

CONSOL Mining Company LLC.
1000 CONSOL Energy Drive
Canonsburg, PA 15317
(724) 485-4267

March 31, 2015

C/015/0015
Received 4/8/2015
Task ID #4865

Daron Haddock
Utah Division of Oil, Gas and Mining
Coal Program
1594 West North Temple, Suite 1210
Box 145801
Salt Lake City, Utah 84114-5801

Re: Emery Deep Mine Permit C/015/015
Revegetation soil sample data

Dear Mr. Haddock:

Per conversations with your staff, please consider this a revision to add the 2014 soil sample data to Chapter III Appendix III-1. Enclosed please find two (2) copies of the above referenced revision, including an executed C1 form, C2 form and revised pages. A cd-rom has been included with the submittal in pdf format.

If you have any questions concerning this request, please contact me at (724) 485-4267.

Sincerely,



Kerry Goodballet P.E.
Director of Permitting – Coal

Enclosure

APPLICATION FOR COAL PERMIT PROCESSING

Permit Change New Permit Renewal Exploration Bond Release Transfer

Permittee: CONSOL Mining Company LLC

Mine: Emery Mine

Permit Number: 015/015

Title: Revegetation regrading and soil samples

Description, Include reason for application and timing required to implement:

add soil sample data from regraded areas

03/15

Instructions: If you answer yes to any of the first eight (gray) questions, this application may require Public Notice publication.

- Yes No 1. Change in the size of the Permit Area? Acres: _____ Disturbed Area: _____ increase decrease.
- Yes No 2. Is the application submitted as a result of a Division Order? DO# _____
- Yes No 3. Does the application include operations outside a previously identified Cumulative Hydrologic Impact Area?
- Yes No 4. Does the application include operations in hydrologic basins other than as currently approved?
- Yes No 5. Does the application result from cancellation, reduction or increase of insurance or reclamation bond?
- Yes No 6. Does the application require or include public notice publication?
- Yes No 7. Does the application require or include ownership, control, right-of-entry, or compliance information?
- Yes No 8. Is proposed activity within 100 feet of a public road or cemetery or 300 feet of an occupied dwelling?
- Yes No 9. Is the application submitted as a result of a Violation? NOV # _____
- Yes No 10. Is the application submitted as a result of other laws or regulations or policies?
Explain: _____
- Yes No 11. Does the application affect the surface landowner or change the post mining land use?
- Yes No 12. Does the application require or include underground design or mine sequence and timing? (Modification of R2P2)
- Yes No 13. Does the application require or include collection and reporting of any baseline information?
- Yes No 14. Could the application have any effect on wildlife or vegetation outside the current disturbed area?
- Yes No 15. Does the application require or include soil removal, storage or placement?
- Yes No 16. Does the application require or include vegetation monitoring, removal or revegetation activities?
- Yes No 17. Does the application require or include construction, modification, or removal of surface facilities?
- Yes No 18. Does the application require or include water monitoring, sediment or drainage control measures?
- Yes No 19. Does the application require or include certified designs, maps or calculation?
- Yes No 20. Does the application require or include subsidence control or monitoring?
- Yes No 21. Have reclamation costs for bonding been provided?
- Yes No 22. Does the application involve a perennial stream, a stream buffer zone or discharges to a stream?
- Yes No 23. Does the application affect permits issued by other agencies or permits issued to other entities?

Please attach four (4) review copies of the application. If the mine is on or adjacent to Forest Service land please submit five (5) copies, thank you. (These numbers include a copy for the Price Field Office)

I hereby certify that I am a responsible official of the applicant and that the information contained in this application is true and correct to the best of my information and belief in all respects with the laws of Utah in reference to commitments, undertakings, and obligations, herein.

KERRY L. GOODBAIKT
Print Name

Kerry Goodbait, Dist Coal Permits, 3-31-15
Sign Name, Position, Date

Subscribed and sworn to before me this 31 day of MARCH, 2015

Jane M. Young
Notary Public
My commission Expires: _____, 20____ }
Attest: State of PENNSYLVANIA } ss:
County of WASHINGTON

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Jane M. Young, Notary Public
Cecil Twp., Washington County
My Commission Expires June 20, 2017
MEMBER, PENNSYLVANIA ASSOCIATION OF NOTARIES

For Office Use Only:	Assigned Tracking Number:	Received by Oil, Gas & Mining
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Est. 1970

Jamey Sage III
Stantec- Sandy, UT
8160 South Highland Dr, Suite A4
Sandy, UT 84093-7402

Report Summary

Wednesday March 04, 2015

Report Number: L750756

Samples Received: 02/27/15

Client Project: 203703005

Description: Consol Soil Sampling

The analytical results in this report are based upon information supplied by you, the client, and are for your exclusive use. If you have any questions regarding this data package, please do not hesitate to call.

