.1</td>
<td>54.0</td>
<td>49.9</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>11.5</td>
<td>6.40</td>
<td>3.20</td>
<td>4.80</td>
<td>9.90</td>
<td>4.70</td>
</tr>
</tbody>
</table>

As presented in Figure 6-4, no evident linear relationships between soil PCE concentrations and % fine-grained materials were observed, with $R^2$ values ranging between 0.33 and 0.57. Furthermore, the correlation coefficients between these parameters did not indicate any strong correlation with coefficients of 0.75 between PCE concentration and % Fines, 0.57 between PCE concentration and % Silt, and 0.69 between PCE concentration and % Clay. Given these analyses, soil grain size analysis was not included in the subsequent soil sampling events.

Figure 6-4. Soil PCE Concentration vs. Soil Grain Size (Baseline; 18.5 ft bgs)
Figure 6-5 below presents a comparison of soil CVOC concentrations at corresponding locations between the three (3) sampling events. The data presented in Figure 6-5 are arranged per individual locations and sampling depths. Overall, soil PCE concentrations of all samples collected from 18.5 ft bgs at the nine (9) locations within the TTA decreased by 78% (C6) to 99% (C3) from baseline to post-Stage 2, with an average decrease of 88%. With the exceptions of C1 and C6, the decreases of PCE concentrations were already significant (75% at C8 to 99% at C3) from the baseline event to the post-Stage 1 event. Both C1 and C6 showed evident PCE decrease from the post-Stage 1 event to the post-Stage 2 event. It was also noted that while C6 was the only location with a significant baseline PCE concentration at 21 ft bgs (5.5 mg/kg), the PCE concentration at 21 ft bgs of the C6 corresponding sampling location decreased to 0.21 mg/kg and below in subsequent post-operation sampling events.

Location C10 was in the general area of former Building 106 and approximately 35 ft from the upgradient edge of the TTA. No decreases in PCE concentrations were observed at C10 at 18.5 ft bgs or 21 ft bgs between the baseline and post-Stage 1 events. PCE concentrations declined at both depths at this location from the post-Stage 1 event to the post-Stage 2 event. While the reason for the decline is unclear and may be due to heterogeneity (attempts were made to repeat boreholes as close as possible to prior co-located borings), a slight increase in dichlorination intermediates was observed in the 18.5 ft bgs sample, suggesting some increase in biological activity in this area over time.

While the decreases in soil PCE concentrations over the Dem/Val are evident, significant, and generally consistent among all sampling locations within the TTA, there were no clear, corresponding increases of dechlorination intermediates in the soil samples. Additional assessment of the effects of EK-BIO remediation on soil quality is further discussed below based on soil microbial analysis.
Figure 6-5. Soil CVOC Data – Comparisons Between Events
6.3.2 Soil Microbial Analytical Results

Soil samples from all three (3) events were analyzed for multiple biomarkers: reductive dechlorination bacteria Dehalococcoides (Dhc) and functional genes for TCE and VC dechlorination. The analyses of all soil samples collected during the baseline and post-Stage 1 events did not detect any of these biomarkers above the detection limit (6E+03 to 8E+03 enumeration or gene copies per gram). Given the observed PCE distributions and the lack of biomarkers in the first two events, only the soil samples from 18.5 ft bgs from the post-Stage 2 event were submitted for biomarker analyses and the results are summarized in Table 6-9.

Table 6-9. Soil Microbial Analytical Data (Post-Stage 2 Samples; 18.5 ft bgs)

<table>
<thead>
<tr>
<th>Location / Parameter</th>
<th>Dhc (baseline)*</th>
<th>vcrA</th>
<th>bvcA</th>
<th>tceA</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>2E+03 J (below 8E+03)</td>
<td>Below 7E+03</td>
<td>Below 7E+03</td>
<td>Below 7E+03</td>
</tr>
<tr>
<td>C2</td>
<td>7E+04 (below 8E+03)</td>
<td>1E+04</td>
<td>2E+04</td>
<td>3E+03 J</td>
</tr>
<tr>
<td>C3</td>
<td>9E+05 (below 8E+03)</td>
<td>1E+05</td>
<td>1E+05</td>
<td>3E+05</td>
</tr>
<tr>
<td>C4</td>
<td>7E+03 (below 8E+03)</td>
<td>Below 8E+03</td>
<td>Below 8E+03</td>
<td>Below 8E+03</td>
</tr>
<tr>
<td>C5</td>
<td>5E+04 (below 8E+03)</td>
<td>4E+04</td>
<td>2E+03 J</td>
<td>7E+03</td>
</tr>
<tr>
<td>C6</td>
<td>Below 8E+03</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>C7</td>
<td>4E+04 (below 7E+03)</td>
<td>Below 8E+03</td>
<td>1E+04</td>
<td>Below 8E+03</td>
</tr>
<tr>
<td>C8</td>
<td>Below 7E+03</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>C9</td>
<td>7E+03 (below 6E+03)</td>
<td>1E+03 J</td>
<td>Below 7E+03</td>
<td>Below 7E+03</td>
</tr>
<tr>
<td>C10</td>
<td>Below 8E+03</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

* For the samples with detected Dhc, the baseline Dhc data were provided in ( ).

Dhc: Dehalococcoides (enumeration/gram); vcrA : VC Reductase (gene copies/gram)
bvcA : BAV1 VC Reductase (gene copies/gram) tceA : TCE Reductase (gene copied/gram)
J : Estimated quantity between the method detection limit and quantitation limit.
NA : Not applicable because Dhc was not detected.

Among the nine (9) post-Stage 2 samples from within the TAA, six (6) samples were reported with quantifiable levels, plus one with estimated level, of Dhc. Of these seven (7) samples with detected Dhc, five (5) samples, C2, C3, C5, C7, and C9, were detected with functional genes for VC dechlorination. Among all the locations within the TTA, location C3 appeared to have the most established Dhc populations with VC reductase genes, followed by locations C2 and C5.
It is noted that these are the locations in the interior of the TTA generally between supply wells and electrode well E5 which was an anode during both Stage 1 and Stage 2 operation. Electron donor would have been consistently migrating towards electrode well E5 during both Stages, and as such, it is not unexpected that the best electron donor availability and microbial growth would be detected in this area.

Overall, the soil sampling results presented in this section indicate that the EK-BIO operation resulted in significant decreases of PCE in clay soil across the TTA. The data also showed that microbial populations capable of reductive dechlorination of chlorinated ethenes, including VC, were established within the clay materials in at least part of the TTA.
7.0 PERFORMANCE ASSESSMENT

This section provides an assessment of the performance of the Dem/Val relative to the performance objectives previously discussed in Section 3. Each subsection discusses the performance relative to an individual performance objective.

7.1 DEMONSTRATE UNIFORM DISTRIBUTION

The success criteria for this performance objective include:

Criterion
At groundwater monitoring locations within the TTA, groundwater TOC is at least 5x baseline, or 10x detection limit if baseline is below detection.

As presented in Table 6-4, every monitoring well within the TTA had TOC concentrations >8x baseline levels (for each well) during Stage 1 and/or Stage 2 operation, with the exception of EKMW-04 where the maximum TOC detected was 1.8x of the baseline. However, at EKMW-04 the maximum VFA detected was >9x its baseline. With respect to VFAs, all but one monitoring well (EKMW-05) had concentrations >9x baseline levels. As such, the Dem/Val has met this criterion in the EK was able to substantially increase electron donor concentrations across the entire TTA. Of note, TOC concentrations were more than 100x average baseline levels in groundwater samples located between the supply wells and central anode (E5), indicating the electrode layout and electrical field design as important parameters in achieving optimal electron donor distribution across the TTA.

Criterion
No local focusing of electric field within the TTA – no electrical potential gradient between any individual pair of cathode-anode is 5x the average electrical gradient between all pairs of electrodes.

As presented in Figure 6-2, the voltage measured at discrete locations within the TTA were between 5.3V and 6.2V, with a standard deviation of 0.31V (5%). Voltage gradients were calculated between locations of closest pairs shown in Figure 6-2 and range between 0.1 to 0.26 V/m. The calculated voltage gradients between these pairs are within 3x of each other and within 2x of the average gradients (0.13 V/m) indicating no local focusing of electric field within TTA. The Dem/Val has met this criterion.

Criterion
Electrical potential gradient between electrode pairs maintained at level no more than 5x target gradient at design current.

The EK system was designed and operated at a constant current, determined after the start-up period, during the Dem/Val. As presented in Figure 6-1, during Stage 1 and Stage 2 operation, the voltage required of the power supply unit was generally consistent at between 15V and 30V, except for a few occasions when electrodes were in need of replacement. The electrical current supplied to individual wells during each stage of operation was generally steady (variation within 37% of average).
Given that (1) soil electrical resistivity is a soil property not expected to vary over the course of Dem/Val, and (2) the voltage output by the power supply unit and the current supplied to individual electrodes were generally steady, the electrical potential between electrode pairs within the TTA should maintain within 5x of target during operation. The Dem/Val has met this criterion.

7.2 DEMONSTRATE TREATMENT EFFECTIVENESS

The success criteria for this performance objective include:

Criterion

> 60% reduction in average PCE concentrations in soil and groundwater within the TTA, with coupled and comparable molar concentration increases of dechlorination daughter and end products.

Figure 6-3 presents a comparison of groundwater CVOC and biomarker monitoring results. The % decrease of PCE concentration and % increases of concentrations of dechlorination daughter products and ethene from the baseline levels are summarized in Table 7-1.

Table 7-1. Changes of Groundwater CVOC and Ethene Concentrations*

<table>
<thead>
<tr>
<th>Well</th>
<th>Stage 1 PCE Decrease</th>
<th>Stage 2 PCE Decrease</th>
<th>Stage 1 Increase of Products</th>
<th>Stage 2 Increase of Products</th>
<th>Stage 1 Increase of Ethene</th>
<th>Stage 2 Increase of Ethene</th>
</tr>
</thead>
<tbody>
<tr>
<td>EKMW-01</td>
<td>90%</td>
<td>95%</td>
<td>310%</td>
<td>-41%</td>
<td>14x</td>
<td>84x</td>
</tr>
<tr>
<td>EKMW-02</td>
<td>86%</td>
<td>74%</td>
<td>-41%</td>
<td>-13%</td>
<td>58x</td>
<td>47x</td>
</tr>
<tr>
<td>EKMW-03</td>
<td>70%</td>
<td>83%</td>
<td>-13%</td>
<td>-24%</td>
<td>30x</td>
<td>26x</td>
</tr>
<tr>
<td>EKMW-04</td>
<td>89%</td>
<td>72%</td>
<td>-18%</td>
<td>-34%</td>
<td>11x</td>
<td>3.8x</td>
</tr>
<tr>
<td>EKMW-05</td>
<td>90%</td>
<td>67%</td>
<td>160%</td>
<td>200%</td>
<td>1x</td>
<td>1.6x</td>
</tr>
<tr>
<td>EKMW-07</td>
<td>84%</td>
<td>93%</td>
<td>140%</td>
<td>200%</td>
<td>13x</td>
<td>22x</td>
</tr>
</tbody>
</table>

* Calculations for each well are based on molar concentrations and comparing between Baseline to End-of-Stage 1 and Baseline to End-of-Stage 2. Calculations for increases of products include TCE, cis-1,2-DCE, VC, and ethene.

For each of the six monitoring wells located within the TTA, decreases of >80% in PCE concentration were achieved at the end of either Stage 1 and/or Stage 2. Also presented in Figure 6-3 and Table 7-1, the decreases of PCE from baseline at each well within the TTA were coupled with evident increases of dechlorination daughter products and/or ethene. The Dem/Val has met this criterion for groundwater.
**Figure 6-5** presents a comparison of soil CVOC at corresponding locations between the three (3) sampling events. The data presented in **Figure 6-5** are arranged per individual locations and sampling depths. Overall, soil PCE concentrations of all samples collected from 18.5 ft bgs at the nine (9) locations within the TTA decreased by 78% (C6) to 99% (C3) from baseline to post-Stage 2, with an average decrease of 88%. It was also noted that while C6 was the only location with evident baseline PCE concentration at 21 ft bgs (5.5 mg/kg), the PCE concentration at this depth and location decreased to 0.21 mg/kg (96% reduction) and below in subsequent post-operation sampling events. As such, the Dem/Val met the PCE soil reduction criterion.

While the decreases of soil PCE concentrations over the period of Dem/Val were evident, significant, and generally consistent among all sampling locations within the TTA, there were no corresponding increases of dechlorination intermediates in the soil samples. The reason for the general lack of intermediates in the soil samples is unclear, particularly since these degradation intermediates were clearly present in the groundwater samples. Thus, while this criterion was not clearly met for soils, this may not be an appropriate performance metric for the soils.

**Criterion**

*Ethene/ethane detected at > 75% of groundwater monitoring wells within the TTA before the completion of post-EK monitoring.*

As presented in **Figure 6-3** and **Table 7-1**, every (100%) monitoring well within the TTA showed increased concentrations of ethene (up to >1,000 µg/L) during the Dem/Val. The Dem/Val has met this criterion.

**Criterion**

*> 10x increases of Dhc from baseline at > 50% of soil and groundwater samples collected from within the TTA before the completion of post-EK monitoring.*

For the groundwater, **Figure 6-3** shows that every monitoring well within the TTA showed significant increases (several orders of magnitude) of Dhc and vcrA. The Dem/Val has met this criterion for groundwater.

As presented in **Table 6-9**, among the nine post-Stage 2 soil samples collected from within the TAA, six samples were reported with quantifiable levels, plus one with estimated level, of Dhc, while all baseline soil samples did not contain detectable levels of Dhc. Of the seven samples with detected Dhc, five samples (C2, C3, C5, C7, and C9) showed functional genes for VC dechlorination. Thus, while not as impressive as the groundwater results, the Dem/Val has met this criterion for soil.

### 7.3 DEMONSTRATE SUITABILITY FOR FULL-SCALE IMPLEMENTATION

The success criteria for this performance objective include:

**Criterion**

*System operation conditions (voltage and current) within ± 50% of the designed target conditions.*
The EK system was designed and operated at a constant current, determined after the start-up period, during the Dem/Val. As discussed in Section 7.1 (criterion related to electrical gradient) and presented in Figure 6-1, the operating voltage and current remained relatively steady except when electrodes were in need of replacement. There were three occasions when different electrodes needed to be replaced: late October/early November 2015 and late January/early February 2016 during Stage 1 operation; and December 2016 during Stage 2 operation. Prior to electrode replacement, the rising system voltage readings would indicate the operating conditions were becoming unsteady. As discussed in Section 6.1, excluding the temporary unstable readings during the three periods shortly before the electrode replacement, the overall system operation conditions were steady and within 50% of the average during each normal operation period. The Dem/Val has met this criterion.

Criterion

*Amendment supply up-time > 75% of target.*

Other than the scheduled major O&M events between the two stages of operation, there were only three occasions when the system was shut down to allow replacement of electrodes. Overall, the system up-time was well >75% during the Dem/Val. The Dem/Val has met this criterion.

Criterion

*Energy consumption within ± 30% of design estimates.*

The EK system was designed and operated at a constant current, determined after the start-up period, during Stage 1 and Stage 2 operation. Figure 6-1 presents cumulative energy consumption during each stage of operation. Given that the energy consumption is a function of voltage and current and as discussed above regarding the steady system operation condition criterion, excluding the temporary unstable voltage conditions during the three short periods before the electrode replacement, the overall system operations were steady and, thus, the energy usage as well. The Dem/Val has met this criterion.

7.4 SAFE AND RELIABLE OPERATION

The success criteria for this performance objective include:

Criterion

*Operation conditions remain stable within the normal designed ranges over the course of the demonstration period.*

As discussed in Sections 7.1 and 7.3 above, the overall operation conditions remained relatively steady over the course of system operation. The Dem/Val has met this criterion.

Criterion

*No lost-time incidents.*

There were no safety-related lost-time incidents. The Dem/Val has met this criterion.
7.5 EASE OF IMPLEMENTATION

The success criteria for this performance objective include:

**Criterion**

*Ability to construct using conventional techniques and contractors.*

The Dem/Val involved only conventional field construction techniques, including well drilling, well installation, and trenching and piping, as well as remediation system assembly performed by regular, qualified subcontractors. The Dem/Val has met this criterion.

**Criterion**

*A single field technician is able to effectively monitor and maintain normal system operation.*

During the operation, one field technician performed routine system O&M tasks twice per week with approximately 2 to 3 hours per visit. During the routine O&M visit, the tasks primarily included system visual inspections, recording the system operational parameters (voltage, current, amendment flow and pressure), and replenishing amendment solutions as needed. Other than sampling groundwater, there were fewer than 5 scheduled O&M events that involved two field technicians. The Dem/Val has met this criterion.
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8.0 COST ASSESSMENT

This section provides cost information that a remediation professional could use to reasonably estimate the costs for implementing EK-BIO at a given site. The cost analysis is based on actual costs of the tasks completed for this Dem/Val, and supplemented with reasonable estimates based on team’s experience from similar projects.

8.1 COST MODEL

Table 8-1 presents a summary of cost elements and the cost tracking. Select cost elements are briefly discussed.

Table 8-1. Cost Model for EK-enhanced Amendment Delivery In-Situ Remediation
(for a Source Area Measuring 35 ft by 35 ft by 5 ft Thick)

<table>
<thead>
<tr>
<th>Cost Element</th>
<th>Tracked During the Demonstration</th>
<th>Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bench-scale EK tracer test</strong></td>
<td>Aquifer sediment materials provided by NAS Jacksonville. Laboratory bench-scale EK column tracer tests – $25K</td>
<td>$25K</td>
</tr>
<tr>
<td><strong>Remedial Design</strong></td>
<td>System design and demonstration plan – professional labor $80K</td>
<td>$80K</td>
</tr>
<tr>
<td><strong>Remediation Construction</strong></td>
<td>Well driller – 17 electrode/supply wells and 10 monitoring wells; EK system construction subcontractor - $120K Site construction subcontractor - $127K Field construction oversight and system shakedown professional labor (~ 7 weeks) – $40K</td>
<td>$327K</td>
</tr>
<tr>
<td><strong>Baseline characterization</strong></td>
<td>Field staff labor - $6K Laboratory analytical costs - $28K</td>
<td>$34K</td>
</tr>
<tr>
<td><strong>Remediation System Operation &amp; Maintenance</strong></td>
<td>Field O&amp;M subcontractor – over 14 months of active operation, $45K Materials – lactate, $6K Materials - buffer and other chemicals, $3K Materials - system parts &amp; consumables, $4K Professional labor for startup and scheduled O&amp;M visits - $20K</td>
<td>78K (about $6K/month)</td>
</tr>
<tr>
<td><strong>Field Sampling (soil / groundwater)</strong></td>
<td>4 rounds of comprehensive sampling events and 4 rounds of limited scale sampling events Standard soil and groundwater sampling activities Field sampling staff labor (partially provided by NAS Jacksonville) Laboratory analytical costs (partially provided by NAS Jacksonville)</td>
<td>-</td>
</tr>
<tr>
<td><strong>Waste disposal</strong></td>
<td>NAS Jacksonville provided waste disposal; no cost tracking</td>
<td>-</td>
</tr>
<tr>
<td><strong>Reporting &amp; Other Compliance Requirements</strong></td>
<td>Project reporting and meetings.</td>
<td>-</td>
</tr>
</tbody>
</table>
Cost Element – Bench-scale EK Column Testing

For this Dem/Val, the team conducted a bench-scale EK column tracer test to estimate the transport rate as a design basis. It is recommended that such bench-scale testing be considered as part of the remedial design for an EK-enhanced remedy. The scope of bench testing can vary depending on the test objectives. For example, the bench test can be designed to estimate EK transport rate only or to include assessment of treatment effectiveness facilitated by the enhanced amendment delivery, and the need for bioaugmentation. The costs of bench testing, therefore, vary based on the scope and objectives, but will typically range in cost between $15,000 to $40,000.

Cost Element – Remediation Construction

For this Dem/Val, no special drilling or field construction methods were required. The EK system, including an amendment supply system, a power supply system, and electrolyte cross-circulation system, was constructed by a remediation system vendor in accordance with the project-specific design. No special equipment or parts, other than off-the-shelf commercial products, were required for the EK system. The electrodes and power supply unit were also commercially available products. The EK system construction costs will vary depending on the project scale (e.g., number of electrode wells needed to cover a treatment area, number of electrodes used, etc.) and site conditions (e.g., the extent of instrument automation due to site access, iron fouling and control measures due to geochemistry, etc.). However, the cost increase for expanding the EK system constructed for this Dem/Val will only be marginal, primarily related to additional parts (e.g., electrode ($240 each), valves, and pipe fittings, etc.). The EK control center used for this Dem/Val could have been capable of incorporating up to 13 electrodes, thereby expanding the treatment footprint (on the electrode spacing used) by approximately 45%.

Cost Element – Remediation System Operation & Maintenance

The system O&M costs can vary depending on the extent of instrument automation and site conditions and restrictions. For this Dem/Val, routine O&M tasks were performed by regular remediation field technicians without needing special personnel. The material costs for chemicals and system consumables are project-specific but generally scalable. Professional labor costs for this Dem/Val were related to initial system start-up operation and a system conditioning during the re-start transition from the end of Stage 1 incubation to Stage 2 operation.

8.2 COST DRIVERS

Based on the information and experience obtained from this Dem/Val, there are three main cost drivers to consider when evaluating implementation costs in future projects, including: (1) footprint, depth interval, and volume of target treatment zone and contaminant mass; (2) presence and location of above-ground and subsurface utilities; and (3) site geochemistry, particularly pH and iron. These are also the same cost drivers for many other in-situ remediation technologies and not unique to EK technology implementation. Each of these cost drivers is discussed below.

Cost Driver – Target Treatment Zone and Contaminant Mass

As for most remediation technologies, the size and volume of the target treatment zone as well as the amount of contaminant requiring treatment significantly affects the overall remediation costs.
Particularly, the drilling and well installation costs for system wells (electrode wells and supply wells) vary based on the number and depth of these wells needed to adequately address the treatment zone. The spacing between electrode wells designed for this Dem/Val was approximately 18 ft, with supply wells located within the electrode well network. This level of well spacing, coupled with the phased operation program and the duration of operations, can be considered as within ranges of normal design for this technology. For this Dem/Val, active EK operation following bioaugmentation lasted approximately 10 months (two separate 5-month stages) and achieved an average soil PCE reduction of 88%. The overall duration of an EK remedy implementation will depend on the contaminant mass and the required mass reduction goal.

While there is no technical limit for applying EK technology in terms of depth, the costs for well construction increase as the depth of target treatment zone. The depth interval (thickness) of target treatment zone may affect the number of electrodes within an electrode well and, therefore, the overall number of electrodes needed. A target treatment zone of shallow depth may need additional measures and costs related to utility protection as discussed below. This technology is suitable mainly in saturated formations; treatment within the vadose zone represents a challenge which is discussed in Section 9.

Utilities

As with other active remediation technologies, a power source is required for this technology. Although not yet tested, the energy demand and the electrical operation conditions (voltage and current) demonstrated in this Dem/Val suggest that solar energy with battery units may be a feasible option.

Special considerations are warranted at sites with metallic subsurface infrastructure or subsurface utilities that may be electrically conductive. This evaluation should take into account the vertical separation of the electric field and the utility of concern. If needed, cathodic protection measures can be considered which can increase the implementation costs. In general, the EK technology is best suited for sites where the target treatment zone is deeper than 8 ft bgs (i.e., below utilities and conduits) and the groundwater table below 5 ft bgs, otherwise special design considerations are needed.

Site Geochemistry

Concentrations of iron and other major cations (e.g., calcium and magnesium) in groundwater is an important factor that can affect the costs of system construction and O&M. While this geochemical parameter is an important factor for most in-situ remediation technologies, it requires a special consideration when implementing an EK remedy because the electric field will result in, at least temporarily, concentrated iron and cations in cathode wells which attract cations in groundwater. The EK system for sites with elevated concentrations of these cations will need to be sized and equipped with adequate units for handling the anticipated amount of precipitates. More robust O&M programs and efforts will also need to be considered for such sites. Over the course of implementation, the O&M issues related to these do diminish.
8.3 COST ANALYSIS

For cost assessment, Table 8-2 provides a cost comparison between EK-BIO, conventional direct-injection EISB, hydraulic fracturing DPT injection of ZVI, and electrical resistance heating (ERH) thermal treatment for a typical CVOC source site in low-K materials. The key characteristics of the framework site are as follows:

- The site characterization and conceptual site model have been completed. The characterization of the target treatment area is sufficient and no additional pre-design investigation data are needed to support the remedial design;
- The footprint of target treatment zone is approximately 80 ft x 80 ft;
- The depth interval of target treatment zone is between 10 and 30 ft bgs;
- Geology consisting of mainly fine-grained clayey material with low permeability (<1.0E-06 cm/sec);
- CVOC mass (chlorinated ethenes) is approximately 500 lbs;
- Treatability testing is already completed to support bioremediation design. The site will require bioaugmentation of dechlorination cultures, which will completely dechlorinate target CVOCs to innocuous end product;
- The site has available potable water supply and adequate power utility; and
- No concerns for site access, subsurface obstruction, electrical interference or corrosion.

Table 8-2 presents estimated full-scale implementation costs and key assumptions associated with each technology on which the estimated costs are developed. Given that performance monitoring requirement is highly project-specific, the estimated costs are presented as with and without the costs for performance monitoring. These estimates are prepared at the level of a feasibility study (e.g., +50%/-30%) for a cleanup site.

For baseline comparison, the costs of excavation with offsite disposal was also estimated. The feasibility-level cost estimate for an excavation-disposal option is in the range of $1,300,000 to $1,500,000. One variable in cost estimation for excavation is the quantity of excavated soil that may need to be managed as hazardous waste. This can significantly increase the cost of this option.

Based on the cost estimates presented in Table 8-2, EK-BIO can be potentially more cost favorable to ERH remedy ($688K to $1,183K before accounting for monitoring costs) and excavation-disposal. The cost saving of EK-BIO compared to ERH is smaller when factoring in the monitoring costs because ERH can complete the remediation within a shorter timeframe (~ 6 months with ERH compared to ~ 2 to 3 years with EK-BIO for the framework site). It is noted the significant difference in the electrical energy needed for these two technologies indicating a much more favorable environmental performance of EK-BIO over ERH.

The feasibility and effectiveness of direct-injection EISB approach is highly dependent on whether direct injection can achieve a reasonable injection rate and a reasonable radius of influence (ROI). For cost estimating purpose, an injection rate of 0.75 gpm to 1 gpm and a ROI of 7 ft are assumed.
The estimated costs for direct-injection EISB are presented in Table 8-2 as a range based on injection rates. It should be noted that it is possible that at certain low-K sites these assumed injection rates and ROI may not be achievable. As presented in Table 8-2, the estimated cost for EK-BIO approach is comparable to that of direct-injection EISB when factoring in the costs for reinjections (assumed two reinjections over five years). When further accounting the performance monitoring costs, which depends on the overall timeframe of individual remedy, EK-BIO is potentially a more cost favorable alternative to direct-injection EISB. Therefore, at sites where low-K material and/or high-degree of heterogeneity limits the feasibility of applying direct injection, EK-BIO provides a cost-effective solution for implementing in situ bioremediation.

