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The following are attachments to the prefiled answers of Mark Hutson.

ATTACHMENT 1, continued

Analytical Report for

AMEC

Certificate of Analysis No.: 10021613

Project Manager: Daniel Ley
Project Name : Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

February 25, 2010

Phase Separation Science, Inc.
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PHASE SEPARATION SCIENCE, INC.

February 25, 2010

Daniel Ley
AMEC
14428 Albermarle Point Pl., Ste. 150
Chantilly, VA 20151

Reference: PSS Work Order No: **10021613**
Project Name : Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Dear Daniel Ley :

The attached Analytical and QC Summary lists the analytical results from the analyses performed on the samples received under the project name referenced above and identified with the Phase Separation Science (PSS) Work Order numbered **10021613**.

All work reported herein has been performed in accordance with referenced methodologies, PSS Standard Operating Procedures and the PSS Quality Assurance Manual. PSS is limited in liability to the actual cost of the sample analysis done.

PSS reserves the right to return any unused samples, extracts or related solutions. Otherwise, the samples are scheduled for disposal, without any further notice, on March 23, 2010. This includes any samples that were received with a request to be held but lacked a specific hold period. It is your responsibility to provide a written request defining a specific disposal date if additional storage is required. Upon receipt , the request will be acknowledged by PSS, thus extending the storage period.

This report shall not be reproduced except in full, without the written approval of an authorized PSS representative. A copy of this report will be retained by PSS for at least 10 years, after which time it will be disposed without further notice, unless prior arrangements have been made.

We thank you for selecting Phase Separation Science, Inc. to serve your analytical needs. If you have any questions concerning this report, do not hesitate to contact us at 410-747-8770 or info@phaseonline.com.

Dan Prucnal
Laboratory Manager

Case Narrative Summary

Client Name: AMEC

Project Name: Dominion-CEC-GW Sampling

Project ID: N/A **Work Order Number: 10021613**

The following samples were received under chain of custody by Phase Separation Science (PSS) on 02/16/2010 at 06:25 pm

Lab Sample Id	Sample Id	Matrix	Date/Time Collected
10021613-001	P0-10	GROUND WATER	02/12/2010 11:53
10021613-002	P0-10-F	GROUND WATER	02/12/2010 11:53
10021613-003	P0-10-As	GROUND WATER	02/12/2010 11:53
10021613-004	P0-10-As-F	GROUND WATER	02/12/2010 11:53
10021613-005	P0-10D	GROUND WATER	02/12/2010 12:30
10021613-006	P0-10D-F	GROUND WATER	02/12/2010 12:30
10021613-007	P0-10D-As	GROUND WATER	02/12/2010 12:30
10021613-008	P0-10D-As-F	GROUND WATER	02/12/2010 12:30
10021613-009	CECW-8	GROUND WATER	02/12/2010 15:19
10021613-010	CECW-8-F	GROUND WATER	02/12/2010 15:19
10021613-011	CECW-8-As	GROUND WATER	02/12/2010 15:19
10021613-012	CECW-8-As-F	GROUND WATER	02/12/2010 15:19
10021613-013	P0-8	GROUND WATER	02/12/2010 14:13
10021613-014	P0-8-F	GROUND WATER	02/12/2010 14:13
10021613-015	P0-8-As	GROUND WATER	02/12/2010 14:13
10021613-016	P0-8-As-F	GROUND WATER	02/12/2010 14:13
10021613-017	SW-1	SURFACE WATER	02/12/2010 15:08
10021613-018	SW-1-F	SURFACE WATER	02/12/2010 15:08
10021613-019	SW-1-AS-F	SURFACE WATER	02/12/2010 15:08
10021613-020	SW-4	SURFACE WATER	02/12/2010 14:29
10021613-021	SW-4-F	SURFACE WATER	02/12/2010 14:29
10021613-022	SW-4-As-F	SURFACE WATER	02/12/2010 14:29
10021613-023	SW-3	SURFACE WATER	02/12/2010 14:44
10021613-024	SW-3-F	SURFACE WATER	02/12/2010 14:44
10021613-025	SW-3-As-F	SURFACE WATER	02/12/2010 14:44
10021613-026	SW-2	SURFACE WATER	02/12/2010 14:48
10021613-027	SW-2-F	SURFACE WATER	02/12/2010 14:48
10021613-028	SW-2-As-F	SURFACE WATER	02/12/2010 14:48
10021613-029	CECW-8D	GROUND WATER	02/12/2010 11:01
10021613-030	CECW-8D-F	GROUND WATER	02/12/2010 11:01
10021613-031	CECW-8D-As	GROUND WATER	02/12/2010 11:01
10021613-032	EB-01	WATER	02/12/2010 12:15
10021613-033	EB-01-F	WATER	02/12/2010 12:15
10021613-034	EB-01-As-F	WATER	02/12/2010 12:15

Please reference the Chain of Custody and Sample Receipt Checklist for specific container counts and preservatives. Any sample conditions not in compliance with sample acceptance criteria are described in the Sample Receipt Checklist.

Any holding time exceedances, deviations from the method specifications, regulatory requirements or variations to the procedures outlined in the PSS Quality Assurance Manual are outlined below.

Case Narrative Summary

Client Name: AMEC

Project Name: Dominion-CEC-GW Sampling

Project ID: N/A

Work Order Number: 10021613

Notes:

1. The presence of common laboratory contaminants such as acetone, methylene chloride and phthalates, may be considered a possible laboratory artifact. Where observed, appropriate consideration of data should be taken.
2. The following analytical results are never reported on a dry weight basis: pH, flashpoint, moisture and paint filter test.
3. Drinking water samples collected for the purpose of compliance with SDWA may not be suitable for their intended use unless collected by a certified sampler [COMAR 26.08.05.07.C.2].

Standard Flags/Abbreviations:

- B — A target analyte or common laboratory contaminant was identified in the method blank. Its presence indicates possible field or laboratory contamination.
- C — Results Pending Final Confirmation.
- D — The sample(s) were diluted due to targets detected over the highest point of the calibration curve, or due to matrix interference. Dilution factors are included in the final results. The result is from a diluted sample.
- E — The data exceeds the upper calibration limit; therefore, the concentration is reported as estimated.
- J — The target analyte was positively identified below the reporting limit but greater than one-half of the reporting limit.
- ND — Not Detected at or above the reporting limit.
- RL — PSS Reporting Limit.
- U — Not detected.

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021613
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: P0-10 | **Date/Time Sampled: 02/12/2010 11:53** | **PSS Sample ID: 10021613-001**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**64**	ug/L	1.0		1	02/17/10	02/18/10 15:37	1033
Iron	**1,000**	ug/L	50		1	02/17/10	02/19/10 17:39	1033

Sample ID: P0-10-F | **Date/Time Sampled: 02/12/2010 11:53** | **PSS Sample ID: 10021613-002**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**58**	ug/L	1.0		1	02/17/10	02/18/10 15:43	1033
Iron	**880**	ug/L	50		1	02/17/10	02/19/10 17:45	1033

Sample ID: P0-10-As | **Date/Time Sampled: 02/12/2010 11:53** | **PSS Sample ID: 10021613-003**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**49**	ug/L	1.0		1	02/17/10	02/18/10 15:49	1033

Sample ID: P0-10-As-F | **Date/Time Sampled: 02/12/2010 11:53** | **PSS Sample ID: 10021613-004**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**36**	ug/L	1.0		1	02/17/10	02/18/10 17:16	1033

Sample ID: P0-10D | **Date/Time Sampled: 02/12/2010 12:30** | **PSS Sample ID: 10021613-005**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**57**	ug/L	1.0		1	02/17/10	02/18/10 17:41	1033
	1,100	ug/L	50		1	02/17/10	02/18/10 17:41	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021613
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: P0-10D-F | **Date/Time Sampled: 02/12/2010 12:30** | **PSS Sample ID: 10021613-006**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**55**	ug/L	1.0		1	02/17/10	02/18/10 17:47	1033
Iron	**960**	ug/L	50		1	02/17/10	02/18/10 17:47	1033

Sample ID: P0-10D-As | **Date/Time Sampled: 02/12/2010 12:30** | **PSS Sample ID: 10021613-007**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**50**	ug/L	1.0		1	02/17/10	02/18/10 17:53	1033

Sample ID: P0-10D-As-F | **Date/Time Sampled: 02/12/2010 12:30** | **PSS Sample ID: 10021613-008**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**57**	ug/L	1.0		1	02/17/10	02/18/10 18:00	1033

Sample ID: CECW-8 | **Date/Time Sampled: 02/12/2010 15:19** | **PSS Sample ID: 10021613-009**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**8.7**	ug/L	1.0		1	02/17/10	02/18/10 18:06	1033
Iron	**27,000**	ug/L	500		10	02/17/10	02/19/10 16:37	1033

Sample ID: CECW-8-F | **Date/Time Sampled: 02/12/2010 15:19** | **PSS Sample ID: 10021613-010**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**6.1**	ug/L	1.0		1	02/17/10	02/18/10 18:12	1033
	310	ug/L	50		1	02/17/10	02/18/10 18:12	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021613
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: CECW-8-As **Date/Time Sampled: 02/12/2010 15:19** **PSS Sample ID: 10021613-011**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals Analytical Method: SW846 6020 Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.1**	ug/L	1.0		1	02/17/10	02/18/10 18:19	1033

Sample ID: CECW-8-As-F **Date/Time Sampled: 02/12/2010 15:19** **PSS Sample ID: 10021613-012**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals Analytical Method: SW846 6020 Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
:nic	**1.1**	ug/L	1.0		1	02/17/10	02/18/10 18:25	1033

Sample ID: P0-8 **Date/Time Sampled: 02/12/2010 14:13** **PSS Sample ID: 10021613-013**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals Analytical Method: SW846 6020A Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**11**	ug/L	1.0		1	02/17/10	02/18/10 18:31	1033
Iron	**120**	ug/L	50		1	02/17/10	02/18/10 18:31	1033

Sample ID: P0-8-F **Date/Time Sampled: 02/12/2010 14:13** **PSS Sample ID: 10021613-014**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals Analytical Method: SW846 6020A Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**9.9**	ug/L	1.0		1	02/17/10	02/18/10 18:56	1033
Iron	**75**	ug/L	50		1	02/17/10	02/18/10 18:56	1033

Sample ID: P0-8-As **Date/Time Sampled: 02/12/2010 14:13** **PSS Sample ID: 10021613-015**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals Analytical Method: SW846 6020 Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.0**	ug/L	1.0		1	02/17/10	02/18/10 19:02	1033

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CERTIFICATE OF ANALYSIS

No: 10021613
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: P0-8-As-F | **Date/Time Sampled: 02/12/2010 14:13** | **PSS Sample ID: 10021613-016**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.7**	ug/L	1.0		1	02/17/10	02/18/10 19:08	1033

Sample ID: SW-1 | **Date/Time Sampled: 02/12/2010 15:08** | **PSS Sample ID: 10021613-017**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
[illegible]nic	**1.3**	ug/L	1.0		1	02/17/10	02/18/10 19:15	1033
Iron	**910**	ug/L	50		1	02/17/10	02/18/10 19:15	1033

Sample ID: SW-1-F | **Date/Time Sampled: 02/12/2010 15:08** | **PSS Sample ID: 10021613-018**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.0**	ug/L	1.0		1	02/17/10	02/18/10 19:21	1033
Iron	**590**	ug/L	50		1	02/17/10	02/18/10 19:21	1033

Sample ID: SW-1-AS-F | **Date/Time Sampled: 02/12/2010 15:08** | **PSS Sample ID: 10021613-019**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**0.7**	ug/L	1.0	J	1	02/17/10	02/18/10 19:27	1033

Sample ID: SW-4 | **Date/Time Sampled: 02/12/2010 14:29** | **PSS Sample ID: 10021613-020**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.2**	ug/L	1.0		1	02/17/10	02/18/10 19:33	1033
[illegible]	**1,100**	ug/L	50		1	02/17/10	02/18/10 19:33	1033

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AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: SW-4-F | **Date/Time Sampled: 02/12/2010 14:29** | **PSS Sample ID: 10021613-021**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.3**	ug/L	1.0		1	02/17/10	02/18/10 13:14	1033
Iron	**810**	ug/L	50		1	02/17/10	02/18/10 13:14	1033

Sample ID: SW-4-As-F | **Date/Time Sampled: 02/12/2010 14:29** | **PSS Sample ID: 10021613-022**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.0**	ug/L	1.0	J	1	02/17/10	02/18/10 14:03	1033

Sample ID: SW-3 | **Date/Time Sampled: 02/12/2010 14:44** | **PSS Sample ID: 10021613-023**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.7**	ug/L	1.0		1	02/17/10	02/18/10 14:09	1033
Iron	**2,900**	ug/L	50		1	02/17/10	02/18/10 14:09	1033

Sample ID: SW-3-F | **Date/Time Sampled: 02/12/2010 14:44** | **PSS Sample ID: 10021613-024**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.4**	ug/L	1.0		1	02/17/10	02/18/10 14:15	1033
Iron	**760**	ug/L	50		1	02/17/10	02/18/10 14:15	1033

Sample ID: SW-3-As-F | **Date/Time Sampled: 02/12/2010 14:44** | **PSS Sample ID: 10021613-025**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
enic	**1.0**	ug/L	1.0	J	1	02/17/10	02/18/10 14:22	1033

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No: 10021613
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: SW-2 | **Date/Time Sampled: 02/12/2010 14:48** | **PSS Sample ID: 10021613-026**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	2.6	ug/L	1.0		1	02/17/10	02/18/10 14:28	1033
Iron	1,100	ug/L	50		1	02/17/10	02/18/10 14:28	1033

Sample ID: SW-2-F | **Date/Time Sampled: 02/12/2010 14:48** | **PSS Sample ID: 10021613-027**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	1.7	ug/L	1.0		1	02/17/10	02/18/10 14:34	1033
Iron	550	ug/L	50		1	02/17/10	02/18/10 14:34	1033

Sample ID: SW-2-As-F | **Date/Time Sampled: 02/12/2010 14:48** | **PSS Sample ID: 10021613-028**
Matrix: SURFACE WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	1.4	ug/L	1.0		1	02/17/10	02/18/10 14:40	1033

Sample ID: CECW-8D | **Date/Time Sampled: 02/12/2010 11:01** | **PSS Sample ID: 10021613-029**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	20	ug/L	1.0		1	02/17/10	02/18/10 14:46	1033
Iron	18,000	ug/L	500		10	02/17/10	02/19/10 16:43	1033

Sample ID: CECW-8D-F | **Date/Time Sampled: 02/12/2010 11:01** | **PSS Sample ID: 10021613-030**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	12	ug/L	1.0		1	02/17/10	02/18/10 14:51	1033
Iron	18,000	ug/L	500		10	02/17/10	02/19/10 16:49	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021613
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: CECW-8D-As | **Date/Time Sampled: 02/12/2010 11:01** | **PSS Sample ID: 10021613-031**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**9.4**	ug/L	1.0		1	02/17/10	02/18/10 15:14	1033

Sample ID: EB-01 | **Date/Time Sampled: 02/12/2010 12:15** | **PSS Sample ID: 10021613-032**
Matrix: WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	ND	ug/L	1.0		1	02/17/10	02/19/10 17:20	1033
Iron	**99**	ug/L	50		1	02/17/10	02/19/10 17:20	1033

Sample ID: EB-01-F | **Date/Time Sampled: 02/12/2010 12:15** | **PSS Sample ID: 10021613-033**
Matrix: WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**0.5**	ug/L	1.0	J	1	02/17/10	02/18/10 15:26	1033
Iron	ND	ug/L	50		1	02/17/10	02/19/10 17:26	1033

Sample ID: EB-01-As-F | **Date/Time Sampled: 02/12/2010 12:15** | **PSS Sample ID: 10021613-034**
Matrix: WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**3.6**	ug/L	1.0		1	02/17/10	02/18/10 15:31	1033

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

www.phaseonline.com
email: info@phaseonline.com

①
CLIENT: AMEC | OFFICE LOC.: Chantilly, VA
PROJECT MGR: Dan Ley | PHONE NO.: (703) 488 3741
EMAIL: Daniel.Ley@amec.com | FAX NO.: (703) 488 3701
PROJECT NAME: Dominion - CEC - GW Sampling | PROJECT NO.:
SITE LOCATION: CEC Chesapeake, VA | P.O. NO.:
SAMPLERS: Jessica Errico & Dan Ley

PSS Work order # 1002/1013 | PAGE 1 OF 4

Matrix Codes:
SW=Surface Wtr DW=Drinking Wrt GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W= Wipe

②

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE (C = COMP, G = GRAB)	③ Preservatives Used: HNO3 — Analysis/Method Required: As, Fe, Co	Preservatives Used: HNO3 — Analysis/Method Required: As	REMARKS
1	PO-10	2/12/10	11:53	GW	1	G	X		
2	PO-10-F	2/12/10	11:53	GW	1	G	X		
3	PO-10-As^{3+}	2/12/10	11:53	GW	1	G		X	
4	PO-10-As^{3+}-F	2/12/10	11:53	GW	1	G		X	
5	PO-10D	2/12/10	12:30	GW	1	G	X		
6	PO-10D-F	2/12/10	12:30	GW	1	G	X		
7	PO-10D-As^{3+}	2/12/10	12:30	GW	1	G		X	
8	PO-10D-As^{3+}-F	2/12/10	12:30	GW	1	G		X	
9	CECW-8	2/12/10	15:19	GW	1	G	X		
10	CECW-8-F	2/12/10	15:19	GW	1	G	X		

⑤

Relinquished By	Date	Time	Received By
(1) Jessica Errico	2/16/10	16:35 ~~17:00~~	Dan Parker, #337
(2) Dan Parker, #337	2/16/10	6:25	[illegible signature]
(3)			
(4)			

④ **Requested Turnaround Time**
☒ 5-Day ☐ 3-Day ☐ 2-Day
☐ Next Day ☐ Emergency ☐ Other

Data Deliverables Required: Standard, Excel EDD

# of Coolers: 2
Custody Seal: No
Ice Present: Yes | Temp: 1°C
Shipping Carrier: DAL

Special Instructions:

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

www.phaseonline.com
email: info@phaseonline.com

CLIENT: AMEC	OFFICE LOC. Chantilly, VA
PROJECT MGR: Dan Ley	PHONE NO.: (703) 488-3741
EMAIL: Daniel.Ley@amec.com	FAX NO.: (703) 488 3701
PROJECT NAME: Dominion-CEC-GW Sampling	PROJECT NO.:
SITE LOCATION: CEC-Chesapeake, VA	P.O. NO.:
SAMPLERS: Jessica Errico & Dan Ley	

PSS Work Order #: 1002113 — PAGE 2 OF 4

Matrix Codes:
SW=Surface Wtr DW=Drinking Wrt GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W= Wipe

Preservatives Used: HNO3 | HNO3 | none

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE (C = COMP, G = GRAB)	As, Fe, Co (HNO3)	As (HNO3)	TSS (none)									REMARKS
11	CECW-8-As^{3+}	2/12/10	15:19	GW	1	G		X										
12	CECW-8-As^{3+}-F	2/12/10	15:19	GW	1	G		X										
13	PO-8	2/12/10	14:13	GW	1	G	X											
14	PO-8-F	2/12/10	14:13	GW	1	G	X											
15	PO-8-As^{3+}	2/12/10	14:13	GW	1	G		X										
16	PO-8-As^{3+}-F	2/12/10	14:13	GW	1	G		X										
17	SW-1	2/12/10	15:08	SW	2	G	X		X									
18	SW-1-F	2/12/10	15:08	SW	1	G	X											
19	SW-1-As^{3+}-F	2/12/10	15:08	SW	1	G		X										
20	SW-4	2/12/10	14:29	SW	2	G	X		X									

Relinquished By	Date	Time	Received By
(1) Jessica Errico	2/15/10	16:35 ~~17:00~~	Dan Carter #222
(2) Dan Carter #222	02/16/10	6:25	[signature]
(3)			
(4)			

Requested Turnaround Time

- [x] 5-Day
- [ ] 3-Day
- [ ] 2-Day
- [ ] Next Day
- [ ] Emergency
- [ ] Other

Data Deliverables Required: Standard
Excel EDD

# of Coolers: 2
Custody Seal: No
Ice Present: Yes Temp: 1°C
Shipping Carrier: [illegible]

Special Instructions:

6630 Baltimore National Pike • Route 40 West • Baltimore, Maryland 21228 • (410) 747-8770 • (800) 932-9047 • Fax (410) 788-8723

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

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email: info@phaseonline.com

PSS Work Order #: 1002-1613 | PAGE 3 OF 4

Matrix Codes:
SW=Surface Wtr DW=Drinking Wrt GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W= Wipe

(1)
CLIENT: AMEC | OFFICE LOC. Chantilly, VA
PROJECT MGR: Dan Ley | PHONE NO.: (703) 488 3741
EMAIL: Daniel.Ley@amec.com | FAX NO.: (703) 488-3701
PROJECT NAME: Dominion - CEC - GW Sampling | PROJECT NO.:
SITE LOCATION: CEC - Chesapeake, VA | P.O. NO.:
SAMPLERS: Jessica Errico & Dan Ley

(2) (3)

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE C = COMP G = GRAB	As, Fe, Co (Preservative: HNO3)	As3+ (Preservative: HNO3)	TSS (Preservative: None)										REMARKS
21	SW-4-F	2/12/10	14:29	SW	1	G	X												
22	SW-4-As3+-F	2/12/10	14:29	SW	1	G		X											
23	SW-3	2/12/10	14:44	SW	2	G	X		X										
24	SW-3-F	2/12/10	14:44	SW	1	G	X												
25	SW-3-As3+-F	2/12/10	14:44	SW	1	G		X											
26	SW-2	2/12/10	14:48	SW	2	G	X		X										
27	SW-2-F	2/12/10	14:48	SW	1	G	X												
28	SW-2-As3+-F	2/12/10	14:48	SW	1	G		X											
29	CECW-8D	2/12/10	11:01	GW	1	G	X												
30	CECW-8D-F	2/12/10	11:01	GW	1	G	X												

(5)

Relinquished By:	Date	Time	Received By:
(1) Jessica Errico	2/15/10	17:00	Van Carter, #222
(2) Van Carter, #222	2/16/10	6:25	[signature]
(3)			
(4)			

(4)
Requested Turnaround Time
- [x] 5-Day
- [ ] 3-Day
- [ ] 2-Day
- [ ] Next Day
- [ ] Emergency
- [ ] Other

Data Deliverables Required: Standard
Excel EDD

# of Coolers: 2
Custody Seal: No
Ice Present: Yes | Temp: 1°C
Shipping Carrier: DHL

Special Instructions:

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SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

www.phaseonline.com
email: info@phaseonline.com

1

CLIENT: AMEC
OFFICE LOC.: Chantilly, VA
PROJECT MGR: Dan Ley
PHONE NO.: (703) 488-3741
EMAIL: Daniel.ley@amec.com
FAX NO.: (703) 488-3701
PROJECT NAME: Dominion-CEC-GW Sampling
PROJECT NO.:
SITE LOCATION: CEC-Chesapeake, VA
P.O. NO.:
SAMPLERS: Jessica Errico & Dan Ley

PSS Work Order #: 1002[illegible]
PAGE 4 OF 4

Matrix Codes:
SW=Surface Wtr DW=Drinking Wrt GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W= Wipe

2 **3**

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE C = COMP G = GRAB	Preservatives Used: HNO3 / Analysis/Method Required: As, Fe, Co	Preservatives Used: HNO3 / Analysis/Method Required: As										REMARKS
31	CECW-8D-As3+	2/12/10	11:01	GW	1	G		X										
32	EB-01	2/12/10	12:15	—	1		X											
33	EB-01-F	2/12/10	12:15	—	1		X											
34	EB-01-As3+-F	2/12/10	12:15	—	1			X										

5

Relinquished By	Date	Time	Received By
(1) Jessica Errico	2/15/10	6:35 ~~17:00~~	Dan Carter, #222
(2) Dan Carter	2/16/10	6:35	[signature]
(3)			
(4)			

4

Requested Turnaround Time
- [x] 5-Day
- [ ] 3-Day
- [ ] 2-Day
- [ ] Next Day
- [ ] Emergency
- [ ] Other

Data Deliverables Required: Standard Excel EDD

\# of Coolers: 2
Custody Seal: N/O
Ice Present: yes
Temp: 1°C
Shipping Carrier: Drop

Special Instructions:

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The client (Client Name), by signing, or having client's agent sign, this "Sample Chain of Custody/Agreement Form", agrees to pay for the above requested services per the latest version of the Service Brochure or PSS-provided quotation including any and all attorney's or other reasonable fees if collection becomes necessary.

Phase Separation Science, Inc

Sample Receipt Checklist

Wo Number	10021613	**Received By**	Chuks Iregbu
Client Name	AMEC	**Date Received**	02/16/2010 06:25:00 PM
Project Name	Dominion-CEC-GW Sampling	**Delivered By**	Dial Courier
Project Number	N/A	**Tracking No**	Not Applicable
Disposal Date:	03/23/2010	**Logged In By**	Lynn Moran

Shipping Container(s)

No. of Coolers	2	Ice	Present
Custody Seals	Absent	Temp (deg C)	1
Seal Condition	Absent	Temp Blank Present	No

Documentation

COC agrees with sample labels? ✓ Yes or ___ No   Sampler Name: Jessica Errico

Chain of Custody (COC) ✓ Yes or ___ No   MD DW Cert. No.: ________

Sample Container

Appropiate for Specified Analysis?	Yes ✓	No ___	Custody Seal(s)	Absent
Intact?	✓	___	Custody Seal(s) Intact?	Not Applicable
Labeled and Labels Legible	✓	___	Seal(s) Signed / Dated	Not Applicable
Total No of Samples Received	34		Total No of Containers Received	38

Preservation

		Yes	No	N/A
Metals	(pH<2)	✓		
Cyanides	(pH>12)			✓
Sulfide	(pH>9)			✓
TOC, COD, Phenols	(pH<2)			✓
TOX, TKN, NH3, Total Phos	(pH<2)			✓
VOC, BTEX (VOA Vials Rcvd Preserved)	(pH<2)			✓
Do VOA vials have zero headspace?				✓

Comments: (Any "No" response must be detailed in the comments section below.)

For any improper preservation conditions, list sample ID, preservative added (reagent ID number) below as well as documentation of any client notification as well as client instructions. Samples for pH, chlorine and dissolved oxygen should be analyzed as soon as possible, preferably in the field at the time of sampling.

Samples Inspected/Checklist Completed By: LM   Date: 2/17/10

PM Review and Approval: [signature]   Date: 2/17/10

Printed. 02/17/2010 12:20 PM

Analytical Report for

AMEC

Certificate of Analysis No.: 10021614

Project Manager: Daniel Ley
Project Name : Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

February 25, 2010

Phase Separation Science, Inc.
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Baltimore, MD 21228
Phone: (410) 747-8770
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PHASE SEPARATION SCIENCE, INC.

20 YEARS 1989 - 2009 ANALYTICAL CHEMISTRY ENVIRONMENTAL SCIENCE EXCEEDING THE STANDARD

February 25, 2010

Daniel Ley
AMEC
14428 Albermarle Point Pl., Ste. 150
Chantilly, VA 20151

Reference: PSS Work Order No: **10021614**
Project Name : Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Dear Daniel Ley :

The attached Analytical and QC Summary lists the analytical results from the analyses performed on the samples received under the project name referenced above and identified with the Phase Separation Science (PSS) Work Order numbered **10021614**.

All work reported herein has been performed in accordance with referenced methodologies, PSS Standard Operating Procedures and the PSS Quality Assurance Manual. PSS is limited in liability to the actual cost of the sample analysis done.

PSS reserves the right to return any unused samples, extracts or related solutions. Otherwise, the samples are scheduled for disposal, without any further notice, on March 23, 2010. This includes any samples that were received with a request to be held but lacked a specific hold period. It is your responsibility to provide a written request defining a specific disposal date if additional storage is required. Upon receipt , the request will be acknowledged by PSS, thus extending the storage period.

This report shall not be reproduced except in full, without the written approval of an authorized PSS representative. A copy of this report will be retained by PSS for at least 10 years, after which time it will be disposed without further notice, unless prior arrangements have been made.

We thank you for selecting Phase Separation Science, Inc. to serve your analytical needs. If you have any questions concerning this report, do not hesitate to contact us at 410-747-8770 or info@phaseonline.com.