Entire Report Reviewed By:


Jared Willis , ESC Representative

Laboratory Certification Numbers

A2LA - 1461-01, AIHA - 100789, AL - 40660, CA - 01157CA, CT - PH-0197,
FL - E87487, GA - 923, IN - C-IN-01, KY - 90010, KYUST - 0016,
NC - ENV375/DW21704/BIO041, ND - R-140, NJ - TN002, NJ NELAP - TN002,
SC - 84004, TN - 2006, VA - 460132, WV - 233, AZ - 0612,
MN - 047-999-395, NY - 11742, WI - 998093910, NV - TN000032011-1,
TX - T104704245-11-3, OK - 9915, PA - 68-02979, IA Lab #364, EPA - TN002

Accreditation is only applicable to the test methods specified on each scope of accreditation held by ESC Lab Sciences.

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REPORT OF ANALYSIS

March 04, 2015

Jamey Sage III
 Stantec- Sandy, UT
 8160 South Highland Dr, Suite A4
 Sandy, UT 84093-7402

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-1-12
 Collected By : J, Sage
 Collection Date : 02/25/15 12:35

ESC Sample # : L750756-01
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	9.6	0.10	su	9045D	02/28/15	1
Sodium Adsorption Ratio	11.			Calc.	03/03/15	1
Specific Conductance	3900		umhos/cm	9050AMod	03/04/15	1

BDL - Below Detection Limit
 Det. Limit - Practical Quantitation Limit(PQL)
 Note:
 The reported analytical results relate only to the sample submitted.
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Reported: 03/04/15 15:54 Printed: 03/04/15 16:27
 L750756-01 (PH) - 9.6@21.1c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-1-6
 Collected By : J, Sage
 Collection Date : 02/25/15 12:40

ESC Sample # : L750756-02

Site ID :

Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	9.2	0.10	su	9045D	02/28/15	1
Sodium Adsorption Ratio	17.			Calc.	03/03/15	1
Specific Conductance	4500		umhos/cm	9050AMod	03/04/15	1

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 L750756-02 (PH) - 9.2@20.2c



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March 04, 2015

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 Stantec- Sandy, UT
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 Sandy, UT 84093-7402

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-2-12
 Collected By : J, Sage
 Collection Date : 02/25/15 13:00

ESC Sample # : L750756-03
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	9.5	0.10	su	9045D	02/28/15	1
Sodium Adsorption Ratio	9.0			Calc.	03/03/15	1
Specific Conductance	4200		umhos/cm	9050AMod	03/04/15	1

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 L750756-03 (PH) - 9.5@19.6c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-2-6
 Collected By : J, Sage
 Collection Date : 02/25/15 13:05

ESC Sample # : L750756-04

Site ID :

Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	8.9	0.10	su	9045D	02/28/15	1
Sodium Adsorption Ratio	10.			Calc.	03/03/15	1
Specific Conductance	2900		umhos/cm	9050AMod	03/04/15	1

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 L750756-04 (PH) - 8.9@19.5c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-3-12
 Collected By : J, Sage
 Collection Date : 02/25/15 13:55

ESC Sample # : L750756-05
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	7.4	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	12.			Calc.	03/03/15	1
Specific Conductance	3500		umhos/cm	9050AMod	03/04/15	1

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Reported: 03/04/15 15:54 Printed: 03/04/15 16:27
 L750756-05 (PH) - 7.4@22.8c



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REPORT OF ANALYSIS

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 8160 South Highland Dr, Suite A4
 Sandy, UT 84093-7402

March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-3-6
 Collected By : J, Sage
 Collection Date : 02/25/15 14:00

ESC Sample # : L750756-06
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	7.8	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	11.			Calc.	03/03/15	1
Specific Conductance	3700		umhos/cm	9050AMod	03/04/15	1

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 L750756-06 (PH) - 7.8@22.3c



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REPORT OF ANALYSIS

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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-4-12
 Collected By : J, Sage
 Collection Date : 02/25/15 13:35