Fracturing DPT injection has an overall estimated cost slightly higher than EK-BIO. Certain site conditions may present more constraints for fracturing DPT injection than EK-BIO, such as sensitive subsurface utilities, shallow treatment zone close to the ground surface, or oxidizing geochemical conditions requiring more site conditioning to facilitate reductive treatment. While fracturing DPT technology can enhance aquifer permeability, if a target treatment zone is in a heterogeneous formation, the fracturing technique may still result in non-uniform distribution of injected amendment. Alternately, the depth interval for fracturing will need to be reduced, with associated increased costs to achieve uniform distribution.
<table>
<thead>
<tr>
<th><strong>Cost Element</strong></th>
<th><strong>Tasks</strong></th>
<th><strong>Excavation - Disposal</strong></th>
<th><strong>EK-BIO</strong></th>
<th><strong>Injection EISB</strong></th>
<th><strong>Hydraulic Fracturing ZVI Injection</strong></th>
<th><strong>ERH</strong></th>
<th><strong>Descriptions / Assumptions</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Remedial Design and Permitting</td>
<td>Design, project workplans, UIC permit</td>
<td>$50K</td>
<td>$70K</td>
<td>$50K</td>
<td>$65K</td>
<td>$80K</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>ERH – also needs air permit, wastewater discharge permit</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Remedial Construction (Excavation-disposal and hydraulic fracturing ZVI injection costs presented only in Remediation System Operation & Maintenance below) | EK-BIO – 1. Well installations 2. Site construction; utilities 3. EK system & control center fabrication/ mobilization/ field connections 4. Professional field oversight and system shakedown/startup | | $53K | $140K | $169K | $60K | • 25 electrode wells and 15 supply wells; all 4-in PVC wells  
• Electrode well spacing at ~ 18 ft  
• Two electrodes vertically spaced in each electrode well  
• One EK control/ amendment supply system |
| | Injection EISB – 1. Well installations 2. Site construction; utilities 3. Injection system mobilization/ field connections 4. Professional field oversight and system shakedown/startup | | $70K | $35K | $20K | $40K | • 49 injection wells; 2-inch PVC wells  
• Injection well spacing at ~ 13 ft  
• Injection ROI at ~ 7 ft  
• Up to three injection manifolds are constructed  
• Area is accessible during injection, and no trenching is required |
| | ERH – 1. Well installations 2. Site construction; utilities 3. ERH system mobilization/ field connection/ system shakedown/startup 4. Professional field oversight | | | $92K | $180K | $190K | $60K | • 25 electrode wells and 25 co-located vapor recovery wells  
• Electrode well spacing at ~ 18 ft  
• A surface cap will not be required  
• Include a 20-hp vapor extraction blower  
• Adequate power supply is available for a 500-kW power unit |
• 150,000 gallons dewater volume  
• 50% excavated volume as hazardous  
• 25 miles to disposal facility |
<table>
<thead>
<tr>
<th>Remedial System</th>
<th>Operation &amp; Maintenance</th>
<th>EK BIO –</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Materials – chemicals</td>
<td>1. $60K - $75K</td>
<td>1. Lactate as electron donor; also supply buffer and bioaugmentation culture</td>
</tr>
<tr>
<td>2. Materials – parts and supplies</td>
<td>2. $25K - $40K</td>
<td>Approximately up to 3A current between each pair of cathode and anode</td>
</tr>
<tr>
<td>3. Labor – O&amp;M operator</td>
<td>3. $65K - $95K</td>
<td>Four stages of operation over two years; each stage is four months of active EK operation followed by two months of incubation; alternate electric field orientation between each stage; a 3rd year is assumed for contingency</td>
</tr>
<tr>
<td>4. Labor – professional</td>
<td>4. $50K - $75K</td>
<td>Less than 5,000 kW-hr electrical energy required for EK operation</td>
</tr>
<tr>
<td>5. Utilities – water and electrical power</td>
<td>5. $5K - $8K</td>
<td>Weekly visit by a system operator; up to three major O&amp;M events</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Injection EVENTS – (injection rate from 1 gpm to 0.75 gpm*)</th>
<th>DPT Hydraulic Fracturing ZVI Injection –</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Injection system rental *</td>
<td>1. Injection vendor all labor/material inclusion costs</td>
</tr>
<tr>
<td>2. Materials – chemicals</td>
<td>2. Professional oversight</td>
</tr>
<tr>
<td>3. Labor – field injection *</td>
<td></td>
</tr>
<tr>
<td>4. Utilities – water and electrical power</td>
<td></td>
</tr>
<tr>
<td>5. Rejection – 2 rejection events*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Injection EVENTS – (injection rate from 1 gpm to 0.75 gpm*)</th>
<th>DPT Hydraulic Fracturing ZVI Injection –</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Injection system rental *</td>
<td>1. Injection vendor all labor/material inclusion costs</td>
</tr>
<tr>
<td>2. Materials – chemicals</td>
<td>2. Professional oversight</td>
</tr>
<tr>
<td>3. Labor – field injection *</td>
<td></td>
</tr>
<tr>
<td>4. Utilities – water and electrical power</td>
<td></td>
</tr>
<tr>
<td>5. Rejection – 2 rejection events*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>DPT Hydraulic Fracturing ZVI Injection –</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Injection vendor all labor/material inclusion costs</td>
</tr>
<tr>
<td>2. Professional oversight</td>
</tr>
</tbody>
</table>

| ERH – |
| 1. System rental and system operator |
| 2. Labor – professional oversight |
| 3. Utilities – electrical power |
| 4. Permit monitoring (air and condensate) |
| 5. Waste (activated carbon) disposal |

<table>
<thead>
<tr>
<th>Estimated Total (no performance monitoring costs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$1,300K - $1,500K</td>
</tr>
</tbody>
</table>

- EMulsified vegetable oil (EVO) as the electron donor; also inject buffer and bioaugmentation culture
- Achievable injection rate from 1 gpm to 0.75 gpm
- Up to two re-injection events over a period of five years

- 25 DPT injection points; ROI ~12 ft; spacing ~ 20 ft
- 7 fractures per DPT location (~ 3 ft depth interval per fracturing)
- 1.5% wt ZVI to soil mass (total ZVI mass = 210,000 lbs)
- 20 to 25 days of field injection

- Total heating time of 180 days
- Approximately 142,000 kW-hr electrical energy needed
- Approximately 8,000 lb of activated carbon for regeneration/disposal
- Vapor and condensate sampling and analysis in compliance with permits
<table>
<thead>
<tr>
<th>Remediation Performance Monitoring</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>EK-BIO –</td>
<td>$190K - $240K</td>
<td>$290K</td>
<td>$190K</td>
<td>$90K</td>
</tr>
<tr>
<td>Semi-annual groundwater monitoring for 3 to 4 years; Final soil sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injection EISB –</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-annual groundwater monitoring for 5 years; Final soil sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydraulic fracturing DPT ZVI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injection –</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Semi-annual groundwater monitoring for 3 years; Final soil sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ERH –</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Two semi-annual groundwater following the active operation; Final soil sampling</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>For costing purpose, assuming</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$25K per semi-annual groundwater monitoring event; $40K for final soil sampling event</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Estimated Total (with performance monitoring costs)</th>
<th>$1,300K - $1,500K</th>
<th>$878K - $1,010K</th>
<th>$885K - $1,036K</th>
<th>$980K - $1,130K</th>
<th>$1,273K</th>
</tr>
</thead>
</table>
9.0 IMPLEMENTATION ISSUES

EK-BIO is mainly a variation on standard EISB whereby EK is used to more effectively deliver the required amendments (electron donors, buffers and microbes) through low-K materials. As such, there are very few additional requirements or implementation issues that needed to be addressed beyond those typically encountered with a standard EISB implementation. Some areas where additional attention may be required, on a site-specific basis, include:

- Safety considerations related to potential stray current/voltage to surface. To address this question, we checked the current and voltage at the manhole steel cover located within the treatment area while the EK system was in operation to confirm that there was no safety concern. Depending on project site, and for sensitive and active facilities with dedicated safety departments, additional design and explanation effort may be required for project approvals.

- Iron fouling of filters and valves along the catholyte (well water from cathode wells) extraction line. In this Dem/Val, we re-plumbed the system to minimize potential flow restriction points. Scaling of the cathodes also required maintenance actions to clean the cathode surface. As indicated above, this issue diminished over the course of the Dem/Val.

- Corrosion of metallic parts in the manifold system & wellhead fittings due to elevated chloride concentrations. In this Dem/Val, we replaced most metallic contacting parts with plastic parts upon discovering that chloride levels were far higher than initially known.

- The technology implementation did not require specialized/proprietary equipment. We used only standard commercial off-the-shelf equipment. We designed the manifold and control system and had a remediation system vendor assemble the system per design, but the overall system was similar to other “typical” in-situ remediation systems.

- If the technology is to be implemented near (laterally and/or vertically) utilities that are “sensitive” to electric interference or corrosion concerns, some protection measures, such as cathodic protection, may be considered.

- No special regulatory requirements or permits beyond what are typical for other EISB or ISCO projects such as UIC permit. Depending on the locality-/facility-specific requirements, local or facility power/electrical departments should be consulted.
10.0 REFERENCES


ESTCP ER-1740. Basic Research Addressing Contaminants in Low Permeability Zones.


Geosyntec Consultants, Inc. (2013), Enhanced In Situ Bioremediation Pilot Test Workplan, Operable Unit 3 (OU3), Naval Air Station Jacksonville, Florida.


Robertson, TJ. (2009), Electrokinetic transport of persulfate under voltage gradients, ME dissertation, University of Technology Sydney.


## APPENDIX A  POINTS OF CONTACT

<table>
<thead>
<tr>
<th>Point of Contact Name</th>
<th>Organization Name Address</th>
<th>Phone Fax Email</th>
<th>Role in Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evan Cox</td>
<td>Geosyntec Consultants, Guelph, ON, Canada</td>
<td>519-514-2235 <a href="mailto:ECox@Geosyntec.com">ECox@Geosyntec.com</a></td>
<td>PI Supervising the project</td>
</tr>
<tr>
<td>David Gent</td>
<td>US Army ERDC Environmental Lab Vicksburg, MS</td>
<td>601-634-4822 <a href="mailto:David.B.Gent@usace.army.mil">David.B.Gent@usace.army.mil</a></td>
<td>Co-PI Technical direction</td>
</tr>
<tr>
<td>James Wang</td>
<td>Geosyntec Consultants Columbia, MD</td>
<td>410-910-7622 <a href="mailto:JWang@Geosyntec.com">JWang@Geosyntec.com</a></td>
<td>Performer Technical design and execution</td>
</tr>
<tr>
<td>David Reynolds</td>
<td>Geosyntec Consultants Kingston, ON, Canada</td>
<td>519-515-0883 <a href="mailto:DReynolds@Geosyntec.com">DReynolds@Geosyntec.com</a></td>
<td>Performer Data analysis</td>
</tr>
<tr>
<td>Michael Singletary</td>
<td>NAVFAC Southeast Jacksonville, FL</td>
<td>904-542-4204 <a href="mailto:Michael.a.singletary@navy.mil">Michael.a.singletary@navy.mil</a></td>
<td>Site coordination, technical review</td>
</tr>
</tbody>
</table>
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Memorandum

Subject: Results of Laboratory Testing of NAS Jacksonville Samples for Potential Application of Electrokinetic Remediation

ESAT TOA 601218

BACKGROUND

Geosyntec Consultants Inc. (Geosyntec), in conjunction with Naval Facilities Engineering Command (NAVFAC) and the Army Engineer Research and Development Center (ERDC), submitted a proposal to ESTCP for pilot testing electrokinetic–enhanced remediation at Operable Unit 3 (OU3) NAS Jacksonville. To develop site-specific data supporting the preparation of the ESTCP proposal, soil samples were collected from the vicinity of proposed pilot test area at OU3, and sent to Geosyntec for bench-scale laboratory testing. The bench-scale testing was funded through a Rapid Response Task (task order number 601218-03). Geosyntec has developed this memorandum to document the test completed and report the test results.

SCOPE OF WORK

The scope of work for the bench-scale electrokinetic (EK) testing program included the following tasks:

1) Mineralogical analysis of the supplied soil
2) Zeta potential testing of the supplied soil
3) Non-reactive tracer testing of the supplied soil

RESULTS

Mineralogical Analysis

A sample of the soil from NAS Jacksonville was sent to GR Petrology Consultants Inc. (GRP) in Calgary, Alberta, Canada for bulk and glycolated clay x-ray diffraction (XRD) analysis. The sample was found to contain 80.1% non-clay minerals and 19.9% clay minerals in the bulk XRD fraction. Quartz was the principal mineral detected, forming 61.3% of the bulk fraction. The high percentage of non-clay minerals is likely due to the selected subsample containing multiple sand grains, as the overall visual bulk soil was classified as sandy-clay.
The clay fraction was primarily composed of kaolinite (63% of the clay fraction), with smaller portions of illite, chlorite, and smectite.

**Zeta Potential Testing**

A sample of the soil from NAS Jacksonville was sent to the University of Toronto for measurement of zeta potential. Zeta potential is a key parameter which in part controls the rate of electroosmosis of bulk water through soil pores under an applied electric potential. Two sets of measurements were performed at various pH values, the first (run 1) immediately after pH adjustment and the second (run 2) after the solutions had been allowed to equilibrate overnight. The results are presented in Figure 1.

![Figure 1 – Zeta Potential Results](image-url)
Tracer Testing

A conservative tracer test was conducted on a 10-cm long soil core using the EK testing apparatus (Figure 2). Under a process known as electromigration, anions and cations in bulk solution will migrate towards the oppositely charged electrode when an electrical potential is applied (independent of the effects of electroosmosis). Bromide was added to the cathode reservoir of the EKTA at a concentration of 1.0 g/L (as NaBr), and a constant current of 25 mA was applied to the soil core. The test was run for 72 hours. Following the test, the soil core was frozen and then sectioned into 1-cm long increments. The samples were sent to Maxxam Analytics (Maxxam) for analysis of bromide concentrations in the soil. Table 1 presents the distribution of bromide in the soil as a function of distance from the cathode reservoir.

![Figure 2 – EK Column Test Apparatus](image)

**Table 1 – Bromide Analytical Results in Samples Collected Along the Soil Column**

<table>
<thead>
<tr>
<th>Sample</th>
<th>Background Soil</th>
<th>3-cm from cathode</th>
<th>5-cm from cathode</th>
<th>7-cm from cathode</th>
<th>10-cm from cathode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bromide (mg/kg)</td>
<td>&lt; 1</td>
<td>295</td>
<td>158</td>
<td>157</td>
<td>284</td>
</tr>
</tbody>
</table>

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WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: 51
Drilling Company: EDS
Driller(s): J.T. Mitchell
Geologist/Eng/Tech.: George Zachary
Signature: 

Site: NAS Jax
Project Number: TR0482
Installation Method: HSP
Casing Installation Date: 10/15/14
Well Type: Supply
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N) Date: 11/17/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 2' Weep Hole (Y/N)

Grout
Composition/Proportions:

Placement Method: tremie pipe

Seal
Date: 10/15/14
Type: 201 Plug Bentonite Pallets
Source: 5 gal bucket
Set-up/Hydration Time: 30 min

Vol. Fluid Added:

Filter Pack
Type: 201/30 water treat; 201/65 screen sand
Source: 50 gal buckets
Amount Used: 3 bags 201/80; 1 bag 201/65
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: Schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: Schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.01 in.
Percent Open Area: 0
Sump or Bottom Cap (Y/N)
Type/Length: cap / 0.25'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: 
Date:

10/17/14 13:25 Development begins ~20 gal milky brown to clear, clear next day
10/20/14 16:21 Development continues ~8 gal clear

Comments

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
Well I.D.: 52
Drilling Company: EDS
Driller(s): T.P. Mich., Sean
Geologist/Eng./Tech.: P. Worley, Z.地毯
Signature: 

Site: NAS Jax
Project Number: TR04B2
Installation Method: USA
Casing Installation Date: 10/15/14
Well Type: supply
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N): Y
Date: 11/17/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 21 Weep Hole (Y/N):

Grout
Composition/Proportions: Portland cement type I

Placement Method: 

Seal
Date: 10/15/14
Type: PDC Plug Reinforcing Bolts
Source: 5 gal bucket
Set-up/Hydration Time: 30 min
Place Method: 
Vol. Fluid Added:

Filter Pack
Type: 20/40 silica sand, 30/60 silica sand
Source: 50 lb bags
Amount Used: 3 bags 20/40, 1 bag 30/60
Place Method: 

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y/N): Y/N
Type/Length: cap / 0.75'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: 
Date: 

10/17/14 13:05 Development begins, ~18 gal, milky brown, too clear then grey clay
10/20/14 16:00 development continues, ~10 gal clear.
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: S3
Drilling Company: EDS
Driller(s): Jamie Miller
Geologist/Eng./Tech.: Chris Zidnyk
Signature: 

Site: NAS TEx
Project Number: TR04BZ
Installation Method: HSA
Casing Installation Date: 10/15/14
Well Type: Supply
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N): Date: 11/7/14
Surface Pad Size: 3 ft x 3 ft
Protective Casing or Cover
Diameter/Type: 2" x 2" steel vault
Depth BGS: 2" Weep Hole (Y/N)

Grout
Composition/Proportions: portland cement type I
Placement Method: tremie pipe

Seal
Date: 10/15/14
Type: Per Aug Benmiche pellets
Source: 5 gal bucket
Set-up/Hydration Time: 30 min
Placement Method: direct push
Vol. Fluid Added: no fluid added due to existing water in borehole

Filter Pack
Type: 20/30 silica sand, 10/65 silica sand
Source: 50 lb bag
Amount Used: 3 bags 20/30, 1 bag 80/65
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside diameters: 4 in.

Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y/N)
Type/Length: cap 1/2.25'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: 
Date: 

11/17/14 12:45 Development begins. ~10 gal, milky brown to light brown, then goes dry.
10/20/14 15:49 Development continues. ~10 gal, light brown to clear.
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: 54
Drilling Company: EDS
Driller(s): Joe Mitchell
Geologist/Eng./Tech.: Boyce Zwickert
Signature: [Signature]

Site: NAS Tex
Project Number: TR0452
Installation Method: HSA
Casing Installation Date: 10/16/14
Well Type: supply
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N): Date: 11/7/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2 x 2 steel vault
Depth BGS: 2 Weep Hole (Y/N)

Grout
Composition/Proportions: Portland cement type I

Placement Method: tremie pipe

Seal
Date: 10/16/14
Type: Pel-Plug Benelco Pallets
Source: 5 gal bucket
Set-up/Hydration Time: 30 min
Placement Method: direct pour
Vol. Fluid Added: no fluid added due to existing water in borehole

Filter Pack
Type: 20/40 silica sand, 80/160 silica sand
Source: 3 bags 20/40, 1 bag 80/160
Amount Used: 5 bags 20/40, 1 bag 80/160
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y/N)
Type/Length: 10/15'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: [Signature]
Date: 10/7/14

Comments
10/7/14 10:55 Development begins ~ 15 gal, milky brown to light brown, then gray clay
10/20/14 14:10 Development continues, ~10 gal, light brown to clear, development ends.

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: S5
Drilling Company: EDG
Driller(s): J.E. Miller, Sean
Geologist/Eng/Tech.: Bruce Zander
Signature: [Signature]

Site: [Blank]
Project Number: TR0482
Installation Method: HSA
Casing Installation Date: 10/15/11
Well Type: supply
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N): Date: 11/27/11
Surface Pad Size: 24 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 21/2 steel vault
Depth BGS: 2' Weep Hole (Y/N)

Grout
Composition/Proportions: Portland cement type I
Placement Method: tremie's pipe

Seal
Date: 10/15/11
Type: Pel-Plug Bentonite Pallets
Source: 5 gal buckets
Set-up/Hydration Time: 30 min
Placement Method: direct pour
Vol. Fluid Added: no fluid added due to existing water in borehole

Filter Pack
Type: 20/40 silica sand; 30/60 silica sand
Source: 50 lb bags
Amount Used: 3 bags 20/40; 1 bag 30/60
Placement Method: tremie's pipe

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: in.

Screen
Material: schedule 40 PVC
Inside Diameter: in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0%
Sump or Bottom Cap (Y/N): Y
Type/Length: cap / 0.25'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: [Blank]
Date: [Blank]

Comments
10/17/11 11:23 Development begins. 12 gal, milky brown to light brown, then grey day.
10/20/11 16:12 Development continues. 10 gal, light brown to clear. Development ends.
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: 56
Drilling Company: EOS
Driller(s): J.R. Witchs
Geologist/Eng/Tech.: Bryce Zundegger
Signature: [Signature]

Site: NAS Tax
Project Number: TR0192
Installation Method: HCA
Casing Installation Date: 10/11/14
Well Type: Supply
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N): [Y]
Date: 11/17/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 2' Weep Hole (Y/N): [Y]

Grout
Composition/Proportions: Portland cement type I

Placement Method: [Placement Method]

Seal
Date: 10/11/14
Type: Polyethylene or nylon layers
Source: 5 gal bucket
Set-up/Hydration Time: 20 min
Placement Method: [Placement Method]
Vol. Fluid Added: [Vol. Fluid Added]

Filter Pack
Type: 25/50 silica sand, 30/65 silica sand
Source: 50 lb bags
Amount Used: 3 bags 25/50, 1 bag 30/65
Placement Method: [Placement Method]

Well Riser Pipe
Casing Material: Schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: Schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.01 in.
Percent Open Area: 0%
Sump or Bottom Cap (Y/N): Cap / 0.25'
Type/Length: [Type/Length]

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: [Reviewed By]
Date: [Date]

Comments:
10/17/14 10:32 Development begins. 12 gals, milky brown to light brown. Then grey clay
10/21/14 13:46 Development continues. 15 gals, light brown to clear. Development ends.
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: 57
Drilling Company: BDS
Driller(s): J. C. Spann
Geologist/Eng./Tech.: P. Zundeck
Signature: 

Site: NWS Jay
Project Number: TE0182
Installation Method: HSA
Casing Installation Date: 10/16/14
Well Type: Supply
Well Completion Method: Flush Mount

Well Completion
Guard Posts (Y/N) Date: 11/7/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2" x 2" steel
Depth BGS: 2" Weep Hole (Y/N)

Grout
Composition/Proportions: Portland cement + type 1

Placement Method: 

Seal Date: 10/16/14
Type: Permeable Bentonite Pellets
Source: 5 gal bucket
Set-up/Hydration Time: 30 min
Placement Method: Direct Pour
Vol. Fluid Added: n/a (no fluid added due to existing water in borehole)

Filter Pack
Type: 60/70 nice sand; 30/50 nice mud
Source: 15 kgs
Amount Used: 2 bags 60/30, 1 bag 30/50
Placement Method: 

Well Riser Pipe
Casing Material: Schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: Schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0%
Sump or Bottom Cap (Y/N) Type/Length: cap / 0.25

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: 

Comments

10/17/14 10:10 development begins, 12 gal, clear, dirty brown to clear then gray
10/20/14 12:25 development continues, 15 gal, brown to clear, then gray, development ends.

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: SB
Drilling Company: EDS
Driller(s): J.P. With, Sean
Geologist/Eng./Tech.: Enrique Zuniga, S
Signature: [Signature]

Site: NAS Tux
Project Number: TRO482
Installation Method: USA
Casing Installation Date: 10/16/14
Well Type: Supply
Well Completion Method: Flush Mount

Well Completion
Guard Posts (Y/N) Date: 10/17/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 2'
Weep Hole (Y/N): [ ]

Grout
Composition/Proportions: Portland cement type I

Placement Method: [ ]

Seal
Date: 10/16/14
Type: [ ]
Source: [ ]
Set-up/Hydration Time: 30 min
Placement Method: Direct Pour
Vol. Fluid Added: [ ]

Filter Pack
Type: [ ]
Source: [ ]
Amount Used: [ ]
Placement Method: [ ]

Well Riser Pipe
Casing Material: Schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: [ ]
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y/N): [ ]
Type/Length: [ ]

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: [ ] Date: [ ]

Comments
10/17/14 09:55 Development begins w/ unsubmersible ~15 gal pumped, silted clean to clear, then goes dry 10/20/14 17:08 Development continues ~10 gal, light brown to clear
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: E1
Drilling Company: EDS
Driller(s): J.R. Mitch Sean
Geologist/Eng./Tech.: Roger Zumberge
Signature: __________

Site: NAS Tax
Project Number: TRO4B2
Installation Method: HSA
Casing Installation Date: 10/14/14
Well Type: exclude
Well Completion Method: flush mount

Well Completion
Guard Posts (Y / N) Date: 11/7/14
Surface Pad Size: 30 ft x 30 ft
Protective Casing or Cover
Diameter/Type: 20/30 steel x 10 ft
Depth BGS: 20/30 Weep Hole (Y / N)
Grout
Composition/Proportions: portland cement type I
Placement Method: tremie pipe

Seal
Date: 10/14/14
Type: Pel-Plug Bentonite pellets
Source: 5 gal bucket
Set-up/Hydration Time: 30 min
Placement Method: direct pour
Vol. Fluid Added: 30 gal added due to casing water in borehole

Filter Pack
Type: 20/30 silica sand; 30/165 silica sand
Source: 50 lb bag
Amount Used: 3 bags 20/30; 1 bag 30/165
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: 4 in.
Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y / N)
Type/Length: 8 in. / 0.25'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: __________ Date: __________

10/14/14 14:50 Development begins ~20 gal milky brown to clear.
Development ends.

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.:  F2
Drilling Company:  EOS
Driller(s):  TR, Sean, With
Geologist/Eng/Tech.:  Bape, Zincko, S
Signature:  [Signature]

Site:  NAS Tax
Project Number:  TR0482
Installation Method:  HSA
Casing Installation Date:  10/14/14
Well Type:  Electrode
Well Completion Method:  Flush mount

Well Completion
Guard Posts (Y/N): Date:  10/14/14
Surface Pad Size:  3 ft x 3 ft

Protective Casing or Cover
Diameter/Type:  2' x 2' steel vault
Depth BGS:  2' Weep Hole (Y/N): 

Grout
Composition/Proportions:  Portland cement type 1
Placement Method:  Placement pipe

Seal
Date:  10/14/14
Type:  Pint plug, Bentonite pellets
Source:  5 gal bucket
Set-up/Hydration Time:  30 min
Placement Method:  Direct push
Vol. Fluid Added:  as fluid noted due to existing water in borehole

Filter Pack
Type:  20/40 Villa sand; 30/60 Villa sand
Source:  50 ft bags
Amount Used:  4 bags; 20/40, 1 bag; 30/60
Placement Method:  Placement pipe

Well Riser Pipe
Casing Material:  schedule 40 PVC
Casing Inside Diameters:  4 in.