Dan Prucnal
Laboratory Manager

Case Narrative Summary

Client Name: AMEC

Project Name: Dominion-CEC-GW Sampling

Project ID: N/A **Work Order Number: 10021614**

The following samples were received under chain of custody by Phase Separation Science (PSS) on 02/16/2010 at 06:25 pm

Lab Sample Id	Sample Id	Matrix	Date/Time Collected
10021614-001	CECW-1D	GROUND WATER	02/10/2010 12:54
10021614-002	CECW-1D-F	GROUND WATER	02/10/2010 12:54
10021614-003	CECW-1D-As	GROUND WATER	02/10/2010 12:54
10021614-004	MW-5	GROUND WATER	02/10/2010 09:57
10021614-005	MW-5-F	GROUND WATER	02/10/2010 09:57
10021614-006	MW-5-As	GROUND WATER	02/10/2010 09:57
10021614-007	MW-5D	GROUND WATER	02/09/2010 16:05
10021614-008	MW-5D-F	GROUND WATER	02/09/2010 16:05
10021614-009	MW-5D-As	GROUND WATER	02/09/2010 16:05
10021614-010	CECW-2D	GROUND WATER	02/10/2010 16:00
10021614-011	CECW-2D-F	GROUND WATER	02/10/2010 16:00
10021614-012	CECW-2D-As	GROUND WATER	02/10/2010 16:00
10021614-013	CECW-1	GROUND WATER	02/10/2010 14:27
10021614-014	CECW-1-F	GROUND WATER	02/10/2010 14:27
10021614-015	CECW-1-As	GROUND WATER	02/10/2010 14:27
10021614-016	Dup-01	GROUND WATER	02/11/2010 00:00
10021614-017	Dup-01-F	GROUND WATER	02/11/2010 00:00
10021614-018	Dup-01-As	GROUND WATER	02/11/2010 00:00
10021614-019	CECW-6I	GROUND WATER	02/11/2010 13:16
10021614-020	CECW-6I-F	GROUND WATER	02/11/2010 13:16
10021614-021	CECW-6I-As	GROUND WATER	02/11/2010 13:16
10021614-022	CECW-6D	GROUND WATER	02/11/2010 12:21
10021614-023	CECW-6D-F	GROUND WATER	02/11/2010 12:21
10021614-024	CECW-6D-As	GROUND WATER	02/11/2010 12:21
10021614-025	CECW-3	GROUND WATER	02/11/2010 09:53
10021614-026	CECW-3-F	GROUND WATER	02/11/2010 09:53
10021614-027	CECW-3-F-As	GROUND WATER	02/11/2010 09:53
10021614-028	CECW-3D	GROUND WATER	02/11/2010 11:00
10021614-029	CECW-3D-F	GROUND WATER	02/11/2010 11:00
10021614-030	CECW-3D-As	GROUND WATER	02/11/2010 11:00
10021614-031	CECW-15	GROUND WATER	02/11/2010 15:50
10021614-032	CECW-15-F	GROUND WATER	02/11/2010 15:50
10021614-033	CECW-15-As	GROUND WATER	02/11/2010 15:50
10021614-034	P0-8D	GROUND WATER	02/11/2010 16:43
10021614-035	P0-8D-F	GROUND WATER	02/11/2010 16:43
10021614-036	P0-8D-As	GROUND WATER	02/11/2010 16:43
10021614-037	CECW-2	GROUND WATER	02/10/2010 16:38
10021614-038	CECW-2-F	GROUND WATER	02/10/2010 16:38
10021614-039	CECW-2-As	GROUND WATER	02/10/2010 16:38

Case Narrative Summary

Client Name: AMEC

Project Name: Dominion-CEC-GW Sampling

Project ID: N/A **Work Order Number: 10021614**

Please reference the Chain of Custody and Sample Receipt Checklist for specific container counts and preservatives. Any sample conditions not in compliance with sample acceptance criteria are described in the Sample Receipt Checklist.

Any holding time exceedances, deviations from the method specifications, regulatory requirements or variations to the procedures outlined in the PSS Quality Assurance Manual are outlined below.

Notes:

1. The presence of common laboratory contaminants such as acetone, methylene chloride and phthalates, may be considered a possible laboratory artifact. Where observed, appropriate consideration of data should be taken.
2. The following analytical results are never reported on a dry weight basis: pH, flashpoint, moisture and paint filter test.
3. Drinking water samples collected for the purpose of compliance with SDWA may not be suitable for their intended use unless collected by a certified sampler [COMAR 26.08.05.07.C.2].

Standard Flags/Abbreviations:

- B A target analyte or common laboratory contaminant was identified in the method blank. Its presence indicates possible field or laboratory contamination.
- C Results Pending Final Confirmation.
- D The sample(s) were diluted due to targets detected over the highest point of the calibration curve, or due to matrix interference. Dilution factors are included in the final results. The result is from a diluted sample.
- E The data exceeds the upper calibration limit; therefore, the concentration is reported as estimated.
- J The target analyte was positively identified below the reporting limit but greater than one-half of the reporting limit.
- ND Not Detected at or above the reporting limit.
- RL PSS Reporting Limit.
- U Not detected.

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FAX 410-788-8723

PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: CECW-1D **Date/Time Sampled: 02/10/2010 12:54** **PSS Sample ID: 10021614-001**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**19**	ug/L	1.0		1	02/17/10	02/18/10 16:32	1033
Iron	**10,000**	ug/L	500		10	02/17/10	02/19/10 16:24	1033

Sample ID: CECW-1D-F **Date/Time Sampled: 02/10/2010 12:54** **PSS Sample ID: 10021614-002**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**17**	ug/L	1.0		1	02/17/10	02/18/10 17:03	1033
Iron	**9,300**	ug/L	500		10	02/17/10	02/19/10 16:30	1033

Sample ID: CECW-1D-As **Date/Time Sampled: 02/10/2010 12:54** **PSS Sample ID: 10021614-003**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**20**	ug/L	1.0		1	02/17/10	02/18/10 17:10	1033

Sample ID: MW-5 **Date/Time Sampled: 02/10/2010 09:57** **PSS Sample ID: 10021614-004**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**3.5**	ug/L	1.0		1	02/17/10	02/18/10 15:54	1033
Iron	**570**	ug/L	50		1	02/17/10	02/19/10 17:57	1033

Sample ID: MW-5-F **Date/Time Sampled: 02/10/2010 09:57** **PSS Sample ID: 10021614-005**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
~~enic	**3.2**	ug/L	1.0		1	02/17/10	02/18/10 16:00	1033
~~on	**40**	ug/L	50	J	1	02/17/10	02/19/10 18:03	1033

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FAX 410-788-8723

PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: MW-5-As **Date/Time Sampled: 02/10/2010 09:57** **PSS Sample ID: 10021614-006**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**0.7**	ug/L	1.0	J	1	02/17/10	02/18/10 16:22	1033

Sample ID: MW-5D **Date/Time Sampled: 02/09/2010 16:05** **PSS Sample ID: 10021614-007**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
nic	**8.8**	ug/L	1.0		1	02/18/10	02/19/10 21:47	1033
Iron	**160,000**	ug/L	5,000		100	02/18/10	02/22/10 15:05	1033

Sample ID: MW-5D-F **Date/Time Sampled: 02/09/2010 16:05** **PSS Sample ID: 10021614-008**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**8.8**	ug/L	1.0		1	02/18/10	02/19/10 22:25	1033
Iron	**160,000**	ug/L	5,000		100	02/18/10	02/22/10 15:11	1033

Sample ID: MW-5D-As **Date/Time Sampled: 02/09/2010 16:05** **PSS Sample ID: 10021614-009**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**9.3**	ug/L	1.0		1	02/18/10	02/19/10 22:33	1033

Sample ID: CECW-2D **Date/Time Sampled: 02/10/2010 16:00** **PSS Sample ID: 10021614-010**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**21**	ug/L	1.0		1	02/18/10	02/19/10 22:41	1033
	16,000	ug/L	500		10	02/18/10	02/22/10 15:17	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS
No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: CECW-2D-F — **Date/Time Sampled: 02/10/2010 16:00** — **PSS Sample ID: 10021614-011**
Matrix: GROUND WATER — **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**20**	ug/L	1.0		1	02/18/10	02/19/10 23:11	1033
Iron	**15,000**	ug/L	500		10	02/18/10	02/22/10 15:24	1033

Sample ID: CECW-2D-As — **Date/Time Sampled: 02/10/2010 16:00** — **PSS Sample ID: 10021614-012**
Matrix: GROUND WATER — **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**21**	ug/L	1.0		1	02/18/10	02/19/10 23:18	1033

Sample ID: CECW-1 — **Date/Time Sampled: 02/10/2010 14:27** — **PSS Sample ID: 10021614-013**
Matrix: GROUND WATER — **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**35**	ug/L	1.0		1	02/18/10	02/19/10 23:26	1033
Iron	**7,600**	ug/L	500		10	02/18/10	02/22/10 15:49	1033

Sample ID: CECW-1-F — **Date/Time Sampled: 02/10/2010 14:27** — **PSS Sample ID: 10021614-014**
Matrix: GROUND WATER — **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**33**	ug/L	1.0		1	02/18/10	02/19/10 23:34	1033
Iron	**7,100**	ug/L	500		10	02/18/10	02/22/10 15:55	1033

Sample ID: CECW-1-As — **Date/Time Sampled: 02/10/2010 14:27** — **PSS Sample ID: 10021614-015**
Matrix: GROUND WATER — **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
enic	**34**	ug/L	1.0		1	02/18/10	02/19/10 23:41	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: Dup-01 | **Date/Time Sampled: 02/11/2010 00:00** | **PSS Sample ID: 10021614-016**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.3**	ug/L	1.0	B	1	02/18/10	02/19/10 23:49	1033
Iron	**31,000**	ug/L	500		10	02/18/10	02/22/10 16:01	1033

Sample ID: Dup-01-F | **Date/Time Sampled: 02/11/2010 00:00** | **PSS Sample ID: 10021614-017**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.3**	ug/L	1.0	B	1	02/18/10	02/19/10 23:57	1033
Iron	**30,000**	ug/L	500		10	02/18/10	02/22/10 16:07	1033

Sample ID: Dup-01-As | **Date/Time Sampled: 02/11/2010 00:00** | **PSS Sample ID: 10021614-018**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.4**	ug/L	1.0	B	1	02/18/10	02/20/10 00:05	1033

Sample ID: CECW-6I | **Date/Time Sampled: 02/11/2010 13:16** | **PSS Sample ID: 10021614-019**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**210**	ug/L	1.0		1	02/18/10	02/20/10 00:12	1033
Iron	**15,000**	ug/L	500		10	02/18/10	02/22/10 16:13	1033

Sample ID: CECW-6I-F | **Date/Time Sampled: 02/11/2010 13:16** | **PSS Sample ID: 10021614-020**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
...enic	**210**	ug/L	1.0		1	02/18/10	02/20/10 00:19	1033
...on	**15,000**	ug/L	500		10	02/18/10	02/22/10 16:19	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: CECW-6I-As **Date/Time Sampled: 02/11/2010 13:16** **PSS Sample ID: 10021614-021**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**210**	ug/L	1.0		1	02/18/10	02/20/10 00:50	1033

Sample ID: CECW-6D **Date/Time Sampled: 02/11/2010 12:21** **PSS Sample ID: 10021614-022**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
;nic	**25**	ug/L	1.0		1	02/18/10	02/20/10 00:57	1033
Iron	**14,000**	ug/L	500		10	02/18/10	02/22/10 16:26	1033

Sample ID: CECW-6D-F **Date/Time Sampled: 02/11/2010 12:21** **PSS Sample ID: 10021614-023**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**23**	ug/L	1.0		1	02/18/10	02/20/10 01:05	1033
Iron	**14,000**	ug/L	500		10	02/18/10	02/22/10 16:32	1033

Sample ID: CECW-6D-As **Date/Time Sampled: 02/11/2010 12:21** **PSS Sample ID: 10021614-024**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020 — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**19**	ug/L	1.0		1	02/18/10	02/20/10 01:13	1033

Sample ID: CECW-3 **Date/Time Sampled: 02/11/2010 09:53** **PSS Sample ID: 10021614-025**
Matrix: GROUND WATER **Date/Time Received: 02/16/2010 18:25**

Total Metals — Analytical Method: SW846 6020A — Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**11**	ug/L	1.0		1	02/18/10	02/20/10 01:20	1033
	1,200	ug/L	50		1	02/18/10	02/20/10 01:20	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: CECW-3-F | **Date/Time Sampled: 02/11/2010 09:53** | **PSS Sample ID: 10021614-026**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**5.0**	ug/L	1.0	B	1	02/18/10	02/20/10 01:28	1033
Iron	**52**	ug/L	50		1	02/18/10	02/20/10 01:28	1033

Sample ID: CECW-3-F-As | **Date/Time Sampled: 02/11/2010 09:53** | **PSS Sample ID: 10021614-027**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.3**	ug/L	1.0		1	02/18/10	02/19/10 19:23	1033

Sample ID: CECW-3D | **Date/Time Sampled: 02/11/2010 11:00** | **PSS Sample ID: 10021614-028**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**130**	ug/L	1.0		1	02/18/10	02/19/10 18:53	1033
Iron	**1,700**	ug/L	50		1	02/18/10	02/19/10 18:53	1033

Sample ID: CECW-3D-F | **Date/Time Sampled: 02/11/2010 11:00** | **PSS Sample ID: 10021614-029**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**120**	ug/L	1.0		1	02/18/10	02/19/10 19:29	1033
Iron	**1,300**	ug/L	50		1	02/18/10	02/19/10 19:29	1033

Sample ID: CECW-3D-As | **Date/Time Sampled: 02/11/2010 11:00** | **PSS Sample ID: 10021614-030**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
›nic	**110**	ug/L	1.0		1	02/18/10	02/19/10 19:36	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: CECW-15 | **Date/Time Sampled: 02/11/2010 15:50** | **PSS Sample ID: 10021614-031**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.0**	ug/L	1.0		1	02/18/10	02/19/10 20:04	1033
Iron	**32,000**	ug/L	500		10	02/18/10	02/22/10 14:53	1033

Sample ID: CECW-15-F | **Date/Time Sampled: 02/11/2010 15:50** | **PSS Sample ID: 10021614-032**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.2**	ug/L	1.0		1	02/18/10	02/19/10 20:11	1033
Iron	**31,000**	ug/L	500		10	02/18/10	02/22/10 14:59	1033

Sample ID: CECW-15-As | **Date/Time Sampled: 02/11/2010 15:50** | **PSS Sample ID: 10021614-033**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.2**	ug/L	1.0		1	02/18/10	02/19/10 20:18	1033

Sample ID: P0-8D | **Date/Time Sampled: 02/11/2010 16:43** | **PSS Sample ID: 10021614-034**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**9.4**	ug/L	1.0		1	02/18/10	02/19/10 20:26	1033
Iron	**2,300**	ug/L	50		1	02/18/10	02/19/10 20:26	1033

Sample ID: P0-8D-F | **Date/Time Sampled: 02/11/2010 16:43** | **PSS Sample ID: 10021614-035**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
enic	**4.2**	ug/L	1.0		1	02/18/10	02/19/10 20:33	1033
Iron	**1,000**	ug/L	50		1	02/18/10	02/19/10 20:33	1033

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PHASE SEPARATION SCIENCE, INC.

CERTIFICATE OF ANALYSIS

No: 10021614
AMEC, Chantilly, VA
February 25, 2010

Project Name: Dominion-CEC-GW Sampling
Project Location: CEC-Chesapeake, VA

Sample ID: P0-8D-As | **Date/Time Sampled: 02/11/2010 16:43** | **PSS Sample ID: 10021614-036**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**1.3**	ug/L	1.0		1	02/18/10	02/19/10 20:40	1033

Sample ID: CECW-2 | **Date/Time Sampled: 02/10/2010 16:38** | **PSS Sample ID: 10021614-037**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
nic	**14**	ug/L	1.0		1	02/18/10	02/19/10 20:47	1033
Iron	**1,000**	ug/L	50		1	02/18/10	02/19/10 20:47	1033

Sample ID: CECW-2-F | **Date/Time Sampled: 02/10/2010 16:38** | **PSS Sample ID: 10021614-038**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020A | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**3.9**	ug/L	1.0		1	02/18/10	02/19/10 20:55	1033
Iron	**84**	ug/L	50		1	02/18/10	02/19/10 20:55	1033

Sample ID: CECW-2-As | **Date/Time Sampled: 02/10/2010 16:38** | **PSS Sample ID: 10021614-039**
Matrix: GROUND WATER | **Date/Time Received: 02/16/2010 18:25**

Total Metals | Analytical Method: SW846 6020 | Preparation Method: SW846 3010A

	Result	Units	RL	Flag	Dil	Prepared	Analyzed	Analyst
Arsenic	**2.2**	ug/L	1.0		1	02/18/10	02/19/10 21:02	1033

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

www.phaseonline.com
email: info@phaseonline.com

CLIENT: AMEC	OFFICE LOC. Chantilly, VA	PSS Work Order #: 1002[illegible]34	PAGE 1 OF 4
PROJECT MGR: Dan Ley	PHONE NO.: (703) 488-3741		
EMAIL: Daniel.Ley@amec.com	FAX NO.: (703) 488-3701		
PROJECT NAME: Dominion - CEC - GW Sampling	PROJECT NO.:		
SITE LOCATION: CEC - Chesapeake, VA	P.O. NO.:		
SAMPLERS: Jessica Errico & Dan Ley			

Matrix Codes:
SW=Surface Wtr DW=Drinking Wrt GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W= Wipe

Preservatives Used: HNO_3, HNO_3

Analysis/Method Required (3): As, Fe, Co; As

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE C = COMP G = GRAB	As, Fe, Co (HNO_3)	As (HNO_3)	REMARKS
1	CECW-1D	2/10/10	12:54	GW	1	G	X		
2	CECW-1D-F	2/10/10	12:54	GW	1	G	X		
3	CECW-1D-As^{3+}	2/10/10	12:54	GW	1	G		X	
4	MW-5	2/10/10	9:57	GW	1	G	X		
5	MW-5-F	2/10/10	9:57	GW	1	G	X		
6	MW-5-As^{3+}	2/10/10	9:57	GW	1	G		X	
7	MW-5D	2/9/10	16:05	GW	1	G	X		
8	MW-5D-F	2/9/10	16:05	GW	1	G	X		
9	MW-5D-As^{3+}	2/9/10	16:05	GW	1	G		X	
10	CECW-2D	2/10/10	16:00	GW	1	G	X		

Relinquished By:	Date	Time	Received By:
(1) Jessica Errico	2/15/10	16:35 (~~17:00~~)	Sam Carter #222
(2) Sam Carter, #222	2/16/10	6:21	[signature]
(3)			
(4)			

Requested Turnaround Time (4)
- [x] 5-Day
- [ ] 3-Day
- [ ] 2-Day
- [ ] Next Day
- [ ] Emergency
- [ ] Other

Data Deliverables Required: Standard - Excel - EDD

# of Coolers: 2	
Custody Seal: NO	
Ice Present: Yes	Temp: 1°C
Shipping Carrier: SW	

Special Instructions:

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

www.phaseonline.com
email: info@phaseonline.com

PSS Work Order #: 1002110134   PAGE 2 OF 4

CLIENT: AMEC   OFFICE LOC. Chantilly, VA
PROJECT MGR: Dan Ley   PHONE NO.: (703) 488-3741
EMAIL: Daniel.ley@amec.com   FAX NO.: (703) 488-3701
PROJECT NAME: Dominion-CEC-GWsampling   PROJECT NO.:
SITE LOCATION: CEC-Chesapeake, VA   P.O. NO.:
SAMPLERS: Jessica Errico & Dan Ley

Matrix Codes: SW=Surface Wtr DW=Drinking Wtr GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W=Wipe

Preservatives Used: HNO_3, HNO_3

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX	No. CONTAINERS	SAMPLE TYPE (C = COMP, G = GRAB)	B, Fe, Li MS	As	REMARKS
11	CECW-2D-F	2/10/10	16:00	GW	1	G	X		
12	CECW-2D-As^{3+}	2/10/10	16:00	GW	1	G		X	
13	CECW-1	2/10/10	14:27	GW	1	G	X		
14	CECW-1-F	2/10/10	14:27	GW	1	G	X		
15	CECW-1-As^{3+}	2/10/10	14:27	GW	1	G		X	
16	DUP-01	2/11/10	—	GW	1	G	X		
17	DUP-01-F	2/11/10	—	GW	1	G	X		
18	DUP-01-As^{3+}	2/11/10	—	GW	1	G		X	
19	CECW-6I	2/11/10	13:16	GW	1	G	X		
20	CECW-6I-F	2/11/10	13:16	GW	1	G	X		

Relinquished By	Date	Time	Received By
(1) Jessica Errico	2/16/10	16:35 (~~17:00~~)	Van Carter #222
(2) Van Carter #222	02/16/10	6:25	[signature]
(3)			
(4)			

Requested Turnaround Time: ☒ 5-Day ☐ 3-Day ☐ 2-Day ☐ Next Day ☐ Emergency ☐ Other

# of Coolers: 2
Custody Seal: No
Ice Present: Yes Temp: 1°C
Shipping Carrier: DFAZ

Data Deliverables Required: Standard
Excel EDD

Special Instructions:

6630 Baltimore National Pike • Route 40 West • Baltimore, Maryland 21228 • (410) 747-8770 • (800) 932-9047 • Fax (410) 788-8723

The client (Client Name), by signing, or having client's agent sign, this "Sample Chain of Custody/Agreement Form", agrees to pay for the above requested services per the latest version of the Service Brochure or PSS-provided quotation including any and all attorney's or other reasonable fees if collection becomes necessary.

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

www.phaseonline.com
email: info@phaseonline.com

1

CLIENT: AMEC OFFICE LOC.: Chantilly, VA
PROJECT MGR: Dan Ley PHONE NO.: (703) 488-3741
EMAIL: Daniel.Ley@amec.com FAX NO.: (703) 488-3701
PROJECT NAME: Dominion-CEC-GW Sampling PROJECT NO.:
SITE LOCATION: CEC-Chesapeake, VA P.O. NO.:
SAMPLERS: Jessica Errico & Dan Ley

PSS Work Order #: 10021603 PAGE 3 OF 4

Matrix Codes:
SW=Surface Wtr DW=Drinking Wrt GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W=Wipe

2

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE (C = COMP, G = GRAB)	As, Fe, Co (Preservative: HNO3)	As3 (Preservative: HNO3)										REMARKS
21	CECW-6I-As3+	2/11/10	13:16	GW	1	G		X										
22	CECW-6D	2/11/10	12:21	GW	1	G	X											
23	CECW-6D-F	2/11/10	12:21	GW	1	G	X											
24	CECW-6D-As3+	2/11/10	12:21	GW	1	G		X										
25	CECW-3	2/11/10	9:53	GW	1	G	X											
26	CECW-3-F	2/11/10	9:53	GW	1	G	X											
27	CECW-3-As3+	2/11/10	9:53	GW	1	G		X										
28	CECW-3D	2/11/10	11:00	GW	1	G	X											
29	CECW-3D-F	2/11/10	11:00	GW	1	G	X											
30	CECW-3D-As3+	2/11/10	11:00	GW	1	G		X										

3 Analysis/Method Required

5

Relinquished By:	Date	Time	Received By:
(1) [signature]	2/16/10	16:35	[signature] #333
(2) [signature] #333	2/16/10	8:35	[signature]
(3)			
(4)			

4

Requested Turnaround Time
- [x] 5-Day
- [ ] 3-Day
- [ ] 2-Day
- [ ] Next Day
- [ ] Emergency
- [ ] Other

# of Coolers: [illegible]
Custody Seal: No
Ice Present: [illegible] Temp: [illegible]°C
Shipping Carrier: [illegible]

Data Deliverables Required: Standard Excel-EDD

Special Instructions:

SAMPLE CHAIN OF CUSTODY/AGREEMENT FORM

PHASE SEPARATION SCIENCE, INC.

www.phaseonline.com
email: info@phaseonline.com

CLIENT: AMEC	OFFICE LOC. Chantilly, VA	PSS Work Order #: 10021634	PAGE 4 OF 4
PROJECT MGR: Dan Fey	PHONE NO.: (703) 488 3741		
EMAIL: Daniel.Fey@amec.com	FAX NO.: (703) 488 3701		
PROJECT NAME: Dominion-CEC-GW Sampling	PROJECT NO.:		
SITE LOCATION: CEC-Chesapeake, VA	P.O. NO.:		
SAMPLERS: Jessica Errico & Dan Fey			

Matrix Codes:
SW=Surface Wtr DW=Drinking Wrt GW=Ground Wtr WW=Waste Wtr O=Oil S=Soil WL=Waste Liquid WS=Waste Solid W= Wipe

Preservatives Used: HNO_3, HNO_3

LAB NO.	SAMPLE IDENTIFICATION	DATE	TIME	MATRIX (See Codes)	No. CONTAINERS	SAMPLE TYPE (C = COMP, G = GRAB)	As, Fe, Co	As	REMARKS
31	CECW-15	2/11/10	15:50	GW	1	G	X		
32	CECW-15-F	2/11/10	15:50	GW	1	G	X		
33	CECW-15-As3+	2/11/10	15:50	GW	1	G		X	
34	PO-8D	2/11/10	16:43	GW	1	G	X		
35	PO-8D-F	2/11/10	16:43	GW	1	G	X		
36	PO-8D-As3+	2/11/10	16:43	GW	1	G		X	
37	CECW-2	2/10/10	16:38	GW	1	G	X		
38	CECW-2-F	2/10/10	16:38	GW	1	G	X		
39	CECW-2-As3+	2/10/10	16:38	GW	1	G		X	

Relinquished By	Date	Time	Received By
(1) Jessica Errico	2/15/10	16:35	Dan Carter, #222
(2) Dan Carter, #222	02/16/10	6:25	[signature]
(3)			
(4)			

Requested Turnaround Time
- [x] 5-Day
- [ ] 3-Day
- [ ] 2-Day
- [ ] Next Day
- [ ] Emergency
- [ ] Other

Data Deliverables Required: Standard - Excel EDD

Special Instructions:

# of Coolers:	2
Custody Seal:	N/A
Ice Present:	Yes; Temp: 1°C
Shipping Carrier:	Drive

Phase Separation Science, Inc

Sample Receipt Checklist

Wo Number	10021614	**Received By**	Chuks Iregbu
Client Name	AMEC	**Date Received**	02/16/2010 06:25:00 PM
Project Name	Dominion-CEC-GW Sampling	**Delivered By**	Dial Courier
Project Number	N/A	**Tracking No**	Not Applicable
Disposal Date:	03/23/2010	**Logged In By**	Lynn Moran

Shipping Container(s)

No of Coolers	2	Ice	Present
Custody Seals	Absent	Temp (deg C)	1
Seal Condition	Absent	Temp Blank Present	No

Documentation

COC agrees with sample labels? ✓ Yes or ____ No   Sampler Name: Jessica Errico

Chain of Custody (COC) ✓ Yes or ____ No   MD DW Cert. No.: N/A

Sample Container

Appropiate for Specified Analysis?	Yes ✓	No ___	Custody Seal(s)	Absent
Intact?	✓	____	Custody Seal(s) Intact?	Not Applicable
Labeled and Labels Legible	✓	____	Seal(s) Signed / Dated	Not Applicable
Total No of Samples Received	39		Total No. of Containers Received	39

Preservation

		Yes	No	N/A
Metals	(pH<2)	✓		
Cyanides	(pH>12)			✓
Sulfide	(pH>9)			✓
TOC, COD, Phenols	(pH<2)			✓
TOX, TKN, NH3, Total Phos	(pH<2)			✓
VOC, BTEX (VOA Vials Rcvd Preserved)	(pH<2)			✓
Do VOA vials have zero headspace?				✓

Comments: (Any "No" response must be detailed in the comments section below.)

For any improper preservation conditions, list sample ID, preservative added (reagent ID number) below as well as documentation of any client notification as well as client instructions. Samples for pH, chlorine and dissolved oxygen should be analyzed as soon as possible, preferably in the field at the time of sampling.

Samples Inspected/Checklist Completed By: LM   Date: 2/17/10

PM Review and Approval: [signature]   Date: 2/17/10

Printed 02/17/2010 12:52 PM

APPENDIX E

ARSENIC SPECIATION METHOD

Arsenic Species Separation Using Anion Exchange Resin Columns in the Field

Objective

This is a procedure to separate the inorganic compound pentavalent arsenic acid (H_3AsO_4), from trivalent arsenious acid (H_3AsO_3) and other organic arsenic species in groundwater and surface water. In the environmental literature, the inorganic compounds are commonly referred to as: As(V) and As^{5+}, and, As(III) and As^{3+}, respectively.