ESC Sample # : L750756-07
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	7.9	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	11.			Calc.	03/03/15	1
Specific Conductance	2500		umhos/cm	9050AMod	03/04/15	1

BDL - Below Detection Limit
 Det. Limit - Practical Quantitation Limit(PQL)
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 L750756-07 (PH) - 7.9@21.9c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-4-6
 Collected By : J, Sage
 Collection Date : 02/25/15 13:40

ESC Sample # : L750756-08

Site ID :

Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	7.9	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	8.0			Calc.	03/03/15	1
Specific Conductance	2300		umhos/cm	9050AMod	03/04/15	1

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Reported: 03/04/15 15:54 Printed: 03/04/15 16:27
 L750756-08 (PH) - 7.9@21.9c



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REPORT OF ANALYSIS

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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-5-12
 Collected By : J, Sage
 Collection Date : 02/25/15 14:35

ESC Sample # : L750756-09

Site ID :

Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	8.1	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	29.			Calc.	03/03/15	1
Specific Conductance	8400		umhos/cm	9050AMod	03/04/15	1

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Reported: 03/04/15 15:54 Printed: 03/04/15 16:27
 L750756-09 (PH) - 8.1@21.7c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-5-6
 Collected By : J, Sage
 Collection Date : 02/25/15 14:40

ESC Sample # : L750756-10
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	8.3	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	31.			Calc.	03/03/15	1
Specific Conductance	8200		umhos/cm	9050AMod	03/04/15	1

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 L750756-10 (PH) - 8.3@21.7c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-6-12
 Collected By : J, Sage
 Collection Date : 02/25/15 14:25

ESC Sample # : L750756-11
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	8.4	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	30.			Calc.	03/03/15	1
Specific Conductance	8600		umhos/cm	9050AMod	03/04/15	1

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Reported: 03/04/15 15:54 Printed: 03/04/15 16:27
 L750756-11 (PH) - 8.4@22.0c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-6-6
 Collected By : J, Sage
 Collection Date : 02/25/15 14:30

ESC Sample # : L750756-12

Site ID :

Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	8.3	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	30.			Calc.	03/03/15	1
Specific Conductance	7600		umhos/cm	9050AMod	03/04/15	1

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 L750756-12 (PH) - 8.3@21.7c



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March 04, 2015

Date Received : February 27, 2015
 Description : Consol Soil Sampling
 Sample ID : SS-7-12
 Collected By : J, Sage
 Collection Date : 02/25/15 12:10

ESC Sample # : L750756-13
 Site ID :
 Project # : 203703005

Parameter	Result	Det. Limit	Units	Method	Date	Dil.
pH	8.3	0.10	su	9045D	03/01/15	1
Sodium Adsorption Ratio	10.			Calc.	03/03/15	1
Specific Conductance	3200		umhos/cm	9050AMod	03/04/15	1

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 L750756-13 (PH) - 8.3@21.6c



YOUR LAB OF CHOICE

Stantec- Sandy, UT
 Jamey Sage III
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Sandy, UT 84093-7402

Quality Assurance Report
 Level II

L750756

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March 04, 2015

Analyte	Result	Laboratory Blank		Limit	Batch	Date Analyzed
		Units	% Rec			
Specific Conductance	1.82	umhos/cm			WG773299	03/04/15 14:03

Analyte	Units	Duplicate			Limit	Ref Samp	Batch
		Result	Duplicate	RPD			
pH	su	6.20	6.20	0.0	1	L750532-01	WG772872
pH	su	8.90	8.90	0.224	1	L750756-04	WG772872
pH	su	7.30	7.40	0.950	1	L750756-05	WG772998
pH	su	7.90	7.90	0.127	1	L750846-09	WG772998
Specific Conductance	umhos/cm	3900	3900	0.514	20	L750756-01	WG773299
Specific Conductance	umhos/cm	7600	7600	0.132	20	L750756-12	WG773299

Analyte	Units	Laboratory Control Sample		% Rec	Limit	Batch
		Known Val	Result			
pH	su	5.9	5.86	99.3	98.3-101.7	WG772872
pH	su	5.9	5.93	101.	98.3-101.7	WG772998
Specific Conductance	umhos/cm	759	776.	102.	85-115	WG773299