Screen
Material:  schedule 40 PVC
Inside Diameter:  4 in.
Screen Slot Size:  0.010 in.
Percent Open Area:  0
Sump or Bottom Cap (Y/N): 
Type/Length:  cap / 0.25'

Total Water Volume During Construction
Introduced (Gal):  0
Recovered (Gal):  0

Reviewed
By:  Date:  

Comments
10/17/14 14:27 Development begins; ~15 gal, milky brown to clear then grey clay
10/20/14 16:32 Development continues; ~10 gal clear

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: E3
Drilling Company: EDS
Driller(s): [Signature]
Geologist/Eng/Tech.: [Signature]
Site: NAS Test
Project Number: TR0942
Installation Method: HCA
Casing Installation Date: 10/14/14
Well Type: Electric
Well Completion Method: flush mount

Well Completion
Guard Posts (Y / N): Date: 11/17/14
Surface Pad Size: 3 ft x 3 ft
Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 2' Weep Hole (Y / N)
Grout
Composition/Proportions: portland cement type 1
Placement Method: tremie pipe

Seal
Date: 10/14/14
Type: Pel Plugs Bentonite pellets
Source: 5 gal bucket
Set-up/Hydration Time: 30 min
Placement Method: direct pour
Vol. Fluid Added: [Details]
Filter Pack
Type: 20/40 silica sand; 30/60 silica sand
Source: 50 lb bags
Amount Used: 4 bags 20/40, 1 bag 30/60
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: Schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: Schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0%
Sump or Bottom Cap (Y / N)
Type/Length: cap / 10.25'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: [Signature]
Date:

10/17/14 14:05 Development begins ~ 22 gal milky brown to clear Development ends

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.:  E4
Drilling Company:  EDS
Driller(s):  T.K. Misko, Sean
Geologist/Eng./Tech.:  T.J. Bunge, Zachary S.
Signature:  [Signature]

Site:  NAS Jax
Project Number:  102497
Installation Method:  HSA
Casing Installation Date:  10/16/14
Well Type:  
Well Completion Method:  flush mount

Well Completion
Guard Posts (Y/N):  Y
Date:  10/17/14
Surface Pad Size:  3 ft x 3 ft

Protective Casing or Cover
Diameter/Type:  2" x 2" steel vault
Depth BGS:  2'  Weep Hole (Y/N):  N

Grout
Composition/Proportions:  portland cement type I

Placement Method:  concrete pipe

Seal
Date:  10/16/14
Type:  Perl-Plug Bentonite Bullets
Source:  5 gal bucket
Set-up/Hydration Time:  30 min
Placement Method:  direct pour
Vol. Fluid Added:  water in borehole

Filter Pack
Type:  10/10 silica sand, 30/60 silica sand
Source:  50 in bags
Amount Used:  3 bags 20/30, 1 bag 30/60
Placement Method:  concrete pipe

Well Riser Pipe
Casing Material:  schedule 40 PVC
Casing Inside Diameters:  4 in.

Screen
Material:  schedule 10 PVC
Inside Diameter:  4 in.
Screen Slot Size:  0.010
Percent Open Area:  0
Sump or Bottom Cap (Y/N):  N
Type/Length:  

Total Water Volume During Construction
Introduced (Gal):  0  Recovered (Gal):  0

Reviewed
By:  [Signature]  Date:  [Date]

Comments
10/17/14  10:45 Development begins, ~ 8 gal milky brown then pure clear
10/20/14  14:05 Development continues, ~ 15 gal, light brown to clear. Development ends.
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: E5
Drilling Company: EDS
Driller(s): J.R. Mitch, Sean
Geologist/Eng./Tech.: Boyle Zinklegraf
Signature:

Site: NAS Tax
Project Number: TR04012
Installation Method: HSA
Casing Installation Date: 10/11/11
Well Type: electrode
Well Completion Method: thick mud

Well Completion
Guard Posts (Y/N): Date: 11/17/11
Surface Pad Size: 3 ft x 3 ft
Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 2'
Weep Hole (Y/N): 2
Grout
Composition/Proportions:
Placement Method: premix paper

Seal
Date: 10/11/11
Type: Fort-Plug Bentonite Balls
Source: Sand Outlets
Set-up/Hydration Time: 30 min
Placement Method: premix paper
Vol. Fluid Added:
Filter Pack
Type: 20/40 silica sand, 30/60 silica sand
Source: 50 lb bags
Amount Used: 3 bags 30/60, 1 bag 20/40
Placement Method: premix paper

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: 4 in.
Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y/N)
Type/Length:
Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: Date:

10/17/11 11:12 Development begins; ~8 gal milky brown to light brown; then clear
10/20/11 14:48 Development continues, ~15 gal light brown to clear, Development ends.

Comments
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: Eb Drilling Company: EDS
Driller(s): J.D. Mitch, Sean Geologist/Eng./Tech.: Ray Zwicklewicz
Signature: 

Site: NAS Tax Project Number: TR0492
Installation Method: HSA
Casing Installation Date: 10/15/14
Well Type: electrode
Well Completion Method: Flushing

Well Completion
Guard Posts (Y / N) Date: 11/7/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 2' Weep Hole (Y / N)

Grout
Composition/Proportions: portland cement, type I

Placement Method: tremie pipe

Seal Date: 10/15/14
Type: Pel-Plug Bentonite, pellets
Source: gal bucket
Set-up/Hydration Time: 30 min
Vol. Fluid Added: lot

Filter Pack
Type: 20/30 silica sand, 30/60 silica sand
Source: 50 lb bags
Amount Used: 30 lb
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y / N) Type/Length:
cap / 0.25'

Total Water Volume During Construction
Introduced (Gal): 0 Recovered (Gal): 0

Reviewed
By: Date: 

10/17/14 11:44 Development begins. ~ 8 gal, milky brown to light brown, then gray gray
10/20/14 15:25 Development continues, ~ 20 gal, light brown to clear.

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: E7
Drilling Company: EDS
Driller(s): T.E., Mitch, Sean
Geologist/Eng/Tech.: Bryce Twenty-F
Signature: 

Site: NAS Tar
Project Number: TR0482
Installation Method: HSA
Casing Installation Date: 10/17/14
Well Type: electrode
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N) Date: 11/17/14
Surface Pad Size: 2 ft x 3 ft
Protective Casing or Cover
Diameter/Type: 2' x 2' steel vault
Depth BGS: 2' Weep Hole (Y/N)
Grout
Composition/Proportions: Portland cement + type I

Placement Method: tremie pipe

Seal
Date: 10/17/14
Type: Pei-Plug Bentonite pellets
Source: 5 gal buckets
Set-up/Hydration Time: 30 min
Placement Method: direct pour
Vol. Fluid Added: 0 fluid added due to casing water in borehole

Filter Pack
Type: 20/30 silica sand; 30/60 silica sand
Source: 50 gal bags
Amount Used: 3 bags 20/30; 1 bag 30/60
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010 in.
Percent Open Area: 0
Sump or Bottom Cap (Y/N): cap / 0.25

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: 
Date: 

Comments
10/20/14 11:42 Development begins. ~20 gal milky brown in sight during 20 sec/day 10/20/14 16:37 Development continues. ~7 gal. clear
**WELL CONSTRUCTION LOG**
**STANDARD FLUSH MOUNT**

**Well I.D.:** EB  
**Drilling Company:** EDS  
**Driller(s):** J.R. Mitch, Sue  
**Geologist/Eng./Tech.:** Bruce Zunckel  
**Signature:**  

**Site:** NAS Jax  
**Project Number:** TR0482  
**Installation Method:** H5A  
**Casing Installation Date:** 10/17/14  
**Well Type:** electrode  
**Well Completion Method:** flush mount  

**Well Completion**  
Guard Posts (Y/N): Date: 11/17/14  
Surface Pad Size: 3 ft x 3 ft  
**Protective Casing or Cover**  
Diameter/Type: 2" x 2" steel vault  
Depth BGS: 2' Weep Hole (Y/N)  
**Grout**  
Composition/Proportions: Portland cement type I  
Placement Method: tremie pipe  

**Seal**  
Date: 10/17/14  
Type: Pel-Plug Bentonite pellets  
Source: 5 gal bucket  
Set-up/Hydration Time: 30 sec  
Placement Method: direct pour  
Vol. Fluid Added: 0 fluid added due to casing water in borehole  

**Filter Pack**  
Type: 20/30 silica sand; 30/60 silica sand  
Source: 50 lb bags  
Amount Used: 3 bags 20/30; 1 bag 30/65  
Placement Method: tremie pipe  

**Well Riser Pipe**  
Casing Material: schedule 40 PVC  
Casing Inside Diameters: 4 in.  
**Screen**  
Material: schedule 40 PVC  
Inside Diameter: 4 in.  
Screen Slot Size: 0.010 in.  
Percent Open Area: 0  
Sump or Bottom Cap (Y/N):  
Type/Length: cap / 0.25'  

**Total Water Volume During Construction**  
Introduced (Gal): 0  
Recovered (Gal): 0  
**Reviewed**  
By:  
Date:  

**Comments**  
10/20/14 11:15 Development begins; 15 gal pumped; mud hauled to light hauled; rain 1 day  
10/20/14 16:54 Development continued; 7 gal pumped; light hauled to clear; rain 1 day  

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
WELL CONSTRUCTION LOG
STANDARD FLUSH MOUNT

Well I.D.: E9
Drilling Company: EDS
Driller(s): J.B. John Mutch
Geologist/Eng/Tech.: Benjamin Zunicz-F
Signature: [Signature]

Site: NAS Tax
Project Number: T02482
Installation Method: HSA
Casing Installation Date: 10/17/14
Well Type: electrode
Well Completion Method: flush mount

Well Completion
Guard Posts (Y/N): Date: 10/17/14
Surface Pad Size: 3 ft x 3 ft

Protective Casing or Cover
Diameter/Type: 2' x 2' steel round
Depth BGS: 2' Weep Hole (Y/N)

Grout
Composition/Proportions: Portland cement/bentonite

Placement Method: tremie pipe

Seal
Type: Res-Plug Bentonite Pellets
Source: 5 gal bucket
Set-up/Hydration Time: 30 min
Placement Method: direct pour
Vol. Fluid Added: no fluid added due to existing water in borehole

Filter Pack
Type: 20/30 silica sand; 30/65 silica sand
Source: 50 lb bags
Amount Used: 2 bags 20/30; 1 bag 30/65
Placement Method: tremie pipe

Well Riser Pipe
Casing Material: schedule 40 PVC
Casing Inside Diameters: 4 in.

Screen
Material: schedule 40 PVC
Inside Diameter: 4 in.
Screen Slot Size: 0.010
Percent Open Area: 0
Sump or Bottom Cap (Y/N): Cap / 0-25'
Type/Length: Cap / 0-25'

Total Water Volume During Construction
Introduced (Gal): 0
Recovered (Gal): 0

Reviewed
By: [Signature] Date:

10/20/14 10:15 Development begins. ~ 15 gal, mostly brown to light brown, then goes dark.
10/20/14 16:26 Development continues. ~ 8 gal, light brown to clear, then goes dark.

Comments

FLWP/Forms/Field Forms/Well Construction/Well Construction Logs/well construction log-flushA.doc
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Form FD 9000-24
GROUNDWATER SAMPLING LOG

SITE NAME: NAS Jax
SITE LOCATION: Jacksonville, FL
WELL NO: EKMW-01
SAMPLE ID: EKMW-01
DATE: 10/11/2014

PURGING DATA

WELL DIAMETER (inches): 2
TUBING DIAMETER (inches): 1/4
WELL SCREEN INTERVAL DEPTH: 18 feet to 23 feet
STATIC DEPTH TO WATER (feet): 4.33
PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) X WELL CAPACITY

EQUIPMENT VOLUME PURGE: EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 20.5
FINAL PUMP OR TUBING DEPTH IN WELL (feet): 20.5
PURGING INITIATED AT: 09:20
PURGING ENDED AT: 09:33
TOTAL VOLUME PURGED (gallons): 1.00

<table>
<thead>
<tr>
<th>TIME</th>
<th>VOLUME PURGED (gallons)</th>
<th>CUMUL. VOLUME PURGED (gallons)</th>
<th>PURGE RATE (gpm)</th>
<th>DEPTH TO WATER (feet)</th>
<th>TEMP. (°C)</th>
<th>COND. (micromhos/cm)</th>
<th>DISSOLVED OXYGEN (ppm)</th>
<th>TURBIDITY (NTUs)</th>
<th>COLOR (describe)</th>
<th>ORP (mV)</th>
</tr>
</thead>
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<td>6.43</td>
<td>27.84</td>
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<td>27.80</td>
<td>110.05</td>
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<td>27.75</td>
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<td>9.75</td>
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<td>53.6</td>
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</table>

WELL CAPACITY (Gallons Per Foot): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.55; 5" = 1.02; 6" = 1.47; 12" = 5.88
TUBING INSIDE DIAM. CAPACITY (Gal./FL): 18" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.008; 1/2" = 0.010; 5/8" = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLED BY (PRINT) / AFFILIATION:
By: Zwickgraf & Wozny, Inc.

SAMPLE(S) SIGNATURE(S):
By: [Signature]

SAMPLING INITIATED AT: 09:35
SAMPLING ENDED AT: 09:42
FIELD FILTERED: Y
FILTER SIZE: 0.5 μm
FILTER TYPE: [Specify]

PUMP OR TUBING DEPTH IN WELL (feet): 20.5
TUBING MATERIAL CODE: PE, S

FIELD DECONTAMINATION: PUMP Y
TUBING Y (N/A:"
DECONTAMINATE: Y

SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th>SAMPLE ID CODE</th>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME (ml)</th>
<th>PRESERVATIVE USED</th>
<th>TOTAL VOL. ADDED IN FIELD (ml)</th>
<th>FINAL pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>EKMW-01</td>
<td>1</td>
<td>PE</td>
<td>11</td>
<td>None</td>
<td>None</td>
<td>GeneTrace</td>
</tr>
<tr>
<td>2</td>
<td>PE</td>
<td>40 ml</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>VFAS</td>
</tr>
<tr>
<td>3</td>
<td>PE</td>
<td>250 ml</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>DHOS</td>
</tr>
<tr>
<td>1</td>
<td>PE</td>
<td>150 ml</td>
<td>None</td>
<td>None</td>
<td>None</td>
<td>Metals</td>
</tr>
<tr>
<td>1</td>
<td>PE</td>
<td>150 ml</td>
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<td>None</td>
<td>None</td>
<td>Ions</td>
</tr>
</tbody>
</table>

INTENDED ANALYSIS AND/OR METHOD

<table>
<thead>
<tr>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GPC</td>
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<tr>
<td>TEST</td>
<td>100</td>
</tr>
<tr>
<td>FM</td>
<td>100</td>
</tr>
</tbody>
</table>

REMARKS:

MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

PURGING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; RFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

NOTES: 1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
   pH: ± 0.2 units
   Temperature: ± 0.2 °C
   Specific Conductance: ± 5%
   Dissolved Oxygen: all readings < 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)
   Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revised Date: February 12, 2009
GROUNDWATER SAMPLING LOG

Form FD 9000-24

SITE NAME: NAS Jax
SITE LOCATION: Jacksonville, FL
WELL NO: EKMW-02
SAMPLE ID: EKMW-02
DATE: 10/11/14

PURGING DATA

WELL DIAMETER (inches): 2
TUBING DIAMETER (inches): 1/4
WELL SCREEN INTERVAL (feet): 19
DEPTHS TO WATER (feet): 5-0.2
PURGE PUMP TYPE OR BAILER: PP

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

EQUIPMENT VOLUME PURGE: EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

INITIAL PUMP OR TUBING DEPTHS IN WELL (feet): 21
FINAL PUMP OR TUBING DEPTHS IN WELL (feet): 21
PURGING INITIATED AT: 11:50
PURGING ENDED AT: 12:05
TOTAL VOLUME PURGED (gallons): 1.00

<table>
<thead>
<tr>
<th>TIME</th>
<th>VOLUME PURGED (gallons)</th>
<th>CUMUL. VOLUME PURGED (gallons)</th>
<th>PURGE RATE (gpm)</th>
<th>DEPTH TO WATER (feet)</th>
<th>TEMP. (°C)</th>
<th>COND. (circle units)</th>
<th>DISSOLVED OXYGEN (ppm)</th>
<th>TURBIDITY (NTUs)</th>
<th>COLOR (describe)</th>
<th>ORP (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:58</td>
<td>0.50</td>
<td>0.50</td>
<td>0.06</td>
<td>6.51</td>
<td>5.79</td>
<td>27.75</td>
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<tr>
<td>12:01</td>
<td>0.25</td>
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<td>6.60</td>
<td>5.80</td>
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</tr>
<tr>
<td>12:04</td>
<td>0.25</td>
<td>1.00</td>
<td>0.08</td>
<td>6.71</td>
<td>5.82</td>
<td>27.70</td>
<td>1873</td>
<td>0.21</td>
<td>clear</td>
<td>-18.8</td>
</tr>
</tbody>
</table>

WELL CAPACITY (Gallons Per Foot): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.57; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.66
TUBING INSIDE DIAM. CAPACITY (Gal/ft): 1/8" = 0.0006; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bailer Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT): Bynk
AFFILIATION: Undersea Geoscience

SAMPLER(S) SIGNATURE(S): [Signature]

SAMPLED INITIATED AT: 12:07
SAMPLE ENDED AT: 12:19

PUMP OR TUBING DEPTHS IN WELL (feet): 21

TUBING MATERIAL CODE: PE, S
FIELD-FILTERED: Y
FILTER SIZE: [Specify μm]

FIELD DECONTAMINATION: PUMP Y

TUBING Y [Replaced]

DUPLICATE: Y

SAMPLE CONTAINER SPECIFICATION

SAMPLE ID CODE: EKMW-02
# CONTAINERS: 1
MATERIAL CODE: PE
VOLUME: 1L

SAMPLE PRESERVATION

PRESEVEATIVE USED: None
TOTAL VOL ADDED IN FIELD (ml): -
FINAL pH: -

INTENDED ANALYSIS AND OR METHOD

SAMPLE EQUIPMENT CODE: APP
SAMPLE PUMP FLOW RATE (mL per minute): <100

NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR VARIOUS PHASES OF VARIOUS STAGE (RECORD OF VARIOUS PHASES OF VARIOUS STAGE) (SEE: FS 2212, SECTION 3)

pH ± 0.2 units
Temperature: ± 0.2 °C
Specific Conductance: ± 5%
Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)
Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revision Date: February 12, 2009
## GROUNDWATER SAMPLING LOG

**SITE NAME:** NAS Jacksonville  
**SITE LOCATION:** Jacksonville, FL  
**WELL NO.:** EKAM-03  
**SAMPLE ID:** EKAM-03  
**DATE:** 10/01/14

### PURGING DATA

|-------------------------|---|---------------------------|-----|-----------------------------|------------------|-------------------------------|-----|---------------------------|----|

**WELL VOLUME PURGE:**  
(only fill out if applicable)  
\[ \text{WELL VOLUME} = (\text{TOTAL WELL DEPTH} - \text{STATIC DEPTH TO WATER}) \times \text{WELL CAPACITY} \]

**EQUIPMENT VOLUME PURGE:**  
(only fill out if applicable)  
\[ \text{EQUIPMENT VOLUME} = \text{PUMP VOLUME} + (\text{TUBING CAPACITY} \times \text{TUBING LENGTH}) + \text{FLOW CELL VOLUME} \]

**TOTAL VOLUME PURGED (gallons):** 4.80

### INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 21

### FINAL PUMP OR TUBING DEPTH IN WELL (feet): 21

### PURGING INITIATED AT: 10:10

### PURGING ENDED AT: 11:20

### TIME | VOLUME PURGED (gallons) | CUMUL. VOLUME PURGED (gallons) | PURGE RATE (ppm) | DEPTH TO WATER (feet) | TEMP. (°C) | COND. (circles units) mg/L | DISSOLVED OXYGEN (circles units) | TURBIDITY (NTU) | COLOR (described) | ORP (mv) |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
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<td>6.50</td>
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<td>0.08</td>
<td>6.82</td>
<td>5.81</td>
<td>27.73</td>
<td>1781</td>
<td>0.24</td>
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<td>7.10</td>
<td>5.87</td>
<td>27.10</td>
<td>1854</td>
<td>0.60</td>
<td>yellow</td>
<td>32.7</td>
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<td>10:50</td>
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<td>6.00</td>
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<td>11:05</td>
<td>4.00</td>
<td>10.0</td>
<td>0.07</td>
<td>7.03</td>
<td>5.78</td>
<td>27.11</td>
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<td>27.17</td>
<td>1782</td>
<td>0.16</td>
<td>clear</td>
<td>-21.7</td>
</tr>
</tbody>
</table>

**WELL CAPACITY** (Gallons Per Foot): 0.75" = 0.02; 1" = 0.04; 1 1/8" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.60; 5" = 1.02; 6" = 1.47; 12" = 5.88

**TUBING INSIDE DIA. CAPACITY (Gal./ft):** 1/8" = 0.0006; 3/16" = 0.0004; 1/4" = 0.0006; 3/8" = 0.0006; 1/2" = 0.0010; 5/8" = 0.0016

### PURGING EQUIPMENT CODES:
- B = Bailier  
- BP = Bladder Pump  
- ESP = Electric Submersible Pump  
- PP = Peristaltic Pump  
- O = Other (Specify)

### SAMPLING DATA

**SAMPLED BY (PRINT):**  
**AFFILIATION:**  
**SIGNATURE(S):**  

**PUMP OR TUBING DEPTH IN WELL (feet):** 21

**TUBING MATERIAL CODE:** PE, S

**FIELD DECONTAMINATION:**  
**FILTERED:** Y  
**FILTER SIZE:**  
**Equipment Type:**  

**SAMPLE CONTAINER SPECIFICATION:**  
**SAMPLE PRESERVATION:**  

**INTENDED ANALYSIS AND/OR METHOD:**  
**SAMPLING EQUIPMENT CODE:**  
**SAMPLE PUMP FLOW RATE (mL per minute):**

**REMARKS:**  

**MATERIAL CODES:**
- AG = Amber Glass  
- CG = Clear Glass  
- PE = Polyethylene  
- PP = Polypropylene  
- T = Teflon  
- O = Other (Specify)

**SAMPLING EQUIPMENT CODES:**
- APP = After Peristaltic Pump  
- B = Bailier  
- BP = Bladder Pump  
- ESP = Electric Submersible Pump  
- RFP = Reverse Flow Peristaltic Pump  
- SM = Straw Method (Tubing Gravity Drain)  
- O = Other (Specify)

**NOTES:**
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. Stabilization criteria for range of variation of last three consecutive readings (see FS 2212, Section 3)
   - pH: ± 0.2 units  
   - Temperature: ± 0.2 °C  
   - Specific Conductance: ± 5%  
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)  
   - Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

**Revision Date:** February 12, 2009
# GROUNDWATER SAMPLING LOG

## PURGING DATA

<table>
<thead>
<tr>
<th>WELL NO:</th>
<th>EKMW-04</th>
<th>SAMPLE ID:</th>
<th>EKMW-04</th>
<th>DATE: 10/01/2014</th>
</tr>
</thead>
</table>

**WELL VOLUME PURGE:** (only fill out if applicable)

\[
\text{WELL VOLUME PURGE} = \left( \frac{\text{TOTAL WELL DEPTH}}{\text{STATIC DEPTH TO WATER}} \right) \times \text{WELL CAPACITY}
\]

**EQUIPMENT VOLUME PURGE:** (only fill out if applicable)

\[
\text{EQUIPMENT VOLUME PURGE} = \left( \text{PUMP VOLUME} + \left( \frac{\text{TUBING CAPACITY}}{\text{TUBING LENGTH}} \right) \times \text{FLOW CELL VOLUME} \right)
\]

### TIME (hour:minute)

<table>
<thead>
<tr>
<th>TIME</th>
<th>VOLUME PURGED (gallons)</th>
<th>CUMUL. VOLUME PURGED (gallons)</th>
<th>PURGE RATE (gpm)</th>
<th>DEPTH TO WATER (feet)</th>
<th>pH (standard units)</th>
<th>TEMP. (°C)</th>
<th>COND. (circle units)</th>
<th>DISSOLVED OXYGEN (circle units)</th>
<th>TURBIDITY (NTUs)</th>
<th>COLOR (describe)</th>
<th>ORP (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>12:50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>7.12</td>
<td>4.72</td>
<td>20.73</td>
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<td>0.33</td>
<td>29.1</td>
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<tr>
<td>12:53</td>
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<td>0.75</td>
<td>0.25</td>
<td>7.55</td>
<td>4.68</td>
<td>20.46</td>
<td>1.81</td>
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</tr>
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<td>1.75</td>
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<td>8.55</td>
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<td>&quot;</td>
<td>41.7</td>
</tr>
</tbody>
</table>

**WELL CAPACITY (Gallons Per Foot):** 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.68

**TUBING INSIDE DIA. CAPACITY (Gal./FL):** 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.006; 1/2" = 0.010; 5/8" = 0.016

**PURGING EQUIPMENT CODES:** B = Baller; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

**SAMPLE DATA**

**Sampled By (Print):** Downha / Gregory

**Sampler(S) Signature(S):**

**Sampling Initiated At:** 13:10

**Sampling Ended At:** 13:20

**Pump or Tubing Depth in Well (feet):** 21

**Tubing Material Code:** PE / S

**Field Filtered:** Y

**Filtration Equipment Type:** ___ µm

**Field Decontamination:** PUMP Y

**Tubing Y** (replaced)

**Duplicate:** Y

**Sample Container Specification:** PUMP

**Sample Preservation:**

**Sample ID Code:** EKMW-04

**Preservative:** PE

**Volume:** 1L

**Preservative Used:** none

**Total Vol Added in Field (mL):** -

**Final pH:** Gene Trc

**Intended Analysis and/or Method:** APP

**Sampling Equipment Code:** PE / S

**Sample Pump Flow Rate (mL per minute):** 100

**Remarks:**

**Material Codes:** AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

**Sampling Equipment Codes:** APP = After Peristaltic Pump; B = Baller; BP = Bladder Pump; ESP = Electric Submersible Pump; RFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

**Notes:**

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.