Background

Arsenic mobility, toxicity, and treatment alternatives vary depending on the arsenic species present. The most common species in fresh water natural environments are the trivalent As(III) and pentavalent As(V) oxidation states, generally found in nature as oxyanions; and smaller quantities of organic arsenic compounds, generally as the methylated species monomethylarsonic acid (MMA) and dimethyarsenic acid (DMA) (Cullen and Riemer, 1989). Arsenic species have been found to be unstable in the time between sampling and analysis. Arsenic species analytical and/or preservation methods are under development that should eventually eliminate this problem. An alternative to preservation for later analysis is field separation of arsenic species (Ficklin, 1983). This method has a long history and has been improved with use (Edwards et al., 1998, Miller et al., 2000).

The principle is that the arsenic oxyanions are polyprotic acids that disassociate at pKa's that are fixed for each acid. Anion exchange resins will bind negatively charged ions and allow neutral and positively charged ions (cations) to pass through. The pKa's for common arsenic species are tabularized below. From the table, it is clear that in the pH range of most natural waters, As^{3+} is a neutral species (no charge) and As^{5+} is an ion (negative charge). The attached speciation figure is calculated from the As^{5+} data in the table and equilibrium relationships. From the figure it can be seen that the dominant As^{5+} species in the pH range of natural waters are $HAsO_4^{2-}$ and $H_2AsO_4^-$, and that between pH 3.2 and 6, >90% of the As^{5+} is present as $H_2AsO_4^-$. At pH 3.1 to 6.0, anion exchange resins will pass As^{3+}, and retain As^{5+}, in most fresh water.

It is known that particulate bound arsenic will pass through the column (Edwards et al, 1998) and that DMA and MMA will elute with As^{3+}, causing false positives, or increased levels for As^{3+} (Miller et al., 2000). In the strictest sense, what happens is the column separates dissolved As^{5+} from all other forms of arsenic. In most cases, all of the eluant from the column can be considered As^{3+}.

Table 1. Acid disassociation constants for arsenic compounds.

Species	Below pK_1	pK_1	$pK_1 \Leftrightarrow pK_2$	pK_2	Above pK_2	pK_3
As^{3+}	neutral	9.18	anion			
As^{5+}	neutral	2.26	anion	6.67	anion	11.29
MMAA	neutral	3.41	anion	8.18		
DMAA	cation	2.60	neutral	6.27	anion	

Equipment

1. BioRad Econo-Columns containing 10-12 ml, BioRad AG-1 8X 50-100 mesh, strong anion resin prepared in the acetate form (BioRad, 1997), capped with a HDPE frit.
2. 125 ml wide mouth Nalgene sample bottles.
3. Dropper bottle with 1:20 trace metal grade H_2SO_4 (~5%).
4. pH Tester or pH paper

Site Specific Procedure

Pretest a 100 ml aliquot of groundwater at each well to determine the number of drops of 20:1 H_2SO_4 that are required to cause the pH drop to the range of 3-6. Swirl and wait 30 seconds before measuring. Lower pH can result in some As^{5+} not being retained on the column. Use pH 5 as a target. The number of drops required will be proportional to the alkalinity.

1. Collect one (1) 100 ml aliquot of sample in the same manner as the sample for filtered total metals to be submitted to the laboratory.
2. Add the appropriate number of drops of 20:1 H_2SO_4 to the filtered 100 ml aliquot, cap, swirl, and wait 30 seconds.
3. Test the pH to ensure it is in the range of 3-6. If it is below 3, discard and start over.
4. Uncap the resin column and remove the yellow bottom cap allowing the liquid inside to drain to waste.
5. As the liquid passes into the frit, add a 20 ml aliquot of the 20:1 H_2SO_4 buffered sample to the column, allowing the 20 ml to pass to waste.

   Note: The first few times this is executed it is suggested that the yellow cap be placed back on the outflow between each of the following steps; draining of liquid to waste, preconditioning column with sample to waste, and, collection of the sample. With experience and agility, you will find that it is not necessary to replace the yellow cap between steps. The hazard lies in allowing air to enter the column past the upper frit, or spilling sample down the side of the column. While air causes problems, it does not "ruin" the column, but will impede flow. If, by chance, you air lock columns and run out of ones to use, call me on my cell (505.217.4809) and we will fix it in the field with what you have on hand.

6. Immediately following Step 5, pass 50 ml of sample through the column, collecting the sample in a 125 ml Nalgene. This is the As^{3+} sample. Preserve the sample in the 125 ml Nalgene with trace metal grade HNO_3 to pH <2. Cap this sample, label "As^{3+}" along with other project and well specific information as required, and retain for shipment to the analytical laboratory.
7. Repeat this procedure for one groundwater sample and one surface water sample as field replicates.
8. Pull the tape from the column, place inside, and cap the used column top and bottom for return to Geochemical. This ensures that used columns can be differentiated from unused columns. Please return all columns, used or unused, the dropper bottle, any unused Nalgene, and ship to Geochemical.

Citations

Bio-Rad (1997) AG 1, AG MP-1, and AG 2 strong anion exchange resin instruction manual. LIT212 Rev. C, Bio-Rad Laboratories 2000 Alfred Nobel Drive, Hercules, CA 94547

Cullen, W. R., and Reimer, K. J. (1989). Arsenic speciation in the environment. *Chem. Rev.* **89** 713-764.

Edwards, M., Patel, S., McNeill, L., Chen, H., Frey, M., Eaton, A. D., Antweiler, R. C., and Taylor, H. E. (1998) Considerations in As analysis. *Journal AWWA* 90 (3), 103-113.

Ficklin, W. H. (1983) Separation of arsenic(III) and arsenic(V) in ground waters by ion exchange. *Talanta* 30 (5), 371-373.

Miller, G.P., D.I. Norman, and P.L. Frisch, 2000. A Comment on Arsenic Species Separation Using Ion Exchange. *Water Research* 34(4):1397-1400.

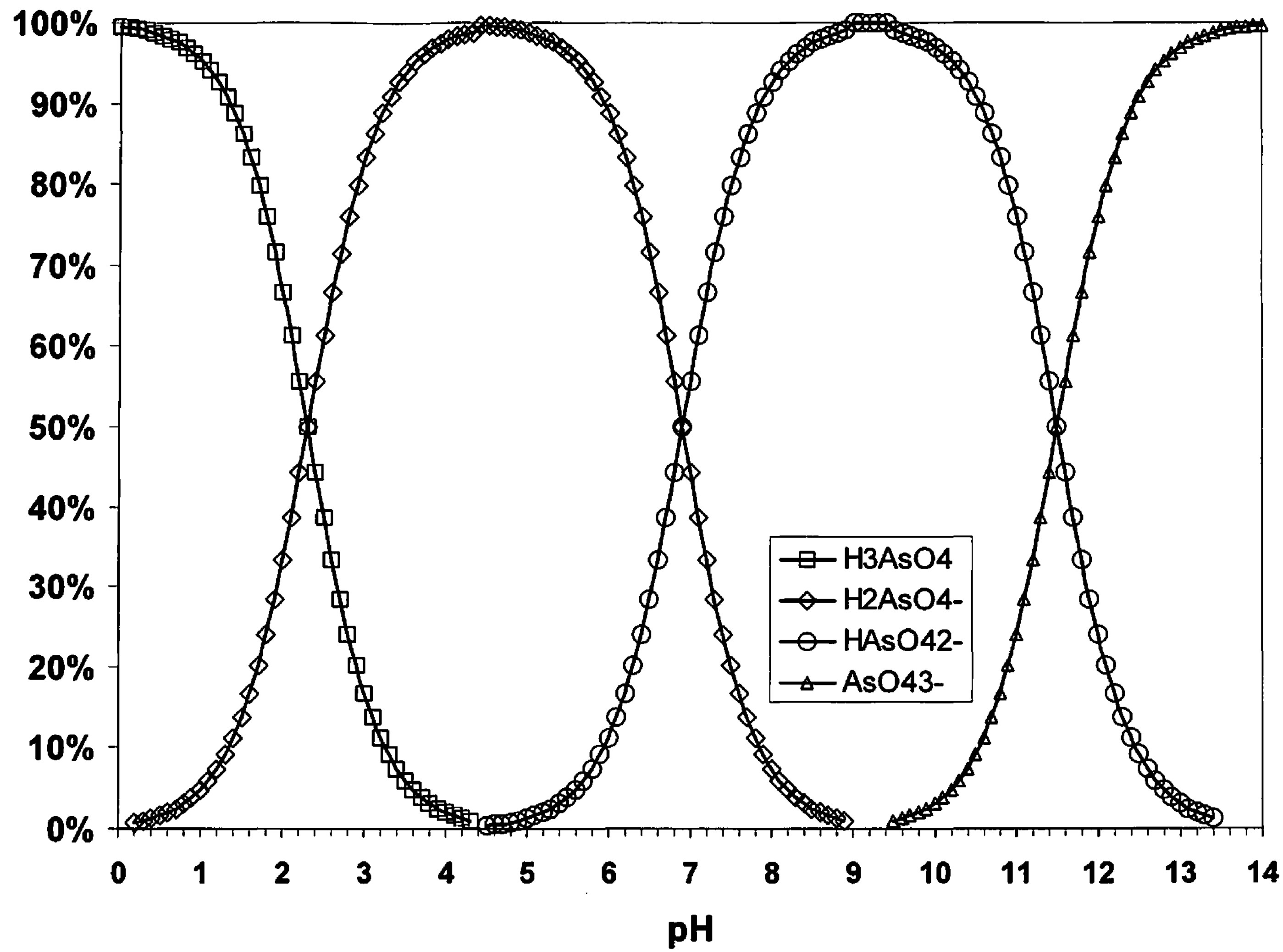
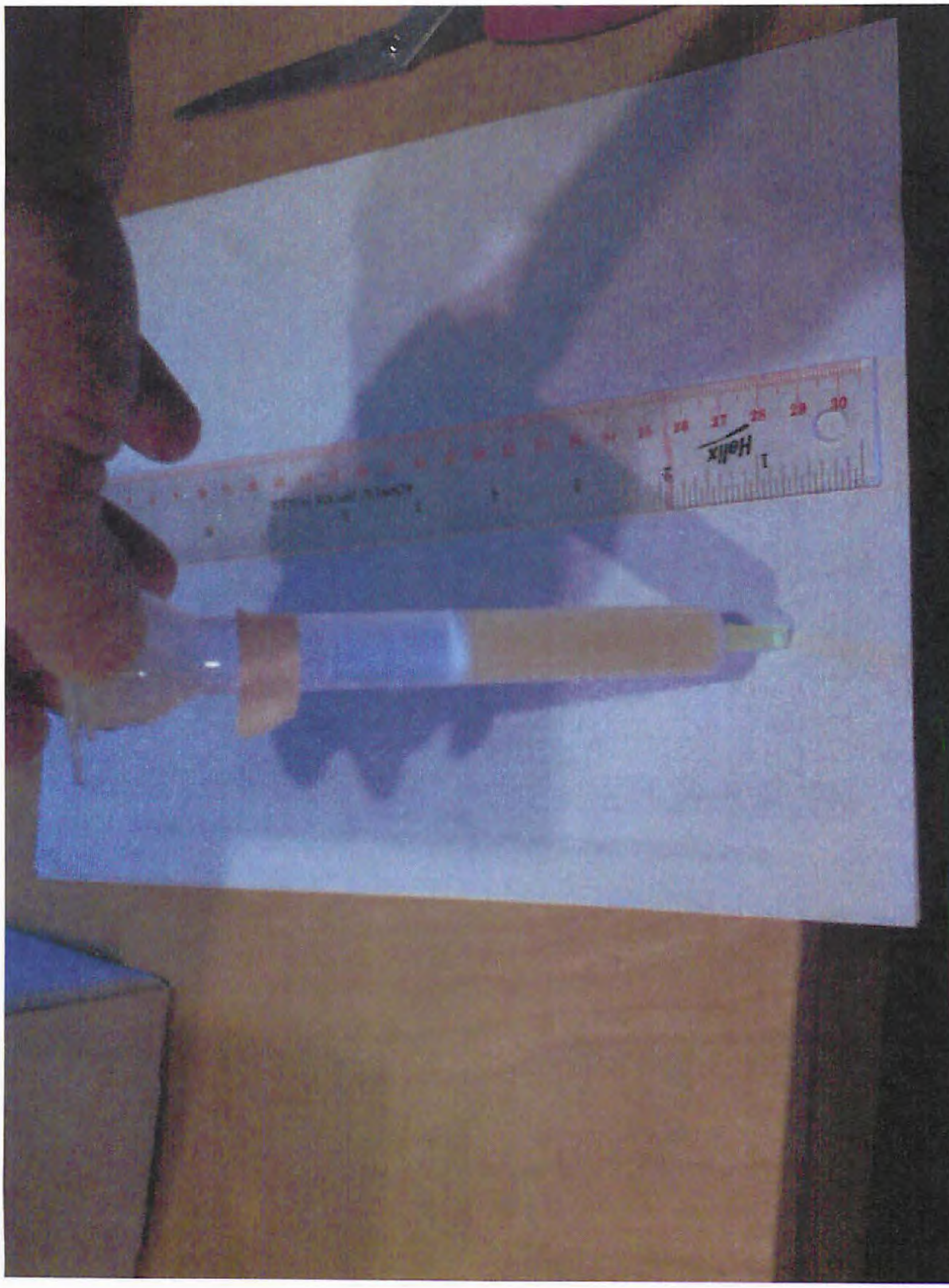
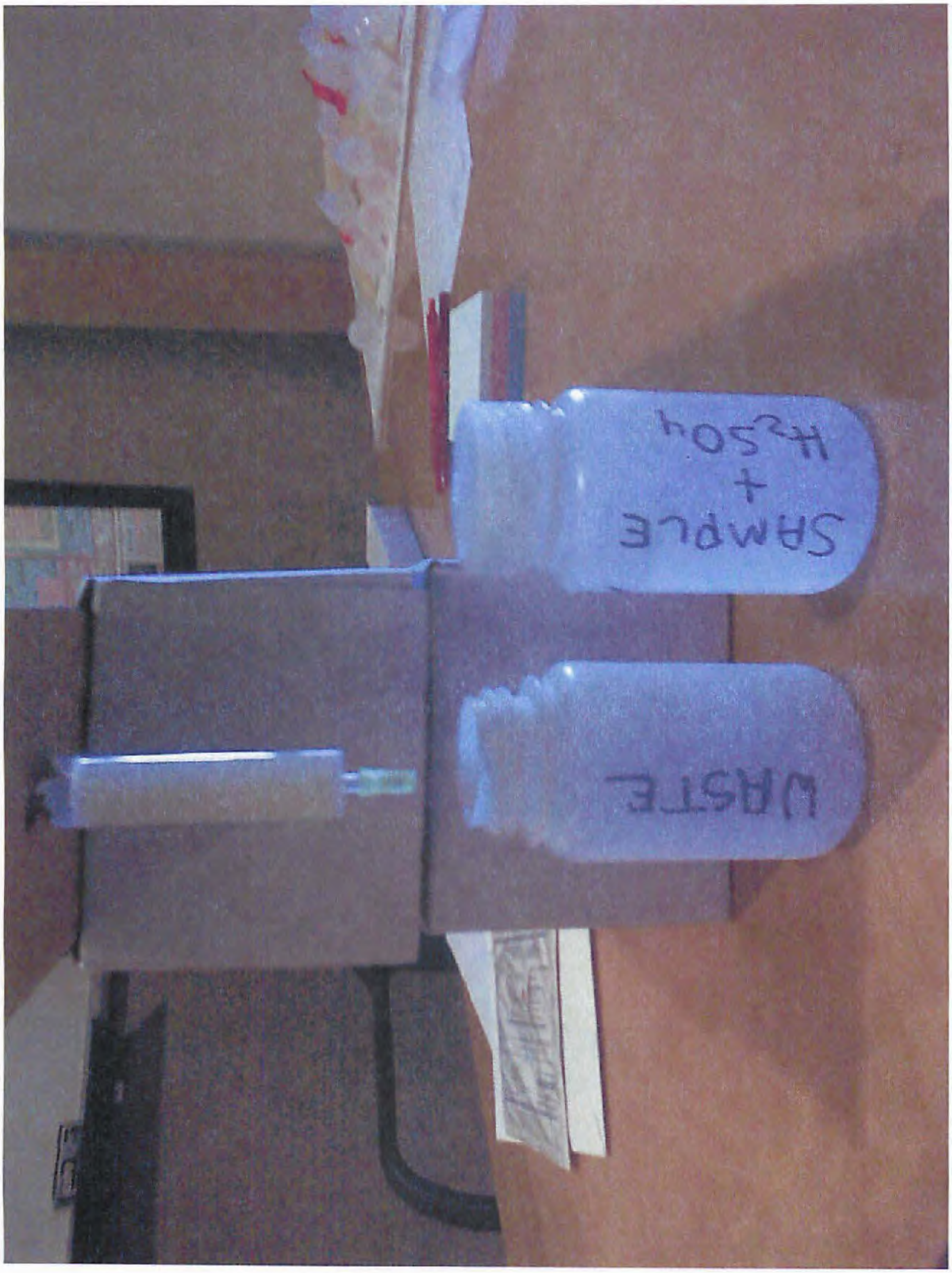


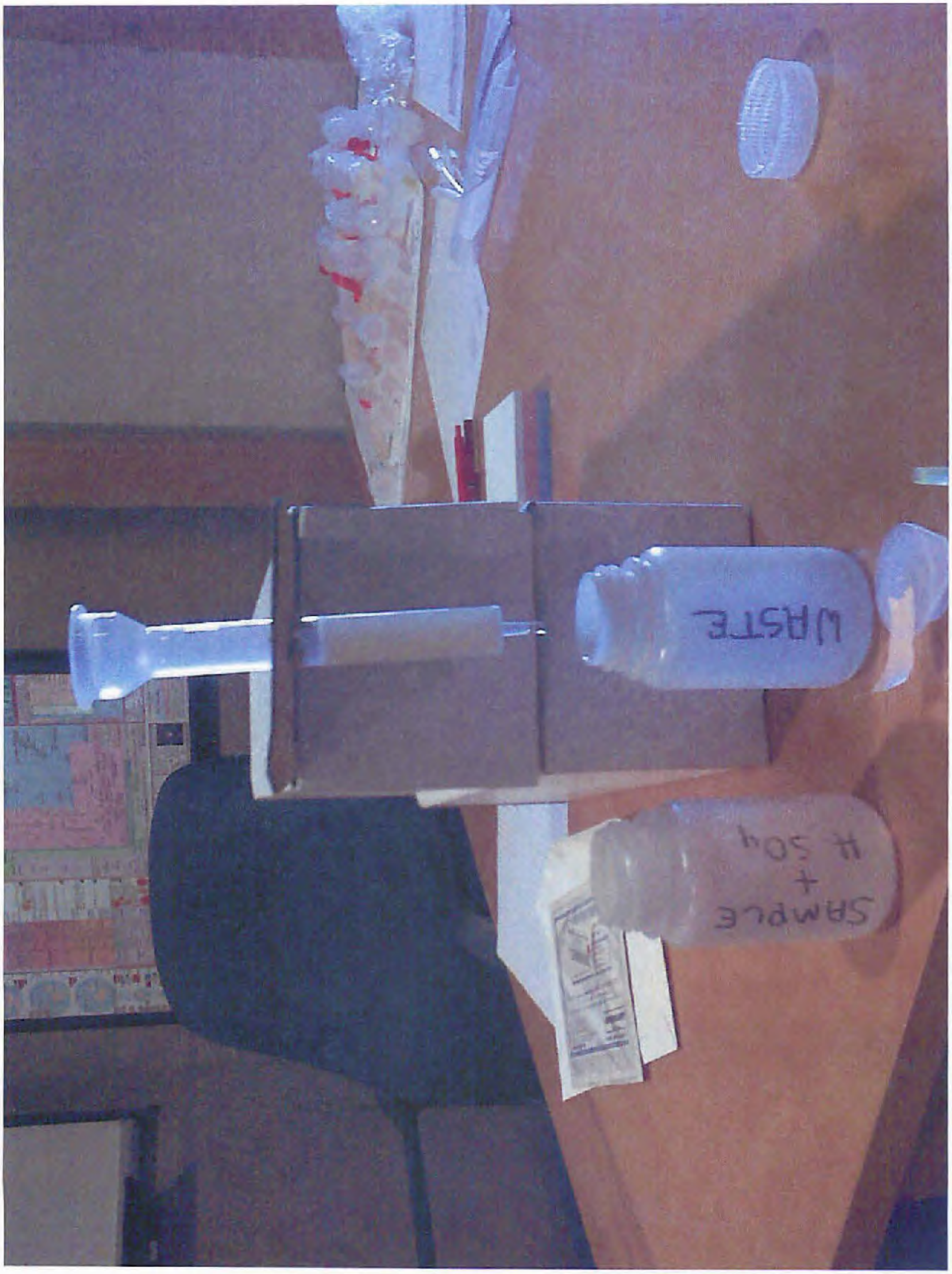
Figure 1. Arsenic speciation graph for arsenic acid.

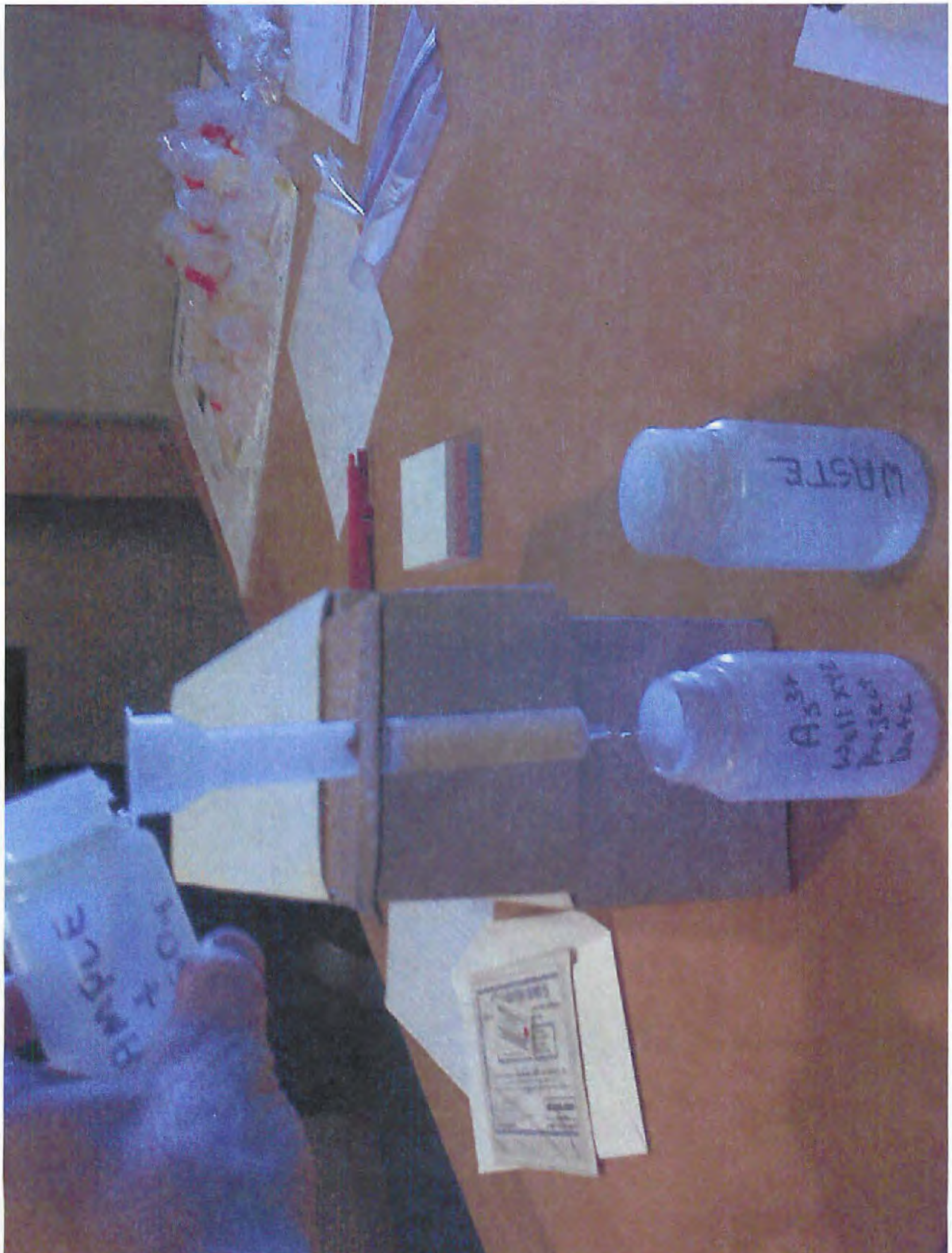
Photographs of speciation technique.

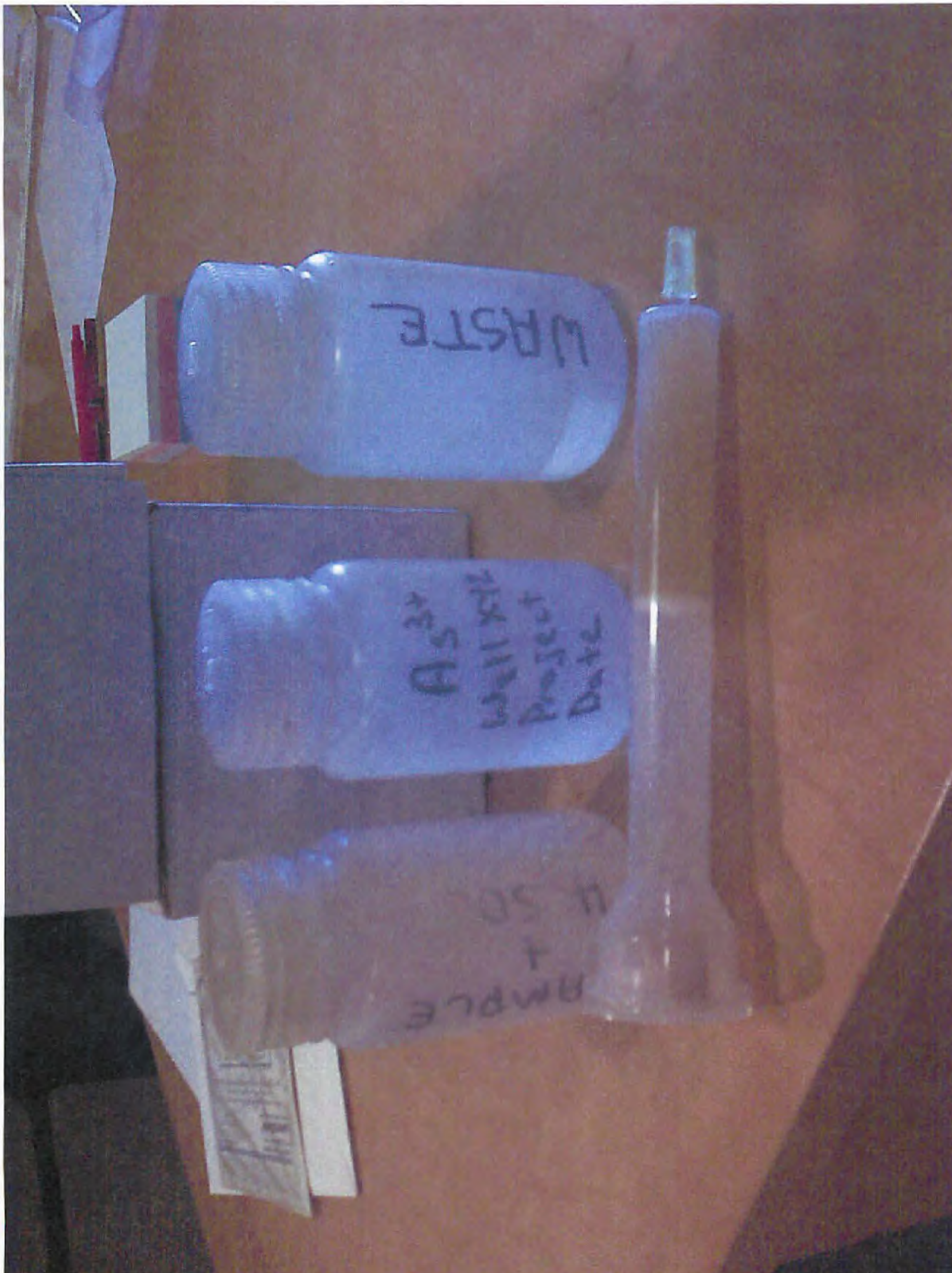



SAMPLE + H_2SO_4
WASTE


SAMPLE
+
H2SO4


WASTE
SAMPLE + H SO4


WASTE


WASTE

ATTACHMENT 2

ENVIRONMENTAL PROTECTION AGENCY

40 CFR Part 257

[EPA–HQ–OLEM–2019–0172 and EPA–HQ–OLEM–2018–0524; FRL–10013–20–OLEM]

RIN 2050–AH10

Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals From Electric Utilities; A Holistic Approach to Closure Part A: Deadline To Initiate Closure

AGENCY: Environmental Protection Agency (EPA).