Analyte	Units	Laboratory Control Sample Duplicate			Limit	RPD	Limit	Batch
		Result	Ref	%Rec				
pH	su	5.86	5.86	99.0	98.3-101.7	0.0	20	WG772872
pH	su	5.94	5.93	101.	98.3-101.7	0.168	20	WG772998
Specific Conductance	umhos/	776.	776.	102.	85-115	0.0	20	WG773299

Batch number /Run number / Sample number cross reference

WG772872: R3022430: L750756-01 02 03 04
 WG772998: R3022434: L750756-05 06 07 08 09 10 11 12 13
 WG772877: R3022748: L750756-01 02 03 04 05 06 07 08 09 10 11 12 13
 WG773299: R3022929: L750756-01 02 03 04 05 06 07 08 09 10 11 12 13

* * Calculations are performed prior to rounding of reported values.
 * Performance of this Analyte is outside of established criteria.
 For additional information, please see Attachment A 'List of Analytes with QC Qualifiers.'



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The data package includes a summary of the analytic results of the quality control samples required by the SW-846 or CWA methods. The quality control samples include a method blank, a laboratory control sample, and the matrix spike/matrix spike duplicate analysis. If a target parameter is outside the method limits, every sample that is effected is flagged with the appropriate qualifier in Appendix B of the analytic report.

Method Blank - an aliquot of reagent water carried through the entire analytic process. The method blank results indicate if any possible contamination exposure during the sample handling, digestion or extraction process, and analysis. Concentrations of target analytes above the reporting limit in the method blank are qualified with the "B" qualifier.

Laboratory Control Sample - is a sample of known concentration that is carried through the digestion/extraction and analysis process. The percent recovery, expressed as a percentage of the theoretical concentration, has statistical control limits indicating that the analytic process is "in control". If a target analyte is outside the control limits for the laboratory control sample or any other control sample, the parameter is flagged with a "J4" qualifier for all effected samples.

Matrix Spike and Matrix Spike Duplicate - is two aliquots of an environmental sample that is spiked with known concentrations of target analytes. The percent recovery of the target analytes also has statistical control limits. If any recoveries that are outside the method control limits, the sample that was selected for matrix spike/matrix spike duplicate analysis is flagged with either a "J5" or a "J6". The relative percent difference (%RPD) between the matrix spike and the matrix spike duplicate recoveries is all calculated. If the RPD is above the method limit, the effected samples are flagged with a "J3" qualifier.

Company Name/Address:
STANTEC
 8160 SO HIGHLAND DRIVE
 SANDY, UTAH 84093
 USA

Billing Information:
 SAME AS

Analysis / Container / Preservative



YOUR LAB OF CHOICE
 12065 Lebanon Rd
 Mount Juliet, TN 37122
 Phone: 615-758-5858
 Phone: 800-767-5859
 Fax: 615-758-5859



Report to:
R. JENSEN & J. SAGE

Email To:
 russel.jensen@consolenergy.com
 jamey.sage@stantec.com

Project: **CONSOL**
 Description: **SOIL SAMPLING**

City/State: **EMERY, UTAH**
 Collected:

Phone: **801 943 4144**
 Fax: **801 942 1852**

Client Project #
203708005

Lab Project #

Collected by (print):
J. SAGE

Site/Facility ID #
 —

P.O. #
 —

Collected by (signature):

Rush? (Lab MUST Be Notified)
 ___ Same Day200%
 ___ Next Day100%
 ___ Two Day50%
 ___ Three Day25%

Date Results Needed
 Email? ___ No Yes
 FAX? ___ No ___ Yes

Immediately Packed on Ice N ___ Y

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	Analysis / Container / Preservative			Rem./Contaminant	Sample # (lab only)
							7H	EC	SAR		
SS-1-12	COMP	SS	6-12	2/25/15	1235	2	X	X	X		-01
SS-1-6		SS	0-6		1240	2					02
SS-2-12		SS	6-12		1300	2					03
SS-2-6		SS	0-6		1305	2					04
SS-3-12		SS	6-12		1355	2					05
SS-3-6		SS	0-6		1400	2					06
SS-4-12		SS	6-12		1335	2					07
SS-4-6		SS	0-6		1340	2					08
SS-5-12		SS	6-12		1435	2					09
SS-5-6		SS	0-6		1440	2					10

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other

Remarks: **6200 8549 4902**

pH _____ Temp _____
 Flow _____ Other _____

Relinquished by: (Signature)

 Relinquished by: (Signature)