2. Stabilization criteria for range of variation of last three consecutive readings (see FS 2212, section 3): pH: ± 0.2 units; Temperature: ± 0.2 °C; Specific Conductance: ± 5%; Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater); Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revision Date: February 12, 2009
# GROUNDWATER SAMPLING LOG

## WELL INFORMATION
- **Site Name:** NAS Tax
- **Site Location:** Jacksonville, FL
- **Well No.:** EKawn-05
- **Sample ID:** EKawn-05
- **Date:** 10/01/2014

## Purging Data
- **Well Diameter (inches):** 2
- **Tubing Diameter (inches):** 1/4
- **Well Screen Interval Depth:** 19 feet to 24 feet
- **Static Depth to Water (feet):** 4.19
- **Purge Pump Type or Bailer:** PP

**Well Volume Purge:**
\[
\text{Well Volume} = (\text{Total Well Depth} - \text{Static Depth to Water}) \times \text{Well Capacity}
\]

**Equipment Volume Purge:**
\[
\text{Equipment Vol.} = \text{Pump Volume} + (\text{Tubing Capacity} \times \text{Tubing Length}) + \text{Flow Cell Volume}
\]

### Purging Data

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cumul. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (feet)</th>
<th>pH (standard units)</th>
<th>Temp. (°C)</th>
<th>Cond. (circuit units)</th>
<th>Dissolved Oxygen (circuit units)</th>
<th>Turbidity (NTUs)</th>
<th>Color (describe)</th>
<th>ORP (mV)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.50</td>
<td>0.50</td>
<td>0.06</td>
<td>4.96</td>
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<td>clear</td>
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<td>'</td>
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<td>0.25</td>
<td>1.00</td>
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<td>5.00</td>
<td>5.19</td>
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<td>9.19</td>
<td>'</td>
<td>63.6</td>
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</table>

**Well Capacity (Gallons Per Foot):**
- 0.75" = 0.02
- 1" = 0.04
- 1.25" = 0.06
- 2" = 0.16
- 3" = 0.37
- 4" = 0.63
- 5" = 1.02
- 6" = 1.47
- 12" = 5.68

**Tubing Inside Dia. Capacity (Gal/ft):**
- 1/8" = 0.0006
- 3/16" = 0.0014
- 1/4" = 0.0026
- 5/16" = 0.004
- 3/8" = 0.006
- 1/2" = 0.010
- 5/8" = 0.016

**Sampling Data:**
- **Sampled by:** Baller
- **Sampler(s) Signature(s):** [Signature]
- **Sampling Initiated At:** 14:00
- **Sampling Ended At:** 14:08

**Filtration Equipment Type:**
- Field-Filtered: Y
- Filter Size: ______ μm

**Well Water:**
- **Field Decontamination:** Y
- **Duplicate:** Y

**Sample Information:**
- **Sample Container Specification:**
- **Sample Preservation:**
- **Intended Analysis and/or Method:**
- **Sampling Equipment Code:**
- **Sample Pump Flow Rate (mL per minute):**

### Notes:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. Stabilization Criteria: For range of variation of last three consecutive readings (see FS 2212, Section 3)
   - pH: ± 0.2 units
   - Temperature: ± 0.2 °C
   - Specific Conductance: ± 5%
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)
   - Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

**Revision Date:** February 12, 2009
## GROUNDWATER SAMPLING LOG

### SITE INFORMATION
- **NAME:** NAS Joy
- **SITE LOCATION:** Jacksonville, FL
- **WELL NO:** EKMW-07
- **SAMPLE ID:** EKMW-07
- **DATE:** 10/02/2014

### PURGING DATA
- **WELL DIAMETER (inches):** 2
- **TUBING DIAMETER (inches):** 3/4
- **WELL SCREEN INTERVAL (feet):** 19 to 23
- **STATIC DEPTH TO WATER (feet):** 4.06
- **PURGE PUMP TYPE OR BAILER:** PP

#### WELL VOLUME PURGE:
- **WELL VOLUME:** (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) \(\times\) WELL CAPACITY
- **EQUIPMENT VOLUME PURGE:** 1 \(\times\) PUMP VOLUME \(\times\) TUBING CAPACITY \(\times\) TUBING LENGTH \(\times\) FLOW CELL VOLUME

#### INITIAL PUMP OR TUBING DEPTH IN WELL (feet):
- 21

#### FINAL PUMP OR TUBING DEPTH IN WELL (feet):
- 21

#### PURGING INITIATED AT:
- 09:30

#### PURGING ENDED AT:
- 09:41

#### TOTAL VOLUME PURGED (gallons):
- 1.00

### SAMPLING DATA
- **SAMPLED BY:** [Signature]
- **AFFILIATION:** [Signature]
- **SAMPLER(S) SIGNATURE(S):** [Signature]
- **SAMPLING INITIATED AT:** 09:45
- **SAMPLING ENDED AT:** 09:57

#### PUMP OR TUBING DEPTH IN WELL (feet):
- 21

#### TUBING MATERIAL CODE:
- PE

#### FIELD FILTERED:
- Y

#### FILTER TYPE:
- [Specify]

#### FIELD DECONTAMINATION:
- Y

#### SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th>SAMPLE ID CODE</th>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>TOTAL VOL ADDED IN FIELD (ml)</th>
<th>FINAL pH</th>
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<tbody>
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<td>-</td>
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<tr>
<td>**</td>
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<td>CG</td>
<td>90L</td>
<td>none</td>
<td>-</td>
<td>-</td>
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<td>**</td>
<td>3</td>
<td>CG</td>
<td>90L</td>
<td>HCl</td>
<td>-</td>
<td>-</td>
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<tr>
<td>**</td>
<td>2</td>
<td>CG</td>
<td>90L</td>
<td>HCl</td>
<td>-</td>
<td>-</td>
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<tr>
<td>**</td>
<td>3</td>
<td>CG</td>
<td>90L</td>
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<td>250L</td>
<td>none</td>
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</table>

#### MEMORANDUM:
- [Remarks]

### NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. **Stabilization Criteria:** For range of variation of last three consecutive readings (see FS 2212, section 3)
   - **pH:** ±0.2 units
   - **Temperature:** ±0.2 °C
   - **Specific Conductance:** ±5%
   - **Dissolved Oxygen:** all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ±0.2 mg/L or ±10% (whichever is greater)
   - **Turbidity:** all readings ≤ 20 NTU; optionally ±5 NTU or ±10% (whichever is greater)

---

**Revision Date:** February 12, 2009
GROUNDWATER SAMPLING LOG

WELL NO: EKMNW - 08  SAMPLE ID: EKMNW - 08
WELL CAPACITY: 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) X WELL CAPACITY

PURGING DATA

WELL VOLUME PURGE = 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) X WELL CAPACITY

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) + FLOW CELL VOLUME

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 21
FINAL PUMP OR TUBING DEPTH IN WELL (feet): 21
PURGING INITIATED AT: 12:18
PURGING ENDED AT: 14:45
TOTAL VOLUME PURGED (gallons): 4.20

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<tr>
<th>TIME</th>
<th>VOLUME PURGED (gallons)</th>
<th>CUMUL. VOLUME PURGED (gallons)</th>
<th>PURGE RATE (gpm)</th>
<th>DEPTH TO WATER (feet)</th>
<th>pH (standard units)</th>
<th>TEMP. (°C)</th>
<th>COND. (circle units)</th>
<th>DISSOLVED OXYGEN (circle units)</th>
<th>TURBIDITY (NTUs)</th>
<th>COLOR (describe)</th>
<th>ORP (mV)</th>
</tr>
</thead>
<tbody>
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<td>4.00</td>
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<td>10.9</td>
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<td>2.728</td>
<td>0.37</td>
<td>18.5</td>
<td></td>
<td>11.6</td>
</tr>
</tbody>
</table>

WELL CAPACITY (Gallons Per Foot): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.27; 4" = 0.65; 5" = 1.02; 6" = 1.37; 12" = 5.68
TUBING INSIDE DIAM. CAPACITY (Gal/ft): 1/8" = 0.0006; 1/4" = 0.0014; 3/16" = 0.0026; 5/32" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLING DATA

SAMPLER(S) SIGNATURE(S): [Signature]

PUMP OR TUBING DEPTH IN WELL (feet): 21
FIELD FILTER TYPE: [Type]
FIELD-FILTERED: Y
FILTER SIZE: [μm]
DUPLICATE: N

SAMPLE CONTAINER SPECIFICATION

SAMPLE PUMP FLOW RATE (mL per minute): 100

NOTES: 1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
   - pH: ± 0.2 units Temperature: ± 0.2°C Specific Conductance: ± 5% Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater) Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revision Date: February 12, 2009
#### GROUNDWATER SAMPLING LOG

##### PURGING DATA

**WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) \* WELL CAPACITY

**EQUIPMENT VOLUME PURGE:** EQUIPMENT VOL = PUMP VOLUME + (TUBING CAPACITY \* TUBING LENGTH) + FLOW CELL VOLUME

##### SAMPLING DATA

<table>
<thead>
<tr>
<th>TIME</th>
<th>VOLUME PURGED (gallons)</th>
<th>FINAL PUMP OR TUBING DEPTH IN WELL (feet)</th>
<th>TEMPERATURE (°C)</th>
<th>COND. (circle units µmhos/cm OR Ω-cm)</th>
<th>DISSOLVED OXYGEN (circle units mg/L OR % SATURATION)</th>
<th>TURBIDITY (NTUs)</th>
<th>COLOR (describe)</th>
<th>ORP (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:54</td>
<td>0.50</td>
<td>2.2</td>
<td>6.0</td>
<td>4.0</td>
<td>0.03</td>
<td>31.2</td>
<td>clear</td>
<td>99.3</td>
</tr>
<tr>
<td>13:57</td>
<td>0.25</td>
<td>0.75</td>
<td>6.0</td>
<td>9.0</td>
<td>0.50</td>
<td>34.4</td>
<td>1.6</td>
<td>99.6</td>
</tr>
<tr>
<td>14:00</td>
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<td>1.00</td>
<td>6.0</td>
<td>0.0</td>
<td>0.16</td>
<td>15.2</td>
<td>1.7</td>
<td>99.6</td>
</tr>
<tr>
<td>14:03</td>
<td>0.25</td>
<td>1.25</td>
<td>6.0</td>
<td>0.0</td>
<td>0.16</td>
<td>15.3</td>
<td>1.8</td>
<td>100.1</td>
</tr>
</tbody>
</table>

**WELL CAPACITY (Gallons Per Foot):** 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.68

**TUBING INSIDE DIA. CAPACITY (Gall./ft):** 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016

**PURGING EQUIPMENT CODES:**
- B = Bailier
- BP = Bladder Pump
- ESP = Electric Submersable Pump
- PP = Peristaltic Pump
- O = Other (Specify)

**SAMPLED BY (PRINT) / AFFILIATION:**
- Bauer Zenderhead / Geosyntec

**SAMPLER(S) SIGNATURE(S):**
- [Signature]

**SAMPLE CONTAINER SPECIFICATION:**
- PUMP Y
- TUBING Y (replaced)

**SAMPLE PRESERVATION:**
- Gene Trac
- VFAs
- DHGs
- Metals, K
- Anions
- TDS

**INTENDED ANALYSIS AND/OR METHOD:**
- Gene Trac
- VFAs
- DHGs
- Metals, K
- Anions
- TDS

**SAMPLING EQUIPMENT CODE:**
- APP = After Peristaltic Pump
- B = Bailier
- BP = Bladder Pump
- ESP = Electric Submersable Pump
- RPP = Reverse Flow Peristaltic Pump
- SM = Straw Method (Tubing Gravity Drain)
- O = Other (Specify)

**SAMPLING FLOW RATE:** 200 ml per minute

**NOTES:**
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION BETWEEN THREE CONSECUTIVE READINGS (SEE FS 2722, SECTION 3)
   - pH: ± 0.2 units
   - Temperature: ± 0.2 °C
   - Specific Conductance: ± 5%
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)
   - Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

Revision Date: February 12, 2009
# GROUNDWATER SAMPLING LOG

**SITE NAME:** NAS Jax  
**SITE LOCATION:** Jacksonville, FL  
**WELL NO:** EKMW-11  
**SAMPLE ID:** EKMW-11  
**DATE:** 01/02/2014

## PURGING DATA

**WELL DIAMETER (inches):** 2  
**TUBING DIAMETER (inches):** 1/4  
**WELL SCREEN INTERVAL DEPTH:** 19 feet to 23 feet  
**STATIC DEPTH TO WATER:** 4.14 feet  
**PURGE PUMP TYPE OR BAILER:** PP

**WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) X WELL CAPACITY

**EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY X TUBING LENGTH) X FLOW CELL VOLUME

**INITIAL PUMP OR TUBING DEPTH IN WELL (feet):** 21  
**FINAL PUMP OR TUBING DEPTH IN WELL (feet):** 21  
**PURGING INITIATED AT:** 15:16  
**PURGING ENDED AT:** 15:37  
**TOTAL VOLUME PURGED (gallons):** 1.50

<table>
<thead>
<tr>
<th>TIME</th>
<th>VOLUME PURGED (gallons)</th>
<th>CUMUL. VOLUME PURGED (gallons)</th>
<th>PURGE RATE (gpm)</th>
<th>DEPTH TO WATER (feet)</th>
<th>pH (standard units)</th>
<th>TEMP. (°C)</th>
<th>COND. (circle units)</th>
<th>DISSOLVED OXYGEN (circle units)</th>
<th>TURBIDITY (NTUs)</th>
<th>COLOR (describe)</th>
<th>ORP (mV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15:23</td>
<td>0.50</td>
<td>0.50</td>
<td>0.07</td>
<td>7.55</td>
<td>10.00</td>
<td>28.35</td>
<td>33.3</td>
<td>0.22</td>
<td>19.7</td>
<td>clear</td>
<td>7.2</td>
</tr>
<tr>
<td>15:25</td>
<td>0.25</td>
<td>0.75</td>
<td>0.125</td>
<td>8.78</td>
<td>10.41</td>
<td>28.45</td>
<td>38.5</td>
<td>0.18</td>
<td>14.8</td>
<td>clear</td>
<td>0.6</td>
</tr>
<tr>
<td>15:27</td>
<td>0.25</td>
<td>1.00</td>
<td>0.125</td>
<td>9.79</td>
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<td>-1.4</td>
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<td>15:29</td>
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<td>0.125</td>
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<td>10.59</td>
<td>28.52</td>
<td>41.9</td>
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<td>17.1</td>
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<td>-5.0</td>
</tr>
<tr>
<td>15:31</td>
<td>0.25</td>
<td>1.50</td>
<td>0.125</td>
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<td>10.60</td>
<td>28.58</td>
<td>42.1</td>
<td>0.15</td>
<td>19.4</td>
<td>clear</td>
<td>-9.2</td>
</tr>
</tbody>
</table>

**WELL CAPACITY (Gallons Per Foot):** 0.75 = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88

**TUBING INSIDE DIA. CAPACITY (Gal/ft):** 1/8" = 0.0006; 1/4" = 0.0028; 1/2" = 0.006; 5/8" = 0.004; 3/4" = 0.008; 1" = 0.010; 1.5" = 0.016

**PURGING EQUIPMENT CODES:** B = Bailier; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

## SAMPLING DATA

**SAMPLED BY (PRINT)/AFFILIATION:**  
**SAMPLER(S) SIGNATURE(S):**  
**SAMPLING INITIATED AT:** 15:35  
**SAMPLING ENDED AT:** 15:45  
**PUMP OR TUBING DEPTH IN WELL (feet):** 21  
**TUBING MATERIAL CODE:** PE/S

**FIELD FILTERED:** Y  
**FILTER SIZE:** __μm

**FIELD DECONTAMINATION:** PUMP Y  
**TUBING Y N (replaced)**

**SAMPLE CONTAINER SPECIFICATION**

<table>
<thead>
<tr>
<th>SAMPLE CODE</th>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>TOTAL VOL ADDED IN FIELD (mL)</th>
<th>FINAL pH</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EKMW-11</td>
<td>1</td>
<td>PE</td>
<td>1 L</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>General Toluene</td>
<td>APP</td>
<td>1000</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>CG</td>
<td>40 mL</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>VFA</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>CG</td>
<td>40 mL</td>
<td>HCl</td>
<td>none</td>
<td>none</td>
<td>VOCs</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>PE</td>
<td>250 mL</td>
<td>HNO3</td>
<td>none</td>
<td>none</td>
<td>DC</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>PE</td>
<td>150 mL</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>DHOF</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>PE</td>
<td>150 mL</td>
<td>none</td>
<td>none</td>
<td>none</td>
<td>&quot;</td>
<td>&quot;</td>
<td>&quot;</td>
</tr>
</tbody>
</table>

**REMARKS:**  
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)

**pH:** ± 0.2 units  
**Temperature:** ± 0.2 °C  
**Specific Conductance:** ± 5%  
**Dissolved Oxygen:** all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)  
**Turbidity:** all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

**Revision Date:** February 12, 2009
### Water Quality Instrument Calibration Form

**Consultants:** Geoanalytical

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>Exp Date</th>
<th>Std</th>
<th>Temp</th>
<th>Loc</th>
<th>C</th>
<th>NO</th>
<th>NO Detector</th>
<th>Nitrogen</th>
<th>Lead</th>
<th>Manganese</th>
<th>Copper</th>
<th>Iron</th>
<th>Zinc</th>
<th>Nickel</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/23/2009</td>
<td>10:00</td>
<td>6/23/2009</td>
<td>60.0</td>
<td>20.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

**Phosphate:**
- **SOP:** 50 ppm
- **DF:** 100 ppm
- **DGP:** 60 ppm
- **Oxigen:** 20 ppm

**Conductance:**
- **FT 1000:** 50 ppm
- **DF:** 100 ppm
- **DGP:** 60 ppm
- **Oxigen:** 20 ppm

**Water Quality Meter - Model/Serial #:** WQ1 555 MPS 12/10/98

**Project #:** TQ9062

**Field Personnel:** Z94 Smalley
GROUNDWATER SAMPLING LOG

---

**WELL NO:** EKMW-01  **SAMPLE ID:** EKMW-01  **DATE:** 3/15/16

---

### PURGING DATA

- **WELL DIAMETER (inches):** 2
- **TUBING DIAMETER (inches):** 1/4
- **WELL SCREEN INTERVAL DEPTH:** 18 feet to 23 feet
- **STATIC DEPTH TO WATER:** 4.75 feet
- **PURGE PUMP TYPE OR BAILER:** Y

**WELL VOLUME PURGE:** WELL VOLUME = (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) × WELL CAPACITY

**EQUIPMENT VOLUME PURGE:** EQUIPMENT VOLUME = PUMP VOLUME + (TUBING CAPACITY × TUBING LENGTH) + FLOW CELL VOLUME

---

### PURGING INITIATED AT:

**TOTAL VOLUME PURGED (gallons):** 4.60

---

### SAMPLING DATA

**SAMPLED BY/PRINT/ AFFILIATION:** Tony Schmucker (Trinity, Inc.)

**TUBING MATERIAL CODE:** PE

**FIELD FILTERED:** Y

**FILTER SIZE:** mm

**FIELD DECONTAMINATION:** PUMP Y

---

### FIELD EQUIPMENT IDENTIFICATION

**SAMPLE CONTAINER SPECIFICATION**

- **# CONTAINERS:** 3
- **MATERIAL CODE:** CG, AC, CG, PE, PE, PE
- **VOLUME:** 40 mL, 40 mL, 500 mL, 250 mL
- **PRESERVATIVE USED:** HCL, HCL, None, HNO3

**SAMPLE PUMP RATE (mL per minute):** 200

---

### H2O QUALITY PARAMETER

**MODEL:** OTI

**SN:** 16A102711

**TURBIDOMETER**

**MODEL:** LaMotte

**SN:** 6229-0116

**OTHER**

---

### REMARKS:

- Put in new lab pack - 24/12

---

**MATERIAL CODES:**

- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicone
- T = Teflon
- O = Other

**TUBING OR MATERIAL CODE:**

- PE, PE, PE

---

### NOTES:

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (see FS 2212, SECTION 3)
   - pH: ± 0.2 units
   - Temperature: ± 0.2°C
   - Specific Conductance: ± 5%
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2210-2)
   - Turbidity: all readings ≤ 20 NTU

---

**OTHER**

- 7B-1

---

**OTHER**

- Trip blk

---

**OTHER**

- PE, PE, PE
**GROUNDWATER SAMPLING LOG**

**SITE NAME:** Side 11 Block 103  
**SITE LOCATION:** NAS JAX  
**DATE:** 5-15-16  

**WELL NO.** Emw-02  
**SAMPLE ID:** Emw-02  
**FREE PRODUCT:** Y  
**DEPTH TO PRODUCT (ft BTOC):** 5.16  
**FIELD DUPLICATE:** Y

### PURGING DATA

<table>
<thead>
<tr>
<th>WELL VOLUME PURGE:</th>
<th>1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(only fill out if applicable)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EQUIPMENT VOLUME PURGE:</th>
<th>1 EQUIPMENT VOLUME = PUMP VOLUME x (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME</th>
</tr>
</thead>
<tbody>
<tr>
<td>(only fill out if applicable)</td>
<td></td>
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</tbody>
</table>

### PURGING

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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<tbody>
<tr>
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<td>0.55</td>
<td>0.005</td>
<td>3.77</td>
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<td>1.54</td>
<td>11.7</td>
<td>Clear/ Colorless</td>
<td>10.19</td>
</tr>
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<td>1530</td>
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<td>0.95</td>
<td>0.004</td>
<td>4.20</td>
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<td>24.0</td>
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<td>Colorless</td>
<td>10.19</td>
</tr>
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<td>1540</td>
<td>0.40</td>
<td>1.35</td>
<td>0.004</td>
<td>7.13</td>
<td>5.16</td>
<td>20.0</td>
<td>2.99</td>
<td>0.12</td>
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<td>Colorless</td>
<td>9.67</td>
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<td>1.75</td>
<td>0.004</td>
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<td>5.85</td>
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<td>2.92</td>
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<td>1590</td>
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<td>3.35</td>
<td>0.004</td>
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<td>1.50</td>
<td>-35.9</td>
<td>Colorless</td>
<td>4.87</td>
</tr>
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</table>

### PURGED EQUIPMENT CODES

<table>
<thead>
<tr>
<th>Air Pump</th>
<th>Bladder Pump</th>
<th>Electric Submersible Pump</th>
<th>Peristaltic Pump</th>
<th>Other</th>
</tr>
</thead>
</table>

### SAMPLING DATA

- **SAMPLED BY (PRINT) / AFFILIATION:** [Signature]
- **PIECER(S) SIGNATURE(S):** [Signature]
- **SAMPLE TIME:** 16:15
- **FILTER SIZE:** __µm
- **FIELD FILTERED:** Y N
- **TUBING INSIDE DIAM. CAPACITY (gal):** 21
- **FIELD DECONTAMINATION:** Y
- **TUBING MATERIAL CODE:** [Code]
- **SAMPLE CONTAINER SPECIFICATION:** [Code]
- **TUBING Y (Replaced):** [Code]
- **FIELD EQUIPMENT IDENTIFICATION:** [Code]

### NOTES

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. Stabilization Criteria for Range of Variation of Last Three Consecutive Readings (See FS 2212, Section 3)
   - pH: ±0.2 units
   - Temperature: ±0.2 °C
   - Specific Conductance: ±5% Dissolved Oxygen: all readings ≤ 50 saturation (see Table FS 2200-2); optionally, ±0.2 mg/L; or ±10% (whichever is greater)
   - Turbidity: all readings ≤ 20 NTU; optionally ±5 NTU or ±10% (whichever is greater)

- Well needs repair: ☐
- Well needs tag: ☐
- Locking cap: ☐
- Other comment: ☐

### MATERIAL CODES

- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicone
- T = Teflon
- O = Other (Specify)

### SAMPLING EQUIPMENT CODES

- APP = After Peristaltic Pump
- B = Baller
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- RPPP = Reverse Flow Peristaltic Pump
- SM = Straw Method (Tubing Gravity Drain)
- O = Other (Specify)

---

**REMARKS:**

- PE 250 mL, HNO3, FE+6, Mg, Cu
- PE 250 mL, HNO3, Fe+3
- PE 1 L, HNO3, Cu+2

---

**20141102**
### GROUNDWATER SAMPLING LOG

**SYSTEM ON** | **SYSTEM OFF** | **NOT APPLICABLE (NO SYSTEM)**
---|---|---

<table>
<thead>
<tr>
<th>SITE NAME:</th>
<th>SITE LOCATION:</th>
<th>DATE:</th>
</tr>
</thead>
</table>

**WELL NO:** EKAW-02 | **SAMPLE ID:** EKAW-02 | **FREE PRODUCT:** Y | **DEPTH TO PRODUCT (ft BTD):** N | **FIELD DUPLICATE:** Y | **DEPTH:** N |

#### PURGING DATA

- **WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY (only fill out if applicable)
- **EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME (only fill out if applicable)

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BTD)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color/ Odor (describe)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9/4/16</td>
<td>6.40</td>
<td>0.40</td>
<td>4.15</td>
<td>0.040</td>
<td>1.4</td>
<td>3.93</td>
<td>26.3</td>
<td>2.90</td>
<td>0.10</td>
<td>1.80</td>
<td>-34.7</td>
<td>n</td>
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</tbody>
</table>

**WELL CAPACITY (gal/ft):** 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88

**TUBING INSIDE DIA. CAPACITY (gal/ft):** 1/8" = 0.0005; 1/16" = 0.00025; 1/8" = 0.0004; 3/8" = 0.0005; 1/2" = 0.001; 5/8" = 0.0015

**PURGING EQUIPMENT CODES:** B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

#### SAMPLING DATA

- **SAMPLED BY (PRINT) / AFFILIATION:**
- **SAMPLER(S) SIGNATURE(S):**
- **SAMPLE TIME:**

<table>
<thead>
<tr>
<th>PUMP OR TUBING DEPTH IN WELL (feet):</th>
<th>TUBING MATERIAL CODE:</th>
<th>FIELD-FILTERED Y N</th>
<th>FILTER SIZE: ____μm</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>FIELD DECONTAMINATION:</th>
<th>PUMP Y N</th>
<th>TUBING Y N (replaced)</th>
<th>FIELD EQUIPMENT IDENTIFICATION</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>SAMPLE CONTAINER SPECIFICATION</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE:</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute):</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>H2O QUALITY PARAMETER</th>
<th>Model:</th>
<th>SN#:</th>
</tr>
</thead>
</table>

| Turbidimeter |
| --- | --- |

| OTHER |

#### REMARKS:

- **MATERIAL CODES:** AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)
- **SAMPLING EQUIPMENT CODES:** APP = AFTER Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; RPP = Reverse flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

**NOTES:**

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. **STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 952, SECTION 3)**
   - pH ± 0.2 units
   - Temperature ± 0.2°C
   - Specific Conductance ± 5%
   - Dissolved Oxygen: all readings ± 20% saturation (see Table FS 2202-2); optionally, ± 0.2mg/L or ± 10% (whichever is greater)
   - Turbidity: all readings ± 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

- Well needs repair
- Needs well tag
- Locking cap
- Other comment

- Water Lot #
- MS / MSD
- Equip blk
- Ambient blk
- Trip blk

2012_1102
# GROUNDWATER SAMPLING LOG

**WELL NO:** EK-MW-03  
**SAMPLE ID:** EK-MW-03  
**FREE PRODUCT:** N  
**DEPTH TO PRODUCT (ft BNG):**  
**FIELD DUPLICATE:**  
**PURGE PUMP TYPE OR BAILER:**  

## PURGING DATA

<table>
<thead>
<tr>
<th>WELL VOLUME PURGE:</th>
<th>EQUIPMENT VOLUME PURGE:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY</td>
<td>1 EQUIPMENT VOL. = PURGE VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INITIAL PURGE OR TUBING DEPTH IN WELL (feet):</th>
<th>FINAL PURGE OR TUBING DEPTH IN WELL (feet):</th>
<th>PURGING INITIATED AT:</th>
<th>PURGING ENDED AT:</th>
<th>TOTAL VOLUME PURGED (gallons):</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>21</td>
<td>1250</td>
<td>1925</td>
<td>4.57</td>
</tr>
</tbody>
</table>

## SAMPLING DATA

- **Sampled by (Print)/Affiliation:** Tony Schmoker (Tri-Y)
- **Sampler's Signature:**
- **Sample Time:** 1/25
- **Field Filtered:** Y
- **Filter Size:**
- **Field Equipment Identification:**

<table>
<thead>
<tr>
<th>Sample Container Specification</th>
<th>Intended Analysis</th>
<th>Sample Pump Flow Rate (mL per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td># Containers</td>
<td>Material Code</td>
<td>Volume</td>
</tr>
<tr>
<td>2</td>
<td>CA</td>
<td>40 mL</td>
</tr>
<tr>
<td>2</td>
<td>AC</td>
<td>40 mL</td>
</tr>
<tr>
<td>2</td>
<td>CG</td>
<td>40 mL</td>
</tr>
<tr>
<td>1</td>
<td>PE</td>
<td>25 mL</td>
</tr>
</tbody>
</table>

## Notes:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. Stabilization Criteria: Per Range of Variation of Last Three Consecutive Readings (See FS 2212, Section 1)
   - pH: ± 0.2 units
   - Temperature: ± 0.2°C
   - Specific Conductance: ± 5%
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2212-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)

### Remarks:
- Water type: DI Water
- Comments on equipment:

**Material Codes:**
- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicone
- T = Teflon
- O = Other (Specify)

**Sampling Equipment Codes:**
- APP = After Peristaltic Pump
- B = Bailer
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- RFP = Reverse Flow Peristaltic Pump
- SM = Straw Method (Tubing Gravity Drainage)
- O = Other (Specify)

**Field Equipment Identification:**
- Model: UBE SN#: A102211
- Turbidity SN#: L224-016
- Other

**Other:**
- Well needs repair
- Well needs well lag
- Locking cap
- Other comments
# GROUNDWATER SAMPLING LOG

**SITE NAME:**

**SITE LOCATION:**

**WELL NO:** Ekmiw-03  
**SAMPLE ID:**  
**FREE PRODUCT:** X  
**DEPTH TO PRODUCTS:**  
**FIELD DUPLICATE:** Y  
**DUPLICATE ID:** N

---

## PURGING DATA

**WELL DIAMETER (inches):**  
**TUBING DIAMETER (inches):**  
**WELL SCREEN INTERVAL (feet):**  
**STATIC DEPTH (feet):**  
**TO WATER (feet):**  
**PURGE PUMP TYPE:** O RIALER

---

### WELL VOLUME PURGE:

<table>
<thead>
<tr>
<th>Volume</th>
<th>Cum. Volume</th>
<th>Purge Rate</th>
<th>Depth to Water</th>
<th>pH</th>
<th>Temp (°C)</th>
<th>Spec. Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (‰)</th>
<th>ORP (mV)</th>
<th>Color/Odor</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1420</td>
<td>0.22</td>
<td>4.35</td>
<td>0.45</td>
<td>5.58</td>
<td>24.6</td>
<td>0.09</td>
<td>1.54</td>
<td>-4.3</td>
<td>3.54</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1425</td>
<td>0.22</td>
<td>4.57</td>
<td>0.46</td>
<td>5.58</td>
<td>26.6</td>
<td>0.05</td>
<td>1.53</td>
<td>-4.5</td>
<td>3.71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### EQUIPMENT VOLUME PURGE:

- **PUMP VOLUME:**  
- **TUBING CAPACITY:**  
- **PURGE CAPACITY:**  

---

**INITIAL PUMP OR TUBING DEPTH IN WELL (feet):**  
**FINAL PUMP OR TUBING DEPTH IN WELL (feet):**  
**PURGING INITIATED AT:**  
**PURGING ENDED AT:**  
**TOTAL VOLUME PURGED (gallons):**

---

**WELL CAPACITY (gal/ft):** 0.75  
**TUBING INSIDE DIA. CAPACITY (gal/ft):** 1/8 = 0.008  
**DRIED ADJUSTMENT (gallons):**  
**PURGING EQUIPMENT CODES:** B = Baller; BP = Bladder Pump; FSP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

---

### SAMPLING DATA

**SAMPLED BY (PRINT) / AFFILIATION:**  
**SAMPLER(S) SIGNATURE(S):**  
**SAMPLE TIME:**  
**PUMP OR TUBING DEPTH IN WELL (feet):**  
**TUBING MATERIAL CODE:**  
**FILTERED:** Y  
**FILTER SIZE:**  
**FIELD EQUIPMENT TYPE:**

### FIELD DECONTAMINATION

**SAMPLE CONTAINER SPECIFICATION**

<table>
<thead>
<tr>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS</th>
<th>ANOTHER METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
<th>H2O QUALITY PARAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### REMARKS

**MATERIAL CODES:** AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

**SAMPLING EQUIPMENT CODES:** APP = After Peristaltic Pump; B = Baller; BP = Bladder Pump; FSP = Electric Submersible Pump; RPFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

**NOTES:**

1. The above do not constitute all of the information required by Chapter 62-150, F.A.C.
2. STABILIZATION CRITERIA FOR RADIUS OF VARIATION OF LAST THREE CONSECUTIVE READINGS (see FS 2212, section 3).
   