ACTION: Final rule.

SUMMARY: On April 17, 2015, the Environmental Protection Agency (EPA or the Agency) promulgated national minimum criteria for existing and new coal combustion residuals (CCR) landfills and existing and new CCR surface impoundments. On August 21, 2018, the U.S. Court of Appeals for the D.C. Circuit issued its opinion in the case of *Utility Solid Waste Activities Group* v. *EPA,* 901 F.3d 414 (per curiam) (*USWAG*). This rule finalizes regulations, proposed on December 2, 2019, to implement the court's vacatur of the 2015 provisions. The court vacated provisions that allowed unlined impoundments to continue receiving coal ash unless they leak, and classified ''clay-lined'' impoundments as lined, thereby allowing such units to operate indefinitely. In addition, EPA is establishing a revised date by which unlined surface impoundments must cease receiving waste and initiate closure, following its reconsideration of those dates in light of the *USWAG* decision. Lastly, EPA is finalizing amendments proposed on August 14, 2019, to the requirements for the annual groundwater monitoring and corrective action report and the requirements for the publicly accessible CCR internet sites.

DATES: This final rule is effective on September 28, 2020.

ADDRESSES: EPA has established two dockets for this action under Docket ID No. EPA–HQ–OLEM–2019–0172 and EPA–HQ–OLEM–2018–0524. All documents in the docket are listed on the *http://www.regulations.gov* website. Although listed in the index, some information is not publicly available, *e.g.,* confidential business information (CBI) or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the internet and will be publicly available only in hard copy form. Publicly available docket materials are available electronically through *http://www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT: For information concerning this final rule, contact Kirsten Hillyer, Materials Recovery and Waste Management Division, Office of Resource Conservation and Recovery, Environmental Protection Agency, 1200 Pennsylvania Avenue NW, MC: 5304P, Washington, DC 20460; telephone number: (703) 347–0369; email address: *Hillyer.Kirsten@epa.gov.* For more information on this rulemaking, please visit *https://www.epa.gov/coalash.*

SUPPLEMENTARY INFORMATION:

Table of Contents

I. Executive Summary

A. Purpose of the Regulatory Action

This rule takes final action on the proposed rule published on December 2, 2019 (84 FR 65941), as well as two issues included in the proposal issued on August 14, 2019 (84 FR 40353). This unit of the preamble summarizes public participation activities associated with both proposed rules. EPA is publishing this final rule to revise portions of the federal CCR regulations in title 40 of the Code of Federal Regulations (CFR) Part 257 so that they accurately reflect the regulations as they now stand in light of the D.C. Circuit's 2018 decision in *USWAG,* which vacated portions of EPA's 2015 final rule promulgating national minimum criteria for existing and new CCR landfills and existing and new CCR surface impoundments. Specifically, the D.C. Circuit vacated (1) the provisions of the 2015 rule that permitted unlined impoundments to continue receiving coal ash unless they leak (see 40 CFR 257.101(a)); and (2) the provisions of the 2015 rule that classified ''clay-lined'' impoundments as lined (see 40 CFR 257.71(a)(1)(i)).

In addition, this final rule addresses the October 31, 2020 deadline in §§ 257.101(a) and (b)(1)(i), by which CCR surface impoundments must cease receipt of waste; in a separate case, these regulatory provisions were remanded back to EPA by the D.C. Circuit for further reconsideration in light of *USWAG. See Waterkeeper Alliance Inc.* v. *EPA,* No. 18–1289 (D.C. Cir. 2019).

Lastly, EPA is finalizing amendments to the regulations in order to address certain issues concerning publicly accessible internet sites, and groundwater monitoring and corrective action annual reports that have arisen since the April 17, 2015 publication of the CCR rule. These amendments were proposed in a separate August 14, 2019 proposal. 84 FR 40353.

B. Summary of the Major Provisions of the Regulatory Action

In this action, EPA is finalizing five amendments to the part 257 regulations. First, EPA is finalizing a change to the classification of compacted-soil lined or ''clay-lined'' surface impoundments from ''lined'' to ''unlined'' under § 257.71(a)(1)(i). This merely reflects the vacatur ordered in the *USWAG* decision.

Second, EPA is finalizing revisions to the initiation of closure deadlines for unlined CCR surface impoundments, and for units that failed the aquifer location restriction, found in §§ 257.101(a) and (b)(1). These revisions address the *USWAG* decisions with respect to all unlined and ''clay-lined'' impoundments, as well as revisions to the provisions that were remanded to the Agency for further reconsideration by the court in the *Waterkeeper* case. Specifically, EPA is finalizing a new deadline of April 11, 2021, for CCR units to cease receipt of waste and initiate closure because the unit either (1) is an unlined or formerly ''clay-lined'' CCR surface impoundment (§ 257.101(a)) or (2) failed the aquifer location standard (§ 257.101(b)(1)).

Third, EPA is finalizing revisions to the alternative closure provisions, § 257.103. These revisions will grant facilities additional time to develop alternative capacity to manage their wastestreams (both CCR and/or non-CCR), to achieve cease receipt of waste and initiate closure of their CCR surface impoundments. Table 1 below summarizes the deadlines finalized in this action.

Lastly, EPA is finalizing two of the proposed amendments from the August 2019 rule: The addition of an executive summary to the annual groundwater monitoring and corrective action reports; and the amended requirements to the publicly accessible CCR internet sites.

TABLE 1—NEW CEASE RECEIPT OF WASTE AND COMPLETION OF CLOSURE DEADLINES

Regulatory citations for CCR surface impoundments	Deadline date
New cease receipt of waste deadline for unlined and formerly ''clay-lined'' surface impoundments (§ 257.101(a)(1)).	No later than April 11, 2021.
New cease receipt of waste deadline for surface impoundments that failed the minimum depth to aquifer location standard (§ 257.101(b)(1)(i)).	No later than April 11, 2021.
New site-specific alternative to initiation of closure due to lack of capacity (§ 257.103(f)(1)).	No later than October 15, 2023 (maximum of 5 years after *USWAG* decision mandate date). For eligible unlined CCR surface impoundment: No later than October 15, 2024.
New site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain (§ 257.103(f)(2)).	Completion of Closure: • No later than October 17, 2023 for surface impoundments 40 acres or smaller. • No later than October 17, 2028 for surface impoundments larger than 40 acres.

C. Costs and Benefits

Several developments have changed the estimated costs of the CCR program since the publication of the final rule in 2015. First, reporting data show that the affected universe of surface impoundments is composed of more unlined units and more leaking surface impoundments than were modeled in the 2015 Regulatory Impact Analysis (RIA). The affected universe of impoundments is therefore incurring higher closure costs sooner, which increases the overall cost of the program. Second, the D.C. Circuit vacated provisions of the rule that allowed certain classes of surface impoundments to continue operating until they leaked. This decision forces these units to close sooner than they were modeled to close in the 2015 RIA. This also increases the overall cost of the CCR program. This cost increase is estimated and shown in the RIA. This increase in costs is attributable solely to the existing provisions of the 2015 CCR rule. Overall, the provisions of this final rule decrease costs by extending certain existing compliance deadlines. The final rule is therefore considered a cost savings rule. This action is expected to result in an estimated annualized net cost savings of $26.1 million per year when discounting at 7 percent. It is also expected to have a modest impact on a subset of the benefits monetized in the RIA accompanying the 2015 CCR Rule. Further information on the economic effects of this action can be found in unit IX of this preamble and the RIA.[1]

II. General Information

A. Does this action apply to me?

This final rule applies to all CCR generated by electric utilities and independent power producers that fall within the North American Industry Classification System (NAICS) code 221112 and may affect the following entities: Electric utility facilities and independent power producers that fall under the NAICS code 221112. This discussion is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. This discussion lists the types of entities that EPA is now aware could potentially be regulated by this action. Other types of entities not described here could also be regulated. To determine whether your entity is regulated by this action, you should carefully examine the applicability criteria found in § 257.50 of title 40 of the Code of Federal Regulations. If you have questions regarding the applicability of this action to a particular entity, consult the person listed in the **FOR FURTHER INFORMATION CONTACT** section.

B. What action is the Agency taking?

EPA is revising certain provisions of the CCR regulations at 40 CFR part 257 in response to the decisions issued by the D.C. Circuit on August 21, 2018, in *Utility Solid Waste Activities Group* v. *EPA* 901 F.3d 414 (D.C. Cir.), and on March 13, 2019, in *Waterkeeper Alliance Inc.* v. *EPA,* No. 18–1289 (D.C. Cir.). In addition, the Agency is also finalizing two of the proposed amendments from the August 14, 2019 rulemaking that are not related to the *USWAG* and *Waterkeeper* decisions.

This final rule addresses the *USWAG* decision's vacatur of the provisions in the 2015 rule that permitted unlined impoundments to continue receiving waste unless they leak, 40 CFR 257.101(a), and that classified ''clay-lined'' impoundments as lined, thereby allowing such units to operate, 40 CFR 257.71(a)(1)(i). The *USWAG* decision also vacated the exemption from the

[1] US EPA. ''Regulatory Impact Analysis, Hazardous and Solid Waste Management System: Disposal of Coal Combustion Residuals from Electric Utilities; A Holistic Approach to Closure Part A: Deadline to Initiate Closure''. July 2020.

2015 rule for inactive surface impoundments at inactive power plants, also known as legacy units, which will be addressed in a subsequent advanced notice of proposed rulemaking.

This final rule also addresses the date by which unlined CCR surface impoundments and CCR units that failed the aquifer location standard must cease receiving waste and initiate closure, which the D.C. Circuit remanded to EPA on March 13, 2019 in the *Waterkeeper* case.

EPA is finalizing amendments to the alternative closure provisions, 40 CFR 257.103. EPA is amending the existing provisions (40 CFR 257.103(a) and (b)) to only apply to CCR landfills. EPA is establishing new alternative closure provisions, 40 CFR 257.103(f)(1) and (f)(2), for which a facility must submit a demonstration to EPA for approval to continue operating a CCR surface impoundment. These new alternative closure provisions do not amend the implementation schedules of groundwater monitoring and corrective action, as they remain unchanged. The new alternative closure provisions will grant facilities additional time to cease receipt of waste and initiate closure.

EPA is finalizing amendments to the regulations from the August 2019 proposal, addressing certain issues raised by stakeholders. EPA is amending the annual groundwater monitoring and corrective action report to include an executive summary. Additionally, EPA is finalizing amendments to the publicly accessible CCR internet sites requirements to ensure that they are truly accessible by the public.

EPA intends that the provisions of this rule be severable. In the event that any individual provision or part of this rule is invalidated, EPA intends that this would not render the entire rule invalid, and that any individual provisions that can continue to operate will be left in place.

C. What is the Agency's authority for taking this action?

These regulations are established under the authority of sections 1008(a), 2002(a), 4004, and 4005(a) and (d) of the Solid Waste Disposal Act of 1970, as amended by the Resource Conservation and Recovery Act of 1976 (RCRA), the Hazardous and Solid Waste Amendments of 1984 (HSWA), and the Water Infrastructure Improvements for the Nation (WIIN) Act of 2016, 42 U.S.C. 6907(a), 6912(a), 6944, and 6945(a) and (d).

D. What are the incremental costs and benefits of this action?

This action is expected to result in an estimated annualized net cost savings of $26.1 million per year when discounting at 7 percent or an estimated annualized net cost savings of $16.7 million per year when discounting at 3 percent. It is also expected to have a modest impact on a subset of the benefits monetized in the RIA accompanying the 2015 CCR Rule. Further information on the economic effects of this action can be found in unit IX of this preamble.

III. Background

A. The ''2015 CCR Rule''

On April 17, 2015, EPA finalized national minimum criteria for the disposal of CCR as a solid waste under Subtitle D of RCRA. 80 FR 21302. The Agency refers to the April 17, 2015 rule as the ''2015 CCR Rule'' in this preamble. CCR are generated from the combustion of coal by electric utilities and independent power producers for the generation of electricity. CCR include fly ash, bottom ash, boiler slag, and flue gas desulfurization materials and are commonly referred to as coal ash. The CCR regulations are codified in subpart D of part 257 of title 40 of the CFR.

The 2015 CCR Rule regulated existing and new CCR landfills and existing and new CCR surface impoundments, as well as all lateral expansions of these CCR units. The federal national minimum criteria consist of location restrictions (siting limitations), design and operating criteria, groundwater monitoring and corrective action requirements, and closure and post-closure care requirements. In addition, the 2015 CCR Rule put in place recordkeeping, notification, and internet posting provisions that require owners and operators of CCR units to maintain a publicly accessible internet site of rule compliance information. The 2015 CCR Rule does not regulate CCR that are beneficially used. It established a definition of ''beneficial use of CCR'' to distinguish between beneficial use and disposal.

Of particular relevance to this action, the 2015 CCR Rule required that any existing unlined CCR surface impoundment that causes groundwater concentrations to exceed a groundwater protection standard must stop receiving waste (CCR and/or non-CCR wastestreams) within six months of making such exceedance determination. This would also trigger the requirement to initiate either unit retrofit or closure activities.[2] See § 257.101(a)(1) at 80 FR 21490 (April 17, 2015). In the 2015 CCR Rule, the term ''unlined'' CCR surface impoundment included any unit not constructed with one of the following types of liners: (1) A composite liner; (2) an alternative composite liner; or (3) a liner consisting of a minimum of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second. Lined CCR surface impoundments (as defined in the CCR regulations) that impact groundwater above the specified groundwater protection standard are not required to close and could continue to operate while corrective action is performed, and the source of the leak is addressed.

The 2015 CCR Rule was challenged by several parties, including a coalition of regulated entities and a coalition of environmental organizations (''Environmental Petitioners''). See *USWAG* v. *EPA,* 901 F.3d 414 (D.C. Cir. 2018). The Environmental Petitioners raised two challenges[3] that are relevant to this final rule. First, they challenged the provision that allowed existing, unlined CCR surface impoundments to continue to operate until they cause groundwater contamination. See § 257.101(a)(1) at 80 FR 21490 (April 17, 2015). They contended that EPA failed to show how continued operation of unlined impoundments met RCRA's baseline requirement that any solid waste disposal site pose ''no reasonable probability of adverse effects on health or the environment.'' See 42 U.S.C. 6944(a). The Environmental Petitioners also challenged the provisions that allowed impoundments lined with two feet of clay (*i.e.,* compacted soil) to continue operating even when they leak, requiring only that they remediate the resulting contamination. The petitioners pointed to record evidence that ''clay-lined'' units are likely to leak and contended that EPA's approach ''authorizes an endless cycle of spills and clean-ups'' in violation of RCRA.

B. The 2018 USWAG Decision

The D.C. Circuit issued the *USWAG* decision on August 21, 2018. The Court

[2] Certain units may be eligible for the alternative closure procedures specified in § 257.103, which would change the date by which the unit must stop receiving waste.

[3] Environmental Petitioners also challenged the provisions exempting inactive surface impoundments at inactive power plants from regulation. The Court ruled for the Petitioners on these claims, vacating these provisions and remanding to EPA. However, in contrast to the other provisions addressed in this rule, additional rulemaking is necessary to effectuate the Court's order, as the Court's vacatur alone did not subject these units to regulation. This aspect of the decision will be addressed in a subsequent proposal.

upheld most of the 2015 CCR Rule but ruled for the Environmental Petitioners on the two claims discussed in unit III.A of this preamble. The Court held that EPA acted ''arbitrarily and capriciously and contrary to RCRA'' in failing to require the closure of unlined surface impoundments and in classifying so-called ''clay-lined'' impoundments as lined, based on the record supporting the rule. 901 F.3d at 431–432. The Court ordered that ''the Final Rule be vacated and remanded with respect to the provisions that permit unlined impoundments to continue receiving coal ash unless they leak, § 257.101(a), [and] classify 'clay-lined' impoundments as lined, see 40 CFR 257.71(a)(1)(i).'' *Id.* The Court issued the mandate for this decision on October 15, 2018. Therefore, part of this final rulemaking action updates the regulations to reflect the provisions that the Court vacated.

C. The July 30, 2018 Final Rule and the 2019 Waterkeeper Decision

EPA issued a final rule on July 30, 2018, amending several parts of the CCR federal regulations (83 FR 36435). First, the rule extended the deadlines for two categories of CCR surface impoundments to cease receipt of waste and to initiate closure when closing for cause: (1) Unlined CCR surface impoundments with an exceedance of a groundwater protection standard for any constituent listed on Appendix IV to part 257; [4] and (2) CCR surface impoundments that failed to meet the location criteria in § 257.60(a) (requiring either a minimum of five feet between the unit base and the uppermost aquifer or a demonstration that there will not be an intermittent, recurring, or sustained hydraulic connection between any portion of the base of the unit and the uppermost aquifer). These deadlines were extended until October 31, 2020, and were codified in § 257.101(a)(1) and (b)(1)(i).

Second, the rule established alternative risk-based groundwater protection standards for the four constituents without a maximum contaminant level (MCL) that are listed on Appendix IV to part 257. The four constituents are cobalt, lead, lithium, and molybdenum, and the alternative standards were codified in § 257.95(h)(2).

Third, the rule established procedures allowing for the suspension of groundwater monitoring requirements, provided that it can be demonstrated that there is no potential for migration of any CCR constituent listed in Appendices III and IV of part 257 from the CCR unit to the uppermost aquifer during the active life of the unit and the post-closure care period. See § 257.90(g).

Finally, the rule amended the federal CCR regulations to allow a Participating State Director (or EPA where EPA is the permitting authority) to issue certifications in lieu of requiring a certification from a Professional Engineer. The 2015 CCR Rule required technical demonstrations, when made by the owner or operator, to be certified by a qualified Professional Engineer in order to provide verification of the facility's technical judgments and to otherwise ensure that the provisions of the rule were properly applied. In 2015, states were unable to apply to EPA for approval to operate a permit program to implement the CCR rule. The situation changed with the passage of the Water Infrastructure Improvements for the Nation (WIIN) Act in 2016, which offers the opportunity for state oversight under an approved permit program. The 2018 amendments to the certification requirements reflect the new authority provided by the WIIN Act.

The July 2018 final rule was challenged by Waterkeeper Alliance, who also requested an expedited review of the October 31, 2020, deadline. See *Waterkeeper Alliance Inc, et al* v. *EPA*, No. 18–1289 (D.C. Cir. 2018) (*Waterkeeper* decision). On March 13, 2019, the Court granted EPA's request to remand the July 2018 rule, ''to allow the agency to reconsider that rule in light of th[e] court's decision in [*USWAG*].'' The December 2, 2019 proposed rule reflected EPA's reconsideration of one of the remanded issues contained in the July 2018 rule: Reconsideration of the current deadline of October 31, 2020, for unlined surface impoundments to cease receiving waste. 84 FR 65944. The Agency also stated in the December 2, 2019, proposal that EPA would address its reconsideration of other aspects (*e.g.,* the adopted alternative risk-based groundwater protection standards for cobalt, lead, lithium, and molybdenum) of the July 2018 rule in subsequent rulemaking actions. *Id.*

D. Public Participation With Respect to the August 2019 and December 2019 Proposed Rules

This rule takes final action on the proposed rule published on December 2, 2019 (84 FR 65941), as well as two issues included in the proposal issued on August 14, 2019 (84 FR 40353). This unit of the preamble summarizes public participation activities associated with both proposed rules.

EPA conducted two public hearings to provide the public with the opportunity to present views or information concerning the August 14, 2019 proposal. The first was an in-person public hearing in Arlington, Virginia on October 2, 2019. A total of 41 people provided oral testimony at the hearing; a transcript of the hearing proceedings is available in the proposed rule docket.[5] The second was held on October 10, 2019 as a virtual public hearing using an internet-based software platform. The platform allowed hearing participants to provide oral testimony using a microphone and speakers connected to their computers or using a phone. It provided the ability for any person to listen to the public hearing via their computer. A total of 52 people provided oral testimony during the virtual hearing and another 147 people participated by listening. The transcript for the virtual public hearing is available in the proposed rule docket.[6]

The Agency received approximately 130,000 comments, of which nearly 300 were unique, from members of the public on the August 2019 proposed rule. Commenters included individual electric utilities and independent power producers, national trade associations, state agencies, public interest and environmental groups, and entities involved with the beneficial use of CCR. All public comment letters submitted in response to the proposal can be found in the proposed rule docket, Docket ID EPA–HQ–OLEM–2018–0524. For those elements included in the August 14, 2019 proposed rule that EPA is finalizing in this action (see unit V of this preamble), EPA's responses to public comments are either addressed in this preamble or the response to comment document available in the docket to this final rule.

EPA also conducted one public hearing to provide the public with the opportunity to present views or information concerning the December 2, 2019 proposed rule. On January 7, 2020, the Agency conducted a virtual public

[4] A groundwater protection standard (GWPS) is established using the methods specified in § 257.95(h). For constituents with a maximum contaminant level (MCL), the GWPS is the MCL for that constituent. For the constituents that do not have an established MCL, the GWPS is the health-based level EPA established in the July 30, 2018 rule. If the background level is higher than the MCL or the health-based level, then background should be used as the GWPS.

[5] See docket items EPA–HQ–OLEM–2018–0524–0046 through –0050.

[6] See docket items EPA–HQ–OLEM–2018–0524–0333 through –0335.

hearing using an internet-based software platform that allowed hearing participants to provide oral testimony using a microphone and speakers connected to their computers or using a phone. This platform also provided an opportunity for any person to listen to the public hearing via their computer. A total of 37 people provided oral testimony during the virtual hearing and over 40 other people participated by listening. The transcript for the virtual public hearing is available in the proposed rule docket.[7]

The Agency received over 67,200 comments, of which nearly 150 were unique, comments from members of the public on the December 2019 proposed rule. Commenters included individual electric utilities and independent power producers, national trade associations, state agencies, and public interest and environmental groups. All public comment letters submitted in response to the proposal can be found in the proposed rule docket, Docket ID EPA–HQ–OLEM–2019–0172. EPA's responses to comments on the proposed rule are either addressed in this preamble or the response to comment document available in the docket to this final rule.

IV. Statutory Authority

RCRA section 1008(a) authorizes EPA to publish ''suggested guidelines for solid waste management.'' 42 U.S.C. 6907(a). RCRA defines solid waste management as ''the systematic administration of activities which provide for the collection, source separation, storage, transportation, transfer, processing, treatment, and disposal of solid waste.'' 42 U.S.C. 6903(28).

Pursuant to section 1008(a)(3), the guidelines are to include the minimum criteria to be used by the states to define the solid waste management practices that constitute the open dumping of solid waste or hazardous waste and are prohibited as ''open dumping'' under section 4005. Only those requirements promulgated under the authority of section 1008(a)(3) are enforceable under section 7002 of RCRA.

RCRA section 4004(a) generally requires EPA to promulgate regulations containing criteria for determining which facilities shall be classified as sanitary landfills (and therefore not ''open dumps''). The statute directs that, ''at a minimum, the criteria are to ensure that units are classified as sanitary landfills only if there is no reasonable probability of adverse effects on health or the environment from disposal of solid wastes at such facility.'' 42 U.S.C. 6944(a).

RCRA section 4005(a), entitled ''Closing or upgrading of existing open dumps,'' generally establishes the key implementation and enforcement provisions applicable to EPA regulations issued under sections 1008(a) and 4004(a). Specifically, this section prohibits any solid waste management practices or disposal of solid waste that does not comply with EPA regulations issued under RCRA section 1008(a) and 4004(a). 42 U.S.C. 6944(a). See also 42 U.S.C. 6903(14) (definition of ''open dump''). This prohibition takes effect ''upon promulgation'' of any rules issued under section 1008(a)(3) and is enforceable through a citizen suit brought pursuant to section 7002. As a general matter, this means that facilities must be in compliance with any EPA rules issued under this section no later than the effective date of such rules, or be subject to a citizen suit for ''open dumping.'' See 42 U.S.C. 6945. RCRA section 4005 also directs that open dumps, *i.e.,* facilities out of compliance with EPA's criteria, must be ''closed or upgraded.'' *Id.*

RCRA section 7004 lays out specific requirements relating to public participation in regulatory actions under RCRA. Subsection (b) provides that ''[p]ublic participation in the . . . implementation, and enforcement of any regulation under this chapter shall be provided for, encouraged, and assisted by the Administrator.'' 42 U.S.C. 6974(b).

Comments on EPA Authority. Several commenters stated that RCRA section 4004(a) allows EPA to take into account non-risk considerations, citing EPA statements in the preamble to the 1991 final rule for municipal solid waste landfills (MSWLF).[8] Specifically, these commenters cited to EPA statements that the term ''reasonable'' ''has been read in other contexts to imply a balancing of competing factors,'' and that the ''use of the word 'probability' in 'no reasonable probability' implies the discretion to impose requirements that are less certain to eliminate a perceived health or environmental threat than standards that are 'necessary to protect human health and the environment,' thus allowing for the consideration of other factors such as cost.'' (quoting 56 FR 50978, 50983 (October 9, 1991)). A number of other commenters, however, stated that EPA lacked the authority to consider costs in establishing any regulation under RCRA section 4004(a), citing EPA's prior statements in the 2015 CCR Rule and to the recent D.C. Circuit opinion in *USWAG* v. *EPA.*

EPA disagrees that RCRA section 4004(a) allows EPA to take into account non-risk considerations. The commenters have misunderstood the discussion in the MSWLF preambles. The cited statements reflect EPA's interpretation of the combined authority under both RCRA sections 4010(c) and 4004(a), rather than an interpretation of section 4004(a) standing alone. 56 FR 50983–50984. As EPA has previously explained, the Agency cannot rely on section 4010(c) to issue regulations applicable to CCR facilities. See 80 FR 21333–21334 (April 17, 2015).

By contrast, EPA has consistently interpreted the mandate in section 4004(a), standing alone, not to authorize consideration of costs or any other factor unrelated to the protection of human health and the environment. EPA did not consider costs in establishing the original part 257 regulations, noting in the 1979 preamble that ''[t]he Act does not call for a balancing of the costs of disposal against the ''value'' of ground-water resources.'' 44 FR 53447 (September 13, 1979). Similarly, EPA explained in the 2015 CCR Rule ''that Congress did not authorize the consideration of costs in establishing minimum national standards under RCRA section 4004(a).'' 80 FR 21406. See also, 80 FR 21363, 21432; 83 FR 11597 (March 15, 2018). As several commenters noted, the D.C. Circuit upheld this interpretation, concluding that ''[u]nder any reasonable reading of RCRA there is no textual commitment of authority to the EPA to consider costs in the open dump standards.'' 901 F.3d at 448–449 (D.C. Cir. 2018). Accordingly, EPA has not considered cost in developing any provision of this final rule.[9]

Another commenter stated that EPA lacks the statutory authority to impose a mandatory closure requirement for non-CCR wastestreams, arguing that imposing deadlines under the CCR Rule for wastestreams that are subject to different deadlines under the ELG rule runs afoul of RCRA section 1006(a)—the anti-duplication provision. The commenter argued that the proposal to ban or greatly restrict the receipt of the wastewater at unlined surface impoundments is a duplicative and inconsistent—and thus prohibited—additional regulatory layer on top of the existing NPDES requirements applicable to those same impoundments.

[7] See docket items EPA–HQ–OLEM–2019–0172–0041 and 0042.

[8] 56 FR 50978 (October 9, 1991).

[9] Although EPA did not consider costs in developing this rule, if the Agency had considered costs, the final rule would not have been different. Based on the estimates developed for the RIA, this rule is expected to largely result in cost savings.

According to the commenter, under the proposed ELG regulations, up to 10 percent of bottom ash transport water piping and equipment volume can be discharged per day until December 31, 2023. Companies subject to the ELG requirements will need to permit, design, and construct a recycling system for the bottom ash sluice waters, a new CCR or non-CCR wastewater pond, or convert to dry handling—essentially the same solutions that must be pursued for compliance under the CCR rules. Yet the deadlines for doing so do not align.

The commenter provided a specific example to demonstrate his concern: One of the Ohio Valley Electric Corporation (OVEC) plants is currently sluicing fly ash to a surface impoundment that is subject to the CCR rule. Because that impoundment meets the CCR siting criteria and has monitored no statistically significant increases above background concentrations for any of the CCR parameters, that plant has anticipated continuing to operate the impoundment through no later than December 31, 2023, consistent with the ELG regulations. The proposed CCR rule, with its August 31, 2020, deadline to discontinue sluicing of fly ash to surface impoundments, effectively eliminates up to three years that OVEC had anticipated using to engineer, design, procure, construct and begin operation of the new infrastructure needed to comply with the ELG rule. The CCR rule and the ELG rule must be aligned so that the timeline for discontinuing placement of CCR into a fly ash surface impoundment is consistent with the timeline that that source has for completing dry fly ash conversion under the final ELG rules applicable to this wastestream.