 Relinquished by: (Signature)

Date: **2/26/15** Time: **1426**

Received by: (Signature)

 Received by: (Signature)

 Received for lab by: (Signature)

Samples returned via: UPS
 FedEx Courier _____
 Temp: **3.2** °C Bottles Received: **26/02**
 Date: **2/27/15** Time: **0900**

Hold #
 Condition: **51** (lab use only)
 COC Seal Intact: ___ Y ___ N ___ NA
 pH Checked: NCF

Company Name/Address:

Billing Information:

Analysis / Container / Preservative

Chain of Custody Page 2 of 2



12065 Lebanon Rd
Mount Juliet, TN 37122
Phone: 615-758-5858
Phone: 800-767-5859
Fax: 615-758-5859



Report to:

Email to:

Project Description:

City/State Collected:

Phone:
Fax:

Client Project #

Lab Project #

Collected by (print):

Site/Facility ID #

P.O. #

Collected by (signature):

Rush? (Lab MUST Be Notified)

Date Results Needed

Immediately Packed on Ice N ___ Y ___

___ Same Day200%
___ Next Day100%
___ Two Day50%
___ Three Day25%

Email? ___ No ___ Yes
FAX? ___ No ___ Yes

No. of Cntrs

Sample ID	Comp/Grab	Matrix *	Depth	Date	Time	No. of Cntrs	pH	EC	SRP										
SS-6-12	Comp	SS	6-12	2/25/15	1425	2	↓	↓	↓										
SS-6-6	↓	SS	0-6	↓	1430	2	↓	↓	↓										4
SS-7-12	↓	SS	6-12	↓	1210	2	↓	↓	↓										12
																			13

* Matrix: SS - Soil GW - Groundwater WW - WasteWater DW - Drinking Water OT - Other _____

pH _____ Temp _____
Flow _____ Other _____

Remarks:

Relinquished by: (Signature)

Date:

Time:

Received by: (Signature)

Samples returned via: UPS

Hold #

Condition: (lab use only)

Relinquished by: (Signature)

Date:

Time:

Received by: (Signature)

Temp: 3.2 °C Bottles Received: 26/4oz

COC Seal Intact: Y ___ N ___ NA

Relinquished by: (Signature)

Date:

Time:

Received for lab by: (Signature)

Date: 2/27/15 Time: 0900

pH Checked: NCF

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(see Revision History at the end of this document for more information)

TITLE: SATURATED PASTE, SODIUM ADSORPTION RATIO, AND EXCHANGEABLE SODIUM
PERCENTAGE (ESP) (US DEPARTMENT OF AGRICULTURE SOIL SURVEY METHOD 4F3)

SOP NUMBER: 340392

Prepared by: Lance Fry

Reviewed by: Katie Garrett/Dixie Marlin

This document bears a watermark in the bottom right hand corner. The watermark is an insignia of the document's approval. The signed original is on file in the Reg. Affairs Office.

Department Manager

QA Department

1.0 SCOPE AND APPLICATION

- 1.1 The saturated soil paste is a particular mixture of soil and water. Upon preparation of a saturated paste, an aqueous extract is obtained which is used in a series of chemical analyses, e.g., electrical conductivity and concentrations of the major solutes.
- 1.2 The commonly determined soluble cations are Ca^{2+} , Mg^{2+} , K^{+} , and Na . Determination of soluble cations is used to obtain the relations between total cation concentration and other properties of saline solutions, such as electrical conductivity and osmotic pressure. The relative concentrations of the various cations in the soil-water extracts also provide information on the composition of the exchangeable cations in the soil.

2.0 METHOD SUMMARY AND DEFINITIONS

- 2.1 A saturated paste is prepared by adding water to a soil sample while stirring the mixture until the soil paste meets the saturation criteria (i.e. the soil paste glistens as it reflects light; flows slightly when the container is tipped; and slides freely and cleanly from a spatula except for those soils with high clay content). The mixture is covered and allowed to stand overnight. The saturation criteria are then re-checked. If the mixture fails to meet these criteria, more water or soil is added until criteria are met.