   **pH:** ± 0.2 units  
   **Temperature:** ± 0.2°C  
   **Specific Conductance:** ± 5%  
   **Dissolved Oxygen:**  
   **Salinity:** ± 5 NTU, optional ± 5 NTU or ± 10% whichever is greater  
   **Turbidity:** all readings ≤ 20 NTU, optional ± 5 NTU or ± 10% whichever is greater

---

**2012_1102**
# GROUNDWATER SAMPLING LOG

## PURGING DATA

<table>
<thead>
<tr>
<th>WELL NO.</th>
<th>SAMPLE ID.</th>
<th>SITE LOCATION</th>
<th>FREE PRODUCT</th>
<th>DEPTH TO PRODUCT (ft BTOC)</th>
<th>FIELD DUPLICATE</th>
<th>DUPLICATE ID.</th>
</tr>
</thead>
<tbody>
<tr>
<td>EK-KW-04</td>
<td>EK-KW-04</td>
<td>JACKSONVILLE FL</td>
<td>Y</td>
<td></td>
<td>Y</td>
<td></td>
</tr>
</tbody>
</table>

## PURGE PUMP TYPE OR BAILER

- **WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) \* WELL CAPACITY
- **EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOL = PUMP VOLUME + (TUBING CAPACITY \* TUBING LENGTH) + FLOW CELL VOLUME

### PURGING DATA

<table>
<thead>
<tr>
<th>Time</th>
<th>GALLONS PURGED (Applicable)</th>
<th>Cum. GALLONS PURGED (gallons)</th>
<th>PURGE RATE (gpm)</th>
<th>DEPTH TO WATER (ft BTOC)</th>
<th>pH (SU)</th>
<th>TEMP. (°C)</th>
<th>SPEC. COND. (gr/scm)</th>
<th>DISSOLVED OXYGEN (mg/l)</th>
<th>SALINITY (‰)</th>
<th>ORP (mV)</th>
<th>COLOR/ODOR (describe)</th>
<th>TURBIDITY (NTUs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>120s</td>
<td>0.15</td>
<td>0.30</td>
<td>1.25</td>
<td>19.5</td>
<td>6.35</td>
<td>26.2</td>
<td>9.02</td>
<td>0.91</td>
<td>0.44</td>
<td>89.1</td>
<td>CLEAR, NO ODOUR</td>
<td>23.0</td>
</tr>
<tr>
<td>300s</td>
<td>0.50</td>
<td>1.80</td>
<td>2.50</td>
<td>25.8</td>
<td>6.12</td>
<td>26.1</td>
<td>14.0</td>
<td>1.23</td>
<td>0.83</td>
<td>9.7</td>
<td>CLEAR, NO ODOUR</td>
<td>12.6</td>
</tr>
<tr>
<td>600s</td>
<td>0.50</td>
<td>2.30</td>
<td>2.50</td>
<td>25.8</td>
<td>5.91</td>
<td>26.8</td>
<td>14.0</td>
<td>1.23</td>
<td>0.83</td>
<td>9.7</td>
<td>CLEAR, NO ODOUR</td>
<td>12.6</td>
</tr>
<tr>
<td>900s</td>
<td>1.00</td>
<td>3.30</td>
<td>2.50</td>
<td>25.8</td>
<td>5.91</td>
<td>26.8</td>
<td>14.0</td>
<td>1.23</td>
<td>0.83</td>
<td>9.7</td>
<td>CLEAR, NO ODOUR</td>
<td>12.6</td>
</tr>
<tr>
<td>1200s</td>
<td>1.00</td>
<td>4.30</td>
<td>2.50</td>
<td>25.8</td>
<td>5.91</td>
<td>26.8</td>
<td>14.0</td>
<td>1.23</td>
<td>0.83</td>
<td>9.7</td>
<td>CLEAR, NO ODOUR</td>
<td>12.6</td>
</tr>
</tbody>
</table>

## WELL CAPACITY (gall/h): 0.75 = 0.02; 1 = 0.04; 1.25 = 0.06; 2 = 0.16; 3 = 0.37; 4 = 0.68; 5 = 1.02; 6 = 1.47; 12 = 5.88

**TUBING INSIDE DIA. CAPACITY (gall/h):** 1/8" = 0.0008; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016

## PURGING EQUIPMENT CODES:

- B = Bailier;
- BP = Bladder Pump;
- ESP = Electric Submersible Pump;
- PP = Peristaltic Pump;
- O = Other (Specify)

## SAMPLING DATA

<table>
<thead>
<tr>
<th>SAMPLED BY (PRINT) / AFFILIATION:</th>
<th>SAMPLE TIME: (14:30)</th>
<th>SAMPLED FROM (WHO):</th>
<th>TUBING MATERIAL CODE:</th>
<th>FIELD-FILTERED:</th>
<th>FILTER SIZE:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>ABC</td>
<td>Y</td>
<td>0.10</td>
</tr>
</tbody>
</table>

## FIELD DECONTAMINATION:

- **TUBING Y**: N
- **TUBING Y (replaced)**: 28

## FIELD EQUIPMENT IDENTIFICATION

<table>
<thead>
<tr>
<th>SAMPLE CONTAINER SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>MATERIAL CODE</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
</tbody>
</table>

## REMARKS:

- ADDITIONAL ANALYSIS ON REQUEST

## MATERIAL CODES:

- AG = Amber Glass;
- CG = Clear Glass;
- PE = Polyethylene;
- PP = Polypropylene;
- S = Silicone;
- T = Teflon;
- O = Other (Specify)

## SAMPLING EQUIPMENT CODES:

- APP = After Peristaltic Pump;
- B = Bailier;
- BP = Bladder Pump;
- ESP = Electric Submersible Pump;
- RFP = Reverse Flow Peristaltic Pump;
- SM = Straw Method (Tubing Gravity Drain);
- O = Other (Specify)

## NOTES:

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C. After Peristaltic Pump;
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)

### pH:
- ± 0.2 units

### Temperature:
- ± 0.2°C

### Conductivity:
- ± 5%

### Dissolved Oxygen:
- All readings ≤ 20% saturation

### Turbidity:
- All readings ≤ 20 NTU

### ORP (mV):
- ± 10% (whichever is greater)

**Di Water Lot #:**

- □ Yes
- □ No

**Other comments:**

2012_1102

2012_1102
# GROUNDWATER SAMPLING LOG

## PURGING DATA

**WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

*(only fill out if applicable)*

**EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOLUME = TUBING VOLUME x TUBING CAPACITY x TUBING LENGTH x FLOW CELL VOLUME

*(only fill out if applicable)*

### SAMPLING DATA

**SAMPLED BY (PRINT) / AFFILIATION:**

**SAMPLE (S) SIGNATURE:**

**SAMPLE TIME:**

**PUMP OR TUBING DEPTH IN WELL (feet):**

**TUBING MATERIAL CODE:**

**FIELD-FILTERED:**

**FILTER SIZE:**

**FIELD DECONTOAMINATION:**

**FIELD EQUIPMENT IDENTIFICATION:**

### SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
<th>H2O QUALITY PARAMETER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**REMARKS:**

**ADDITIONAL ANALYSIS CAN BE REQUESTED**

**MATERIAL CODES:**

- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicone
- T = Teflon
- O = Other (Specify)

**SAMPLING EQUIPMENT CODES:**

- APP = After Peristaltic Pump
- B = Bailer
- BP = Bladder Pump
- ES = Electric Submersible Pump
- PP = Peristaltic Pump
- O = Other (Specify)

**NOTES:**

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (see FS 2212, SECTION 3):
   - pH: ±0.2 units
   - Temperature: ±0.2°C
   - Specific Conductance: ±5% Dissolved Oxygen: all readings ±20% saturation (see Table FS 2200-2), optionally ±0.2 mg/L or ±10% ( whichever is greater)
   - Turbidity: all readings ±20 NTU, optionally ±5 NTU or ±10% ( whichever is greater)

**Well needs repair**

**Needs well tag**

**Locking cap**

**Other comment**

**DI Water Lot #**

**MS / MSD**

**Equip blk**

**Ambient blk**

**Trip blk**

2012_1102
# GROUNDWATER SAMPLING LOG

**SITE:**
- **NAME:** JACKSONVILLE FL
- **SAMPLE ID:**
- **FREE PRODUCT:** Y (NO)
- **DEPTH TO PRODUCT (ft BTDC):** NA
- **FIELD DUPLICATE:** Y (NO)

## PURGING DATA

**WELL DIAMETER (inches):** 2
**TUBING DIAMETER (inches):** 0.25 x 0.11
**WELL SCREEN INTERVAL:** 13 feet to 13 feet
**STATIC DEPTH TO WATER (feet):** 4.70
**PURGE PUMP TYPE**: Pressure Pump

**WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

**EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOLUME = PURGE VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

**INITIAL PUMP OR TUBING DEPTH IN WELL (feet):** 21
**FINAL PUMP OR TUBING DEPTH IN WELL (feet):** 21
**PURGING INITIATED AT:** 10:05
**PURGING ENDED AT:** 10:36
**TOTAL VOLUME PURGED (gallons):** 4.5

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BTDC)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (μS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (ppm)</th>
<th>ORP (mV)</th>
<th>Color/odor (describe)</th>
<th>Turbidity (NTUs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:05</td>
<td>0.50</td>
<td>0.50</td>
<td>200</td>
<td>1.66</td>
<td>6.62</td>
<td>24.1</td>
<td>6126</td>
<td>1.13</td>
<td>3.48</td>
<td>-42.5</td>
<td>321</td>
<td>321</td>
</tr>
<tr>
<td>10:10</td>
<td>0.50</td>
<td>1.00</td>
<td>200</td>
<td>1.70</td>
<td>6.41</td>
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<td>5350</td>
<td>4.50</td>
<td>4.35</td>
<td>-92.6</td>
<td>435</td>
<td>435</td>
</tr>
<tr>
<td>10:15</td>
<td>0.45</td>
<td>1.45</td>
<td>200</td>
<td>1.60</td>
<td>6.46</td>
<td>24.3</td>
<td>8019</td>
<td>6.01</td>
<td>4.43</td>
<td>-95.1</td>
<td>49.0</td>
<td>49.0</td>
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<tr>
<td>10:20</td>
<td>0.25</td>
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<td>205</td>
<td>1.70</td>
<td>6.40</td>
<td>24.6</td>
<td>7240</td>
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<td>-11.0</td>
<td>23.0</td>
<td>23.0</td>
</tr>
<tr>
<td>10:25</td>
<td>0.50</td>
<td>2.20</td>
<td>200</td>
<td>2.16</td>
<td>6.38</td>
<td>24.6</td>
<td>6499</td>
<td>1.90</td>
<td>2.34</td>
<td>-19.1</td>
<td>665</td>
<td>665</td>
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<tr>
<td>10:30</td>
<td>0.50</td>
<td>2.50</td>
<td>200</td>
<td>2.81</td>
<td>6.23</td>
<td>24.8</td>
<td>5040</td>
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</table>

**WELL CAPACITY (gal/hr):** 0.75 = 0.02; 1" = 0.04; 1.25 = 0.06; 2" = 0.10; 3" = 0.37; 4" = 0.65; 5" = 1.00; 6" = 1.47; 12" = 5.88
**TUBING INSIDE DIA. CAPACITY (gallons):** 1/8" = 0.0008; 1/4" = 0.0026; 1/2" = 0.0090; 1/2" = 0.010; 1/2" = 0.016

**PURGING EQUIPMENT CODES:**
- B = Bailier
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- PP = Peristaltic Pump
- O = Other (Specify)

**SAMPLED BY (PRINT):**
- **AFFILIATION:**

**SAMPLER(S) SIGNATURE(S):**

**PUMP OR TUBING DEPTH IN WELL (feet):** 21.0
**TUBING MATERIAL CODE:***
**FIELD-FILTERED:**
**FILTER SIZE:** __µm

**FIELD DECONTAMINATION:**
- **PUMP:** Y
- **TUBING:** Y

**FIELD EQUIPMENT IDENTIFICATION:**

### SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE DUMP FLOW RATE (ml per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>CG</td>
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<td>-</td>
<td>Nocad A</td>
<td>App</td>
<td>2.00</td>
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<tr>
<td>2</td>
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<td>30 mL</td>
<td>Toc</td>
<td>NaNO3, Cl</td>
<td>BLW</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>CG</td>
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<td>DCL</td>
<td>NaOH, Cl</td>
<td>BLW</td>
<td>0.00</td>
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**REMARKS:**
- Additional analyses are general USE - LIMIT TIME 2 hours ahead, need additional USE - All specimens analyzed twice use F-test

**MATERIAL CODES:**
- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicone
- T = Teflon
- O = Other (Specify)

**SAMPLING EQUIPMENT CODES:**
- APP = After Peristaltic Pump
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- FPP = Reverse Flow Peristaltic Pump
- SM = Straw Method (Tubing Gravity Drain)

**NOTES:**
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. Stabilization Criteria for Range of Variation of Last Three Consecutive Readings (See FS 2212, Section 3)
   - pH: ± 0.2 units
   - Temperature: ± 0.2°C
   - Conductance: ± 1%
   - Dissolved Oxygen: All readings ± 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)
   - Turbidity: All readings ± 2 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

- □ well needs repair
- □ needs well tag
- □ looking cap
- □ other comment
- □ Di Water Lot #
- □ MS / MSD
- □ Equip blk
- □ Ambient blk
- □ Trip blk TB-1

2012_1102
<table>
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<tr>
<th>Container</th>
<th>Nat. Conc.</th>
<th>Volume</th>
<th>Preservative</th>
<th>Analysis</th>
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<th>Flow Rate</th>
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<td>-</td>
<td>Remade</td>
<td>7.0</td>
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<tr>
<td>1x IODIDE</td>
<td>20x</td>
<td>200mL</td>
<td>-</td>
<td>IODINE</td>
<td>7.0</td>
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<td>2x VFA</td>
<td>20x</td>
<td>40mL</td>
<td>-</td>
<td>VFA</td>
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<td>1L</td>
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# GROUNDWATER SAMPLING LOG

**SITE NAME:** Ekmw-09  **SAMPLE ID:** Ekmw-09  **FREE PRODUCT:** Y  **DEPTH TO PRODUCT (ft BTGC):**  
**FIELD DUPLICATE:** Y  **DUPLICATE ID:**  

## PURGING DATA

- **WELL DIAMETER (inches):** 2  
- **TUBING DIAMETER (inches):** 1/4  
- **WELL SCREEN INTERVAL:** 36 feet to 23 feet  
- **STATIC DEPTH TO WATER:** 6.09 feet  
- **PURGE PUMP TYPE OR BAILER:** PP  

**WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) x WELL CAPACITY  

**EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOLUME = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME  

**INITIAL PUMP OR TUBING DEPTH IN WELL (feet):** 21  
**FINAL PUMP OR TUBING DEPTH IN WELL (feet):** 21  
**PURGING INITIATED AT:** 3-16-16  
**PURGING ENDED AT:** 3-16-16  
**TOTAL VOLUME PURGED (gallons):** 4.10  

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BTGC)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color/Color (describe)</th>
<th>Turbidity (NTUs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00</td>
<td>0.50</td>
<td>0.50</td>
<td>8.47</td>
<td>2.94 25.3</td>
<td>7.09</td>
<td>2.90</td>
<td>3.99</td>
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<td>12.8</td>
<td>-</td>
<td>Deceased</td>
<td>12.8</td>
</tr>
<tr>
<td>0:05</td>
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<td>1.00</td>
<td>10.42</td>
<td>3.02 25.4</td>
<td>7.20</td>
<td>2.62</td>
<td>4.27</td>
<td>332.1</td>
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<td>-</td>
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</tr>
<tr>
<td>0:10</td>
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<td>12.19</td>
<td>3.15 26.7</td>
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<td>-</td>
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<td>3.29</td>
<td>4.73</td>
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<td>-</td>
<td>Deceased</td>
<td>8.99</td>
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<td>3.67</td>
<td>4.89</td>
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<td>11.0</td>
<td>-</td>
<td>Deceased</td>
<td>11.0</td>
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<tr>
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<td>3.48</td>
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<td>-</td>
<td>Deceased</td>
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<tr>
<td>0:30</td>
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<td>2.90</td>
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<tr>
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<td>207.7</td>
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**WELL CAPACITY (gallons):** 0.75% = 0.02; 1.0% = 0.04; 1.25% = 0.06; 2.0% = 0.16; 3.0% = 0.37; 4.0% = 0.65; 5.0% = 1.02; 6.0% = 1.47; 12.0% = 5.88  
**TUBING INSIDE DIAM. CAPACITY (gallons):** 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/32" = 0.0044; 3/16" = 0.006; 1/8" = 0.010; 5/32" = 0.019  

**PURGING EQUIPMENT CODES:**  B = Bailer  
BP = Bladder Pump  
ESP = Electric Submersible Pump  
PP = Peristaltic Pump  
O = Other (Specify)  

### SAMPLING DATA

**SAMPLED BY (PRINT)/AFFILIATION:** Tony Schwamber (Francy)  
**SAMPLED BY (SIGNATURE):** PE  
**SAMPLE TIME:** 12:05  
**FIELD-FILTERED:** Y  
**FILTER SIZE:**  
**FIELD DECONTAMINATION:** PUMP Y  
**FIELD EQUIPMENT IDENTIFICATION:** PE  
**TUBING (Replaced):** PE  

### SAMPLE CONTAINER SPECIFICATION

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<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP RATE (mL per minute)</th>
<th>H20 QUALITY PARAMETER</th>
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<td>CG</td>
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</table>

**REMARKS:**

**MATERIAL CODES:**  AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)  

**SAMPLING EQUIPMENT CODES:**  APP = After Peristaltic Pump  
BP = Bailer  
ESP = Electric Submersible Pump  
RFP = Reverse Flow Peristaltic Pump  
SM = Straw Method (Tubing Gravity Drain)  
O = Other (Specify)  

### NOTES:

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.  
2. STABILIZATION CRITERIA: FOR RANGE OF VARIANCE OF LAST THREE CONSECUTIVE READINGS (see FS 2212, SECTION 3)
   - pH: ± 0.5 units
   - Temperature: ± 0.2°C
   - Specific Conductance: ± 5%  
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2212-2); optionally, ≤ 0.2 mg/L, or ≤ 10% (whichever is greater)
   - Turbidity: all readings ≤ 20 NTU; optionally ≤ 5 NTU or ≤ 10% (whichever is greater)

**Other:**
- Water Lot #: PE 200 Ml HNO3  
- MS / MSD:  
- Equip bilk: PE 200 Ml Non-Ind.  
- Ambient bilk: PE 200 Ml non-Indo  
- Trip bilk:  

2017-11-02
## GROUNDWATER SAMPLING LOG

**SITE NAME:** ERMW-10  
**SAMPLE ID:** ERMW-10  
**WELL NO:** ERMW-10  
**FREE PRODUCT:** Y  
**DEPTH TO PRODUCT (ft BTOC):**  
**DATE:** 3.16.16  
**FIELD DUPLICATE:** Y  
**DUPLICATE ID:**  

### PURGING DATA

|-------------------------|---|---------------------------|-----|-----------------------------|----|-------------------------------|------|-----------------------------|----|

**WELL VOLUME PURGE:** 

\[
\text{VOL} = \left( \frac{\text{TOTAL WELL DEPTH}}{\text{STATIC DEPTH TO WATER}} \right) \times \text{WELL CAPACITY}
\]

(only fill out if applicable)

**EQUIPMENT VOLUME PURGE:** 

\[
\text{EQUIP VOL} = \text{VOL} \times \left( \frac{\text{TUBING CAPACITY}}{\text{TUBING LENGTH}} \right) \times \text{FLOW CELL VOLUME}
\]

(only fill out if applicable)

### PURGING DATA

<table>
<thead>
<tr>
<th>Time (h)</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Vol. Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BTOC)</th>
<th>Temp. (°C)</th>
<th>pH (SI)</th>
<th>Spec Cond. (mg/L)</th>
<th>DO (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color/Color (describe)</th>
<th>Turbidity (NTUs)</th>
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<td>-</td>
</tr>
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<td>0900</td>
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<td>0.03</td>
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<td>2.73</td>
<td>1.56</td>
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<td>-</td>
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<td>0.03</td>
<td>9.90</td>
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<td>2.99</td>
<td>2.73</td>
<td>1.56</td>
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<td>-</td>
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<td>2.73</td>
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### SAMPLING DATA

**SAMPLED BY (PRINT)/AFFILIATION:** Tony Schmuer (Trinity)  
**SAMPLE(S) SIGNATURE:**  
**SAMPLE TIME:** 2009-04-05  
**PUMP OR TUBING DEPTH IN WELL (feet):** 21  
**TUBING MATERIAL CODE:** E  
**FIELD FILTERED:** Y  
**FILTER SIZE:** 300 um  
**FIELD DECONTAMINATION:** PUMP Y N  
**TUBING Y N (replaced):**  
**FIELD EQUIPMENT IDENTIFICATION:**  

### SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (ml/min)</th>
<th>H2O QUALITY PARAMETER</th>
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<td>None</td>
<td>APP</td>
<td>&lt;200</td>
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</tr>
<tr>
<td>1</td>
<td>PE</td>
<td>20 ml</td>
<td>None</td>
<td>None</td>
<td>APP</td>
<td>&lt;200</td>
<td></td>
</tr>
</tbody>
</table>

### NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA: FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (See FS 2212, SECTION 3)
   - pH: ± 0.2 units
   - Temperature: ± 0.2°C
   - Specific Conductance: ± 5% of conductivity reading
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2220-2); optionally, ±2 mg/L, or ±10% (whichever is greater)
   - Turbidity: all readings ≤ 0.0 NTU, optionally ≤ 0.1 NTU or ≤ 10% (whichever is greater)

### REMARKS:
- well needs repair
- needs well tag
- locking cap:
- other comment:

### MATERIAL CODES:
- AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

### SAMPLING EQUIPMENT CODES:
- APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; RFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)
# GROUNDWATER SAMPLING LOG

## PURGING DATA

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BTDC)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color / Odor (describe)</th>
<th>Turbidity (NTUs)</th>
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<tr>
<td>0835</td>
<td>0.15</td>
<td>3.85</td>
<td>0.03</td>
<td>9.60</td>
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<td>24.5</td>
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<td>1.34</td>
<td>-5.2</td>
<td></td>
<td>12.1</td>
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<td>-6.9</td>
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<td>12.4</td>
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</table>

**WELL CAPACITY** (gallons): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88
**TUBING INSIDE DIAMETER CAPACITY** (gallons): 1/8" = 0.0009; 3/16" = 0.0014; 1/4" = 0.0026; 5/32" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016

**PURGING EQUIPMENT CODES:**
- B = Bailer
- BP = Bladder Pump
- ES = Electric Submersible Pump
- PP = Peristaltic Pump
- O = Other (Specify)

**SAMPLED BY (PRINT) / AFFILIATION:**

**PUMP OR TUBING DEPTH IN WELL (feet):**

**FIELD DECONTAMINATION:**
- PUMP Y N
- TUBING Y N (replaced)

**FIELD EQUIPMENT IDENTIFICATION:**

**SAMPLE CONTAINER SPECIFICATION:**

**H2O QUALITY PARAMETER:**

**NOTE: 1.** The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. **STABILIZATION CRITERIA:**
   - pH: ± 0.2 units
   - Temperature: ± 0.2°C
   - Specific Conductance: ± 5%
   - Dissolved Oxygen: 10% sat (see Table FS 2201-2); optionally, ± 0.2 mg/L or < 10% (whichever is greater)
   - Turbidity: ± 0.5 NTU; optionally ± 0.2 NTU or ± 10% (whichever is greater)