RCRA section 1006(a) does not bar EPA from imposing requirements under one of the listed statutes and RCRA on the same units and waste streams, unless those requirements are inconsistent with a requirement in one of the statutes. 42 U.S.C. 6906(a). This is clear from the second sentence, which provides that ''such integration shall be effected only to the extent that it can be done in a manner consistent with the goals and policies expressed in this chapter and in the other acts referred to in this subsection.'' *Id.* Numerous courts have upheld this interpretation. See, *Ecological Rights Foundation* v. *Pacific Gas & Electric Co.,* 874 F.3d 1083, 1095 (9th Cir., 2017) (''RCRA's anti-duplication provision does not bar RCRA's application unless that application contradicts a specific mandate imposed under the CWA (or another statute listed in RCRA section 1006(a))''); *Goldfarb* v. *Mayor and City Council of Baltimore,* 791 F.3d 500 510 (4th Cir. 2015) (The CWA must require something fundamentally at odds with what RCRA would otherwise require to be ''inconsistent'' under 1006(a)); *Edison Electric Institute* v. *EPA,* 996 F.2d 326, 337 (D.C. Cir.1993) (rejecting ''generalized claim'' that EPA action was barred under section 1006(a) because it interfered with ''the primary purpose'' of the Atomic Energy Act); *U.S.* v. *E.I. du Pont de Nemours & Co.,* Inc., 341 F.Supp.2d 215, 236 (W.D. N.Y. 2004) (approving EPA action as ''not inconsistent'' under RCRA where CERCLA's heightened standard would not be met by release of hazardous substance). The commenter has identified no requirement in the Clean Water Act that is inconsistent with EPA's proposal.

Instead, the commenter argues that the deadlines under the two rules are inconsistent and wholly duplicative. EPA disagrees with both claims. First, the deadlines for the two rules are in fact consistent. To support its claim, the commenter focused exclusively on the proposed date of August 2020, by which facilities must cease receipt of waste into the unit. But EPA also proposed to establish a process by which a facility that needs to continue receiving waste into the unit can do so, by demonstrating that it was not feasible to meet the deadline. See § 257.103(f). Under that proposal, a facility can continue to operate a unit until 2023 if it can demonstrate that that amount of time is necessary to complete its construction of alternative capacity.

Neither are the ELG and CCR proposals duplicative. The CCR requirements are designed to protect groundwater, while the ELG requirements are designed to protect surface waters.

Finally, one commenter stated their belief that EPA was required to have consulted with U.S. Fish and Wildlife Service (FWS) under the Endangered Species Act as part of developing this final rule.

EPA disagrees with the suggestion that consultation was required as part of developing this rule. Under the existing regulations, all CCR units must comply with 40 CFR 257.3–2. 40 CFR 257.52(b). That regulation, which was developed after consultation with FWS, requires facilities not to cause or contribute to the taking of any endangered or threatened species of plant or wildlife, and not to result in the destruction or adverse modification of critical habitat. This obligation is not modified or affected in any way by this final rule. The commenter has presented no facts that convince EPA that re-initiation is warranted by this rule.

V. What final action is EPA taking on the December 2, 2019 proposal?

A. Revisions to § 257.71 To Implement the 2018 USWAG Decision

As discussed in unit III.B of this preamble, the D.C. Circuit found in *USWAG* that the rulemaking record did not support the conclusion that the 2015 CCR Rule would adequately address the adverse effects posed by clay-lined (or compacted soil-lined) CCR surface impoundments. Therefore, the Court vacated the provision that treated ''clay-lined'' surface impoundments differently than unlined impoundments, with the result that such impoundments are now required to be either retrofitted or closed.[10] The affected provision was codified in § 257.71(a)(1)(i), which stated that a unit with a liner consisting of a minimum of two feet of compacted soil with a hydraulic conductivity of no more than 1×10^{-7} centimeters per second was considered to be lined. In the December 2, 2019 proposed rule, EPA proposed to remove § 257.71(a)(1)(i) from the CFR. 84 FR 65944. The Agency also proposed two conforming revisions to § 257.71(a)(3) that were necessary to properly implement the removal of § 257.71(a)(1)(i). *Id.*

In this action, EPA is finalizing these proposed changes to § 257.71(a)(1) and (a)(3). Specifically, the Agency is removing § 257.71(a)(1)(i) from the CFR to reflect its vacatur as a result of the 2018 *USWAG* decision. In addition, EPA is revising § 257.71(a)(3) by removing two cross-references to § 257.71(a)(1)(i) that are no longer appropriate given that paragraph (a)(1)(i) has been removed. See revised § 257.71(a)(3)(i) and (ii).

B. Revisions to § 257.101 as a Result of EPA's Reconsideration

When the 2015 CCR Rule was finalized, § 257.101 required certain existing CCR surface impoundments to close.[11] This included: (1) Unlined CCR

[10] On March 3, 2020, the Agency proposed to allow a limited number of facilities to continue using alternate liners (*i.e.,* liner systems that would otherwise be considered to be unlined systems under the CCR regulations) at existing CCR surface impoundments if the facility can demonstrate to EPA or a Participating State Director that the unit would not adversely affect groundwater, human health, or the environment. 85 FR 12456.

[11] Section 257.101 also requires certain existing CCR landfills and new CCR surface impoundments to close. However, those provisions are not discussed in this preamble section because those CCR units were not affected by the 2018 *USWAG* decision.

surface impoundments whose groundwater monitoring shows an exceedance of a groundwater protection standard (§ 257.101(a)(1)); (2) CCR surface impoundments that do not comply with one or more of the location (siting) criteria (§ 257.101(b)(1)); and (3) CCR surface impoundments that are not designed and operated to achieve minimum factors of safety, which are a component of the structural integrity criteria (§ 257.101(b)(2)). In each of these situations, the 2015 CCR Rule specified that the owner or operator of the CCR unit must cease placing CCR and non-CCR wastestreams into the unit and initiate closure activities (or retrofit the unit under certain circumstances) within a certain period of time after making the relevant determination.

The D.C. Circuit found in the *USWAG* decision that EPA acted ''arbitrarily and capriciously and contrary to RCRA'' in failing to require the closure of all unlined CCR surface impoundments and ordered that ''the Final Rule be vacated and remanded with respect to the provisions that permit unlined impoundments to continue receiving coal ash unless they leak.'' See 901 F.3d at 449. This court-vacated provision is codified in § 257.101(a). The *USWAG* decision did not affect the codified deadlines to cease receipt of waste and initiate closure. These deadlines remained for existing CCR surface impoundments that do not comply with one or more of the location criteria under § 257.101(b)(1), as well as for those impoundments that are not designed and operated to achieve minimum factors of safety under § 257.101(b)(2).

The Agency explained in the December 2, 2019 proposed rule that EPA interprets the *USWAG* decision as only partially vacating § 257.101(a). Specifically, the Agency explained that only the following phrase in § 257.101(a)(1) was vacated by the Court: ''if at any time after October 19, 2015, an owner or operator of an existing unlined CCR surface impoundment determines in any sampling event that the concentrations of one or more constituents listed in Appendix IV of this part are detected at statistically significant levels above the groundwater protection standard established under § 257.95(h) for such CCR unit''. 84 FR 65944–45. The proposal discussed that a vacatur of the entire provision under § 257.101(a) would remove the requirement for unlined CCR surface impoundments to close, which would be inconsistent with the holding that it was arbitrary and capricious for EPA not to have required unlined CCR surface impoundments to close. In response to the December 2, 2019 proposed rule, EPA received no comments opposing the Agency's interpretation of the effect of the *USWAG* decision on § 257.101(a). Therefore, and as EPA discussed in the proposed rule, the vacatur of this phrase from § 257.101(a)(1) results in a requirement that owners and operators must cease placement of both CCR and non-CCR wastestreams into unlined CCR surface impoundments and initiate the closure of such units no later than October 31, 2020. This requirement also applied to both impoundments that were formally considered to be ''clay-lined,'' and unlined impoundments that are inactive.

The October 31, 2020 deadline was established in a final rule published on July 30, 2018 (83 FR 36435). The December 2, 2019 proposal discussed that the July 30, 2018 final rule had not yet been challenged when the court issued its *USWAG* decision on August 21, 2018. As discussed in the proposed rule, the Waterkeeper Alliance subsequently challenged the July 30, 2018 final rule and requested expedited review of the October 31, 2020 deadline. In response, EPA requested a remand of the July 30, 2018 final rule, which the court granted on March 13, 2019 ''to allow the agency to reconsider that rule in light of this court's decision in [USWAG].''

1. EPA's Reconsideration of the October 31, 2020 Deadline

The December 2, 2019 proposed rule reflects EPA's reconsideration of the deadline of October 31, 2020 for unlined CCR surface impoundments to cease receiving CCR and non-CCR wastestreams and initiate closure or retrofit activities.[12] As explained in the proposed rule, the *USWAG* decision faulted EPA for failing to fully estimate the risks associated with the continued operation (and potential leakage) of unlined impoundments and for failing to address the risks from allowing these units to continue to operate until they leak. The court held that RCRA requires the Agency to determine that such risks would be acceptable under the § 4004(a) standard in order to authorize the continued operation of such units. In the absence of such an assessment, the court vacated the provision that allowed for the continued operation of unlined impoundments. 901 F.3d at 430. For the reasons discussed in the proposed rule, the Agency was unable to develop a nationwide risk assessment of continued operation of these unlined CCR surface impoundments. 84 FR 65945.

[12] As stated in the proposed rule, EPA will address its reconsideration of other aspects of the July 30, 2018, final rule in subsequent rulemaking actions. 84 FR 65944.

EPA further explained in the December 2, 2019 proposal that many utilities could not immediately cease the placement of CCR and non-CCR wastestreams into their surface impoundments without causing potentially significant disruptions to plant operations, and thus the provision of electricity to their customers. This is because there is no additional capacity to manage these wastes elsewhere. To support this conclusion, EPA pointed to the information laid out in several industry filings to the *Waterkeeper* court. The *Waterkeeper* court also recognized this, declining to vacate the July 2018 Rule partly because ''EPA and the intervenors have shown that the consequences of vacatur would be disruptive.'' No. 18–1289, Order at 1.

To address these competing considerations in a manner consistent with the statute and the D.C. Circuit's decisions, EPA proposed to require that facilities cease placement of all wastes (both CCR and non-CCR) into impoundments as soon as technically feasible. 84 FR 65945. The proposal explained that such a requirement would meet the RCRA § 4004(a) standard because it requires the facility to do what is possible in the shortest achievable time. Similar to the concept behind a force majeure provision, EPA cannot impose protective measures under this provision that are not technically feasible for any facility to implement. See *USWAG* at 448; *Hughey* v. *JMS Development Corp,* 78 F.3d 1523 (11th Cir. 1996); *Cherry-Burrell Corp* v. *United States,* 367 F.2d 669 (8th Cir. 1966). The proposal further concluded that requiring facilities to expedite the initiation of closure of unlined CCR surface impoundments is consistent with the court's finding that further evidence is needed to permit such units to continue to operate. See *USWAG,* 901 F.3d at 429–430. The proposal explained that EPA lacked the evidence to support the continued operation of such units on a national level and it did not anticipate being able to develop such information in the near-term.

2. Approaches To Identify Alternative Capacity

EPA proposed to determine technical feasibility based on the steps that owners and operators need to take to obtain alternative disposal capacity. Six approaches, and the timeframes needed to implement them, were evaluated. 84 FR 65945–51. The evaluation relied principally on information contained in the declarations submitted with the *Waterkeeper* briefs, as well as CCR rule compliance information posted on facilities' publicly accessible CCR internet sites (*e.g.,* written retrofit plans required by § 257.102(k)(2)). The proposed rule discussed each technology approach and the Agency's analysis of the average time needed to implement it. This included the entire process to obtain alternative capacity, from the start of the project to its completion, including the general project phases of planning and design, procurement, permitting, and construction, commissioning. Using the average timeframe for each of the six approaches was intended to capture some of the variability due to site-specific circumstances and to provide for an accurate national benchmark. The six technology approaches presented in the proposed rule and the estimated average time necessary to develop each technology approach are shown in Table 2.

TABLE 2—SUMMARY OF PROPOSED TECHNOLOGY APPROACHES

Alternative capacity technology	Average time (months)
Conversion to dry handling	36.
Non-CCR wastewater basin	21.
Wastewater treatment facility	16 to 21.
New CCR surface impoundment.	27.
Retrofit of a CCR surface impoundment.	31.5 (large unit retrofits). 4 to 12 (small unit retrofits).
Multiple technology system	21 to 36.

(a) Specific Comments on Individual Alternative Capacity Technologies and Average Time Estimates

This preamble unit summarizes the data and information considered for each of the six technology approaches in the proposed rule; the comments received in response to the use of these data and information; and the Agency's response to comments on these approaches. Several commenters submitted actual project timeframes for completed or ongoing efforts to obtain alternative capacity. The Agency evaluated each submission according to the procedures described in this unit of the preamble. In most cases, this project information was used in the final rule alternative capacity analysis.

In general, EPA considered submissions that described completed projects or portions of completed projects to be the most persuasive and reliable. These submissions reflect projects that were in fact completed within the reported timeframe and therefore provided some guarantee that other facilities can replicate those timeframes. As these projects were initiated before the *USWAG* decision, it is likely that they do not represent expedited timeframes. EPA therefore considered them to be outer bounds of the amount of time necessary to complete these projects.

The second most reliable category of information came from submissions in which the commenter provided a detailed narrative description and project schedule, explaining all phases of the project. Submissions that fell into this category generally provided sufficient information to allow the Agency to determine whether the estimated timeframes were reasonable and consistent with those timeframes presented in submissions from commenters describing completed projects. In some cases, EPA discounted some portions of the estimated time where it appeared that the amount of time substantially exceeded the time presented in other submissions or were based on factors unique to that site that are unlikely to be relevant to other facilities nationwide. EPA calculated these adjustments by examining the project schedule and determining whether the task in question overlapped with other tasks. If the discounted task did not overlap with other activities, the Agency reduced the project schedule by the length of time of the task. However, when the task in question partially overlapped with another activity, EPA only reduced the time duration by the amount that did not overlap with a non-discounted task. EPA also reduced some portions of estimates if, based on other submissions, EPA determined that the commenter had assumed that a phase of a project was sequential when in fact it could be completed at the same time as another phase of the project. In this final rule, EPA used the information from both of these categories of submissions to calculate the deadline to cease receipt of waste.

EPA did not use provided information when a project timeline did not include all phases of the project, or when the project timeline was presented with insufficient detail to evaluate it. EPA also excluded estimates that appeared to be outliers when compared to other estimates. As EPA explained in the proposal, outliers should not extend the deadline for all facilities to cease receipt of waste, because such action would not be consistent with ensuring that this transition occurs as quickly as technically feasible. Rather, such situations are more appropriately accounted for and addressed, if necessary, under the alternative closure process in § 257.103.

Conversion to dry handling. The first technology approach EPA considered in the proposed rule was conversion to dry handling of CCR. Some facilities use wet sluicing (*e.g.,* water) to convey CCR from the boiler to a CCR surface impoundment. In the context of this rulemaking, a conversion from wet sluicing to another means of CCR ash conveyance (*e.g.,* mechanical) would allow the facility to cease use of the unlined CCR surface impoundment once the conversion is complete (assuming, in this example, that no other wastestreams are also directed to the unlined impoundment). EPA proposed that the average amount of time needed to implement the conversion to dry handling is 36 months, although the proposed rule presented information that times ranged from 36 to 48 months. 84 FR 65946. The Agency also recognized that some facilities may need new capacity to dispose of the CCR after a conversion to dry handling is complete, such as a CCR landfill. EPA stated that it did not have information on the time needed to construct a new landfill and therefore the time needed to obtain such capacity was not included in the proposed 36-month timeframe. The proposed rule solicited information on whether landfills are being constructed for alternative capacity in conjunction with dry handling system conversions and, if so, the timeframes to put in place such capacity. 84 FR 65947.

In response, several commenters stated that CCR landfills are constructed as part of the conversion to dry handling and that the time required to construct and permit these landfills is significant. These commenters argued, therefore, that EPA should include the time required to obtain capacity for a CCR landfill in its calculation of the time it takes a facility to convert to dry handling. These commenters provided information on seven examples from Delaware, Kentucky, Missouri, and South Carolina showing that the process from initial application to operational permit issuance of a CCR landfill had taken approximately three to five years. The commenters further explained that construction of three of these new CCR landfills was done as part of the process of converting to dry handling. However, none of the landfill construction information provided by the commenters included integrated project schedules showing both the construction of the landfill and the dry ash handling conversion, which could proceed simultaneously.

The Agency disagrees that the final rule approach should include the time to construct a CCR landfill in its calculation of the time it takes a facility to convert to dry handling. After further consideration, EPA views a combined dry ash handling conversion and new CCR landfill construction project to be more analogous to a multiple technology system, which is discussed in the ''Multiple technology system'' section of this preamble. In this instance, the multiple technology system would consist of a dry handling conversion project and a separate disposal capacity project. The Agency is taking this position in the final rule because some dry handling conversion projects do not involve the need to obtain disposal capacity for dry CCR, while other conversions do. EPA also notes that it did not receive any integrated project schedules showing the construction of the landfill and the dry ash handling conversion.

EPA also received new project information regarding conversions to dry handling of CCR from Cleco Corporate Holdings LLC (Cleco) and DTE Energy.[13] The information provided by each is briefly summarized below.

Cleco submitted detailed project information and projections for dry ash conversion projects at two different Cleco plants in Louisiana. The first was for the installation of a submerged flight conveyor for bottom ash removal at its Dolet Hills Power Plant (Dolet Hills). A submerged flight conveyor is a type of mechanical ash handling system that collects bottom ash that has fallen from the bottom of the boiler into a water-filled trough.[14] Currently at Dolet Hills, bottom ash is wet sluiced to one of two 33-acre unlined CCR surface impoundments. The commenter stated that prior to the *USWAG* decision, these bottom ash impoundments were not subject to closure for cause. The commenter's project timeline shows that it will take approximately 44.5 months to complete the bottom ash handling conversion. Cleco's comments do not indicate where the bottom ash will be managed after the conversion, but EPA notes that Cleco currently operates a CCR landfill at Dolet Hills for the disposal of fly ash and scrubber sludge. The commenter's conversion project timeline includes approximately nine months for the task of ''joint owner & board approval'' and another five months for a budgetary study. The commenter explains that the coal-fired boiler at Dolet Hills is jointly owned and this time is needed to engage in substantial discussions with and reach concurrence with the joint owners. The commenter further stated that the time allotted for discussions and decision-making with joint owners is based on its experience in reaching consensus with joint owners on the EPA air rulemaking titled the Mercury and Air Toxic Standards rule.[15] The commenter's project timeline also included three months to seek an alternative liner determination pursuant to a proposed process under consideration by the Agency in a separate rulemaking.[16] However, this 17 months (3 + 5 + 9 months) reflected in Cleco's timeline only partially overlaps with the planning and initial design phase of the project, which increased the amount of time estimated to complete the total project.

The second bottom ash dry conversion project described by Cleco was for the installation of a submerged grind conveyor, another type of mechanical ash handling system, for bottom ash removal at its Rodemacher Power Plant. Currently, bottom ash is wet sluiced to a 43-acre unlined CCR surface impoundment. The commenter stated that prior to the *USWAG* decision, the bottom ash impoundment was not subject to closure for cause. The commenter's project timeline shows that it will take approximately 45 months to complete the bottom ash handling conversion. Cleco's comments do not indicate where the bottom ash will be managed after the conversion nor if disposal capacity is needed for generated bottom ash. Similar to the timeline for Dolet Hills, Cleco's conversion project timeline includes approximately 17 months for obtaining joint owner and board approval, conducting the budgetary study, and seeking an alternative liner demonstration.

After evaluating the new information provided by Cleco, EPA is using this information in its final rule calculation of the amount of time needed to convert to dry handling because this commenter provided a detailed narrative description and project schedule explaining all phases of the project that allowed EPA to evaluate the reasonableness of the estimate. However, after reviewing the commenter's project schedule, the Agency is adjusting the dry handling conversion timeframes used in the capacity analysis for the reasons discussed below. As discussed earlier, this commenter explains that the project schedule includes approximately nine months for the task of joint owner and board approval, five months for a budgetary study, and three months to seek an alternative liner determination (a total of 17 months). However, these actions would only partially overlap with the planning and initial design phase of the project. As EPA explained elsewhere in this preamble, the goal of the Agency's alternative capacity analysis is to identify capacity that can be obtained in the shortest feasible time. A schedule based on a protracted lengthy decision-making process is not consistent with this goal. Moreover, the length of time it takes to make a decision is within the facility's (or multiple co-owner's) control and can be expedited as necessary. For similar reasons EPA is not accounting for time taken for the facility to seek a variance under the proposed alternative liner determination provisions. Developing the materials for that process is largely within the facility's control and can therefore be undertaken simultaneously with other measures. Therefore, EPA is eliminating the time to seek an alternative liner determination (three months) and additionally reducing by eight months the upfront 14 months allocated for joint owner and board approval and the budgetary study. This action would retain six months for the planning and initial design phase of the project, which is the same amount of time identified for this phase at proposal. Thus, for purposes of the final rule alternative capacity analysis EPA will use an adjusted estimate of 33.5 months (44.5 minus 11 months) to complete the dry conversion at the Dolet Hills facility and an adjusted estimate of 34 months (45 minus 11 months) to complete the dry conversion at the Rodemacher facility. In addition, the Agency is using the Cleco data points in lieu of the information considered in the proposed rule because it is a more comprehensive analysis of a dry ash handling conversion project. Table 3 in unit V.B.3.a of this preamble shows the information used in the final rule alternative capacity analysis for this technology approach.

DTE Energy submitted comments describing an ongoing dry fly ash handling conversion project of four boilers at its Monroe Power Plant (Monroe) in Michigan. The commenter states that one CCR surface

[13] See docket items EPA–HQ–OLEM–2019–0172–0085 and 0094, respectively.

[14] For additional information on bottom ash handling systems, see USEPA, 2019. ''Supplemental Technical Development Document for Proposed Revisions to the Effluent Limitations Guidelines and Standards for the Steam Electric Power Generating Point Source Category''. EPA–821–R–19–009 (November).

[15] 77 FR 9304 (February 16, 2012).

[16] 85 FR 12456 (March 3, 2020).

impoundment currently receives wet sluiced fly ash and that prior to the *USWAG* decision, this 331-acre impoundment was not subject to closure for cause. The commenter's narrative description of the timeline estimates that the dry fly ash conversion project will take at least 57 months until the dry ash handling systems are operational and wet sluicing of ash can end. Monroe currently operates a CCR landfill. The commenter explained that the conversion construction schedule has been designed to coincide with already scheduled periodic unit outages and has been coordinated with the Midwest Independent System Operator so as to maintain grid stability and electrical reliability.[17] The commenter stated that for plants such as Monroe that have multiple generating units, outages for those units are seldom concurrent. Therefore, the commenter explained that the schedule for the dry ash handling conversions are coordinated into a series of sequential generating unit outages that adds to the required time to install and start up the systems.

After considering the comments submitted by DTE Energy, EPA is not using its project information in the final rule calculation of the amount of time needed to convert all four of its boilers to dry fly ash handling. DTE Energy explained in its comments that two of its boiler units currently have a dual ash handling system that allows fly ash generated from these boilers to be handled dry or wet. The commenter further explained that a portion of the fly ash generated from these two boilers is transported dry (*e.g.,* collected fly ash is conveyed to storage silos using air pressure) and sold for beneficial use, while the remaining portion of fly ash not sold for beneficial use is wet sluiced to its unlined CCR surface impoundment. The commenter further explained that fly ash generated by the other two boilers is currently wet sluiced to the same impoundment. As explained earlier, the project timeline to convert all four boilers to dry handling is estimated to take 57 months; however, the commenter does not explain why closure of the unlined surface impoundment could not be initiated sooner than 57 months given that two boilers are already currently configured to dry handle fly ash. Nor is the project timeline sufficiently detailed for the Agency to discern whether alternative capacity could be obtained sooner than projected.

Non-CCR wastestream basins. The second technology approach for alternative capacity proposed by the Agency was construction of a new wastewater basin for non-CCR wastestreams. A new wastewater basin could be needed in a situation where one or more non-CCR wastestreams are managed in an existing unlined CCR surface impoundment subject to closure. EPA proposed that the average amount of time needed to construct a new basin for non-CCR wastestreams was 21 months, but also explained that available data showed that permitting of the unit can greatly impact the amount of time needed to complete the new capacity. The data in the proposal showed new capacity could be obtained in a range of 18 to 41 months. EPA further explained that when removing the variable permitting component from consideration, the average time to plan and design, procure, and construct and commission the new basin was 21 months. 84 FR 65947.

In response to the proposed rule, several commenters stated that obtaining permits is a necessary component of the process to construct a non-CCR wastestream basin and provided examples of the types of permits, licenses or approvals that may be needed. These commenters argued that EPA must include some time for obtaining permits for this alternative capacity method. The Agency also received new project information from several entities regarding construction of a new wastewater basin for non-CCR wastestreams. However, these projects were done as part of a larger multiple technology system effort. These multiple technology system projects included the construction of non-CCR wastewater basins or storage in conjunction with either dry ash handling conversions or development of other alternative capacity at the New Madrid Power Plant, Thomas Hill Energy Center, Salt River Project, and the Boswell Energy Center. Those project descriptions are not included in the capacity analysis for non-CCR wastestream basins, but are discussed in the ‘‘Multiple technology systems’’ section of this preamble. The Agency did not receive any new project information from commenters documenting the time needed to construct a new non-CCR wastewater basin when such project was not part of a multiple technology system.

After considering comments, EPA is adjusting the approach used in the proposed rule to determine the time needed to obtain alternative capacity with a non-CCR wastewater basin. Several commenters were critical of the proposed approach because it removed permitting timeframes considerations from the estimation. The Agency agrees with commenters that obtaining a permit (*e.g.,* the time needed to modify a National Pollutant Discharge Elimination System permit) is a necessary component to putting in place a new non-CCR wastewater capacity. EPA re-evaluated the project schedule associated with the high-end estimate of 41 months considered in the proposed rule. This review determined that the design and permitting phase of the project—18 months of the project duration—includes environmental reviews required under the National Environmental Policy Act (NEPA). As noted in the submission, the NEPA review process ‘‘can take up to a year or longer depending on the level of review’’ required. The Agency also reviewed other documents associated with the NEPA review for this non-CCR wastewater basin and found that the process well exceeded a year to complete.[18] But because the majority of facilities are not subject to NEPA, EPA considers this situation to be an outlier that is more appropriately accounted for and, if necessary, addressed under the alternative closure process in § 257.103. Because the NEPA review process overlaps with other project tasks, such as detailed engineering design and preparing permit applications, EPA adjusted the estimate to remove 12 of the 18 months associated with the NEPA review process, rather than deleting the entire 18 months. The resulting six-month time frame is consistent with the estimate provided by other facilities for the engineering design phase. Therefore, for purposes of the final rule alternative capacity analysis EPA will use an adjusted estimate of 29 months (41 minus 12 months) to complete the construction of the non-CCR wastewater basin.

EPA is using the estimate to construct a new non-CCR wastewater basin provided by Southern Company in the final rule alternative capacity analysis. This information was considered in the proposed rule and describes a project estimated to take 18 months. Table 3 in unit V.B.3.a of this preamble shows the information used in the final rule alternative capacity analysis for this approach.

[17] The Federal Energy Regulatory Commission (FERC) defines an Independent System Operator as an independent, federally regulated entity established to coordinate regional transmission in a non-discriminatory manner and ensure the safety and reliability of the electric system.

[18] 83 FR 54162 (October 26, 2018). ‘‘Shawnee Fossil Plant Coal Combustion Residual Management; Issuance of Record of Decision.’’ The draft Environmental Impact Statement was released on June 8, 2017, and the final Record of Decision was published on October 26, 2018.

Wastewater treatment facility. The third technology approach considered by EPA at proposal was to build a new wastewater treatment facility (or system) for CCR and/or non-CCR wastestreams. A wastewater treatment system can take different forms, as explained in the proposed rule. For example, a chemical precipitation wastewater treatment system is a system where chemicals are added to the wastewater to alter the physical state of dissolved and suspended solids to facilitate settling and removal of solids. Other systems, such as settling ponds, are designed to remove particulates from wastewater by means of gravity. EPA proposed that the average amount of time needed to construct a wastewater treatment system is 16 to 21 months based on information obtained for a related rulemaking for the Steam Electric Power Generating Effluent Guidelines and Standards (Steam Electric ELG). The Agency also presented an example of a concrete treatment tank system being considered by an electricity producer that estimated the time to obtain alternative capacity to be 27 months. 84 FR 65948.