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TITLE: SATURATED PASTE, SODIUM ADSORPTION RATIO, AND EXCHANGEABLE SODIUM PERCENTAGE (ESP) (US DEPARTMENT OF AGRICULTURE SOIL SURVEY METHOD 4F3)

- 2.2 The analysis described in this method involves multi-elemental determinations by ICP-AES using sequential or simultaneous instruments. The instrument measures characteristic atomic-line emission spectra by optical spectrometry. Samples are aspirated into the nebulizer and the resulting aerosol is transported to the plasma torch. The emission spectra are dispersed by a grating spectrometer separating the light emitted into the distinct wavelengths generated by each element in the sample. A photosensitive device monitors the intensities of each wavelength line in the spectra. The intensity of light on the photosensitive device produces a signal that is measured and processed by a computer system.
- 2.3 This procedure includes a formula for calculating the Exchangeable Sodium Percentage (ESP) from the Sodium Adsorption Ratio (SAR).
- 2.4 Cations – Atom or group of atoms carrying a positive electric charge, indicated by a superscript plus sign after the chemical symbol.
- 2.5 Sodium Adsorption Ratio (SAR) – The tendency for sodium cations to be adsorbed at cation exchange sites in soil at the expense of other cations. The SAR is calculated as the ratio of sodium to calcium and magnesium in a soil.
- 2.6 Exchangeable Sodium Percentage (ESP) – The degree to which the soil exchange complex is saturated with sodium. It can be calculated from the SAR.
- 3.0 HEALTH AND SAFETY
- 3.1 No significant hazards are associated with the performance of this procedure; however soil samples analyzed using this procedure may contain hazardous components not identified by this preparation and the resulting analytical methods. Follow standard laboratory safety practices. The analyst should use safety glasses, gloves, and a laboratory coat to minimize the possibility of trans-dermal adsorption of these compounds.
- 4.0 SAMPLE PRESERVATION, CONTAINERS, HANDLING, AND STORAGE
- 4.1 All samples must have been collected using a sampling plan that addresses the considerations of this method.
- 4.2 All sample containers must be pre-washed with detergents, acids, and water. Plastic and glass containers are both suitable for sampling, preparation and storage of field samples.
- 4.3 Solid samples require no preservation prior to analysis other than storage at $4 \pm 2^{\circ}\text{C}$. Solid samples can be held up to six months prior to analysis.

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5.0 INTERFERENCES

- 5.1 Special precautions must be taken for peat and muck soils and for very fine or very coarse textured soils. Dry peat and muck soils, especially if coarse textured or woody, require an overnight wetting to obtain a definite endpoint for the saturated paste. After the first wetting, pastes of these soils usually stiffen and lose their glisten. However, upon adding water and re-mixing, the paste usually retains the saturated paste characteristics. With finely textured soils, enough water should be added immediately, with a minimum of mixing, bring the sample nearly to saturation. Care also should be taken not to over-wet coarse-textured soils. The presence of free water on the surface of the paste after standing is an indication of over-saturation in coarsely textured soils.
- 5.2 When analyzing samples on the ICP, caution must be taken to minimize interferences. Spectral interferences are caused by background emission from continuous or recombination phenomena, stray light from the line emission of high concentration elements, overlap of a spectral line from another element, or unresolved overlap of molecular band spectra. Due to the many possible wavelengths of light generated by each element and possible overlapping of high intensity peaks, a background correction technique is required for trace element determination. Background intensities must be measured adjacent to the analyte spectra lines during analysis. The position selected for background intensity measurement can be selected on either or both sides of the analytic line and must be determined by the complexity of the spectrum adjacent to the analyte line. The position used for background correction should be as free from spectral interference and should reflect the same change in background intensity as occurs at the analyte wavelength.
- 5.2.1 Background correction is not required in cases of line broadening where the background correction measurement would actually degrade the analytical result.
- 5.2.2 The possibility of additional interferences should also be recognized and appropriate corrections made.

6.0 EQUIPMENT AND SUPPLIES

- 6.1 Borosilicate beakers - 250mL
- 6.2 Spatulas, wooden
- 6.3 Electronic balance, ± 1 mg sensitivity
- 6.4 Filtering apparatus
- 6.5 Filter paper