**REMARKS:**

**MATERIAL CODES:**
- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicone
- T = Teflon
- O = Other (Specify)

**SAMPLING EQUIPMENT CODES:**
- APP = After Peristaltic Pump
- B = Bailer
- BP = Bladder Pump
- ES = Electric Submersible Pump
- RFP = Reverse Flow Peristaltic Pump
- SM = Straw Method (Tubing Gravity Drain)
- O = Other (Specify)

**NOTES:**

- Well needs repair
- Needs well tag
- Locking cap
- Other comment
- DI Water Lot #
- MS / MSD
- Equip blk
- Ambient blk
- Trip blk

2012_1102
## GROUNDWATER SAMPLING LOG

**SITE NAME:** W. V. A. 6K B I S D E P  
**WELL NO:** 07  
**SAMPLE ID:** 07  
**FREE PRODUCT:** Y  
**DEPTH TO PRODUCT (ft BTDC):** 4.39  
**FIELD DUPLICATE:** Y  

### PURGING DATA

<table>
<thead>
<tr>
<th>WELL DIAMETER (inches):</th>
<th>2</th>
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<tr>
<td>TUBING DIAMETER (inches):</td>
<td>0.5</td>
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<td>WELL SCREEN INTERVAL</td>
<td>DPH: 7 feet to 12 feet</td>
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<tr>
<td>STATIC DEPTH TO WATER (feet):</td>
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<tr>
<td>PURGE PUMP TYPE OR BAILER:</td>
<td>Peristaltic Pump</td>
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</table>

**WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY  
**EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOL = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME  

### PURGING INITIATED AT: 01/05  
### PURGING ENDED AT: 01/05  
### TOTAL VOLUME PURGED (gallons): 4.00

### PURGING EQUIPMENT CODES:
- **B** = Bailer  
- **BP** = Bladder Pump  
- **ESP** = Electric Submersible Pump  
- **PP** = Peristaltic Pump  
- **O** = Other (Specify)

### SAMPLING DATA

**SAMPLED BY (PRINT)/AFFILIATION:**  
**SAMPLER(S) SIGNATURE(S):**  
**SAMPLE TIME:** 01/05  
**FILTER SIZE:** — µm  

### FIELD DECONTAMINATION:
- PUMP: Y  
- TUBING: N  
- (replaceable) 20  
- FIELD EQUIPMENT IDENTIFICATION:
- **H2O QUALITY PARAMETER**  
- **TURBIDIMETER**  
- **OTHER**

### SAMPLE CONTAINER SPECIFICATION

<table>
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<th>CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/or METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
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<tr>
<td>3</td>
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<td>40</td>
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<tr>
<td>1</td>
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<td>40</td>
<td>Acid</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3</td>
<td>A6</td>
<td>40</td>
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<td></td>
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</table>

### REMARKS:
- Additional Analyses on request

### MATERIAL CODES:
- **AG** = Amber Glass  
- **CG** = Clear Glass  
- **PE** = Polyethylene  
- **PP** = Polypropylene  
- **S** = Silicone  
- **T** = Teflon  
- **O** = Other (Specify)

### SAMPLING EQUIPMENT CODES:
- **APP** = After Peristaltic Pump  
- **B** = Bailer  
- **BP** = Bladder Pump  
- **ESP** = Electric Submersible Pump  
- **RPFP** = Reverse Flow Peristaltic Pump  
- **SM** = Straw Method (Tubing Gravity Drain)  
- **O** = Other (Specify)

### NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.  
2. Stabilization criteria for range of variation of last three consecutive readings (see FS 2212, section 3)
   - pH: ± 0.2 units  
   - Temperature: ± 0.2 °C  
   - Specific Conductance: ± 5%  
   - Dissolved Oxygen: ± readings < 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L, or ± 10% (whichever is greater)
   - Turbidity: all readings ≤ 20 NTU, optionally ≤ 5 NTU or ± 10% (whichever is greater)

- well needs repair  
- needs well tag  
- locking cap  
- other comment  
- Di Water Lot #  
- RS / MSD  
- Equip blk  
- Ambient blk  
- Trip blk

2012_102
<table>
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<th>Volume</th>
<th>Programming</th>
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### GROUNDWATER SAMPLING LOG

**SITE NAME:** Site II  
**SITE LOCATION:** Nassau County  
**DATE:** 3/23/2017  
**WELL NO.:** EKW-01  
**SAMPLE ID:** EKW-01  
**FREE PRODUCT:** Y  
**FIELD DUPLICATE:** Y  

#### PURGING DATA
- **WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATC DEPTH TO WATER) x WELL CAPACITY  
- **VOLUME PURGED:** = (gal/ft) x (ft)  
- **EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME  
- **INITIAL PUMP OR TUBING DEPTH IN WELL (ft):**  
- **FINAL PUMP OR TUBING DEPTH IN WELL (ft):**  
- **PURGING INITIATED AT:**  
- **PURGING ENDED AT:**  
- **TOTAL VOLUME PURGED (gallons):**  

<table>
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<tr>
<th></th>
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<tbody>
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<td>1040</td>
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<td>0.6</td>
<td>0.06</td>
<td>6.78</td>
<td>5.48</td>
<td>26.1</td>
<td>0.08</td>
<td>4.06</td>
<td>0.99</td>
<td>Clear</td>
<td>0.00</td>
</tr>
<tr>
<td>1040</td>
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<td>0.6</td>
<td>0.06</td>
<td>6.78</td>
<td>5.48</td>
<td>26.2</td>
<td>0.08</td>
<td>4.06</td>
<td>0.99</td>
<td>Clear</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**WELL CAPACITY (gal/ft): 0.75% = 0.02; 1% = 0.04; 1.25% = 0.06; 2% = 0.16; 2.5% = 0.37; 4% = 0.65; 5% = 1.2; 6% = 1.47; 12% = 5.48**

**TUBING INSIDE DIA. CAPACITY (gal/ft): 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0028; 5/32" = 0.0056; 1/2" = 0.010; 5/8" = 0.016**

**PURGING EQUIPMENT CODES:**  
- B = Blader  
- BP = Bladder Pump  
- EBP = Electric Submersible Pump  
- PP = Peristaltic Pump  
- O = Other (Specify)

### SAMPLING DATA

**SAMPLED BY (PRINT):** Daniel Bell  
**SAMPLED BY (SIGNATURE):** Daniel Bell  
**DATE:** 3/23/2017  
**SAMPLE TIME:** 11:35  
**TUBING MATERIAL CODE:** PE  
**FILTER SIZE:** —μm  
**FIELD DECONTAMINATION:** PUMP Y  
**TUBING Y (replaced):**  
**FIELD EQUIPMENT IDENTIFICATION:**  

**SAMPLE CONTAINER SPECIFICATION:**  
- **# CONTAINERS:** 2  
- **MATERIAL CODE:** Ye  
- **VOLUME (ml):** 10  
- **PRESERVATIVE USED:** None  
- **INTENDED ANALYSIS AND/OR MENTION:** NCS  
- **TUBING**  
- **Y (replaced):**  
- **TUBING**  

**SAMPLE PUMP FLOW RATE:** (ml per minute)  
- **Model:** TBD  
- **SN#:** 15101068  
- **TURBIDITY:**  

**REMARKS:**

**MATERIAL CODES:**  
- AG = Amber Glass  
- CG = Clear Glass  
- PE = Polyethylene  
- PP = Polypropylene  
- S = Silicone  
- T = Teflon  
- O = Other (Specify)

**SAMPLING EQUIPMENT CODES:**  
- APP = Air Pump  
- BP = Bladder Pump  
- EBP = Electric Submersible Pump  
- RPP = Reverse Flow Peristaltic Pump  
- SM = Straw Method (Tubing Gravity Drain)  
- O = Other (Specify)

**NOTES:**  
- The above do not constitute all of the information required by Chapter 62-160, F.A.C.
GROUNDWATER SAMPLING LOG

SITE NAME: S111  
SITE LOCATION: NAS JACKSONVILLE  
DATE: 23 March 17  
WELL NO.: EXMN-02  
SAMPLE ID: EXMN-02  
FREE PRODUCT: N  
FIELD DUPLICATE: Y  

PURGING DATA

WELL DIAMETER (inches): 2  
TUBING DIAMETER (inches): 3/16  
WELL SCREEN DEPTH (feet): 0  
STATIC DEPTH (feet): 5.34  
PURGE PUMP TYPE OR BAILER: PP  
WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH - STAT. DEPTH TO WATER) x WELL CAPACITY

INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 21  
FINAL PUMP OR TUBING DEPTH IN WELL (feet): 21  
PURGING INITIATED AT: 1200  
PURGING ENDED AT: 1310  
TOTAL VOLUME PURGED (gallons): 4.20

Initial PURGE

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purred (gallons)</th>
<th>Cumulative Volume Purred (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (BTDWC)</th>
<th>PH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec Conc (mS/m)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color</th>
<th>Odor</th>
<th>Turbidity (NTUs)</th>
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</thead>
<tbody>
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<td>-10.9</td>
<td>Color</td>
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<td>1.90</td>
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WELL CAPACITY (gallons): 0.75 = 0.02; 1.25 = 0.04; 2.5 = 0.16; 3.75 = 0.37; 4.5 = 0.65; 5 = 1.02; 6 = 1.47; 12 = 5.88
TUBING INSIDE DIAMETER CAPACITY (gallon): 1/8 = 0.0006; 3/16 = 0.0014; 1/4 = 0.0026; 5/16 = 0.0044; 3/8 = 0.0068; 1/2 = 0.010; 5/8 = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; SPF = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT): AFFILIATION: A. Haynes / Tunity  
SAMPLE(S) SIGNATURE(S):  
SAMPLE TIME: 1311  
PUMP OR TUBING DEPTH IN WELL (feet): 21  
TUBING MATERIAL CODE: PE  
FIELD-FILTERED: Y  
FILTER SIZE: (pm)  
FIELD DECONTAMINATION: PUMP Y • TUBING Y • (replaced)  
FIELD EQUIPMENT IDENTIFICATION

<table>
<thead>
<tr>
<th>SAMPLE CONTAINER SPECIFICATION</th>
<th>TUBING Y (replaced)</th>
<th>FIELD EQUIPMENT IDENTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td># CONTAINERS</td>
<td>MATERIAL CODE</td>
<td>VOLUME (mL)</td>
</tr>
<tr>
<td>1</td>
<td>PE</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>CG</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>CG</td>
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<tr>
<td>3</td>
<td>CG</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>CG</td>
<td>40</td>
</tr>
</tbody>
</table>

REMARKS: OK to sample

MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

SAMPLING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; SPF = Electric Submersible Pump; RPP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

NOTES: 1. The above does not constitute all of the information required by Chapter 62-100, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEC. FS 2212, SECTION 3)
   pH: ± 0.2 unit; Temperature: ± 0.2 °C; Specific Conductance: ± 5%; Dissolved Oxygen: ± 1.0% (whichever is greater)
   Turbidity: all readings ± 0.2 NTU; optionally ± 2 NTU or ± 10% (whichever is greater)
   □ well needs repair  □ needs well tag  □ locking cap  □ other comment
   □ DI Water Lot #  □ MS / MSD  □ Equip blk  □ Ambient blk  □ Trip blk

2012_1102
GROUNDWATER SAMPLING LOG

Site Name: Glenn 03
Site Location: NAS JAX
Date: 3/23/17

Well No: Glenn 03
Sample ID: Glenn 03
Free Product: Y
Depths to Product: 14 ft
Field Duplicate: N
Duplicated: Y

WELL VOLUME PURGE: 1
WELL VOLUME = (TOTAL WELL DEPTH x STATIC DEPTH TO WATER) x WELL CAPACITY

EQUIPMENT VOLUME PURGE: 1
EQUIPMENT VOL = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

INITIAL PUMP OR TUBING DEPTH IN WELL (feet)
FINAL PUMP OR TUBING DEPTH IN WELL (feet)
PURGING INITIATED AT
PURGING ENDED AT
TOTAL VOLUME PURGED (gallons)

Time | Volume Purged (gallons) | Cumulative Volume Purged (gallons) | Purge Rate (gpm) | Depth to Water (ft BTD) | pH | Temp (°C) | Spec Conc (mg/L) | Dissolved Oxygen (mg/L) | Salinity (‰) | ORP (mV) | Color (describe) | Color (describe) | Turbidity (NTU)
-----|-------------------------|----------------------------------|-----------------|--------------------------|----|-----------|-----------------|--------------------------|------------|--------|----------------|----------------|---------------
1140 | 0.0 | 0.0 | 0.00 | 8.06 | 5.69 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.1 | 0.1 | 0.06 | 8.04 | 5.67 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.2 | 0.2 | 0.12 | 8.00 | 5.64 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.3 | 0.3 | 0.18 | 7.95 | 5.61 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.4 | 0.4 | 0.24 | 7.90 | 5.58 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.5 | 0.5 | 0.30 | 7.85 | 5.55 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.6 | 0.6 | 0.36 | 7.80 | 5.52 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.7 | 0.7 | 0.42 | 7.75 | 5.49 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.8 | 0.8 | 0.48 | 7.70 | 5.46 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 0.9 | 0.9 | 0.54 | 7.65 | 5.43 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |
1140 | 1.0 | 1.0 | 0.60 | 7.60 | 5.40 | 25.1 | 2.88 | 0.10 | 116 | 0.2 | 8.94 | 0.2 |

WELL CAPACITY (gal/h): 0.75 = 0.02; 1.25 = 0.04; 2.0 = 0.1; 3.0 = 0.2; 4.0 = 0.3; 6.0 = 0.5; 10.0 = 0.8
TUBING INSIDE DIAM. CAPACITY (gal/h): 1/8" = 0.008; 3/16" = 0.014; 1/4" = 0.026; 5/32" = 0.05; 3/32" = 0.008; 1/8 = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLED BY PRINT/ AFFILIATION: 

SAMPLER(S)/SIGNATURE(S): 

PUMP OR TUBING DEPTH IN WELL (feet):

FIELD DECONTAMINATION: PUMP Y TUBING Y "Displaced"

FIELD EQUIPMENT IDENTIFICATION:

SAMPLE CONTAINER SPECIFICATION:

INTENDED ANALYSIS AND/OR METHOD:

SAMPLE EQUIPMENT CODE:

SAMPLE PUMP FLOW RATE (ml per minute)

120 QUALITY PARAMETER:

TURBIDIMETER

NOTES:

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STANDARIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (STF: FS 2212, SECTION 3)
   - pH: ±0.2 units
   - Temperature: ±0.2°C
   - Specific Conductance: ±5%
   - Dissolved Oxygen: all readings ≥ 20% saturation (see Table FS 2200-2); optionally, ±0.2 mg/L or ±10% (whichever is greater)

   Turbidity: all readings ≤ 20 NTU; optionally ±5 NTU or ±10% (whichever is greater)

   - well needs repair
   - needs well tag
   - locking cap
   - other comment

   - CI Water Log #
   - MS/MSD
   - Equip bk
   - Ambient bk
   - Trip bk
# Groundwater Sampling Log

**Site Name:** Site 11  
**Site Location:**  
**Free Product:** Y  
**Duplicate:** Y

---

## Purging Data

**Well:**  
**Well Diameter (inches):**  
**Tubing Diameter (inches):**  
**Well Screen Interval (feet):**  
**Static Depth to Water (feet):**  
**Purge Pump Type:**  
**Well Volume Purge:** (Total Volume) = (Well Depth - Static Depth to Water) x Well Capacity  
**Equipment Volume Purge:** (Total Volume) = Purge Volume x Tubing Capacity x Flow Cell Volume

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Pumped (gallons)</th>
<th>Cum. Volume Pumped (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BOC)</th>
<th>PH</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mg/l)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Sativity (%)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (NTUs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:15</td>
<td>0.18</td>
<td>0.43</td>
<td>0.06</td>
<td>10.88</td>
<td>5.83</td>
<td>25.8</td>
<td>0.05</td>
<td>1.00</td>
<td>48.2</td>
<td>7.02</td>
<td>-</td>
<td>-</td>
<td>0.59</td>
</tr>
<tr>
<td>0:30</td>
<td>0.18</td>
<td>0.61</td>
<td>0.06</td>
<td>10.88</td>
<td>5.89</td>
<td>25.8</td>
<td>0.05</td>
<td>1.00</td>
<td>43.0</td>
<td>8.57</td>
<td>-</td>
<td>-</td>
<td>0.59</td>
</tr>
<tr>
<td>0:45</td>
<td>0.14</td>
<td>0.75</td>
<td>0.06</td>
<td>10.88</td>
<td>5.84</td>
<td>25.8</td>
<td>0.05</td>
<td>1.00</td>
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<td>-</td>
<td>-</td>
<td>0.59</td>
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<tr>
<td>0:60</td>
<td>0.14</td>
<td>0.90</td>
<td>0.06</td>
<td>10.88</td>
<td>5.84</td>
<td>25.9</td>
<td>0.05</td>
<td>1.00</td>
<td>40.7</td>
<td>8.94</td>
<td>-</td>
<td>-</td>
<td>0.59</td>
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</tbody>
</table>

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## Sampling Data

**Sampled by:** [Signature]  
**Sampled by:** [Signature]  
**Sampled on:**  
**Sample Time:** 1304

---

<table>
<thead>
<tr>
<th>Pump or Tubing</th>
<th>Depth in Well (feet)</th>
<th>Field Filtered</th>
<th>Filter Size</th>
<th>Field Equipment Type</th>
<th>Field Equipment Identification</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Well Capacity:** (gallons) = 0.70 x 0.02; 1° x 0.04; 1.25° x 0.06; 2° x 0.16; 3° x 0.37; 4° x 0.65; 5° x 1.02; 6° x 1.47; 12° x 5.68

**Tubing Inside Diameter:** (gallons) = 0.70 x 0.02; 1° x 0.04; 1.25° x 0.06; 2° x 0.16; 3° x 0.37; 4° x 0.65; 5° x 0.89; 1/2° x 0.010; 5/8° x 0.016

---

**Notes:**
1. The above do not constitute all of the information required by Chapter 62-166, F.A.G.
2. Stabilization Criteria: For Range of Variation (or last three consecutive readings (see FS 2212, Section 3)

**pH:** ± 0.2 units  
**Temperature:** ± 0.2 °C  
**Specific Conductance:** ± 5%  
**Dissolved Oxygen:** All readings ≤ 20% saturation (see Table FS 2203-2), optionally ± 0.2 mg/l or ± 10% (whichever is greater)

**Total Dissolved Solids:** All readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

**Remarks:**

---

**Material Codes:**  
**Sampling Equipment Codes:**  
**Other:**

---

**Remarks:** Page 2/2
**GROUNDWATER SAMPLING LOG**

**SITE NAME:** Site 11  
**SITE LOCATION:** NAS JAX  
**DATE:** 3/23/17

**PURGING DATA**

- **WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY
- **EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOL. = PUMP VOLUME * (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

**INITIAL OR PUMP OR TUBING DEPTH IN WELL (feet):**

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BPTC)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:01</td>
<td>0.4</td>
<td>0.4</td>
<td>0.2</td>
<td>5.36</td>
<td>18.0</td>
<td>0.36</td>
<td>0.93</td>
<td>7.7</td>
<td>44.9</td>
<td>44.9</td>
<td>Turbine nore</td>
<td>Turbine nore</td>
<td>27.44</td>
</tr>
<tr>
<td>10:11</td>
<td>0.4</td>
<td>0.8</td>
<td>0.6</td>
<td>5.37</td>
<td>20.4</td>
<td>0.14</td>
<td>0.93</td>
<td>(44.9)</td>
<td>(44.9)</td>
<td></td>
<td>Turbine nore</td>
<td>Turbine nore</td>
<td>44.9</td>
</tr>
<tr>
<td>10:21</td>
<td>1.8</td>
<td>2.2</td>
<td>0.2</td>
<td>5.37</td>
<td>24.2</td>
<td>0.11</td>
<td>0.97</td>
<td>7.1</td>
<td>4.3</td>
<td>4.3</td>
<td>Turbine nore</td>
<td>Turbine nore</td>
<td>7.1</td>
</tr>
<tr>
<td>10:31</td>
<td>2.6</td>
<td>4.8</td>
<td>0.2</td>
<td>5.36</td>
<td>29.5</td>
<td>0.90</td>
<td>0.99</td>
<td>0.9</td>
<td>6.1</td>
<td>6.1</td>
<td>Turbine nore</td>
<td>Turbine nore</td>
<td>6.1</td>
</tr>
<tr>
<td>10:41</td>
<td>3.2</td>
<td>8.0</td>
<td>0.2</td>
<td>5.57</td>
<td>22.7</td>
<td>0.90</td>
<td>0.99</td>
<td>0.8</td>
<td>7.9</td>
<td>7.9</td>
<td>Turbine nore</td>
<td>Turbine nore</td>
<td>7.9</td>
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<td>10:51</td>
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<td>11.8</td>
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<td>0.82</td>
<td>0.8</td>
<td>8.1</td>
<td>8.1</td>
<td>Turbine nore</td>
<td>Turbine nore</td>
<td>8.1</td>
</tr>
<tr>
<td>11:01</td>
<td>5.2</td>
<td>17.0</td>
<td>0.2</td>
<td>5.57</td>
<td>22.7</td>
<td>0.82</td>
<td>0.82</td>
<td>0.8</td>
<td>8.0</td>
<td>8.0</td>
<td>Turbine nore</td>
<td>Turbine nore</td>
<td>8.0</td>
</tr>
</tbody>
</table>

**WELL CAPACITY (gal/h): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88**

**PURGING EQUIPMENT CODES:**
- **B** = Bailer;  
- **BP** = Bladder Pump;  
- **ESP** = Electric Submersible Pump;  
- **PP** = Peristaltic Pump;  
- **O** = Other (Specify)

**SAMPLE DATA**

**SAMPLED BY:**  
**AFFILIATION:**

---

**PUMP OR TUBING DEPTH IN WELL (feet):**

**TUBING MATERIAL CODE:**

**FIELD-FILTERED:**

**FILTER SIZE:**

<table>
<thead>
<tr>
<th>SAMPLE CONTAINER SPECIFICATION</th>
<th>TUBING</th>
<th>FIELD EQUIPMENT IDENTIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong># CONTAINERS</strong></td>
<td><strong>MATERIAL CODE</strong></td>
<td><strong>VOLUME (ml)</strong></td>
</tr>
<tr>
<td>2</td>
<td>CG</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>CG</td>
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<td>CG</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>AG</td>
<td>40</td>
</tr>
</tbody>
</table>

**REMARKS:**

**MATERIAL CODES:**
- **AD** = Amber Glass;  
- **CG** = Clear Glass;  
- **PE** = Polyethylene;  
- **PP** = Polypropylene;  
- **S** = Silicone;  
- **T** = Teflon;  
- **O** = Other (Specify)

**SAMPLING EQUIPMENT CODES:**
- **APP** = After Peristaltic Pump;  
- **B** = Bailer;  
- **BP** = Bladder Pump;  
- **ESP** = Electric Submersible Pump;  
- **RFP** = Reverse Flow Peristaltic Pump;  
- **SM** = Swast Method (Tubing Gravity Drain);  
- **O** = Other (Specify)

**NOTES:**
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. **STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS** (see FS 2212, SECTION 3)
   - pH: ± 0.2 units
   - Temperature: ± 0.2°C
   - Specific Conductance: ± 5% Dissolved Oxygen: all readings ± 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)
   - Turbidity: all readings ± 2 NTU, optionally ± 5 NTU or ± 10% (whichever is greater)

- well needs repair  
- needs well top  
- looking cap: y  
- other comment:  
- DI Water Lot #:  
- MS / MSD:  
- Equip blk:  
- Ambient blk:  
- Trip blk: 

---

2012_1192
# GROUNDWATER SAMPLING LOG

**SITE NAME:** Site 11  
**SITE LOCATION:** NAS Lockwood  
**DATE:** 23 Mar 2017  
**WELL NO.:** EKNW-05  
**SAMPLE ID:** EKNW-05

## PURGING DATA

| WELL DIAMETER (inches): | 2 |
| TUBING DIAMETER (inches): | 3/16 |
| WELL SCREEN INTERVAL (feet): | 0.00 |
| DEPTH: | 0.00 |
| STATIC DEPTH TO WATER (feet): | 5.29 |
| PURGE PUMP TYPE OR BAILER: | PP |

### WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

### EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

### INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 0.00

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (R TO C)</th>
<th>PH (7)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mg/l)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Salinity (‰)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>OD (describe)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>07/10/2012 0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>5.79</td>
<td>23.07</td>
<td>5.29</td>
<td>0.85</td>
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<td>27.4</td>
<td>NA</td>
<td>20.8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>23.08</td>
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<td>2.4</td>
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<tr>
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<td>0.70</td>
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</tbody>
</table>

**WELL CAPACITY (gal/ft):** 0.75 = 0.12; 1.00 = 0.04; 1.25 = 0.06; 2.00 = 0.16; 3.00 = 0.37; 4.00 = 0.65; 5.00 = 1.02; 6.00 = 1.47; 12.0 = 5.68

**TUBING INSIDE DIAM. CAPACITY (gal/ft): 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/32" = 0.0044; 3/32" = 0.006; 1/2" = 0.010; 5/8" = 0.016**

### PURGING EQUIPMENT CODES:
- B = Baller
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- PP = Peristaltic Pump
- O = Other (Specify)

## SAMPLING DATA

**SAMPLED BY (PRINT)/AFFILIATION:** A. Hawkins  
**ANALYSIS:**  
**SAMPLED BY AFFILIATION:**  
**FIELD FILTERED:** Y (O)  
**FILTER SIZE:** mm

**PUMP OR TUBING DEPTH IN WELL (feet):** 2.1  
**TUBING MATERIAL CODE:** PE  
**FIELD DECONTAMINATION:** PUMP Y (O)  
**TUBING Y (O) Replacement**  
**FIELD EQUIPMENT IDENTIFICATION:**

### SAMPLE CONTAINER SPECIFICATION:
- # CONTAINERS: 2
- MATERIAL CODE: PE
- VOLUME (mL): 11
- PRESERVATIVE USED: NGS
- INTENDED ANALYSIS AND/OR METHOD: APP
- SAMPLING EQUIPMENT CODE: NOP
- SAMPLE PUMP FLOW RATE (mL per minute): 220

### WATER QUALITY PARAMETER:
- TURBIDITY: 0.00 G2421
- OTHER: 13100C2943

## NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. **STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (ref: FS 2212, SECTION 3)**
   - pH ≥ 2.0 units: Temperature ≥ 0.2°C: Specific Conductance ≥ 5%: Dissolved Oxygen: all readings ≥ 20% saturation (see Table FS 2200-2); optionally, ≥ 2.0 mg/L or ≥ 10% (whichever is greater)
   - Turbidity: all readings ≥ 2 NTU: optionally ≥ 5 NTU or ≥ 10% (whichever is greater)

## REMARKS:
- Water depth repair: __________
- Needs well tag: __________
- Locking cap: __________
- Other comment: __________
- Di Water Lot #: __________
- MS / MSD: __________
- Equip bik: __________
- Ambient bick: __________
- Trip bick: __________
GROUNDWATER SAMPLING LOG