In response to the proposed rule, several commenters stated that information available in the rulemaking docket estimates significantly longer timeframes to obtain capacity with a wastewater treatment system than EPA's proposed time. These commenters pointed to information in the docket from Arizona Public Service stating that it will require approximately 27 months to complete construction of the wastewater treatment facility.[19] The commenters also identified new information contained in a comment by Southern Company in the Steam Electric rulemaking docket, stating that a complex wastewater treatment project at a plant with over 50 wastestreams can take up to 52 months to implement.[20] The commenters further stated that EPA's proposal fails to consider the time needed to obtain or modify National Pollutant Discharge Elimination System (NPDES) permits, which is a crucial aspect of the process of constructing and implementing a wastewater treatment facility. Therefore, these commenters argued that the Agency should include the time required to obtain or modify NPDES permits in its calculation of the time it takes to implement a wastewater treatment facility as a method of alternative capacity.

The Agency also received new project information from several entities regarding construction of a new wastewater treatment facility. However, these projects were done as part of a larger multiple technology system effort. These multiple technology system projects included the construction of wastewater treatment capacity in conjunction with either dry ash handling conversions or other alternative capacity additions at the New Madrid Power Plant, Thomas Hill Energy Center, and the Leland Olds Station. Those projects are not included in the wastewater treatment system analysis and are discussed in the ''Multiple technology systems'' section of this preamble.

As discussed earlier for the approach for non-CCR waste basins, the Agency agrees with commenters that obtaining or modifying a NPDES permit is a necessary component to establishing new capacity with a wastewater treatment facility. To better capture the range of times needed to obtain or modify a NPDES permit, the final rule is supplementing the Steam Electric ELG information used at proposal with the project information from Arizona Public Service, which shows alternative capacity will be in place within approximately 26 months.[21] In addition, the Steam Electric ELG timeframes were presented as ranging from 16 to 21 months in the proposed rule. For reasons discussed in unit V.B.3 of this preamble, the Agency is representing this information as a mean of the range (*i.e.,* 18.5 months) so as to not overrepresent this information relative to other data. However, EPA is not including in the alternative capacity calculation the information characterized as a ''complex wastewater treatment project at a plant with over 50 wastestreams'' that can take up to 52 months to implement (these comments were also submitted as comments in response to a separate Steam Electric ELG proposed rule). This information is not being included in the calculation because the Agency was unable to determine whether this project at an unspecified facility involved unique or unusually complex site-specific circumstances that would be better addressed through the alternative closure provisions discussed in unit V.C of this preamble. Table 3 in unit V.B.3.a of this preamble shows the information used in the final rule alternative capacity analysis for this technology approach.

New CCR surface impoundment. The fourth technology approach considered by EPA at proposal was to build a new CCR surface impoundment to replace the impoundment subject to closure for cause. Such a unit could be used for CCR alone or could also be used to manage non-CCR wastestreams. EPA proposed that the average length of time needed to build a new CCR surface impoundment is 27 months. 84 FR 65949. As explained in the proposed rule, this average time was developed from available information submitted by three facilities—Xcel Energy, Arizona Public Service, and Southern Company.[22] The proposed 27-month average was comprised of six months for planning and design, six months for permitting (though the preamble presented a range of six to 18 months and acknowledged that the permitting phase can take longer than this range), 14 months for material procurement and construction, and one month for capacity commissioning.

In response to the proposed rule, several commenters stated that EPA must fully consider the additional time required to apply for and obtain the necessary permits when estimating the timeframe for constructing a new CCR surface impoundment. These commenters argued that EPA inappropriately selected the low end of the range needed for permitting (*i.e.,* six months), despite the record showing that it is not a rare occurrence when more time is needed for permitting. These commenters stated that the timeframes must also account for the time needed to install a groundwater monitoring system for the new impoundment given that the federal CCR regulations require that the new impoundment must be in compliance with groundwater monitoring requirements prior to initial receipt of CCR. These CCR requirements include, for example, installing the groundwater monitoring system and developing a groundwater sampling and analysis program.

EPA also received new project information regarding the construction of new CCR surface impoundments from a number of companies, including Xcel Energy (Xcel), Great River Energy (Great River), and CPS Energy.[23] The information provided by each is briefly summarized below.

Xcel submitted detailed project information for a new CCR surface impoundment that is currently under

[19] See docket item EPA–HQ–OLEM–2019–0172–0008.

[20] See docket item EPA–HQ–OW–2009–0819–8457.

[21] EPA re-examined the APS schedule to complete construction of the wastewater treatment facility and determined that the project would take 26 months versus the 27 months presented in the proposed rule.

[22] See docket items EPA–HQ–OLEM–2019–0172–0007, 0008, and 0011, respectively.

[23] See docket items EPA–HQ–OLEM–2019–0172–0067, 0076, and 0070, respectively.

construction to replace an existing 18-acre CCR surface impoundment. That impoundment is used for the temporary storage of bottom ash prior to its excavation and beneficial use or disposal elsewhere. The commenter explained that the existing impoundment at the Sherburne County Generating Plant (Sherburne) in Minnesota is currently considered unlined pursuant to the CCR regulations and that the unit was not subject to closure for cause until the 2018 *USWAG* decision. At proposal, EPA relied on information provided by Xcel in an earlier submission specific to this new CCR surface impoundment. Xcel stated in its comments that even with the benefit of work completed prior to the *USWAG* decision, it does not anticipate that alternative capacity (the new impoundment) will be available until mid-October 2020. The commenter explained that EPA's time estimate at proposal for the new Sherburne impoundment did not include already completed essential tasks related to the new impoundment, including an assessment of options for alternative capacity, and preliminary design, permitting and project planning. Xcel further explained that the actual timeline since project initiation in January 2014 to completion in October 2020 would not be consistent with the standard in the proposed rule to obtain alternative capacity ''as soon as technically feasible,'' because there has not been a continuous and sustained effort to obtain the alternative capacity. Therefore, Xcel reconstructed the activities completed prior to the *USWAG* decision and developed a hypothetical project schedule reflecting a project start date of October 15, 2018 (*i.e.,* the *USWAG* mandate). The commenter stated that expedited durations were used where feasible and provided examples. The commenter further stated that constructing the new CCR surface impoundment would take a minimum of 34 months, which would equate to mid-August 2021 under this hypothetical schedule. Xcel's comments included a narrative description explaining all phases of the entire project and a detailed project schedule, both for the actual and hypothetical cases.

Great River submitted detailed project information for a new CCR surface impoundment at its Coal Creek Station in North Dakota. The commenter stated that the new 66-acre impoundment will replace two existing CCR surface impoundments that receive fly ash, bottom ash, and flue gas desulfurization materials. The existing impoundments are approximately 75 and 100 acres in size, according to the closure plans posted on the plant's CCR compliance website. The commenter also explained that the two existing surface impoundments were considered lined units pursuant to the CCR regulations prior to the 2018 *USWAG* decision. The commenter further stated that Coal Creek Station initiated efforts to obtain alternative disposal capacity immediately following the *USWAG* decision and that constructing the new CCR surface impoundment will take approximately 59.5 months. However, the commenter explained that the future location of the new CCR surface impoundment is currently occupied by two existing, state-regulated non-CCR surface impoundments. The commenter further explained that the proposed plan is for the two non-CCR surface impoundments to be combined into one CCR surface impoundment, and to expedite availability, construction efforts will focus on conversion of only one non-CCR surface impoundment at a time. Great River's comments included a detailed project schedule and a technical memorandum from its engineering consultant explaining the steps of the project in detail from start to finish.

CPS Energy submitted information for a new two-acre CCR surface impoundment at its Calaveras Power Station in Texas. The commenter stated that the new impoundment will replace two existing CCR surface impoundments that receive CCR sludge from the air pollution control equipment. The existing impoundments are each approximately 1.5 acres in size, according to the closure plan posted on the plant's publicly accessible CCR internet site. CPS Energy stated in its comments that constructing the new CCR surface impoundment will take approximately 30 months. While the commenter provided summary information on the amount of time needed to construct the new unit, neither a detailed narrative description nor a detailed project schedule explaining all phases of the project was submitted with the comments.

After evaluating the comments that provided new information, EPA is including the 34-month timeframe for the Xcel project in its final rule calculation of the amount of time needed to put in place new CCR surface impoundment capacity. This commenter provided a detailed narrative description and project schedule explaining all phases of the project that allowed EPA to evaluate the reasonableness of the estimates. EPA is not including, however, the summary information for the new impoundment planned at Coal Creek Station because of the unique real estate challenges at the site. As discussed earlier in this section, construction of the new impoundment cannot commence until one of the former non-CCR surface impoundments is dewatered and cleaned out. According to the commenter's project schedule, these tasks are anticipated to consume at least one of the three construction seasons dedicated to the construction of the new impoundment. Given that the facility is located in North Dakota, an area of the country that has shorter construction seasons, the decision to build the new impoundment at a site occupied by two state-regulated non-CCR surface impoundments affects the project duration by at least one year. While the Agency recognizes that some facilities have legitimate real estate constraints and limitations, EPA considers these situations to be outliers and more appropriately accounted for and addressed, if necessary, under the alternative closure provisions under § 257.103 (see section V.C of this preamble).

The Agency is also not including the summary information provided by CPS Energy in the final rule calculation because the commenter did not provide sufficient detail on its planned alternative capacity project to allow the Agency to evaluate whether the project could have been concluded more quickly.

EPA is using the 28-month estimate to construct a new seven-acre impoundment provided by Arizona Public Service (APS FCPP) for the Four Corners Power Plant in New Mexico in the final rule alternative capacity analysis. The APS FCPP information was considered in the proposed rule and describes the project schedule from start to completion. EPA has included in its calculations the time required to obtain necessary permits and to install a groundwater monitoring system for the new impoundment. The data used in the final rule alternative capacity analysis represent the amount of time to obtain capacity from start to completion, including these permitting and regulatory project elements. Table 3 in unit V.B.3.a of this preamble shows the information used in the final rule alternative capacity analysis for this technology approach.

Retrofit of a CCR surface impoundment. The fifth technology approach considered by EPA at proposal was to retrofit a CCR surface impoundment to meet the requirements specified in the CCR regulations for a new impoundment. Such a unit could be used for both CCR and non-CCR wastestreams. EPA proposed that the time to retrofit a large surface impoundment (approximately 50 acres) was 31.5 months. 84 FR 65950. The 31.5-month timeframe was based on information provided by Vistra Energy for the Martin Lake Power Plant (Martin Lake) in Texas.[24] While the Martin Lake timeline pertains to a larger retrofit project of four surface impoundments, EPA used it to determine the time needed to retrofit a single impoundment. The Agency also proposed that a small CCR surface impoundment could be retrofitted in four to 12 months. The small impoundment time estimate was based on information extracted from rule information posted on publicly accessible CCR internet sites for three facilities (*i.e.,* written retrofit plans required by § 257.102(k)(2)), including Keystone Generating Station, Weston Generating Station, and Mount Storm Power Station.

In response to the proposed rule, several commenters stated that it was not appropriate for EPA to discount the need for sequential retrofitting of impoundments at the Martin Lake facility and use 31.5 months as the average time to retrofit. Given that Vistra Energy's submission makes clear that retrofitting must occur sequentially in order for the plant to continue operating and generating electricity during the retrofit work, the commenters argued that the final rule should consider the full time to retrofit its impoundments. These commenters also objected to the proposed rule averaging methodology stating that EPA both overrepresented the impoundment retrofit technology approach (*i.e.,* three of the ten data points used to calculate the proposed 22.5-month average time to obtain alternative disposal capacity were derived from impoundment retrofit information), and inappropriately skewed the retrofit time average to small units. The commenters further contended that approximately 68 percent of CCR surface impoundments are larger than 10 acres and more weight should be given to the actual timeframes experienced by facilities in retrofitting these larger impoundments. These commenters also argued that the timeframes must account for situations where the waste boundary of the unit changes during the retrofit to provide the time needed to install a groundwater monitoring system for the retrofitted impoundment, given that the federal CCR regulations require that the impoundment must be in compliance with groundwater monitoring requirements prior to initial receipt of CCR.

The Agency disagrees with commenters that it was inappropriate to discount the need for sequential retrofitting of Martin Lake's four impoundments and instead used the time to retrofit a single impoundment. The Agency is using the Martin Lake information to determine the time to retrofit a single impoundment. The Martin Lake circumstances are unique in that the facility plans to retrofit four impoundments, and each retrofit must occur sequentially because the facility requires a minimum of three impoundments to be operating at any one time in order for the plant to operate. To use the Martin Lake information, the Agency adjusted the total retrofit time so that it is on the same scale as other facilities (*i.e.,* construction times normalized for a single impoundment retrofit). The proposed rule estimated it would take Martin Lake 31.5 months to retrofit a single impoundment.[25] EPA continues to believe that the 31.5-month estimate is appropriate and is using this data point in its final rule alternative capacity analysis to determine the time needed to retrofit of a CCR surface impoundment. Finally, the Agency intends for unique circumstances like Martin Lake to be addressed through the alternative closure provisions of the final rule.

EPA also received new project information regarding the amount of time needed to retrofit a CCR surface impoundment in comments from Arizona Electric Power Cooperative (AEPCO). AEPCO submitted project information for a surface impoundment retrofit project at its Apache Generating Station in Arizona. The commenter stated that this plant has four CCR ash impoundments, which also manage non-CCR wastestreams, and a scrubber sludge impoundment subject to the CCR regulations. The commenter explained that it will need to retrofit one of the ash impoundments and the scrubber sludge impoundment before it can cease placement of CCR in the units at the plant. The existing ash and scrubber sludge impoundments are approximately 33 acres and 42 acres in size, respectively, according to the closure plans posted on the facility's publicly accessible CCR internet site.[26] The commenter noted that these existing surface impoundments were not subject to closure for cause under the CCR regulations prior to the 2018 *USWAG* decision. The commenter further explained that after conducting preliminary design work for evaluating potential alternative capacity, AEPCO decided to retrofit the existing impoundments, which involves removal of approximately 900,000 cubic yards of solids from the existing impoundments. The commenter estimated that it will take approximately 47 months to complete the retrofit of the scrubber sludge impoundment and 55 months to retrofit one ash impoundment; however, both impoundment retrofits, which will be conducted concurrently, must be completed before the facility can cease using the existing impoundments. AEPCO must first obtain Board approval of an initial scoping of the project and initiate project financing activities. The commenter explained that many electric cooperatives finance large projects through the U.S. Department of Agriculture's Rural Utilities Service (RUS) because RUS can offer low-interest federal loans. RUS funding can require an environmental review under the National Environmental Policy Act before funds will be released by RUS to the cooperative. The commenter's project schedule included approximately 16 months for obtaining internal approval of the project, initiating RUS financing, and completing preliminary design work. AEPCO's comments included a narrative description explaining all phases of the project and a detailed project schedule, including an estimate of the impact of pursuing RUS funding for these retrofits.

After evaluating AEPCO's comments, EPA is incorporating the impoundment retrofit projects at Apache Generating Station into the final rule alternative capacity analysis. However, the Agency is adjusting the project timeframes used in the capacity analysis for this facility for reasons discussed below. As discussed earlier, this commenter explained that the project schedule includes 16 months for Board approval activities and initiating a process to obtain lower-cost financing through the RUS program. The environmental review process required by RUS can be a lengthy process—longer than a year in some cases—as noted by this and other

[24] See docket item EPA–HQ–OLEM–2019–0172–0005.

[25] See docket item EPA–HQ–OLEM–2019–0172–0005. EPA subtracted off 27 months for the retrofit of the remaining three impoundments and the six months for contingencies built into the schedule to obtain 31.5 months to retrofit a single impoundment.

[26] ''Closure Plan—Revision No. 1, Apache Generating Station, Arizona Electric Power Cooperative, Inc., Cochise County, Arizona'', October 13, 2016.

commenters.[27] These commenters further explained that borrowers must wait for the conclusion of RUS's environmental review before taking any action on projects that could have an environmental impact or otherwise limit or affect the USDA's final decision.

As EPA explained elsewhere in this preamble, the goal of the Agency's alternative capacity analysis is to identify capacity that can be obtained in the shortest feasible time. A schedule based on a lengthy decision-making and administrative process is not consistent with this goal, especially when other faster financing options are available and within the facility's control. The length of time it takes to make a decision is also within the facility's control and can be expedited as necessary. Therefore, EPA evaluated the timeline to determine the extent that the lengthy decision-making and financing approach impacted the project's schedule. As a result, the Agency is reducing the initial 16-month decision-making and financing activities by nine months. This adjustment would retain seven months for the planning and initial design phase of the project that would occur within the initial 16-month period. The seven-month period is the same amount of time identified for this project phase at proposal. Therefore, for purposes of the final rule alternative capacity analysis EPA will use an adjusted estimate of 38 months (47 minus nine months) to complete the retrofit of the scrubber sludge impoundment and 46 months (55 minus nine months) to retrofit one ash impoundment. Finally, given that the retrofits of the scrubber sludge and ash impoundments were concurrent activities (*i.e.,* the retrofit construction began at the same time), EPA views this as one retrofit project and is including the longer retrofit estimate of 46 months in its alternative capacity analysis because the impoundment retrofits would be completed within this 46-month period.

As discussed elsewhere in this preamble, EPA also received comments that the proposed alternative capacity technology approaches are missing key components of the project planning process (*e.g.,* the time needed to obtain required permits). These commenters stated that EPA must account for any missing components when determining the time needed to obtain alternative capacity. EPA re-evaluated the information available in the three retrofit reports for small impoundment retrofits that supported the proposed rule. Weston Generating Station (Weston) located in Wisconsin operates two sets of bottom ash dewatering and settlement basins (each set is approximately three acres in size). The two sets are operated in parallel thus allowing one set of basins to be taken offline while the second set remains in use. Thus, only one set of basins must be in operation in order for the plant to operate. The schedule provided in its retrofit plan includes time estimates for all project components, including the phases of planning and design, procurement, permitting, construction, and capacity commissioning.[28] This report shows that it will take approximately 12 months to complete the retrofit of the first series of dewatering and settlement basins and an additional three months to complete the retrofit construction of the second series of basins. Weston posted a construction certification at the end of November 2017 documenting the completion of the retrofit project[29] confirming that the actual time needed to complete the retrofit project was consistent with the project schedule considered by EPA in the proposed rule. Therefore, EPA continues to believe that 12 months accurately reflects the amount of time the commenter needs to retrofit a single surface impoundment and is including this data point in the final rule alternative capacity analysis.

Regarding the surface impoundment retrofits at Keystone Generating Station in Pennsylvania and Mount Storm Power Station in West Virginia, EPA's re-evaluation found that the retrofit reports for both plants lack information on the phases of planning and design, procurement and permitting. The Agency was unable to obtain additional information for these retrofit projects. As a result, EPA is no longer considering these retrofit reports as part of the final rule alternative capacity analysis.

Finally, as a result of including new retrofit information from commenters and of the Agency's re-evaluation of information used in the proposed rule, two thirds of the data used in final rule alternative capacity analysis for the impoundment retrofit method is associated with impoundments greater than ten acres. EPA believes this addresses the comment that the retrofit alternative capacity analysis was overrepresented by information from small units under ten acres in size. Table 3 in unit V.B.3.a of this preamble shows the information used in the final rule alternative capacity analysis for this technology approach.

Multiple technology system. The final technology approach considered in the proposed rule was utilizing a combination of technologies that together could provide alternative capacity. An example is a utility that decides to end wet sluicing of bottom ash to a CCR surface impoundment by making modifications to the boiler so that the bottom ash can be handled dry, thereby allowing its unlined CCR surface impoundment to be closed or retrofitted. If, in this example, the existing unlined impoundment was also used to manage non-CCR wastestreams, then the utility would also need to obtain alternative capacity for its non-CCR wastestreams (*e.g.,* a wastewater treatment system). Thus, the combination of a dry ash handling system and wastewater treatment system is an example of a multiple technology system.

EPA proposed that the average amount of time needed to obtain alternative capacity with a multiple technology system was 21 to 36 months, although the Agency generally lacked detailed information on the engineering, design and permitting phases of the underlying projects. In the proposed rule, EPA estimated the time needed for the engineering and design phase and assumed that permitting occurs concurrently with other project steps. The Agency also acknowledged in the proposed rule that the time needed to construct a multiple technology system is highly dependent on the alternative capacity approaches selected and that more time may be needed for planning and design because these systems can be more complex. 84 FR 65950.

In response to the proposed rule, several commenters stated that permitting considerations were omitted from the proposed timelines because permitting was assumed to occur concurrently with other project steps, such as construction. These commenters further stated that this assumption is not supported by the information in the record which demonstrates that permitting is a necessary and key component of the process of developing alternative capacity and that construction work rarely can proceed until all the necessary permits are obtained. Therefore, they argued that the final rule should include some time for obtaining permits. Commenters also stated that the proposed rule approach does not contemplate multiple technology systems when they must be

[27] See docket items EPA–HQ–OLEM–2019–0172–0086 and –0102.

[28] See docket item EPA–HQ–OLEM–2019–0172–0004.

[29] ''Construction Certification for the Weston Units 3 & 4 Ash Basins Liner Retrofit, Wisconsin Public Service Corporation, Weston Generating Station, Rothschild, Wisconsin'', November 29, 2017.

implemented sequentially. An example presented was for a facility that implements a dry ash handling conversion; once the large-volume sluice flows are removed from the impoundment, the facility begins a partial retrofit within that impoundment footprint for other non-CCR wastestreams. The commenters explained that this could be the case when the facility has real estate constraints that prevent construction from beginning until after the sluice flows are removed. Impoundment closure could not begin until after the partial retrofit is completed and the non-CCR wastestreams relocated. Other commenters stated that schedules based on completed projects, such as those of Duke Energy, did not provide enough details to understand whether the facility acted as expeditiously as possible or whether tasks were conducted sequentially or with some overlap.

EPA also received project information from several entities regarding multiple technology systems, including from Associated Electric Cooperative, Inc. (AECI), Minnesota Power, American Electric Power (AEP), Salt River Project Agricultural Improvement and Power District (Salt River Project), and Basin Electric Power Cooperative (Basin Electric).[30] The information provided by each is briefly summarized below.

AECI submitted project timelines and related information for its two CCR-generating facilities in Missouri: New Madrid Power Plant (New Madrid) and Thomas Hill Energy Center (Thomas Hill). The commenter described ongoing efforts at both facilities to put in place new alternative capacity using multiple technology systems. The commenter further explained that both facilities are subject to the CCR rules and the Steam Electric ELG rules. The project timelines provided include six projects required to comply with the CCR and Steam Electric ELG rules. The commenter stated that the proposed rule does not account for several integral steps in the process of obtaining alternative capacity. For example, they contend that EPA's proposal did not fully consider the interactive relationship between multiple technology systems that require iterative engineering design and construction sequencing to accommodate complex system development and functionality, such as a new wastewater treatment facility that will discharge into a non-CCR surface impoundment. The commenter also stated that the proposal did not fully consider the commissioning and start-up testing phase for multiple technology systems. The commenter's experience is that more complex systems with multiple and varying water streams will take more time to allow for start-up of equipment before becoming fully operational. For example, elements such as seasonality, varying plant operating conditions, periodic activities (*e.g.,* boiler washes), and inconsistent flow rates require extensive post-construction operational configuring and calibration of pumps, treatment dosing, and effluent monitoring. In addition, initial design activities, such as feasibility studies and alternatives analyses, are more complex for multiple technology systems, which they argued are not properly accounted for in the proposed rule. The commenter stated that the capacity timelines must account for the inherent complexities with multiple technology systems due to the iterative nature of the process.

Of the six projects AECI described, four are underway at the New Madrid facility, including two separate conversions to dry handling (a dry light ash handling conversion and a dry boiler slag handling conversion); construction of a non-CCR wastestream basin for coal pile runoff and process water; and construction of a new water treatment facility for other wastestreams. According to information provided by the commenter, the dry light ash handling conversion was initiated in April 2015 and is expected to be completed by February 2021, a duration of approximately 71 months. The dry boiler slag handing conversion, which includes conversions for two boilers, also began in April 2015 and is estimated to be completed by August 2023, a duration of approximately 102 months.

The final two projects at the New Madrid facility were initiated in October 2018 following the *USWAG* decision. According to information provided by the commenter, they are planned for completion in November 2021, a duration of approximately 37.5 months. The two projects at the Thomas Hill facility include plans to construct a wastewater treatment facility and non-CCR wastestream basins. The specific projects include constructing a concrete dewatering tank to handle boiler slag wastewaters, a new coal pile runoff pond, and other process water ponds. According to information provided by the commenter, these projects would take approximately 37.5 months to complete.

Minnesota Power also submitted project timelines and related information for its Boswell Energy Center (Boswell) in Minnesota describing ongoing efforts to put in place new alternative capacity using multiple technology systems. The commenter stated that it has two CCR surface impoundments that are subject to closure for cause. The first impoundment receives bottom ash and non-CCR wastestreams and the second impoundment receives flue gas desulfurization (FGD) materials, as well as bottom ash dredge materials from the first impoundment. The commenter stated that a multiple technology system for alternative capacity is being pursued at Boswell that will convert the bottom ash handling systems for two boilers to dry systems and install an FGD dewatering system on one of the boiler systems. In addition, a new wastewater storage unit will be constructed for non-CCR wastestreams. The commenter stated that completion of these projects will allow CCR to be managed at its on-site CCR landfill, allowing for the closure of the two CCR surface impoundments. The project timelines submitted by the commenter show that both dry handling conversions will be completed early in 2023, with one conversion taking 40 months to complete and the other one 52 months. The construction of the non-CCR storage unit is planned to be finished in 34 months.

The commenter stated that the proposed rule timelines were deficient in that they did not adequately address the role and extent to which existing economic regulation requires coordinated decision-making for electric utility investments. These regulations include requirements for review and approval of investments to comply with state and federal environmental requirements, which would apply to the dry handling conversions being implemented. The commenter explained its requirements under the Minnesota statute and argued that the proposal would create an environmental regulatory approach that contradicts the economic regulatory approach under which Minnesota Power must make its decisions. The commenter also stated that the proposal did not allow adequate time for state permitting for dry conversion or solid waste management, which, they contended, can be the longest and most uncertain part of the entire dry conversion process. The commenter explained that construction of conversion activities cannot commence until the permits for those changes are issued by the appropriate state or federal regulatory agency. A dry handling conversion will require a major Title V Permit amendment, due to

[30] See docket items EPA–HQ–OLEM–2019–0172–0087, 0075, 0077, 0079, and 0069, respectively.

increased air emissions that will result from the conversion from wet to dry. The commenter also stated that it is projected to take between nine and 21.5 months to receive final permits, and the commenter provided a letter from the Minnesota Pollution Control Agency indicating that this is a reasonable estimate for its conversion project.

AEP also submitted project planning information regarding timeframes to convert to dry bottom ash and fly ash handling and to develop alternative disposal capacity for non-CCR wastewater streams. AEP explained its methodology for performing engineering design, planning and construction of all construction projects, but that it has not previously converted any of its facilities to a dry bottom ash handling system, nor has it developed alternative storage or treatment options for non-CCR wastewater streams. The commenter presented a typical timeline for obtaining such alternative capacity that indicates that it could take 62 months to complete a new non-CCR wastestream basin and 51 months to complete the dry ash handling conversion. These timeframes appear to be based on a scenario where the non-CCR wastestream basin would be constructed on top of a closing CCR surface impoundment. The commenter notes on its timeline that the impoundment would be closed in phases, so that new alternative disposal capacity can be built in the existing footprint of the impoundment.

Salt River Project also submitted detailed project information for a new CCR surface impoundment and non-CCR wastewater impoundment to replace an existing 330-acre CCR surface impoundment used primarily for the disposal of flue gas desulfurization materials and other non-CCR wastestreams. The commenter stated that the existing impoundment at the Coronado Generating Station in Arizona is currently considered unlined under the CCR regulations and that the unit was not subject to closure for cause until the 2018 *USWAG* decision. The commenter stated that it immediately began a preliminary analysis of compliance options under the CCR rule after the *USWAG* decision and began to evaluate options for developing alternative disposal capacity. The commenter further explained that the facility plans to obtain alternative capacity using a collection of modular surface impoundments for CCR and non-CCR wastestreams having an aggregate surface area of approximately 100 acres. Salt River Project stated that it selected a staged pond construction project approach, which will establish initial alternative capacity for both CCR and non-CCR wastestreams in separate impoundments and allow additional ponds to be constructed as needed in the future. Salt River Project stated it will take approximately 55 months to replace the existing unlined impoundment with the new CCR and non-CCR impoundments. Salt River Project's comments included a narrative description explaining all phases of the entire project and a detailed project schedule.