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7.0 REAGENTS AND STANDARDS

7.1 Nanopure water, ASTM Type 2 grade of reagent water

8.0 PROCEDURE

- 8.1 Place a 250g of soil sample in the 250mL beaker. If 250g is not supplied by the client, record the actual weight.
- 8.2 Add sufficient Nanopure water to bring the sample nearly to saturation. To reduce soil puddling and to obtain a more definite endpoint of the saturation criteria, mix the paste with a minimum of stirring.
- 8.3 Occasionally tap the container on the workbench to consolidate the soil:water mixture. At saturation, the soil paste glistens as it reflects light; flows slightly when the container is tipped; and slides freely and cleanly off the spatula except for those soils with high clay content.
- 8.4 Cover the container and allow the sample to stand overnight.
- 8.5 Re-check saturation criteria, i.e., ordinarily, free water should not collect on the soil surface. The paste should not stiffen markedly and should not lose its glisten upon standing.
- 8.6 If the paste does not meet the saturation criteria, re-mix the paste with more Nanopure water or dry soil. Allow the paste to stand for at least 4 hours and recheck the saturation criteria.
- 8.7 Filter the paste using a vacuum-assisted filtering apparatus. Save the filtrate to be analyzed by ICP.
- 8.8 Determine Na^+ , Ca^{2+} , and Mg^{2+} concentrations by ICP-AES (see ESC SOP No. 340386).

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9.0 DATA ANALYSIS AND CALCULATIONS

- 9.1 Sodium Adsorption Ratio (SAR): Compute the sodium adsorption ratio (SAR) by dividing the molar concentration of the monovalent cation Na^+ by the square root of the molar concentration of the divalent cations Ca^{2+} and Mg^{2+} . The SAR is calculated as follows:

$$\text{SAR} = \frac{[\text{Na}^+]}{\sqrt{\frac{[\text{Ca}^{2+}] + [\text{Mg}^{2+}]}{2}}}$$

where: SAR = Sodium Adsorption Ratio
 Na^+ = Water soluble Na^+ (ppm).
 Ca^{2+} = Water soluble Ca^{2+} (ppm).
 Mg^{2+} = water soluble Mg^{2+} (ppm).

- 9.2 Exchangeable Sodium Percentage (ESP): Calculate the ESP from the SAR determined in 9.1 as follows:

$$\text{ESP} = \frac{100 (-0.0126 + 0.01475 \text{ SAR})}{[1 + (0.0126 + 0.01475 \text{ SAR})]}$$

10.0 QUALITY CONTROL AND METHOD PERFORMANCE

- 10.1 Achieve proper soil consistency in preparation and verify soil consistency the following day.

11.0 DATA VALIDATION AND CORRECTIVE ACTION

- 11.1 All data must undergo a second analyst review.
11.2 Re-check all calculations.
11.3 See *SOP#030201, Data Handling and Reporting* and *SOP #030208, Corrective Action*.

12.0 POLLUTION PREVENTION AND WASTE MANAGEMENT

- 12.1 The EPA requires that laboratory waste management practice to be conducted consistent with all applicable federal and state laws and regulations. Excess reagents, samples and method process wastes must be characterized and disposed of in an acceptable manner. See *ESC Waste Management Plan*.
12.2 See *SOP #030302, Pollution Prevention*.

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13.0 METHOD MODIFICATIONS/CLARIFICATIONS

- 13.1 The published method is written for analysis by Atomic Absorption Spectroscopy; however ESC utilizes only Inductively Coupled Plasma-Atomic Emission (ICP) Spectrometric for analysis. ICP technology can be demonstrated to be effective in the analysis of extracts produced using this preparation method.
- 13.2 The procedure for calculation of ESP as noted in reference #2 is performed by following the empirical relationship based on the SAR and ESP results.

14.0 REFERENCES

- 14.1 United States Department of Agriculture, Soil Survey Laboratory Methods Manual, Soil Survey Investigations Report, No. 42 Version 4.0 November 2004.
- 14.2 Treatment of Salt Affected Soil in the Oil Field, Remediation and Applied Technology

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PERCENTAGE (ESP) (US DEPARTMENT OF AGRICULTURE SOIL SURVEY METHOD 4F3)

Attachment I: Revision History

Current Version:

Version	Date	Description of Revisions
4	8/1/12	Technical and Quality Review and update. Added sections 2.6, 9.2, 13.2, and 14.2; Revised title and sections 2.3 and 2.5.

Superseded Versions:

This document supersedes the following:

Version	Date	Description of Revisions
0	11/22/05	Origination
1	9/21/07	Technical and Quality Review and update.
2	9/18/09	Technical and Quality Review and update. Added section 2.3; Revised section 12.1.
3	11/23/10	Technical and Quality Review and update. Revised section 12.1.
	1/4/12	Reviewed with no changes per E. Reed/Dixie Marlin

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