SYSTEM ON:  D  SYSTEM OFF:  D  NOT APPLICABLE (NO SYSTEM)

SITE NAME:  Elumw-7  SAMPLE ID:  SHAH 4Elm-07  FREE PRODUCT:  Y  DEPTH TO PRODUCT (ft BTD):  0  FIELD DUPLICATE:  Y

WELL NO:  4Elm-7  SITE LOCATION:  NAS JAX  DATE:  3/13/17

PURGING DATA

WELL DIAMETER (inches):  2  TUBING DIAMETER (inches):  3/4
WELL SCREEN INTERVAL (feet):  19  TO WATER (feet):  51 1/2  PURGE PUMP TYPE OR BAILER:  PP
WELL VOLUME PURGE:  1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

EQUIPMENT VOLUME PURGE:  1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

INITIAL PUMP OR TUBING DEPTH IN WELL (feet):  0.1  FINAL PUMP OR TUBING DEPTH IN WELL (feet):  0.1
PURGING INITIATED AT:  0800  PURGING ENDED AT:  0513  TOTAL VOLUME PURGED (gallons):  7.38

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WELL CAPACITY (gallons): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.66; 5" = 1.02; 6" = 1.47; 12" = 5.88
TUBING INSIDE DIAMETER CAPACITY (gallons): 1/8" = 0.0008; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.008; 1/2" = 0.010; 5/8" = 0.016

PURGING EQUIPMENT CODES:  B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Puristatic Pump; O = Other (Specify)

SAMPLING DATA

SAMPLED BY (PRINT): JOHN BROWN  AFFILIATION: TRINITY ANALYTICS  SAMPLE(S) SIGNATURE(S):  E  FIELD FILTERED OR TUBING MATERIAL CODE:  Y  FILTER SIZE: ___μm

FIELD DECONTAMINATION:  Y  PUMP:  Y  TUBING:  Y (replaced)  FIELD EQUIPMENT IDENTIFICATION:  Y  FILTER TYPE:  Y  FILTER SIZE: ___μm

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<th>INTENDED ANALYSIS AND/or METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
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<td>PE</td>
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TURBIDITY

REMARKS:

MATERIAL CODES:  AG = Amber Glass;  CG = Clear Glass;  PE = Polyethylene;  PP = Polypropylene;  S = Silicone;  T = Teflon;  O = Other (Specify)

SAMPLING EQUIPMENT CODES:  APP = After Peristaltic Pump;  B = Bailer;  BP = Bladder Pump;  ESP = Electric Submersible Pump;  RFP = Reverse Flow Peristaltic Pump;  SM = Straw Method (Tubing Gravity Drain);  O = Other (Specify)

NOTES: 1. The above does not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (see FS 2212, SECTION 3)
   a. pH = ± 0.2 units
   b. Temperature = ± 0.2°C
   c. Specific Conductance = ± 5%
   d. Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L, or ± 10% (whichever is greater)
   e. Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

   □ well needs repair  □ needs well tag  □ locking cap  □ other comments:  □ Di Water Lot #:  □ MS / MSD:  □ Equip blk:  □ Ambient blk:  □ Trip blk: 

2012_1102
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**WELL IDENTIFICATION**

- **WELL NO.**: STCL-001
- **DATE**: 23.MAY.05
- **SITE NAME**: STCL-001
- **WP AQUIFIER**: APP 220, PE 125, PE 250

**WELL DATA**

- **WELL VOLUME PURGE**: 21 gallons
- **WELL VOLUME**: 21 gallons
- **TOTAL DEPTH**: 21 feet
- **STATIC DEPTH**: 15 feet
- **WELL CAVITY**: 5 feet
- **PURGE PUMP**: Electric Submersible Pump
- **PURGE VOLUME**: 21 gallons

**GROUNDWATER SAMPLING LOG**

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<th>SAMPLE NO.</th>
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**ANALYSIS RESULTS**

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**NOTES**

- **WELL NO.**: STCL-001
- **DATE**: 23.MAY.05
- **SITE NAME**: STCL-001
- **WP AQUIFIER**: APP 220, PE 125, PE 250

**WELL DECONVERSION**

- **WELL DECONVERSION DATE**: 2005-08-25
- **WELL DECONVERSION METHOD**: Electric Submersible Pump

**WELL DECONVERSION RESULTS**

- **WELL VOLUME PURGE**: 21 gallons
- **WELL VOLUME**: 21 gallons
- **TOTAL DEPTH**: 21 feet
- **STATIC DEPTH**: 15 feet
- **WELL CAVITY**: 5 feet

**PURGE PUMP**: Electric Submersible Pump

**PURGE VOLUME**: 21 gallons

**TOTAL PURGE VOLUME**: 21 gallons
# GROUNDWATER SAMPLING LOG

**SITE NAME:** SITE 11  
**SITE LOCATION:** NWS Jacksonville  
**DATE:** 3/23/2017

**WELL NO.:** EKM-10  
**SAMPLE ID:** EKM-10  
**FREE PRODUCT:**  
**FIELD DUPLICATE:** Y

## PURGING DATA

**WELL DIAMETER (inches):** 2  
**TUBING DIAMETER (inches):** 3/16  
**WELL SCREEN INTERVAL (feet):** 19  
**STATIC DEPTH TO WATER (feet):** 530  
**PURGE PUMP TYPE OR BALER:** P. pump

**WELL VOLUME PURGE:**  
TOTAL VOLUME (WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

**EQUIPMENT VOLUME PURGE:**  
PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

**INITIAL PUMP OR TUBING DEPTH IN WELL (feet):** 51  
**FINAL PUMP OR TUBING DEPTH IN WELL (feet):** 51  
**PURGING INITIATED AT:** 0815  
**PURGING ENDED AT:** 0930  
**TOTAL VOLUME PURGED (gallons):** 45

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<th>Time</th>
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<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BTDG)</th>
<th>pH</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (µS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (NTUs)</th>
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**WELL CAPACITY (gallons):** 0.75 = 0.02, 1.25 = 0.06, 1.5 = 0.16, 3.0 = 0.37, 4.0 = 0.55, 5.0 = 0.92, 6.0 = 1.47, 12.0 = 5.61

**TUBING INSIDE DIA. CAPACITY (gal/ft):** 1/8" = 0.0006, 3/16" = 0.0014, 1/4" = 0.0026, 5/32" = 0.0004, 1/2" = 0.016, 5/16" = 0.0020

**PURGING EQUIPMENT CODES:** B = Bailer, BP = Bladder Pump, ESP = Electric Submersible Pump, PPE = Peristaltic Pump, O = Other (Specify)

## SAMPLE DATA

**SAMPLED BY (PRINT AFFILIATION):** Daniel Beal, S.Eng.  
**SAMPLED BY (SIGNATURE):** Daniel Beal  
**TUBING MATERIAL CODE:** PE  
**FIELD FILTERED:** Y  
**FILTER SIZE:** 10 µm

**PUMP OR TUBING DEPTH IN WELL (feet):** 51

**TUBING DECONTAMINATION:** PUMP Y ⊗  
**FIELD DECONTAMINATION:** TUBING Y ⊗

**SAMPLE CONTAINER SPECIFICATION:**

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<td>678</td>
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<tr>
<td>PPE</td>
<td>200</td>
<td>413</td>
<td>678</td>
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</table>

**TURBIDOMETER:**

<table>
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<tr>
<th>MODEL</th>
<th>N 1</th>
<th>N 2</th>
<th>N 3</th>
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</thead>
<tbody>
<tr>
<td>PPE</td>
<td>200</td>
<td>413</td>
<td>678</td>
</tr>
</tbody>
</table>

**REMARKS:**

- **MATERIAL CODES:** AG = Amber Glass, CG = Clear Glass, PE = Polyethylene, PP = Polypropylene, S = Silicone, T = Teflon, O = Other (Specify)
- **SAMPLING EQUIPMENT CODES:** APP = After Peristaltic Pump, B = Bailer, BP = Bladder Pump, ESP = Electric Submersible Pump, RPP = Reverse Flow Peristaltic Pump, SM = Straw Method (Tubing Gravity Drain), O = Other (Specify)

**NOTES:**

1. The above do not constitute all the information required by Chapter 62-160, F.A.C.
2. Stabilization Criteria for Range of Variation of Last Three Consecutive Readings (See FS 2212, Section 3)
   - pH: ± 0.2 units
   - Temperature: ± 0.2 °C
   - Specific Conductance: ± 5% dissolved oxygen at readings ± 20% saturation (see Table FS 2202-2); optionally ± 0.2 mg/L ± 10% (whichever is greater)
   - Turbidity: ± 2 NTU; optionally ± 2 NTU or ± 10% (whichever is greater)
   - Sulfate: ± 10%

   □ well needs repair  □ needs well tag  □ locking cap  □ other comment

   □ DI Water Lot #  □ MS/MISC  □ Equip blk  □ Ambient blk  □ Trip blk

2012_1122
## GROUNDWATER SAMPLING LOG

- **SITE NAME:** > Site E11
- **SITE LOCATION:** > Nass, Jacksonville
- **DATE:** > 3/13/2017
- **WELL NO.:** > EK11
- **SAMPLE ID:** > EK11
- **FREE PRODUCT:** > NO
- **FIELD DUPLICATE:** > NO

### PURGING DATA

<table>
<thead>
<tr>
<th>WELL VOLUME PURGE:</th>
<th>1 WELL VOLUME = (TOTAL WELL DEPTH − STATIC DEPTH TO WATER) × WELL CAPACITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PURGE PUMP TYPE:</td>
<td>p. pump</td>
</tr>
<tr>
<td>EQUIPMENT VOLUME PURGE:</td>
<td>1 EQUIPMENT VOLUME = PUMP VOLUME × (TUBING CAPACITY × TUBING LENGTH) + FLOW CELL VOLUME</td>
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### PURGING DATA

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BTDWI)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mg/l)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (NTU)</th>
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<td>0.40</td>
<td>105.07</td>
<td>CLEAR</td>
<td>NO</td>
<td>15.8</td>
</tr>
</tbody>
</table>

### SAMPLING DATA

- **PUMP OR TUBING DEPTH IN WELL (feet):** > 10.5
- **TUBING MATERIAL CODE:** > PE
- **FIELD FILTERED:** > Y
- **FILTER SIZE:** > 0.45 μm
- **FIELD DECONTAMINATION:** > PUMP Y
- **TUBING Y (toppled):** > FIELD EQUIPMENT IDENTIFICATION

### FIELD DECONTAMINATION

<table>
<thead>
<tr>
<th>SAMPLE CONTAINER SPECIFICATION</th>
<th>PUMP</th>
<th>TUBING</th>
<th>FIELD EQUIPMENT IDENTIFICATION</th>
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<td>VOLUME (ML)</td>
<td>PRESERVATIVE USED</td>
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<tr>
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<td></td>
</tr>
<tr>
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<td>PE</td>
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</table>

### NOTES

1. The above do not constitute all of the information required by Chapter 63-160, F.A.C.
2. STABILIZATION CRITERIA: FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 22:21; SECTION 3)
   - pH: ≤ 2.0 units; Temperature: ≤ 0.2 °C; Specific Conductance: ≤ 5; Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 22:02); optionally, ≤ 0.2 mg/l or ≤ 10% (whichever is greater)
   - Turbidity: all readings ≤ 20 NTU; optionally ≤ 5 NTU or ≤ 10% (whichever is greater)

### FIELD DECONTAMINATION

- **REMARKS:**
  - Well needs repair
  - Needs well tag
  - Locking cap
  - Other comment
  - D: Water Lot #
# Groundwater Sampling Log

**Site Name:** Site II  
**Site Location:** Jacksonville  
**Date:** 6/13/17  
**Well No.:** GW426-01  
**Sample ID:** GW426-01  
**Depth to Product:** Y  
**Depth to Water:** 4.05  
**Field Duplicate:** Y  

## Purging Data

<table>
<thead>
<tr>
<th>WELL VOLUME PURGE (gallons)</th>
<th>EQUATION VOLUME PURGE (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 WELL VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME</td>
<td></td>
</tr>
<tr>
<td>(only fill if applicable)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cumulative Volume Purged (gallons)</th>
<th>Purge Rate (rpm)</th>
<th>Depth to Water (ft BGC)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (‰)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (NTU)</th>
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</thead>
<tbody>
<tr>
<td>0824</td>
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<td>0.6</td>
<td>0.6</td>
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<td>3.41</td>
<td>-161</td>
<td>Clear</td>
<td>None</td>
<td>11.1</td>
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</table>

**Well Capacity (gallons):** 0.75 = 0.02; 1.0 = 0.04; 1.25 = 0.06; 2.0 = 0.16; 3.0 = 0.37; 4.0 = 0.65; 5.0 = 1.02; 6.0 = 1.47; 12.0 = 5.68

**Wells inside D.I. Capacity (gallons):** 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/32" = 0.004; 1/2" = 0.008; 5/8" = 0.016

**Purging Equipment Codes:** B = Ballast; BP = Ballast Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

---

**Sampling Data**

**Sampled By:** [Name]  
**Print Affiliation:** [Affiliation]  
**Sampler(s) Signature:** [Signature]  
**Sample Time:** 09:25  
**Pump or Tubing Depth in Well (feet):** 21  
**Tubing Material Code:** PE  
**Field Filtered:** N  
**Field Size:** 0.1 µm  
**Field Decontamination:** Pump Y  
**Tubing Y:** Yes  
**Field Equipment Identification:**

<table>
<thead>
<tr>
<th>Sample Container Specification</th>
<th>Sample Pump Flow Rate (ml/minute)</th>
<th>H20 Quantity</th>
<th>Turbidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 YH</td>
<td>25</td>
<td>YSH</td>
<td>OTHER</td>
</tr>
<tr>
<td>5 YH</td>
<td>25</td>
<td>YSH</td>
<td>OTHER</td>
</tr>
<tr>
<td>6 YH</td>
<td>25</td>
<td>YSH</td>
<td>OTHER</td>
</tr>
</tbody>
</table>

**Material Codes:** AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicon; T = Teflon; O = Other (Specify)

**Sampling Equipment Codes:** BPL = Ballast Pump; B = Ballast; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

**Notes:**
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. Stabilization criteria for range of variation of last three consecutive readings (see PS 2212, SECTION 3)
   - pH: ± 0.2 units  
   - Temperature: ± 0.2 °C  
   - Specific Conductance: ± 5%  
   - Dissolved Oxygen: all readings ± 20% saturation (see Table FS 2200-2); optionally ± 0.2 mg/L or ± 10% (whichever is greater)
   - Turbidity: all readings ± 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

- Well needs repair —  
- Needs well tag —  
- Locking cap —  
- Other comments —
- DI water line # —  
- MS / MSD —  
- Equip bbl —  
- Ambient bbl —  
- Trip bbl —  

2 AG 40 HCl TiCl  
3 CG 40 HCl NCl  
4 CG 40 HCl Vol
### GROUNDWATER SAMPLING LOG

**SITE NAME:** SITU.11  
**WELL NO.:** EKMW-02  
**SAMPLE ID:** EKMW-02  
**FREE PRODUCT:** Y  
**FIELD DUPLICATE:** Y  
**DATE:** 12 JUN 17

#### PURGING DATA

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<th>WELL DIAMETER (inches)</th>
<th>TUBING DIAMETER (inches)</th>
<th>WELL SCREEN INTERVAL</th>
<th>DEPTH TO WATER (feet)</th>
<th>STATIC DEPTH TO WATER (feet)</th>
<th>PURGE PUMP TYPE</th>
<th>OR BAILER</th>
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**WELL VOLUME PURGE:** 1  
**EQUIPMENT VOLUME:** 1

**PURGING INITIATED AT:** 1013  
**PURGING ENDED AT:** 1123  
**TOTAL VOLUME PURGED (gallons):** 4.20

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (&quot; STOC)</th>
<th>pH (SU)</th>
<th>Temp. (°C)</th>
<th>Spec Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (‰)</th>
<th>ORP (mv)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (NTUs)</th>
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**WELL CAPACITY (gal/h):** 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.66; 5" = 1.02; 6" = 1.47; 12" = 5.86

**TUBING INSIDE DIA. CAPACITY (gal/h):** 1/8" = 0.0006; 3/16" = 0.0014; 1/4" = 0.0026; 5/16" = 0.004; 3/8" = 0.009; 1/2" = 0.010; 5/8" = 0.016

**PURGING EQUIPMENT CODES:** B = Bailer; BP = Bailer Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

### SAMPLING DATA

**SAMPLED BY:** A HAYLA  
**AFFILIATION:** TURVITY  
**TUBING(S) SIGNATURE(S):**  
**PUMP OR TUBING DEPTH IN WELL (feet):** 21

**TUBING MATERIAL CODE:** PE  
**FIELD FILTERED:** Y  
**FILTER SIZE:** 0.1 um  
**FIELD EQUIPMENT IDENTIFICATION:** 15.1.02933

**SAMPLE CONTAINER SPECIFICATION:**  
**# CONTAINERS:** 2  
**MATERIAL CODE:** CG  
**VOLUME (ml):** 40  
**DEEPING:** HC1  
**PRESERVATIVE USED:** YOC  
**TUBING:** Y  
**REMARKS:** CG  
**MATERIAL CODES:** AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

**SAMPLING EQUIPMENT CODES:** APP = After Peristaltic Pump; B = Bailer; BP = Bailer Pump; ESP = Electric Submersible Pump; RFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

**H2O QUALITY PARAMETER:**  
**Mode:** PTD/DRILL  
**TURBIDITY:** 15.1.02933

**NOTES:** 1. The above do not constitute all the information required by Chapter 62-160, F.A.C.  
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)  
   - pH: ± 0.2 units  
   - Temperature: ± 0.2 °C  
   - Conductance: ± 5%  
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)  
   - Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

**Di Water:** Lot #  
**MS / MSD:** Y  
**Equip blk:**  
**Ambient blk:**  
**Trip blk:**

---

2012_1_02
# GROUNDWATER SAMPLING LOG

## PURGING DATA

**WELL NO.** 44W04 - 03  
**SAMPLE ID:** 44W04 - 03  
**FREE PRODUCT:** Y  
**DEPTH TO PRODUCT (ft BGL):** 5.65  
**FIELD DUPLICATE:** Y  

### WELL VOLUME PURGE

**WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY**  

### EQUIPMENT VOLUME PURGE

**EQUIPMENT VOLUME PURGE = PUMP VOLUME x TUBING CAPACITY x TUBING LENGTH x FLOW CELL VOLUME**

### INITIAL PUMP OR TUBING DEPTH IN WELL (feet):

**FINAL PUMP OR TUBING DEPTH IN WELL (feet):** 21  
**PURGING INITIATED AT:** 10:17  
**PURGING ENDED AT:** 10:27  
**TOTAL VOLUME PURGED (gallons):** 4.2

### PURGING DATA

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purged (gallons)</th>
<th>Cum. Volume Purged (gallons)</th>
<th>Purge Rate (gpm)</th>
<th>Depth to Water (ft BGL)</th>
<th>pH (su)</th>
<th>Temp. (F)</th>
<th>Spec. Cond. (mS/cm)</th>
<th>Dissolved Oxygen (mg/L)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (NTU)</th>
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<tbody>
<tr>
<td>10:17</td>
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<td>0.6</td>
<td>0.06</td>
<td>5.81</td>
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<td>0.12</td>
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<td>1.47</td>
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<td>Clear</td>
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<td>9.80</td>
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</table>

**WELL CAPACITY (gal/ft): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.08; 2" = 0.16; 3" = 0.37; 4" = 0.63; 5" = 1.02; 6" = 1.47; 12" = 5.98**  

**TUBING INSIDE DIA. CAPACITY (gal/ft): 1/8" = 0.006; 3/16" = 0.008; 1/4" = 0.02; 5/16" = 0.004; 1/2" = 0.01; 5/8" = 0.016**

**PURGING EQUIPMENT CODES:**  
B = Bailier  
BP = Bladder Pump  
ESP = Electric Submersible Pump  
PP = Peristaltic Pump  O = Other

## SAMPLING DATA

**SAMPLED BY/IDENTIFICATION:** John Gorman, Trinity  
**SAMPLED BY/IDENTIFICATION:** Travis Howard, Trinity  
**SAMPLE TIME:** 11:28  
**FILTER SIZE:** 0.45 μm

### FIELD DECONTAMINATION

**FIELD DECONTAMINATION:** PUMP Y  
**TUBING**  
**REPLACED:**

### SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME (ml)</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
<th>H20 QUALITY PARAMETER (ppm)</th>
</tr>
</thead>
</table>
| 3            | LG            | 50          | VIC               | APP                            | APP                      | 7.00                                  | YSI 128d  
**SNR:** 15177  
**TURBIOMETR:** 57 39 - 0.58  
**OTHER:**

### REMARKS:

- **MATERIAL CODES:**  
  - AG = Amber Glass  
  - CD = Clear Glass  
  - PE = Polyethylene  
  - PP = Polypropylene  
  - BS = Siloxanes  
  - TL = Teflon  
  - O = Other

### SAMPLING EQUIPMENT CODES:

- APP = After Peristaltic Pump  
- B = Bailier  
- BP = Bladder Pump  
- ESP = Electric Submersible Pump  
- RFP = Reverse Flow Peristaltic Pump  
- TM = Straw Method (Tubing Gravity Drain)  
- O = Other

### NOTES:

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. **STABILIZATION CRITERIA, PER RANGE OF VARIATION OF LAST THREE CONSECUTIVE REACTIONS (see FS 2212, SECTION 9)**

   - pH: ± 0.2 units  
   - Temperature: ± 0.2 °C  
   - Specific Conductance: ± 5%  
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally ≥ 0.2 mg/L or ≤ 10% (whichever is greater)

**Turbidity:** all readings ≤ 20 NDU; optionally ± 5 NDU or ≤ 10% (whichever is greater)

- **well needs repair:**  
- **needs well tag:**  
- **locking cap:**  
- **other comment:**

- **Dil Water Lot #**  
- **MS / MSD**  
- **Equip blk**  
- **Ambient blk**  
- **Trip blk**

2012_1102
# GROUNDWATER SAMPLING LOG

## SITE INFORMATION
- **SITE NAME:** Site II
- **SITE LOCATION:** NAS JAX
- **DATE:** 6/11/2017
- **WELL NO:** 2LLMMW-04
- **SAMPLE ID:** 2LLMMW-04
- **FREE PRODUCT:** Y
- **DEPTH TO PRODUCT (ft BTD):** 1 foot
- **STATIC DEPTH TO WATER (feet):** 4.52
- **PURGE PUMP TYPE OR BAILER:** PP
- **PURGE DATA**
  - WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY
  - EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOLUME = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

## PURGING DATA

<table>
<thead>
<tr>
<th>Time</th>
<th>Volume Purg (gallons)</th>
<th>Cum. Volume Purg (gallons)</th>
<th>Purg Rate (gpm)</th>
<th>Depth to Water (ft BTD)</th>
<th>pH</th>
<th>Temp. (°C)</th>
<th>Spec. Cond. (ms/cm)</th>
<th>Dissolved Oxygen (mg/l)</th>
<th>Salinity (%)</th>
<th>ORP (mV)</th>
<th>Color (describe)</th>
<th>Odor (describe)</th>
<th>Turbidity (N/TUs)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## WEL CAPACITY (gallons): 0.75" x 0.03; 1" x 0.04; 1.5" x 0.006; 3" x 0.006; 5" x 0.065; 7" x 0.12; 12" x 0.5

## TUBING INSIDE DIA. CAPACITY (gallons): 1/8" x 0.0006; 3/16" x 0.0014; 1/4" x 0.0026; 3/8" x 0.008; 1/2" x 0.010; 5/8" x 0.016

## PURGING EQUIPMENT CODES:
- B = Bailer
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- PP = Peristaltic Pump
- O = Other (Specify)

## SAMPLING DATA

- **SAMPLED BY (PRINS):** JUNEAU TRINITY
- **SAMPLER(S) SIGNATURE(S):** JUNEAU TRINITY
- **PUMP OR TUBING DEPTH IN WELL (feet):**
- **TUBING MATERIAL CODE:** Y
- **FIELD-FILTERED:** N
- **FILTER SIZE:** 0.45 µm
- **FIELD EQUIPMENT IDENTIFICATION:**
- **SAMPLE CONTAINER SPECIFICATION:**
  - **# CONTAINERS:**
  - **MATERIAL CODE:**
  - **VOLUME (Lt):**
  - **PRESERVATIVE USED:**
- **INTENDED ANALYSIS AND/OR METHOD:**
  - **sampling EQUIPMENT CODE:**
  - **SAMPLE PUMP FLOW RATE (ml per minute):**
- **H2O QUALITY PARAMETER:**
  - **Model:** VSI Pro
  - **S/N:** 151672923
  - **TURBIDIMETER:**
  - **Model:** NOT STATED
  - **S/N:** 20160936
  - **OTHER:**

## REMARKS:
- **Other:**

## MATERIAL CODES:
- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicone
- T = Teflon
- O = Other (Specify)

## SAMPLING EQUIPMENT CODES:
- APP = After Peristaltic Pump
- B = Bailer
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- RFP = Reverse Flow Peristaltic Pump
- SM = Straw Method (Tubing Gravity Drain)
- O = Other (Specify)

## NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA FOR RANGE OF VARIATION OR LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
- pH: ±0.2 units
- Temperature: ±0.2°C
- Specific Conductance: ±0.5%
- Dissolved Oxygen: all readings ±20% saturation (See Table FS 2200-2) (Optionally, ±0.2 mg/L or ±10% (whichever is smaller)
- Turbidity: all readings ±20 NTU; optionally ±3 NTU or ±10% (whichever is greater)

- **well needs repair:**
- **needs well tag:**
- **locking cap:**
- **other comment:**

- **DI Water Lot #:**
- **MS / MSD:**
- **Equip blk:**
- **Ambient blk:**
- **Trip blk:**

2012_1103
GROUNDWATER SAMPLING LOG

WELL NO: EKMN-05  DATE: 12 JUNE 17
WELL LOCATION: NAS JACRAVILLE

PURGING DATA

<table>
<thead>
<tr>
<th>Initial Pump or Tubing Depth in Well (feet)</th>
<th>Final Pump or Tubing Depth in Well (feet)</th>
<th>Purging Initiated At:</th>
<th>Purging Ended At:</th>
<th>Total Volume Purged (gallons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>21</td>
<td>09/12</td>
<td>09/22</td>
<td>4.70</td>
</tr>
</tbody>
</table>

WELL CAPACITY (gallons): 0.75 = 0.52; 1.28 = 0.68; 2.67 = 1.67; 3.37 = 0.37; 4.85 = 0.48; 6.02 = 1.02; 6.48 = 1.47; 12.58 = 0.58
TUBING INSIDE DIAM. CAPACITY (gallons): B = 0.0008; 3/16 = 0.0014; 1/4 = 0.0026; 5/32 = 0.0036; 1/2 = 0.010; 5/8 = 0.016

PURGING EQUIPMENT CODES:
- B = Baller
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- PP = Peristaltic Pump
- O = Other (Specify)

SAMPLING DATA

Sampled By: PHORNO FURTAY

Sampled at: ANAYA

Sampled at: 09/23

PUMP OR TUBING DEPTH IN WELL (feet): 21

FIELD FILTERED: O

FILTER SIZE: ___ μm

FIELD DECONTAMINATION: PUMP Y O

TUBING Y O (replaced)