Basin Electric submitted information for a multiple technology system involving dry bottom ash conversion and construction of a process water treatment system at its Leland Olds Station in North Dakota. The commenter stated that the project took approximately 40 months from start to completion, beginning in January 2016 and ending in the spring of 2019. While the commenter provided summary information on the amount of time needed to construct the new unit, neither a detailed narrative description nor a detailed project schedule explaining all phases of the project were submitted with the comments.

After evaluating the comments that provided new project information, EPA is including the information from Thomas Hill, Boswell Energy Center, Salt River Project, and Leland Olds, as well as an average time derived from the Duke Energy data described in the proposed rule (the Duke Energy data are discussed further in the next paragraph), in its final rule alternative capacity calculation for multiple technology systems. The Agency is not including the information for the New Madrid facility in the final rule calculation. The New Madrid information shows that the engineering design and procurement phases last approximately three years for each boiler's dry handling conversion (the timeline calls for two boilers to be converted sequentially). The commenter did not provide sufficient details for EPA to understand why these timeframes are substantially longer than other dry handling conversions. As a result, the Agency attributes these longer timelines to unique or unusually complex site-specific circumstances that would be better addressed through the alternative closure provisions discussed in unit V.C of this preamble.

EPA is also not including the new information provided by AEP in its final rule alternative capacity calculation for multiple technology systems. As discussed in its comments, the commenter's estimate of 62 months to obtain alternative capacity is governed by the amount of time to construct a non-CCR wastestream basin, which in turn cannot be constructed until real estate becomes available by closing part of a CCR surface impoundment. While the Agency recognizes that some facilities may be constrained by available real estate, the commenter did not provide any design information or site-specific circumstances supporting this construction approach. EPA has not received information from the utility sector stating that it will be commonplace and necessary to build new alternative capacity on top of existing disposal units that first need to be closed. For these reasons, the Agency is not using this new information in the final capacity calculation.

The Agency included information submitted by Duke Energy regarding various multiple technology system projects that have been completed at nine Duke Energy plants in Indiana, Kentucky and North Carolina at proposal. The projects varied at each facility, but they generally involved converting to dry ash handling and construction of non-CCR wastestream basins and/or wastewater treatment facilities. While the submission includes detailed information on the time needed to complete the construction and capacity commissioning phases of the project, less information is available on the project phases prior to construction, such as planning and design, procurement, and permitting. However, because the data reflect completed projects, EPA considers the data are sufficiently reliable to include in its estimate. The commenter provides the total time for all project phases to develop alternative capacity at these nine facilities, which ranged from 30 to 42 months, including the time to obtain necessary permits. However, the commenter did not provide specific timeframes for each of the nine facilities, and because the projects were initiated before the *USWAG* decision, they may not represent expedited timeframes. Even though these timeframes are considered to be the outer bounds of the time necessary to complete these projects, the Agency considers these timeframes persuasive because they provide some guarantee that other facilities can replicate them. Consequently, the Agency is using the average time of the range—36 months—that it took Duke Energy to obtain alternative capacity. Nevertheless, because the timeframe for Duke Energy represents nine facilities, EPA considers this to represent nine data points. When taken with the data from the four other facilities discussed above, EPA has 13 data points to factor into its final alternative capacity calculation.

Regarding commenters stating that the capacity timelines must account for the inherent complexities with multiple technology systems, and the permitting of such systems, the Agency believes this issue is addressed in the final rule by incorporating actual timelines from four additional multiple technology system projects. Table 3 in unit V.B.3.a of this preamble shows the information used in the final rule alternative capacity analysis for this technology approach.

(b) Response to Comments on Other Types of Technology Approaches That Commenters Believe EPA Should Have Considered

Several commenters stated the proposed rule should have addressed additional options for obtaining alternative capacity. For each of these approaches, the commenters argued that alternative capacity could be obtained faster as compared to EPA's proposed timeframes. First, commenters stated that the proposed rule should have considered staged construction. The comments described ''staged construction'' as quickly building some capacity initially followed by the building of additional capacity that will be needed for the long term. A second approach identified by commenters was described as preventing the commingling of stormwater with non-CCR wastestreams which can allow the faster development of alternative capacity. The commenters explained that the quantities of non-CCR wastestreams are magnified because low volume non-CCR wastestreams generated at the facility are allowed to commingle with stormwater. Third, commenters stated that the installation of temporary tanks to manage non-CCR wastes should have been considered in the proposal. The commenters claimed that an approach using temporary tanks would allow the facility to avoid siting-related delays typically associated with in-ground options such as wastewater treatment plants and impoundments. One of these commenters was a vendor of mobile wastewater treatment systems, which can support the dewatering of CCR surface impoundments and the treatment of non-CCR wastestreams. The commenter stated that such mobile treatment systems are commercially proven at full-scale, including at utilities, available on demand, and can be put in place in less time than any of EPA's proposed technology approaches.

EPA disagrees with commenters that ''staged construction'' should be considered as an additional alternative capacity approach on par with the six technology approaches considered. The Agency does not view staged construction as a separate, standalone technology comparable to the existing categories, but instead as a technique that could be employed to expedite a project when feasible. The commenter neither described how the Agency could incorporate staged construction as a separate technology into the final rule alternative capacity analysis, nor identified any source of data or information that could be used. While the commenter identified an example where staged construction was used, EPA notes that there are several other examples where this technique is incorporated in projects supporting the final rule alternative capacity analysis. This suggests that the final rule approach already includes elements of staged construction in the analyses when it was feasible, so it does not merit consideration as a separate approach. In one example, a utility pursuing construction of a new CCR surface impoundment selected a ''staged pond construction project approach, with the first few ponds being constructed for initial commissioning and remaining ponds constructed as needed for future use.'' [31] Another example involved the retrofit of a set of dewatering and settlement basins subsequently followed by the retrofit of a second set of basins.[32] In this example, the facility was able to cease use of the unlined impoundments after the first set of basins were retrofitted, which was the time used in the final rule capacity analysis. A final example of staged construction considered by EPA was a facility planning to build a new CCR surface impoundment in a location currently occupied by two existing, state-regulated non-CCR surface impoundments.[33] The commenter explained that the plan is for the two non-CCR surface impoundments to be combined into one CCR surface impoundment, but to expedite availability, construction efforts will focus on conversion of only one non-CCR surface impoundment at a time.

EPA disagrees with commenters that preventing the commingling of stormwater with non-CCR wastestreams would have had a material effect on the timeframes to obtain alternative capacity. The Agency reviewed the CCR surface impoundment projects included in the final rule alternative capacity analysis and available information indicates that stormwater is not commingled with other wastes. Therefore, the design and size of the new impoundments were not impacted by commingling of stormwater.

The Agency agrees with commenters that temporary tanks could serve as alternative capacity to manage non-CCR wastestreams for either storage or treatment. EPA also agrees that such storage or treatment capacity may likely be implemented on a faster timeframe at some facilities. However, EPA does not have detailed project information covering the entire process of obtaining alternative capacity through this method. For some project phases, such as planning and design, EPA would expect the timeframes to obtain capacity through temporary tanks to be comparable to the technology approaches considered in the final rule. For other project phases, such as procurement and construction, the timeframes to secure alternative capacity may be shorter. Without such detailed information, EPA cannot include the suggested approach in its analysis. Under the alternative closure procedures discussed in unit V.C.3.a of this preamble, the Agency is requiring owners to evaluate the viability of obtaining temporary storage or treatment capacity while other permanent capacity is developed.

3. Establishing the Revised Deadline for Affected Units To Cease Receipt of Waste

For all unlined CCR surface impoundments, EPA proposed to revise the deadline to cease receipt of waste under § 257.101(a)(1) from October 31, 2020, to August 31, 2020, based on the Agency's analysis of the average time needed to obtain alternative disposal capacity. 84 FR 65951. This preamble section explains how EPA calculated the average length of time needed to obtain alternative disposal capacity, how the Agency determined the deadline, key changes that EPA is making in response to comments submitted on the proposed rule, and our responses to many of the comments received. A full response to comments is provided in the response to comments document available in the docket to this rulemaking.

(a) Average Length of Time Needed To Obtain Alternative Disposal Capacity

EPA proposed that the average length of time needed to obtain alternative disposal capacity for an unlined CCR surface impoundment was 22.5 months. 84 FR 65951 (December 2, 2019). The

[31] See docket item EPA–HQ–OLEM–2019–0172–0079.

[32] See docket item EPA–HQ–OLEM–2019–0172–0004.

[33] See docket item EPA–HQ–OLEM–2019–0172–0076.

Agency calculated this average time by summing the ten estimates for the six technology approaches shown in Table 2 of this preamble and dividing by the number of estimates shown in Table 2. The proposal stated that 22.5 months, although an average, would appear to provide enough time for a substantial proportion of facilities to put in place alternative disposal capacity. In addition, EPA explained that 22.5 months would be a sufficient amount of time to retrofit all but the largest surface impoundments, and smaller surface impoundments with unique design situations. *Id.* The proposal stated that these outliers should not be the basis to extend the time for all facilities beyond 22.5 months because such action would not be consistent with ensuring that the development of alternative disposal capacity occurs as quickly as technically feasible; outliers can be accommodated by the proposed alternative closure provisions.[34]

The proposed rule also discussed why the Agency chose to rely on a single average time (*i.e.,* the average of the average times associated with the six technology approaches) to establish a single new deadline to cease receipt of waste. First, the proposal stated that 22.5 months would provide sufficient (but not excessive) time for a substantial proportion of facilities, under a variety of approaches. Second, the proposal explained that some facilities will need less than the average amount of time to obtain the alternative capacity and some will need more. Each of the averages summarized in Table 2 reflects ranges of estimated times to develop alternative capacity, which can vary depending on site conditions and the specific facility operations. The Agency explained in the proposal that to reliably determine which facilities need less time, EPA would need to make individual facility-specific determinations and that trying to craft individualized time frames could ultimately result in longer delays in the initiation of closure for a greater number of facilities than would potentially be caused by reliance on an overall average that most facilities can meet.

Recognizing that a single deadline is necessarily less precise and that some facilities may in fact be able to construct alternative capacity more quickly than EPA's proposed deadline, the Agency also solicited comment on an alternative approach under which the deadline would vary according to the technology adopted. For example, a facility that chose to install a non-CCR wastewater basin would have a different deadline than a facility that constructed a new wastewater treatment facility. 84 FR 65951. In this scenario, the timeframes for each approach could be based on the averages presented in Table 2 of this preamble. The proposal discussed EPA's concern that this option could be challenging to implement and to track compliance. In addition, EPA expressed concern that this approach may not result in measurably shorter time frames for most facilities, given the range of time estimates, and could lead to a greater number of variance requests under the alternative closure provisions. The proposal sought comment on this approach, including, for example, whether this more complicated regulatory approach would result in measurably shorter time frames for most facilities.

Several commenters stated that the Agency's methodology used to calculate the 22.5-month time frame is flawed. These commenters argued that EPA did not calculate a true average of the data points used in the proposal (see Table 2 of this preamble) because the Agency used more than one data point for a single method when calculating the average, which had the effect of overrepresenting that method in the calculated average.[35] In doing so, the commenters explained that EPA has skewed the data by overrepresenting certain technology approaches compared to other approaches with fewer data points, and stated that EPA did not provide a rationale for giving more weight to certain technologies. Accordingly, these commenters urged the Agency to recalculate the average time needed to obtain alternative capacity so that alternative capacity technologies are equally represented.

EPA agrees that the proposed methodology to calculate the average time needed to obtain alternative capacity overrepresented certain technology approaches over others (*e.g.,* the retrofit of a CCR surface impoundment was overrepresented relative to constructing a new CCR surface impoundment). In the final rule, each technology approach is represented by a single average, which is calculated as the arithmetic mean of the individual data points for the specific technology. Thus, the final rule methodology ensures that none of the six technologies is overrepresented compared to another technology.

As discussed in unit V.B.2.a of this preamble, several commenters stated that the estimated timeframes to obtain alternative capacity overlooked key project components that must be completed in order to construct and bring online each of the proposed alternative capacity approaches. As an example, these commenters explained that the proposed time estimates fail to account for the time that is actually needed by regulatory agencies to complete permit reviews and obtain the necessary permits required for construction of alternative capacity. These commenters further explained that the proposed time estimates fail to factor in the additional time needed to accommodate site-specific circumstances such as plant size, the number of boilers at the plant, location of the plant, and the number and volume of wastestreams affected by the conversion.

The Agency also agrees with commenters stating that certain project components (*e.g.,* time to obtain a permit) were missing from the calculations for some technology approaches in the proposed rule. In response to this comment, EPA's final rule calculation relies on information that covers the entire process of obtaining alternative capacity, from the start of the project to its completion, including the general project phases of planning and design, procurement, permitting, and construction and capacity commissioning. For those data used in the proposed rule that were missing a project component, the Agency removed them from the final rule calculation if the missing information could not be located. An example of where the Agency removed a data source from the final rule calculation is the surface impoundment retrofits at Keystone Generating Station in Pennsylvania. As discussed in the "Retrofit of a CCR surface impoundment" section of the preamble, EPA's re-evaluation of the retrofit report considered at proposal contained missing components of the project planning process. Because the Agency was unable to obtain additional information for this retrofit project, it was not used as part of the final rule alternative capacity analysis. Individual data handling decisions are discussed further in unit V.B.2.a of this preamble.

For each of the technology approaches evaluated, Table 3 summarizes the individual time estimates to obtain such capacity, as well as average timeframe for each technology. As discussed earlier in unit V.B.2.a of this preamble, the Agency supplemented the data set used in the proposed rule with

[34] The alternative closure provisions are discussed in section V.C of this preamble.

[35] For example, the "wastewater treatment facility", "retrofit of a CCR surface impoundment", and "multiple technology system" technology approaches include two, three and two data points, respectively, while the remaining three approaches each include one data point.

additional project timeframes submitted by commenters. These new timeframes were not simply incorporated into the alternative capacity analysis. Instead, each submission was examined thoroughly, and, in some cases, portions of the estimated time were reduced where EPA determined that those portions were not appropriate for the analysis.

TABLE 3—SUMMARY OF DATA USED IN FINAL RULE ALTERNATIVE CAPACITY ANALYSIS

Alternative capacity technology	Data used in final rule analysis (months)	Average (months)
Conversion to dry handling	33.5, 34	33.8
Non-CCR wastestream basin	18, 29	23.5
Wastewater treatment facility	18.5, 26	22.3
New CCR surface impoundment	28, 34	31.0
Retrofit of a CCR surface impoundment	12, 31.5, 46	29.8
Multiple technology system	36, 36, 36, 36, 36, 36, 36, 36, 36, 37.5, 40, 52, 55.	39.1
Average		29.9

(b) Deadline To Cease Receipt of Waste for Unlined CCR Surface Impoundments

EPA proposed to revise the deadline for unlined CCR surface impoundments under § 257.101(a)(1) from October 31, 2020, to August 31, 2020. 84 FR 65951. The proposed rule explained that this revised deadline would apply to both CCR and non-CCR wastestreams. The proposal also explained that the August 31, 2020 deadline was derived by adding 22.5 months (*i.e.,* the average length of time needed to obtain alternative disposal capacity) to October 15, 2018, which is the date of the issuance of the court's mandate for the *USWAG* decision. The proposal explained that the language of the *USWAG* decision was clear that all units that do not have a composite liner or alternative composite liner (see § 257.71(a)(1)(ii) and (iii)) will be required to cease receiving waste and close. The proposal further explained EPA's belief that owners and operators of unlined CCR surface impoundments would have started preparing to close such units upon issuance of the mandate on October 15, 2018.

Many commenters criticized EPA's proposal to rely on the date of the *USWAG* mandate as the starting point to calculate the deadline for initiating closure. These commenters argued that the *USWAG* decision did not set a new deadline or other requirements regarding the mandatory closure of CCR surface impoundments. Rather, the *USWAG* court vacated the mandatory closure provisions in § 257.101(a) that allowed unlined surface impoundments to continue to operate even when they are not leaking, and the relevant provisions in § 257.71(a)(1) for ''clay-lined'' impoundments, based on the rulemaking record before the court at the time of ruling, which was August 21, 2018. These commenters also noted that the court did not prohibit the Agency from developing future regulations that might allow some unlined and ''clay-lined'' impoundments to continue to operate if EPA determines that those impoundments do not pose a risk to human health and environment, but left open this issue for EPA to address in future rulemakings in response to the court's remand of the case.

Another commenter argued that EPA has issued no formal guidance on the impact of the *USWAG* vacatur or how EPA intends to address the court decision. This commenter stated that the commenter was hesitant to make significant investments involving advanced engineering design, state permitting, and equipment procurement before receiving further guidance on whether and to what extent its ''clay-lined'' impoundments would be affected. This commenter further stated that regulatory uncertainty still persists due to ongoing EPA rulemakings and, as a result, the commenter argued that it was not provided adequate notice required under administrative law that its ''clay-lined'' impoundments would be re-classified as ''unlined'' until EPA issued the December 2, 2019 proposed rule. Therefore, the commenter contended that the date of the *USWAG* decision is not appropriate. Another commenter further argued that ''any effort by the Agency to impose a closure deadline with a start date tied to issuance date of the *USWAG* mandate would have the effect of imposing a retroactive legislative regulation that is impermissible under the RCRA statutory scheme.''

Other commenters stated that EPA's proposal to use the date of the *USWAG* mandate (*i.e.,* October 15, 2018) represents an unlawful deadline extension. With one exception, these commenters argued that the proposed *USWAG* starting point provides owners and operators of unlined CCR surface impoundments with additional time to begin closing impoundments that they would have otherwise been prepared to close consistent with the requirements of the 2015 CCR Rule.[36] These commenters stated that the one exception would be for CCR surface impoundments that did not face closure deadlines but will now have to close following the *USWAG* decision.

The commenters also stated that the proposed deadline of August 31, 2020 represents an unjustified extension of the 2015 CCR Rule requirements for CCR surface impoundments that leak or fail the aquifer location restriction, which were the minimum standard necessary to ensure no reasonable probability of adverse effect on human health and the environment for these types of CCR units. The commenters further explained that neither the current proposal nor the July 30, 2018 final rule[37] provide any evidence showing that a later deadline (than the deadlines finalized in the 2015 CCR Rule) meets RCRA's protectiveness standard. The commenters also argued that the proposed deadline is inconsistent with the *USWAG* decision. The commenters stated that the current

[36] The 2015 CCR Rule required owners and operators of an existing unlined CCR surface impoundment to cease placing CCR and non-CCR wastestreams into such CCR surface impoundment and either retrofit or close the CCR unit within six months of making a determination that the concentrations of one or more constituents listed in Appendix IV to this part are detected at statistically significant levels above the groundwater protection standard established under § 257.95(h).

[37] 83 FR 36435. In this final rule EPA extended the deadline to October 31, 2020 by which facilities must cease the placement of waste in CCR units closing for cause in the situations where the facility has detected a statistically significant increase above a groundwater protection standard and where the impoundment is unable to comply with the aquifer location restriction.

proposal and the July 30, 2018 final rule are based on impermissible considerations of cost and ignore evidence of widespread contamination caused by leaking impoundments.

Finally, these commenters criticized the proposal for failing to actually require facilities to close as soon as feasible. According to these commenters, because it would establish a single deadline, the proposal would effectively grant additional time to units that could in fact close more quickly. The commenters explained that an industry average violates RCRA's protectiveness standard by basing regulatory requirements on what is convenient or most affordable for facilities, rather than the most expeditious schedule that is technically feasible. The commenters also stated that the rulemaking record was lacking in that the proposal did not include a determination about whether the projects reflected in the industry submissions supporting the alternative capacity analyses are representative of conditions at CCR impoundments across the country, whether the projects were completed expeditiously, or whether the facilities picked among the various options based on the need for timely compliance with the CCR rule or on the relative costs of the options.

Finally, many of these commenters stated that the CCR Part A proposed rule failed to meet the RCRA 4004(a) protectiveness standard because EPA failed to consider the risks associated with new groundwater monitoring data, violations of location standards, extensions of the operating life of unlined surface impoundments and known compliance issues with groundwater monitoring, annual inspection and liner requirements.

Other commenters suggested that deadlines be extended a specific amount of time following the publication of the final rule or to specific dates. These commenters recommended that the proposed deadline to cease receipt of waste be pushed back by six months to February 2021. This deadline would provide facilities the time needed to understand their obligations and comply with the new regulations, the commenters argued.

The commenters have misunderstood the basis for EPA's proposal. EPA proposed to start the clock on October 15, 2018 because on that date, all unlined surface impoundments, including those that are ''clay-lined,'' were required to cease receipt of waste and initiate closure no later than October 31, 2020. In other words, EPA's proposal merely reflected the state of the law as it existed on that date.

The court ordered that ''the final rule be vacated and remanded with respect to the provisions that permit unlined impoundments to continue receiving coal ash unless they leak.'' 901 F.3d at 431–432. As explained in the proposal, EPA interprets the court as having vacated only the following phrase in § 257.101(a)(1): ''if at any time after October 19, 2015, an owner or operator of an existing unlined CCR surface impoundment determines in any sampling event that the concentrations of one or more constituents listed in Appendix IV of this part are detected at statistically significant levels above the groundwater protection standard established under § 257.95(h) for such CCR unit . . . .'' The court further ordered that ''the Final Rule be vacated and remanded with respect to the provisions that . . . classify ''clay-lined'' impoundments as lined, see 40 CFR 257.71(a)(1)(i) . . . .'' *Id.* Once the mandate issued on October 15, 2018, the vacatur became effective, and with the deletion of those phrases the regulation in fact required all unlined and ''clay-lined'' CCR surface impoundments to cease receipt of waste no later than October 31, 2020. It is for this reason that EPA believes facilities began to plan for closure on that date—a belief confirmed by several commenters who acknowledged that they began planning to close their impoundments as of this date.

For the same reason, EPA disagrees that any facility lacked notice that ''clay-lined'' units would be required to close. And while it is true that the court did not preclude EPA from developing a record to support a new rule, any such future actions would be purely speculative. EPA does not believe that it would be reasonable for facilities to have relied on the mere potential that EPA might adopt some other requirement in the future.

EPA also disagrees that its proposal to rely on the date of the court's mandate would constitute a retroactive application of law. For a regulation to be retroactive, it must change the prior legal status or consequences of past behavior. See *Landgraf* v. *USI Film Products,* 511 U.S. 244, 269, n.4 (1994) (A rule ''is not made retroactive merely because it draws upon antecedent facts for its operation.''). *Treasure State Resource Industry Ass'n* v. *E.P.A.,* 805 F.3d 300, 305 (D.C. Cir. 2015). By contrast, here EPA has merely relied on a past fact to support future requirements.

As a result, the Agency is finalizing an amended version of the approach presented in the proposed rule to determine the deadline for unlined CCR surface impoundments to cease receipt of waste. Specifically, the deadline to cease receipt of waste in the final rule is based on adding the average time to obtain alternative capacity to October 15, 2018, which is the date of the issuance of the court's mandate for the *USWAG* decision. As discussed in unit V.B.3.a of this preamble, EPA determined the average time to obtain alternative capacity to be 29.9 months (or 29 months, 27 days). Adding 29.9 months to October 15, 2018, results in a deadline to cease receipt of waste and to initiate closure of April 11, 2021, which is the new deadline being codified in § 257.101(a)(1). This deadline applies to all unlined CCR surface impoundments, including ''clay-lined'' impoundments. Note that this deadline also applies to any unlined inactive CCR surface impoundments, pursuant to § 257.100(a), which provides that all requirements applicable to existing impoundments apply also to inactive impoundments. An inactive unit is one that has ceased receipt of CCR. Section 257.53. Although these units have already ceased receipt of CCR, some facilities continue to use the unit to manage other non-CCR wastes. Irrespective of whether the unit continues to receive non-CCR waste or has ceased receipt of all waste, they must now initiate closure by the new deadline.

EPA acknowledges that it was unable to conduct a new risk assessment to support this rulemaking in the timeframe that was available. Nevertheless, this rule is consistent with the decisions from the D.C. Circuit. As explained previously, EPA considers that requiring facilities to cease receipt of waste as soon as is technically feasible necessarily meets the RCRA 4004(a) standard, as EPA cannot impose more stringent requirements than those that can be successfully implemented by at least some entities.

Moreover, although the D.C. Circuit determined that EPA lacked the record to authorize the unlimited operation of unlined CCR surface impoundments—and consequently mandated their closure—neither the *USWAG* nor the *Waterkeeper* decision addressed the timing of such actions or what kind of process would be appropriate or necessary. Rather, both the relevant portion of the 2015 CCR rule and the July 18, 2018 rule were remanded back to EPA to allow the Agency to determine the further actions necessary to be consistent with the decision. As part of this rulemaking, EPA is mandating the closure of all unlined impoundments, which is fully consistent with the holding in *USWAG* that the closure of these units is warranted based on the record before the Agency. This rule merely creates an orderly process for ensuring that this occurs.

EPA further disagrees that the use of an average effectively based the requirements on what is convenient or that the Agency failed to evaluate whether the industry estimates represented expeditious time frames. As discussed previously, EPA expressly recognized that in many cases the schedules presented did not reflect an expedited timeline and therefore considered those time frames to reflect the upper bound of the amount of time necessary to complete construction. EPA also discounted estimates that were inconsistent with timeframes presented in submissions from commenters describing completed projects, or were based on factors unique to that site that are unlikely to be relevant to other facilities nationwide. EPA also reduced some portions of estimates to account for overlapping tasks.

EPA also disagrees that the final deadline fails to account for representative conditions across the country. Approximately 85 percent of CCR facilities are located in three geographic regions of the U.S.: The Midwest (41 percent), the Southeast (34 percent), and the Southwest (10 percent). The facilities represented in the final rule alternative capacity analysis include multiple facilities in each of these three geographic regions. The final rule analysis includes facilities located in regions with shorter construction seasons due to frigid winters (Minnesota, Wisconsin, North Dakota), as well as regions with the generally mild winters with longer construction seasons (New Mexico, Arizona, Texas). The analysis also includes facilities located in semiarid regions that receive 10 to 20 inches of rain per year (New Mexico and Arizona), as well as subtropical regions that annually receive 40 to 60 inches of precipitation (North Carolina, Kentucky, Louisiana). As a consequence, the data on which EPA relied to develop the final deadline included data from construction projects located in a wide range of geographic and climactic conditions. The Agency also believes the final rule deadline is representative regarding impoundment size, using surface area acreage of the unit as the surrogate of size. The facilities represented in the final rule alternative capacity analysis include a wide range of unit sizes, including units ranging from less than 10 acres to over 100 acres. As a whole EPA considers these to be representative of the range of conditions at CCR surface impoundments across the country.

EPA acknowledges that one approach would have been to calculate a timeframe based on a single technology method to developing alternative capacity—*e.g.,* selecting a single ''best'' or fastest approach, such as converting to dry handling or constructing a wastewater treatment plant. However, EPA disagrees that this would be appropriate; there are many technical reasons that a facility might select one approach over another that have nothing to do with cost or convenience. For example, the facility might not have sufficient available real estate to construct the alternative capacity, and so might need to retrofit their existing surface impoundment so that they can continue to use a single unit to manage all of their wastes.[38] Similarly, if a facility is trying to comply with multiple EPA regulations or moving away from the commingling of CCR and non-CCR wastestreams, adopting a multiple technology approach may ultimately result in faster compliance overall, even if individual components could theoretically be adopted sooner. Another example could be a facility that sluices bottom ash (or fly ash) to a zero-discharge unlined impoundment where construction of a wastewater treatment facility would not be a viable disposal substitute. In addition, EPA currently lacks the technical record to determine that mandating the single fastest technology for constructing alternative capacity can effectively be implemented by all facilities.

EPA agrees that facilities that can cease receipt of waste more quickly than April 11, 2021 must do so. To address the concern that the new deadline would improperly grant more time to facilities that could close more quickly, EPA has revised the regulation to require that facilities close their unlined impoundments ''as soon as technically feasible, but no later than April 11, 2021.'' See § 257.101(a)(1).

EPA further disagrees that the approach in this rule fails to adequately address the risks. As explained in the proposal, EPA lacked the data to develop a revised nationwide risk assessment to support this rulemaking. Although the commenters are correct that facilities have posted substantial amounts of groundwater monitoring data, as EPA explained, this information could not be easily or readily incorporated into a nationwide risk assessment. EPA estimates that it could have taken as long as one year to develop a revised risk assessment even assuming the Agency could obtain the necessary data. This would have further extended this rulemaking process, which EPA had originally hoped to complete in nine months. A delay in the rulemaking would effectively grant facilities additional time to continue operating these units. Ultimately, the approach that the Agency has taken will result in the initiation of closure—with all the risk reduction that entails—much sooner.