FIELD EQUIPMENT IDENTIFICATION

H2O QUALITY PARAMETER

Model: VSI PROPERTY

Model: MICRO

OTHER

TURBIDITY

E150

201609036

SAMPLE CONTAINER SPECIFICATION

# CONTAINERS | MATERIAL CODE | VOLUME (ml) | PRESERVATIVE USED | INTENDED ANALYSIS AND/OR METHOD | SAMPLING EQUIPMENT CODE | SAMPLE PUMP FLOW RATE (ml per minute)
<table>
<thead>
<tr>
<th></th>
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<td>4</td>
<td>CG</td>
<td>40</td>
<td>NaOH</td>
<td>GSIA</td>
<td>APP</td>
<td>250</td>
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<tr>
<td>1</td>
<td>PE</td>
<td>17</td>
<td></td>
<td>NGS</td>
<td></td>
<td></td>
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<td></td>
<td>DCC</td>
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<tr>
<td>2</td>
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<td>HNO3</td>
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<td>CHL</td>
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</table>

MATERIAL CODES:
- AG = Amber Glass
- CG = Clear Glass
- PE = Polyethylene
- PP = Polypropylene
- S = Silicons
- T = Teflon
- O = Other (Specify)

SAMPLING EQUIPMENT CODES:
- APP = After Peristaltic Pump
- BP = Bladder Pump
- ESP = Electric Submersible Pump
- RFPP = Reverse Flow Peristaltic Pump
- SM = Straw Method (Tubing or Gravity Drain)
- O = Other (Specify)

NOTES:
1. The above do not constitute all of the information required by Chapter 62-180, F.A.C.
2. STABILIZATION CRITERIA, FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 2212, SECTION 3)
   - pH: 6.0 units; Temperature: ± 0.2 C
   - Specific Conductance: ± 5%
   - Dissolved Oxygen: all readings ≤ 20% saturation (see Table FS 2200-2); optionally, ± 0.2 mg/L or ± 10% (whosever is greater)
   - Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whosever is greater)

☐ well needs repair
☐ needs well tag
☐ looking cap
☐ other comment

☐ DI Water Lot #
☐ MS/MGD
☐ Equip blk
☐ Ambient blk for Trip blk

AG 40 HCl
CG 40 HCl
CG 40 HCl
CG 40 HCl
## GROUNDWATER SAMPLING LOG

**SITE NAME:** S199  
**SAMPLE ID:** 2828-07  
**FREE PRODUCT:** Y  
**DEPTH TO PRODUCT (FT BTOC):** 3.40  
**PURGE PUMP Type or Bailer:** PP  
**DATE:** 6/12/17

### PURGING DATA

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<tr>
<th>WELL</th>
<th>DIAMETER (inches)</th>
<th>TUBING DIAMETER (inches)</th>
<th>WELL SCREEN INTERVAL (feet)</th>
<th>DEPTH TO WATER (feet)</th>
<th>STATIC DEPTH TO WATER (feet)</th>
<th>PURGE VOLUME PURGE</th>
<th>PURGE INITIATED AT:</th>
<th>PURGE ENDED AT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>3</td>
<td>1/4</td>
<td>2</td>
<td>2</td>
<td>3.4</td>
<td>7437</td>
<td>0813</td>
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</table>

### INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 23  
### FINAL PUMP OR TUBING DEPTH IN WELL (feet): 23

### SAMPLING DATA

- **Sampled By (Print):** [Name]  
- **Sampler(s) Signatures:** [Signature]  
- **Pump or Tubing Depth in Well (feet):** 21  
- **Tubing Material Code:** K  
- **Field-Filtered:** [Filter]  
- **Field Equipment Identification:** [Equipment ID]

### WELL CAPACITY (gal/ft): 0.75" = 0.02; 1" = 0.04; 1.25" = 0.06; 2" = 0.16; 3" = 0.37; 4" = 0.65; 5" = 1.02; 6" = 1.47; 12" = 5.88

### TUBING INSIDE DIAM. CAPACITY (gal/ft): 1/8" = 0.0008; 3/16" = 0.0014; 1/4" = 0.0028; 5/16" = 0.004; 3/8" = 0.006; 1/2" = 0.010; 5/8" = 0.016

### FIELD DECONTAMINATION: PUMP Y  
### TUBING Y (replaced)

### SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME (ml)</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>CG</td>
<td>40</td>
<td>H2O</td>
<td>VOCs</td>
<td>APP</td>
<td>&gt;400</td>
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<tr>
<td>3</td>
<td>AG</td>
<td>40</td>
<td>H2O</td>
<td>MGC</td>
<td>APP</td>
<td>&gt;400</td>
</tr>
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<td>2</td>
<td>AG</td>
<td>40</td>
<td>H2O</td>
<td>TAC</td>
<td>APP</td>
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<td>CG</td>
<td>40</td>
<td>H2O</td>
<td>YEA</td>
<td>APP</td>
<td>&gt;400</td>
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</tbody>
</table>

### H2O QUALITY PARAMETER

- **Model:** VSI Pnt  
- **SN:** 15AD11477  
- **TURBIDITY:** Other

### SAMPLING EQUIPMENT CODES:

- **APP:** After Peristaltic Pump
- **B:** Baller
- **BP:** Bladder Pump
- **ESP:** Electric Submersible Pump
- **RFPP:** Reverse Flow Peristaltic Pump
- **SM:** Straw Method (Tubing Gravity Drain)
- **O:** Other

### MATERIAL CODES:

- **AG:** Amber Glass
- **CG:** Clear Glass
- **PE:** Polyethylene
- **PP:** Polypropylene
- **S:** Silicone
- **T:** Teflon
- **O:** Other

### NOTES:

1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. **Stabilization Criteria For Range of Variation of Last Three Consecutive Readings (see FS 2212, Section 3)**
   - pH: ±0.2 units
   - Temperature: ±0.2°C
   - Specific Conductance: ±5%
   - Dissolved Oxygen: all readings ≤20% saturation (see Table FS 2200-2); optionally, ≤0.2 mg/L or +10% (whichever is greater)
   - Turbidity: all readings ≤2 NTU; optionally ≤±5 NTU +/−10% (whichever is greater)

- **Well needs repair:** □  
- **Needs well tag:** □  
- **Locking cap:** □  
- **Other comment:** □  

2012_1102
### PURGING DATA

<table>
<thead>
<tr>
<th>WELL</th>
<th>TUBING</th>
<th>WELL SCREEN INTERVAL DEPTH</th>
<th>STATIC DEPTH TO WATER</th>
<th>PURGE PUMP TYPE OR BAILER</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>312</td>
<td>23 feet</td>
<td>4.5 feet</td>
<td>PP</td>
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</tbody>
</table>

**WELL VOLUME PURGE:** 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

**EQUIPMENT VOLUME PURGE:** 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY x TUBING LENGTH) + FLOW CELL VOLUME

### SAMPLING DATA

**PUMP OR TUBING DEPTH IN WELL (feet):** 21

**TUBING MATERIAL CODE:** PE

**FIELD FILTERED:** Y

**FILTER SIZE:** 0.25

**TUBING DECONTAMINATION:** PUMP Y, TUBING Y

**SAMPLE CONTAINER SPECIFICATION:**

<table>
<thead>
<tr>
<th>CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME (ml)</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
<th>MODEL</th>
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</thead>
<tbody>
<tr>
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<td>AG</td>
<td>500</td>
<td>HO</td>
<td>H2SO4</td>
<td>200</td>
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<td>PE</td>
<td>500</td>
<td>HO</td>
<td>H2SO4</td>
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<td>PE</td>
<td>500</td>
<td>HNO3</td>
<td>Diss. Fum.</td>
<td>200</td>
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</tbody>
</table>

**FIELD EQUIPMENT IDENTIFICATION:**

- **SAMPLED BY (PRINT)/AFFILIATION:** A. Haas, Trinity
- **DATE:** 12/04/17
- **TIME:** 14:08

**MATERIAL CODES:** AG = Amber Glass; GC = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicoine; T = Teflon; O = Other (Specify)

**SAMPLING EQUIPMENT CODES:** APP = After Peristaltic Pump; B = Bailer; BP = Bailer Pump; ESP = Electric Submersible Pump; RPP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

**NOTES:**
1. The above do not constitute all of the information required by Chapter 82-160, F.A.C.
2. **Sampling Criteria:** For Range of Variation of Last Three Consecutive Readings (See FS 2212, Section 2)
   - pH = 7.0 ± 0.2
   - Temperature = ± 0.2°C
   - Specific Conductance = ± 5%
   - Dissolved Oxygen: all readings ≤ 20% saturation (See Table FS 2203-3) or optionally ± 0.2 mg/L or ± 10% (whichever is greater)
   - Turbidity: all readings ≤ 20 NTU; optionally ± 5 NTU or ± 10% (whichever is greater)

- well needs repair
- needs well cap
- locking cap
- other comment
- Di Water Lot #
- MS/MS
- Equip blk
- Ambient blk
- Trip blk

2012_1102
**GROUNDWATER SAMPLING LOG**

- **SITE NAME:** SITE 11  
- **SITE LOCATION:** NWS Jacksonville  
- **DATE:** 6/10/17  
- **WELL NO.:** EKNW-09  
- **SAMPLE ID:** EKNW-09  
- **FREE PRODUCT:** Y  
- **DEPT TO PRODUCT (F ROG):**  
- **FIELD DUPLICATE:**  
- **DUPLICATE ID:**  

### PURGING DATA

<table>
<thead>
<tr>
<th>WELL DIAMETER (inches):</th>
<th>TUBING DIAMETER (inches):</th>
<th>WELL SCREEN INTERVAL</th>
<th>DEPTH: feet to feet</th>
<th>STATIC DEPTH TO WATER (feet):</th>
<th>PURGE PUMP TYPE OR BAILER:</th>
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<tr>
<td>3 2</td>
<td>3 6</td>
<td>3 6</td>
<td>5 32</td>
<td>P</td>
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<tr>
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<th>EQUIPMENT VOLUME PURGE:</th>
<th>TUBING CAPACITY</th>
<th>TUBING LENGTH</th>
<th>FLOW CELL VOLUME</th>
<th>PUMP VOLUME</th>
<th>TUBING CAPACITY</th>
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<th>FLOW CELL VOLUME</th>
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<td>(gal/ft)</td>
<td>(gal/ft)</td>
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### INITIAL PUMP OR TUBING DEPTH IN WELL (feet): 8.1

### FINAL PUMP OR TUBING DEPTH IN WELL (feet): 2.1

### PURGING INITIATED: 0825

### PURGING ENDED: 0945

### TOTAL VOLUME PURGED (gallons): 1.8

### PURGING EQUIPMENT CODES: B = Bailor; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

### SAMPLING DATA

#### SAMPLED BY (PRINT)/AFFILIATION:
- DAVIE KELL SIES DAA
- DAVIE KELL SIES DAA

#### SAMPLER(S) SIGNATURE(S):
- DAVIE KELL SIES DAA

#### FIELD-FILTERED:
- N

#### FILTER SIZE: L um

#### FIELD DECONTAMINATION:
- PUMP Y  
- TUBING Y

#### FIELD IDENTIFICATION:
- PUMP Y (replaced)

#### SAMPLE CONTAINER SPECIFICATION

<table>
<thead>
<tr>
<th>CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME (ml)</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (ml/minute)</th>
<th>100 QUALITY PARAMETER</th>
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<tr>
<td>3</td>
<td>CC</td>
<td>40</td>
<td>HCl</td>
<td>P</td>
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<td>2000</td>
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<td>PC</td>
<td>10</td>
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#### MATERIAL CODES:
- AG = Amber Glass; CC = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

#### SAMPLING EQUIPMENT CODES:
- APP = After Peristaltic Pump; B = Bailor; BP = Bladder Pump; ESP = Electric Submersible Pump; RFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

### NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. STABILIZATION CRITERIA, FOR RANGE OF VARIATION OF LAST THREE CONSECUTIVE READINGS (SEE FS 221.2, SECTION 3)
   - pH: ± 0.2 units; Temperature: ± 0°C; Specific Conductance: ± 5%; Dissolved Oxygen: all readings ± 20% saturation (see Table FS 2003-2); optionally, ± 0.2 mg/L or ± 10% (whichever is greater)
   - Turbidity: all readings ± 0 NTU, optionally ± 5 NTU or ± 10% (whichever is greater)

- [ ] well needs repair  
- [ ] needs well tag  
- [ ] locking cap  
- [ ] other comment:  

- [ ] Di Water Lot  
- [ ] MS / MSD  
- [ ] Equip blt  
- [ ] Ambient blt  
- [ ] Trip blt  

---

2012_1102
# Groundwater Sampling Log

**Site:** EKNW-10  
**Date:** 6/13/17

## Purging Data

- **Well:** EKNW-10  
- **Sample:** EKNW-10

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<th>Parameter</th>
<th>Value</th>
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<td>E KNW-10</td>
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<td>S17E 11</td>
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<td>Site Location</td>
<td>S 17E 11</td>
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<tr>
<td>Free Product</td>
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<td>Field Duplicate</td>
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<td>Initial Pump or Tapping Depth (feet)</td>
<td>21</td>
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<tr>
<td>Initial Pump or Tapping Depth (feet)</td>
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<td>Purging Initiated at</td>
<td>1050</td>
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<tr>
<td>Purging Ended at</td>
<td>1300</td>
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## Sampling Data

- **Sampler(S) Signature(S):** David Beall  
- **Sample Time:** 13:00

### Field Decontamination

- **Pump:** Y  
- **Tubing:** Y (replaced)

### Sample Container Specification

<table>
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<tr>
<th>Containers</th>
<th>Material Code</th>
<th>Volume (ml)</th>
<th>Preservative Used</th>
<th>Intensive Analysis Method</th>
<th>Sampling Method</th>
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<tbody>
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</table>

### Soil Quality Parameter

- **Model:** Y440
- **SNR:** 12510664
- **Turbidity:** 200 Q
- **Other:** SLE1

### Material Codes

- **AG:** Amber Glass  
- **CG:** Clear Glass  
- **PE:** Polyethylene  
- **PP:** Polypropylene  
- **S:** Silica  
- **T:** Teflon  
- **O:** Other (Specify)

### Sampling Equipment Codes

- **APP:** After Peristaltic Pump  
- **B:** Ball  
- **BP:** Badder Pump  
- **ESP:** Electric Submersible Pump  
- **RFP:** Reverse Flow Peristaltic Pump  
- **SM:** Straw Method (Tubing Gravity Drain)

### Notes

1. The above do not constitute all of the information required by Chapter 82-166, F.A.C.
2. Stability criteria for range of variation of last three consecutive readings (see FS 2212, Section 3)  
   - pH: ±0.2 units  
   - Temperature: ±0.2°C  
   - Specific Conductance: ±5%  
   - Dissolved Oxygen: all readings ± 2% saturation (see Table FS 2202-2; optionally, ±0.2 mg/L, or ±10% (whichever is greater))  
   - Turbidity: all readings ± 10 NTU, optionally ± 5 NTU or ± 1% (whichever is greater)

### Additional Notes

- Well needs repair  
- Well needs clean  
- Locking cap  
- Other comment:

---

2012_1102
GROUNDWATER SAMPLING LOG

WELL NO.: CKM-11
SAMPLE ID: CKM-11
FREE PRODUCT: Y
DEPTH TO PRODUCT (FT/EC): 438
FIELD DUPLICATE: Y
PURGING DATA

WELL DIAMETER (inches): 2
TUBING DIAMETER (inches): 3/8
WELL SCREEN INTERVAL TO DEPTH: 14 feet
STATIC DEPTH TO WATER (feet): 438
PURGE PUMP TYPE: 3 Pump

WELL VOLUME PURGE: 1 WELL VOLUME = (TOTAL WELL DEPTH - STATIC DEPTH TO WATER) x WELL CAPACITY

EQUIPMENT VOLUME PURGE: 1 EQUIPMENT VOL. = PUMP VOLUME + (TUBING CAPACITY x TUBING-LENGTH) + FLOW CELL VOLUME

INITIAL PUMP OR TUBING DEPTH IN WELL (feet):
FINAL PUMP OR TUBING DEPTH IN WELL (feet):
PURGING INITIATED AT:
PURGING ENDED AT:
TOTAL VOLUME PURGED (gallons):

|------|-------------------------|------------------------------|-----------------|------------------------|---------|-----------|---------------------|-------------------------|-----------------
| 1440 | 0.6                     | 0.6                          | 0.6             | 8.60                   | 5.56    | 26.4      | 5.31               | 0.08                    | 2.85
| 1450 | 0.6                     | 0.6                          | 0.6             | 9.47                   | 5.55    | 26.4      | 5.31               | 0.08                    | 2.85
| 1500 | 0.6                     | 0.6                          | 0.6             | 11.26                  | 5.56    | 26.1      | 5.31               | 0.08                    | 2.85
| 1510 | 0.6                     | 0.6                          | 0.6             | 11.26                  | 5.56    | 26.1      | 5.31               | 0.08                    | 2.85
| 1520 | 0.6                     | 0.6                          | 0.6             | 11.81                  | 5.55    | 26.0      | 5.33               | 0.07                    | 2.87
| 1530 | 0.6                     | 0.6                          | 0.6             | 12.31                  | 5.55    | 26.0      | 5.33               | 0.07                    | 2.87
| 1540 | 0.6                     | 0.6                          | 0.6             | 12.52                  | 5.56    | 26.0      | 5.66               | 0.10                    | 3.01
| 1550 | 0.6                     | 0.6                          | 0.6             | 12.69                  | 5.56    | 26.0      | 5.69               | 0.09                    | 3.20
| 1560 | 0.6                     | 0.6                          | 0.6             | 12.80                  | 5.56    | 26.0      | 5.70               | 0.09                    | 3.21

WELL CAPACITY (gal/hr): 0.75 gph = 0.02; 1 gph = 0.04; 1.25 gph = 0.08; 2 gph = 0.16; 3 gph = 0.33; 4 gph = 0.65; 5 gph = 1.02; 6 gph = 1.47; 12 gph = 5.88
TUBING INSIDE DIA. CAPACITY (gal/hr): 1/8 gph = 0.0006; 3/16 gph = 0.0014; 1/4 gph = 0.0026; 5/32 gph = 0.0080; 1/2 gph = 0.010; 5/8 gph = 0.016

PURGING EQUIPMENT CODES: B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; PP = Peristaltic Pump; O = Other (Specify)

SAMPLED BY (PRINT/AFFILIATION):

SAMPLER(S) SIGNATURE(S):

PUMP OR TUBING DEPTH IN WELL (feet):

FIELD DECONTAMINATION:
PUMP Y
TUBING Y (replaced)

FIELD FILTERED: Y
FILTER SIZE: 0.01 µm

FIELD EQUIPMENT IDENTIFICATION:

SAMPLE CONTAINER SPECIFICATION:

<table>
<thead>
<tr>
<th># CONTAINERS</th>
<th>MATERIAL CODE</th>
<th>VOLUME (ml)</th>
<th>PRESERVATIVE USED</th>
<th>INTENDED ANALYSIS AND/OR METHOD</th>
<th>SAMPLING EQUIPMENT CODE</th>
<th>SAMPLE PUMP FLOW RATE (mL per minute)</th>
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H₂O QUALITY PARAMETER:

Model: YS 1100 SNI 0 0064
TURBIDIMETER
Model: S100 Q SNI 511
OTHER

REMARKS:

MATERIAL CODES: AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

PURGING EQUIPMENT CODES: APP = After Peristaltic Pump; B = Bailer; BP = Bladder Pump; ESP = Electric Submersible Pump; FFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

NOTES:
1. The above do not constitute all of the information required by Chapter 62-160, F.A.C.
2. Stabilization Criteria: For range of variation of last three consecutive readings (See FG 2212, section 3)
   pH: ± 0.2 units
   Temperature: ± 0.2 °C
   Specific Conductance: ± 5%
   Dissolved Oxygen: All readings ≤ 20% saturation (see Table FG 2200-2); optionally, ≤ 0.2 mg/L or ≤ 10% (whichever is greater)
   Turbidity: all readings ≤ 20 NTU; optionally ≤ 2 NTU or ≤ 10% (whichever is greater)
   Turbidity: all readings ≤ 20 NTU; optionally ≤ 2 NTU or ≤ 10% (whichever is greater)

Other comment: __________

2012_1102
## GROUNDWATER SAMPLING LOG

**Site Name:** EKMW-10  
**Site Location:** JACSONVILLE  
**WELL NO.:** EKMW-10  
**Sample ID:** EKMW-10  
**Free Product:** Y  
**Duplicate:** Y  
**DATE:** 6/12/17

### PURGING DATA

**WELL Diameter (inches):**  
**Tubing Diameter (inches):**  
**Well Screen Interval (feet):**  
**Static Depth to Water (feet):**  
**Purge Pump Type or Bailer:**  
**WELL VOLUME PURGE:**  
**Equipment Volume Purge:**  
**Initial Pump or Tubing Depth in Well (feet):**  
**Final Pump or Tubing Depth in Well (feet):**  
**Purging Initiated at:**  
**Purging Ended at:**  
**Total Volume Purged (gallons):**  

### SAMPLING DATA

**Sampled By (Print)/Affiliation:**  
**Sampler(s) Signature(s):**  
**Pump or Tubing Depth in Well (feet):**  
**Tubing Material Code:**  
**Field Filtered:** Y  
**Filter Size:**  
**Filtration Equipment Type:**  
**Field Decontamination:**  
**Pump Y N**  
**Tubing Y N (replaced):**  
**Field Equipment Identification:**  
**Sample Container Specification:**  
**# Containers**  
**Material Code**  
**Volume (ml):**  
**Preservative Used:**  
**Intended Analysis and Method:**  
**Sampling Equipment Code:**  
**Sample Pump Flow Rate (ml per minute):**  
**H2O Quality Parameter:**  
**Model:**  
**SN:**  
**Turbidimeter:**  
**Model:**  
**SN:**  
**Other:**

### REMARKS

**Material Codes:** AG = Amber Glass; CG = Clear Glass; PE = Polyethylene; PP = Polypropylene; S = Silicone; T = Teflon; O = Other (Specify)

**Sampling Equipment Codes:** APP = After Peristaltic Pump; B = Bailer; BP = Bailer Pump; ESP = Electric Submersible Pump; RFP = Reverse Flow Peristaltic Pump; SM = Straw Method (Tubing Gravity Drain); O = Other (Specify)

**Notes:** 1. The above do not constitute all of the information required by Chapter 52-160, F.A.C.

2. <br>Stabilization Criteria for Range of Variation of Last Three Consecutive Readings (see FB 2212, Section 3):<br>
   - pH ± 0.2 units<br>   - Temperature ± 0.2°C<br>   - Conductivity: ± 5%<br>   - Dissolved Oxygen: all readings ± 5% saturation (see Table FB 2200-2); optionally, ± 0.3 mg/L or ± 10% (whichever is greater)<br>   - Turbidity: all readings ± 5 NTU or optionally ± 10% (whichever is greater)<br>

- Well needs repair: ☐  
- Needs well tag: ☐  
- Locking cap: ☐  
- Other comment: ☐

- DI Water Lot #: ☐  
- MS / MSD: ☐  
- Equip blank: ☐  
- Ambient blank: ☐  
- Trip blank: ☐

2012_1102
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<th>MATRIX CODE</th>
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**FOR DRINKING WATER USE**

Device used for measuring: PM/3B Acme (for chloride, pH, iron and sulfate)

Date: 01/02/2011

Time: 11:30

Results by: [Name]

(a) S = NaCl (b) KCl (c) MgSO4 (d) CaSO4

1. T = (total hardness) 2. pHH2O = pH of H20 3. T = (Total hardness)
### FA32283: Chain of Custody

#### Page 1

**Accutest Laboratories Southeast**
**Chain of Custody**

**Client:** [Client Name]
**Address:** [Address]

**Project Information**
- **Project #:** [Project Number]
- **Sampling Location:** [Location]

**Sample Information**
- **Sample ID:** [Sample ID]
- **Matrix:** [Matrix]

**Analysis Information**
- **NOM (National Officers of the Marine):** [NOM]
- **Sample Type:** [Sample Type]
- **Sample Description:** [Sample Description]

**Test Information**
- **Test Code:** [Test Code]
- **Method:** [Method]
- **Sub-Method:** [Sub-Method]

**Results**

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<th>Date</th>
<th>Time</th>
<th>Sample</th>
<th>Matrix</th>
<th>NOM</th>
<th>Test Code</th>
<th>Method</th>
<th>Sub-Method</th>
<th>Results</th>
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**Turnaround Time**
- **Standard:** [Standard Time]
- **Rush:** [Rush Time]

**Approval Details**
- **Approved By:** [Name]
- **Rush Code:** [Code]

**Sample Sealing**
- **Sample Sealed by:** [Sealer]
- **Seal Number:** [Number]

**Laboratory Seal**
- **Sealed by:** [Sealer]
- **Seal Number:** [Number]

**Sample Transfer**
- **Transfer Date:** [Date]
- **Transfer Time:** [Time]

**Sample Receipt**
- **Received Date:** [Date]
- **Received Time:** [Time]

**Sample Analysis**
- **Analysis Date:** [Date]
- **Analysis Time:** [Time]

**Sample Release**
- **Released Date:** [Date]
- **Released Time:** [Time]

**Sample Disposal**
- **Disposal Date:** [Date]
- **Disposal Time:** [Time]

**Footnotes**
- [Footnote]

---

**Accutest Job:** FA32283

**Page 1 of 2**
FA32320: Chain of Custody

Page 1 of 2
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**Conclusions**

*TO BE BILLED TO Trinity A.D.C.*

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**Note**: All samples were collected from the same source and are intended for laboratory analysis. The date and time of collection are as follows: 3/25/17. For any questions or concerns, please contact Trinity A.D.C. at your earliest convenience.
### Chain of Custody and Analytical Request

**Facility:** NA

**Project Name:** Site Name Site 11

**Client Name:** Geomatics

**Project Manager:** Jackie Gibson

**Sample Code:** TSTA117

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<th>Time Report (Full 24 hours)</th>
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<th>Humidity (C)</th>
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**Comments:**

- To be billed to Geosyntec.

**Custody Transfer Form & Received by Laboratory**

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**Laboratory: SGS**

**Received by:**

**Analysis:**

- Complete and return to SGS
- Include all documentation signatures
- Include Chain of Custody
- Include all lab results
- Include all QC samples
- Include all equipment calibrations
- Include all witness signatures

**QA/QC:**

- Quality assurance completed by lab personnel and the members of the accredited QC staff.

- QC sample number: 1001

- QC sample type: 1001

- QC sample weight: 1001

**Site:**

- Site Name Site 11

**Project:**

- Site Name Site 11

**Client:**

- Geomatics

---

**FA42355: Chain of Custody**

Page 1 of 2
## Chain of Custody and Analytical Request

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**Comments:**
Dissolved metal filtered in fluid and delivered to Trinity ADC

---

**Facility:** NAS Jacksonville

**Client Name:** Geonext

**Project Manager:** Jordan Gibson

**Project Name/ Site Name/ Site #:**

**Equipment Label:**

---

**FA44858: Chain of Custody**

Page 1 of 2
Page Intentionally Left Blank
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Re-Baseline Event (September 2016) - 6 months since shutdown after Stage 1 operation; before system re-start for Stage 2

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### June 2017 - 3 Months post Stage 2 operation

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## Grab Groundwater From Soil Core Locations (June 2017)

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