In addition, EPA considers that the approach taken in this rule effectively addresses the risk from these facilities. EPA is requiring facilities to close as soon as it is technically feasible to do so. The final rule defines technical feasibility to mean ''possible to do in a way that would likely be successful.'' As EPA has explained, this standard effectively addresses the risk because it is not possible to impose more protective measures than those that can actually be implemented.

As further measures to address the risk from continued operation of these units, the Agency is requiring all surface impoundments that seek additional time to be in compliance with all applicable requirements in 40 CFR part 257, subpart D. And for those facilities seeking an extension under § 257.103(f)(2) the owner or operator must develop a risk mitigation plan for that surface impoundment. If EPA determines that further measures are needed to address the risk during its review of the § 257.103(f)(2) extension request, EPA will require those measures as a condition of its approval. These provisions are discussed in more detail in subsequent Units of this preamble.

Finally, EPA believes that the revised deadline of April 11, 2021 to cease placing waste into the impoundment provides facilities with adequate time to understand and comply with their obligations under the final rule.

(c) Deadline To Cease Receipt of Waste for CCR Surface Impoundments That Failed the Aquifer Location Restriction

The proposed rule explained that the October 31, 2020 cease receipt of waste date applied not only to the unlined leaking CCR surface impoundments subject to § 257.101(a), but also to the units that failed the minimum depth to aquifer location restriction standard subject to § 257.101(b)(1)(i). 84 FR 65951 (December 2, 2019). Therefore, EPA proposed that the deadline to cease receipt of CCR and non-CCR wastestreams for these CCR units also be amended to August 31, 2020.

[38] See docket item EPA–HQ–OLEM–2019–0172–0005 for an example of real estate constraints.

This proposed rule discussed that the new date was selected based on the same rationale explained for unlined CCR surface impoundments. The proposal stated that these units are similarly situated in that these facilities need additional time to develop alternative capacity to transition away from their surface impoundments. As previously discussed, based on the data received from stakeholders, EPA calculated that the average amount of time to take the necessary steps to cease placement of waste into a surface impoundment was approximately 22.5 months. In addition, based on the data on facilities' publicly accessible CCR internet site regarding compliance with the location restriction standards, the majority of the units that failed the aquifer location restriction are also unlined and must close under § 257.101(a). The proposed rule explained that it is therefore logical to establish the same deadline to cease receipt of waste for units that failed the minimum depth to aquifer location restriction standard. The proposal also stated EPA's belief that it is technically infeasible for a majority of these units to be able to cease receipt of waste prior to August 31, 2020 due to the lack of alternative capacities. EPA further raised the concern that requiring the immediate initiation of closure could disrupt operations at the power plants. Therefore, EPA proposed the date of August 31, 2020 for the deadline to cease placement of waste for § 257.101(b)(1)(i) to replace the date of October 31, 2020, which was established in the July 30, 2018 Final Rule.

This final rule uses the same approach as for unlined and ''clay-lined'' units to establish the cease receipt of waste date to April 11, 2021 for CCR surface impoundments that failed to meet the aquifer location restriction.

(d) Revisions to the Groundwater Monitoring and Corrective Action Requirements in § 257.91(d) and § 257.95(g)(5)

The CCR regulations require each CCR unit to have its own groundwater monitoring system, unless the owner or operator chooses to install a multiunit groundwater monitoring system. If a multiunit groundwater monitoring system is installed, the CCR regulations state that the system must be based on the consideration of several factors that are specified in § 257.91(d)(1). Furthermore, the regulations currently provide under § 257.91(d)(2) that if a multiunit groundwater monitoring system includes at least one unlined CCR surface impoundment, and the concentrations of one or more constituents listed in Appendix IV to this part are detected at statistically significant levels above the groundwater protection standard for the multiunit system, then all unlined CCR surface impoundments comprising the multiunit groundwater monitoring system are subject to the requirements under § 257.101(a) to retrofit or close. In addition, under the assessment monitoring provisions in § 257.95(g), owners and operators of all CCR units are required to take certain actions when one or more constituents listed in Appendix IV of part 257 are detected at statistically significant levels above the groundwater protection standard. Section 257.95(g)(5) specifies that existing unlined CCR surface impoundments are subject to the closure requirements under § 257.101(a) if an assessment of corrective measures is required under § 257.96. Another requirement of § 257.95(g) is that the owner and operator must also prepare a notification stating that an assessment of corrective measures has been initiated.

In the December 2, 2019 rule, the Agency proposed to delete the multiunit system requirements under § 257.91(d)(2) because the provision is no longer relevant, as all unlined CCR surface impoundments are required to retrofit or close. 84 FR 65952. EPA received no comments on this proposed action and the Agency is therefore removing and reserving § 257.91(d)(2) in this action. EPA is also revising § 257.95(g)(5) to remove the requirement specifying that existing unlined CCR surface impoundments are subject to the closure requirements under § 257.101(a) if an assessment of corrective measures is required under § 257.96. The Agency is finalizing this revision because it is redundant to the requirement codified in § 257.101(a) for unlined CCR surface impoundments, which requires all unlined impoundments to close or retrofit. However, the Agency is retaining the other requirement of § 257.95(g)(5) that specifies an owner or operator must prepare a notification stating that an assessment of corrective measures has been initiated.

C. Revisions to the Alternative Closure Standards (§ 257.103)

In the December 2, 2019 proposal, EPA proposed three new alternative closure provisions. As explained in the proposal, these provisions were intended to create procedures by which a CCR surface impoundment could obtain additional time to cease the receipt of waste and initiate closure. The original provisions in the 2015 rule, § 257.103(a) and (b), only allow the continued placement of CCR; both exclude the placement of non-CCR wastestreams. EPA proposed to allow a facility to temporarily continue to manage both the CCR and non-CCR wastestreams currently being managed in the CCR surface impoundment. EPA proposed three new alternative closure standards: (1) A short term alternative to initiation of closure (§ 257.103(e)), (2) a site-specific alternative to initiation of closure due to lack of capacity (§ 257.103(f)(1)), and (3) a site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain (§ 257.103(f)(2)). As explained in the proposal, most of these provisions rely on determinations of how quickly it is feasible for the facility to cease receipt of waste, rather than a determination that continued operation will result in acceptable levels of risk. The exception is that the extension under § 257.103(f)(2) is based on a qualitative risk-risk tradeoff (the increased risk of continuing to operate the unit is offset by the decreased risk of the expedited closure) and a site-specific risk mitigation plan. For all of these, EPA believed it was important to require facilities to submit demonstrations to EPA for approval. This was a significant change from the existing provisions which are self-implementing. Finally, EPA proposed conforming changes to have the existing alternative closure provisions in the 2015 rule, § 257.103(a) and (b), only apply to landfills. The new provisions at § 257.103(f) would then apply only to CCR surface impoundments.

1. Short Term Alternative Deadline To Cease Receipt of Waste (§ 257.103(e))

In the December 2, 2019 proposal, EPA proposed a self-implementing short term alternative to the cease receipt of waste deadline. This alternative was designed for those facilities that need only a little more time to complete development of an alternative capacity technology. EPA proposed that facilities demonstrate and certify that additional time is needed for it to be technically feasible to cease receipt of waste and initiate closure. The provision would have allowed for no more than a three-month extension from the deadlines in § 257.101(a) and (b)(1)(i). The proposal was an acknowledgement that events can occur which are completely out of the facility's control, such as extreme weather or a delay in material fabrication. In essence, this would have been a limited ''force majeure'' provision. EPA proposed requirements of the certification mirroring those in the current requirements of § 257.103(a). 84 FR 65953. EPA proposed that the owner or operator would have to certify the following: (1) No alternative disposal capacity is available on or off-site (an increase in costs or inconvenience is not sufficient support); (2) the owner or operator has made and continues to make efforts to obtain additional capacity; and (3) the owner or operator is (and must remain) in compliance with all other requirements of part 257. EPA proposed that a brief narrative of each component of the certification would be required to explain why a three-month extension is necessary. EPA proposed that the certification to be placed in the facility's operating record, placed on the facility's publicly accessible CCR internet site, and submitted to EPA as a notification of the facility's intent to comply with the alternative deadline under this provision.

EPA received several comments from environmental groups stating concerns that EPA's proposal failed to establish strict criteria that would actually ensure that this extension would only be used in true ''force majeure'' situations. They additionally commented that the demonstration requirements failed to meet the protectiveness standard of RCRA § 4004(a) because it allowed facilities to consider costs or practicable capability.

Industry groups provided comments that supported this proposal on the grounds that events do happen that are out of the facility's control, such as extreme weather, that have a high impact on their construction schedule. They supported this provision being self-implementing. A few industry groups did comment that the short-term alternative and the site-specific longer alternatives should not be mutually exclusive options. They further commented that because the proposed deadline to cease receipt of waste fell in the middle of construction season it was unlikely for facilities to be able to accurately gauge if they could complete development in three months or if they would need longer depending on the severity of the event.

After evaluating the comments, EPA is not finalizing this provision. As discussed in unit V.B.3, EPA has recalculated the deadline by which facilities must cease receipt of waste based on data received in comments; the new deadline is April 11, 2021. As a consequence, EPA considers that this proposal is no longer necessary. In part, the proposal was intended to account for the short interval between the proposed deadline to cease receipt of waste (August 31, 2020) and the expected promulgation of the final rule (July 2020). Such an interval would be too short for a facility to accommodate unforeseen events that impact the construction schedule. This is no longer the case with the revised deadline. Facilities will have several months between promulgation of the final rule and the date by which they must cease receiving waste, and thus should be able to accommodate the circumstances that would have been addressed by the three-month extension. As a further consideration, because the final deadline was calculated with more data than was available for the proposal, EPA has greater confidence that most facilities will be able to meet the deadline.

EPA is reserving paragraph (e) of § 257.103, where the short-term extension was proposed, rather than renumbering the proposed regulation to avoid confusion.

2. Issues Applicable to Both § 257.103(f)(1) and (f)(2)

(a) Scope of Waste That May Continue To Be Managed in the Surface Impoundment

In the December 2, 2019 proposal EPA proposed to allow facilities under the new alternative closure provisions to obtain approval to continue to place CCR and/or non-CCR wastestreams. The existing alternative closure provisions § 257.103(a) and (b) only allow the continued disposal of CCR. EPA sought comment on whether the proposed site-specific alternative closure provisions should only apply to non-CCR wastestreams. Under such an approach, facilities could continue to dispose of CCR pursuant to the existing provisions § 257.103(a) and (b). As explained in the proposal, in the record before the Agency many facilities highlighted that not having capacity for non-CCR wastestreams is a critical issue that places the operation of the facility at risk. Evidence suggests that the average time to develop alternative capacity for non-CCR wastestreams is often the primary driver of determining a technically feasible timeframe for being able to initiate the closure of surface impoundments that comingle CCR and non-CCR wastestreams.

EPA received several comments from industry groups stating that they believe the existing alternative closure provisions, § 257.103(a) and (b), do not prohibit the continued placement of non-CCR wastestreams. Some commented that facilities should be able to continue to use the existing provisions for continued CCR disposal, and only be required to submit applications under the new provisions if they lack capacity for both CCR and non-CCR wastestreams or for non-CCR wastestreams. They claimed that it was burdensome to submit the demonstrations and they believe the self-implementing extensions are sufficient for CCR wastestreams.

EPA received comments from environmental groups stating that non-CCR wastestreams may be subject to hazardous waste regulations when not co-disposed with CCR in surface impoundments. They argued that owners and operators must determine whether the non-CCR wastestreams are listed wastes or whether they exhibit any of the characteristics of a hazardous waste. They further stated that the December 2019 proposed rule did not identify what constitutes a non-CCR wastestream nor any requirements to evaluate different non-CCR wastestreams to determine whether they contain listed hazardous wastes or display hazardous waste characteristics. Lastly, they stated EPA must evaluate the full nature and extent of the risk before allowing disposal of non-CCR wastestreams without adequate safeguards.

After reviewing the public comments, EPA is maintaining its proposed approach that the new site-specific alternative closure provisions will, upon successful demonstration, allow certain CCR surface impoundments to receive CCR wastestreams, or non-CCR wastestreams, or a combination of both. No commenter provided any information rebutting the Agency's conclusion that the need to find alternative capacity for non-CCR wastestream is often the most critical factor in determining the amount of time needed to initiate closure of the unit.

Moreover, if the new provisions applied exclusively to non-CCR wastestreams there would be two sets of regulatory requirements with different criteria applicable to the same surface impoundment. This would create unnecessary complications in implementing and enforcing the provisions. Nor does it make sense for the more stringent requirements in the new provisions to apply exclusively to the non-CCR wastestreams when the vast majority of hazardous constituents are found in the CCR wastestream. EPA understands the concerns that the demonstrations require a new effort by the facilities. However, these considerations are offset by the benefits that come with the enhanced regulatory oversight of the new provisions and having all wastestreams managed in the disposal unit under a single set of regulatory requirements.

EPA disagrees that the proposed rule should have defined non-CCR wastestreams. The regulations already define CCR; therefore, a non-CCR wastestream is any other waste managed in the impoundment. See 40 CFR 257.53 and 261.4(b)(4). EPA agrees that some non-CCR wastestreams are not Bevill-exempt (*e.g.,* wastes that are not covered by § 261.4(b)(4)) and consequently they remain subject to all requirements applicable to solid waste, and if they meet the criteria, the requirements applicable to hazardous waste. This includes the requirement to determine whether the waste is hazardous based on either the generator's knowledge or testing. If the waste is hazardous it must be managed according to the requirements of RCRA subtitle C; when going to an impoundment, the impoundment must meet subtitle C requirements. Mixtures of hazardous waste and Bevill exempt wastes are not exempt unless the only hazardous constituents in the mixture are those that are found in the Bevill exempt waste. In addition, mixing a hazardous waste with a Bevill exempt waste may be considered treatment in some circumstances, which would itself require a permit. However, EPA has no data to indicate that non-CCR wastestreams are characteristically hazardous. Given the existing requirements that currently apply to these wastestreams, EPA disagrees that additional requirements are needed or should have been proposed. Finally, EPA explains below, in unit V.2.d, the reasons that these revisions rely primarily on feasibility rather than risk considerations.

(b) Units Potentially Eligible for Alternative Closure Timeframes

In the December 2, 2019 proposal, EPA discussed several options as to the CCR surface impoundments that would be eligible for the new alternative closure provisions. EPA proposed to allow all CCR surface impoundments to be eligible to submit demonstrations for the new alternative closure provisions. This included surface impoundments that failed one or more location restrictions other than the depth to aquifer location restriction. EPA recognized that these units were not included in the July 2018 final rule that established the October 31, 2020 deadline to cease receipt of waste, and consequently their deadline to cease receipt of waste was April 2019. However, EPA proposed to include them in this new approach to create a consistent regulatory system. 84 FR 65,953. EPA also sought comment on whether the proposed site-specific alternatives to initiation of closure provisions should only apply to the CCR surface impoundments forced into closure by the *USWAG* decision (now defined as ''eligible unlined CCR surface impoundments''—*i.e.,* units that were certified as ''clay-lined'' or units that are unlined but not leaking, compliant with all location standards and compliant with structural stability).

Several utility companies provided comments that surface impoundments closing due to § 257.101(b)(1)(ii) should be able to apply for the new alternatives. They further stated that those who had filed a notification of intent to close pursuant to §§ 257.103(a) or (b) should be grandfathered into the new alternatives. Environmental groups stated that this group of units should not be eligible for the new alternative closure provisions because they should have initiated closure in April 2019 and because it would violate the RCRA 4004(a) protectiveness standard.

Industry groups commented that the alternative closure provisions should not be limited to the eligible unlined CCR surface impoundments. They elaborated that lack of capacity for CCR and/or non-CCR wastestreams is not limited to the facilities recently forced into closure but most facilities. By contrast, environmental groups stated that many facilities have been on notice that they would be required to close and should have prepared for that in advance, and so EPA should not grant them even further time. However, even these commenters acknowledged that the surface impoundments that are unlined, not leaking, and passed all location restrictions were forced into closure unexpectedly, and so may need additional time to initiate closure.

Consistent with the proposal, under the final rule all CCR surface impoundments will be subject to the new provisions in § 257.103. EPA continues to believe there is value in subjecting CCR surface impoundments to a common regulatory system. A common regulatory system for CCR surface impoundments requiring the use of § 257.103 will move these units to initiate closure as quickly as possible and decrease any confusion to the public. The new alternative closure provisions will grant facilities no more than the specific amount of time required for them to cease receipt of waste as fast as technically feasible. EPA cannot compel facilities to do the impossible; therefore, these new provisions will ensure facilities cease receipt of waste as fast as technically feasible.

EPA agrees that the eligible unlined CCR surface impoundments should be eligible to apply for the new alternative closure provisions. The owners and operators of these units had no expectation that they would need to close these units in the near future and so would not have begun planning for such an event. They may, therefore, need more time to construct the alternative capacity necessary to allow them to cease receipt of waste.

However, EPA no longer believes that all surface impoundments should be eligible to apply for all of the new alternative closure provisions. Consequently, the final rule provides that only CCR surface impoundments closing pursuant to § 257.101(a) and § 257.101(b)(1)(i) may apply for the new alternative closure provisions under § 257.103(f)(1) and (f)(2) for CCR and/or non-CCR wastestreams. As previously stated, the surface impoundments that failed a non-aquifer location restriction or multiple location restrictions were triggered into closure under § 257.101(b)(1)(ii) and were to initiate closure in April 2019. The only exception would be for the facilities that posted a notification of intent to close pursuant to § 257.103(a) or (b) based on a lack of capacity for only CCR, as those provisions only authorized continued receipt of CCR. EPA agrees with commenters that no one has presented a factual basis for allowing these units to commence or resume the receipt of wastes (*i.e.,* non-CCR wastestreams) two years after they were required to have ceased. This stands in direct contrast to the units subject to the October 31, 2020 deadline, which currently are authorized to continue receiving both CCR and non-CCR wastestreams. Moreover, the purpose of this rulemaking was to reconsider the closure deadlines in the July 2018 final rule in light of the decision in *USWAG.* What matters in this context is how, if at all, EPA should revise the regulatory status quo based on the direction from the D.C. Circuit. The closure deadlines for impoundments closing in accordance with § 257.101(b)(1)(ii) were not affected by either the *USWAG* decision or the July 2018 rule. EPA does not intend in this rulemaking to revisit closure provisions that were unaffected by either of these things, contrary to the commenter who contended that EPA was relying on the decision and its reconsideration to provide a clean slate to recalculate all deadlines.

Therefore, this final rule allows CCR surface impoundments closing due to § 257.101(b)(1)(ii) that have posted a notification pursuant to § 257.103(a) or (b) to apply to be transitioned to the new alternative closure provisions under § 257.103(f)(1) and (f)(2) for CCR wastestreams only.

(c) Transition for Surface Impoundments Operating Under § 257.103(a) and (b)

In the December 2, 2019 proposal, EPA sought comment on how to transition the facilities that have posted notifications pursuant to § 257.103(a) or (b) due to forced closure under § 257.101(b)(1)(ii) to the new alternative closure provisions. Several utility companies commented that these facilities should be grandfathered into the new provisions without submitting demonstrations to EPA for approval. These commenters additionally stated that these units should be allowed to continue to operate for the amount of time authorized under the existing regulations, which potentially authorize continued operation for as long as 5 years from the notification date. They further stated that the demonstration requirements would add unnecessary burden to the facilities currently closing pursuant to § 257.103(a) and (b).

EPA acknowledges the concern that the demonstrations will add burden to the facilities currently operating under § 257.103(a) and (b). However, the commenters have not provided a compelling rationale for creating two distinct regulatory frameworks for units that are essentially identical. There is substantial value in creating a consistent regulatory framework for all CCR surface impoundments requiring more time to cease receiving waste. As part of that framework, EPA has concluded that closer regulatory oversight is necessary to ensure that facilities initiate closure as soon as technically feasible. EPA has come to this decision based on an evaluation of the current status of compliance of the facilities operating under the self-implementing provisions of § 257.103(a) and (b). For example, notifications and progress reports on facilities' publicly accessible CCR internet sites do not contain all of the information required under § 257.103(a), (b), and (c). Some of these documents do not include the method by which the facility is obtaining alternative capacity, the date by which alternative capacity will be obtained, or a clear demonstration that no other disposal capacity is available on or off-site.[39] Based on this record, it is clear that these provisions require the closer regulatory oversight that comes with requiring prior EPA approval. Consequently, EPA will not grandfather in the facilities that have filed notifications and will require all facilities to submit demonstrations to EPA for approval under the new site-specific alternative closure provisions in order to continue operating that surface impoundment.

Any facility that currently has posted on its publicly accessible CCR internet site a notification to close a CCR surface impoundment pursuant to § 257.103(a) or (b) must submit a demonstration for EPA approval that meets the requirements under § 257.103(f)(1) or (f)(2) in order to continue operating that unit. Therefore, if a facility has a notification posted and is currently operating under § 257.103(a) or (b) due to closure under § 257.101(b)(1)(ii) and does not submit a demonstration to EPA by November 30, 2020, then the facility must cease the receipt of waste into the unit no later than April 11, 2021 and initiate closure.

(d) Consistency With Statutory Standard and USWAG

EPA received comments from environmental groups that the December 2, 2019 proposal with the addition of the new alternative closure provision is inconsistent with the statutory standard and the *USWAG* decision. These commenters stated that the alternative closure provisions allowed unlined CCR surface impoundments to continue to operate when the *USWAG* decision mandated that these units present a risk to human health and the environment and must close. Additionally, they stated that the new alternative closure provisions do not address the risks posed by the continued operation of the surface impoundment, and that as a consequence, the proposed demonstration requirements fail to meet the RCRA protectiveness standard.

EPA disagrees with commenters that these provisions fail to meet the statutory standard as interpreted by the court in *USWAG.* It is true that EPA was unable to conduct a nationwide risk assessment to document that all facilities that obtain an extension under one of the alternative closure provisions will meet the statutory standard; however, both subsections (f)(1) and (f)(2) include conditions designed to address the risks. Both provisions require facilities to affirmatively demonstrate that they are in compliance with all the requirements of part 257, and therefore meet the baseline level of acceptable risk. In addition, as explained in more detail below, subsection (f)(2) requires the submission of a risk mitigation plan as part as a condition of obtaining the extension.

Moreover, with regard to the extensions pursuant to § 257.103(f)(1), as explained in the proposal, EPA considers that requiring facilities to cease receipt of waste as quickly as is feasible necessarily meets the standard in RCRA 4004(a) as it is not possible under this provision to require more stringent—or more protective—measures than can be implemented by at least some facilities. EPA has ensured that the statutory standard has been met by requiring facilities to affirmatively demonstrate to EPA the infeasibility of ceasing receipt of waste by April 11, 2021 and by requiring prior EPA approval of any requested extension, allowing EPA to ensure that units stop receipt of waste as soon as feasible.

EPA also considers that the provisions authorizing extensions pursuant to § 257.103(f)(2) meet the statutory standard. Although facilities are not required to demonstrate that they will cease receipt of waste as soon as feasible under this section, they will be required to expedite the closure of the surface impoundment. Not only will this reduce the risks over the long term, the deadlines will ensure that continued operation of the unit will be limited. Moreover, as discussed at greater length in unit V.C.4, EPA is requiring submission of a risk mitigation plan to address any increased risk from continued operation of the surface impoundment, which EPA will review as part of determining whether to grant the extension. If additional measures to mitigate the risk are necessary to ensure that the statutory standard is met, EPA will require those as a condition of granting the extension.

3. Requirements for Development of Alternative Capacity Infeasible (§ 257.103(f)(1))

In the December 2, 2019 proposal, EPA proposed that a facility can obtain a site-specific deadline to cease receipt of waste by submitting a demonstration that development of alternative capacity for CCR and/or non-CCR wastestreams cannot be completed prior to November 30, 2020 (the end date of the short term alternative) to EPA or the Participating State Director for approval. The owner or operator would be required to demonstrate that it is not technically feasible to complete the development/installation of alternative capacity prior to the deadline to cease receipt of waste. In this demonstration, the facility would need to present in detail the specifics of the process they are undertaking to develop alternative capacities for the necessary CCR and/or non-CCR wastestreams to support the claim that additional time is necessary.

[39] Compiled reports from the facilities utilizing the alternative closure provisions.

(a) Criteria and Documentation

In order to obtain the § 257.103(f)(1) extension, EPA proposed the owner or operator must meet and maintain the criteria listed in the provision. EPA proposed to require that the demonstration for each surface impoundment document or provide evidence for all of the following: (1) That there is no alternative capacity available on or off-site; (2) That CCR and/or non-CCR wastestreams must continue to be managed in the CCR surface impoundment due to the technical infeasibility of obtaining alternative capacity prior to the deadline to cease receipt of waste; as part of this demonstration the facility was required to include an analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; (3) a detailed workplan on obtaining alternative capacity for CCR and/or non-CCR wastestreams; and (4) a narrative of how the owner or operator will continue to maintain compliance with all other aspects of the CCR rule (including ongoing groundwater monitoring and corrective action requirements). Additionally, EPA proposed that this showing must be made for each wastestream that would continue to be managed in the unit and the owner or operator would be required to cease receipt of each wastestream when alternative capacity for each wastestream becomes available. Finally, EPA proposed the time to develop the alternative capacity could not extend beyond October 15, 2023, and that the owner or operator must remain in compliance with all the applicable requirements of this subpart.

No alternative capacity on or off-site. The first criterion EPA proposed is generally the same that is required in § 257.103(a)(1)(i). The owner or operator must demonstrate the lack of alternative capacity available on or off-site to manage the waste. EPA also proposed that an increase in costs or inconvenience would not be sufficient to support qualification under this section.

EPA received no comments opposing the inclusion of this requirement in the final rule. One commenter, who believed that costs should not be considered as part of this determination, raised the concern that the regulatory text would not preclude consideration of cost as part of this determination. EPA disagrees that the regulatory text is ambiguous on this point. EPA proposed to include the same provisions currently found at § 257.103(a) and (b); these provisions were challenged on the grounds that the regulation precluded the consideration of costs in making this exact showing. See *USWAG,* 901 F.3d at 448–449. Therefore, EPA considers the regulatory text to be clear on this point and is finalizing the proposed requirement without revision.

Documentation requirements of no alternative capacity on or off-site. EPA proposed to require facilities to provide documentation that no alternative capacity exists on or off-site of the facility that could be used to manage their waste as part of their submission.

EPA received comments from utilities requesting clarification on the acceptable measures for determining lack of off-site alternative disposal capacity. For example, the comments contended that if the facility sluices CCR to their surface impoundment, their off-site disposal options are significantly limited. However, the disposal options greatly increase for dry handled CCR and the off-site capacity evaluation could then be more extensive. EPA received comments from environmental groups stating that EPA should require the facility to demonstrate the lack of alternative capacity for each wastestream. Some commenters also raised concern that some of the proposed regulatory text could be construed to permit a facility to continue disposing CCR into surface impoundments, even when there is alternative capacity of CCR, due to the lack of alternative disposal capacity for the non-CCR wastestreams. Specifically they pointed to changes to the introductory language of § 257.103 that they believed would allow owners or operators of CCR units that are subject to closure to continue receiving CCR in those units even if alternative disposal capacity for CCR is available, as long as they demonstrate that they lack alternative disposal capacity for non-CCR wastestreams.

EPA agrees that the disposal options for sluiced or wet handled CCR are greatly limited compared to the options available for dry handled CCR. However as discussed below there are disposal options even for sluiced or wet handled CCR, and consistent with the proposal the final rule requires owners or operators to document that no options other than the CCR surface impoundment are available on or off-site to manage these wastes.

EPA also agrees that the owner or operator needs to document the lack of alternative capacity both on and off-site for each wastestream they wish to continue placing into the CCR surface impoundment after the April 11, 2021 deadline. As these commenters pointed out, the justification for continuing to use an unlined or leaking unit based on a lack of capacity for one waste does not extend to any other waste for which there is capacity. It was for this reason that EPA proposed to require documentation of the lack of capacity both on and off-site for each individual wastestream, and that the facility cease receipt of any waste for which capacity becomes available. Accordingly, the final rule requires owners and operators to cease using the CCR surface impoundment as soon as feasible, to document the lack of both on and off-site capacity for each individual wastestream, and expressly requires that as capacity for an individual wastestream becomes available, owners or operators are required to use that capacity, which will slowly decrease the amount of waste being disposed in the unit. EPA has also revised the introductory text at § 257.103 to be consistent with these provisions. Specifically, the text now states that the facility may continue only to receive the wastes specified in either paragraph (a), (b), (f)(1), or (f)(2) in the unit provided the owner or operator meets all of the requirements contained in the respective paragraph.

For sluiced CCR and non-CCR wastestreams, EPA expects the owner or operator to evaluate the viability of other wet temporary storage, such as tanks, to use in lieu of the CCR surface impoundment while permanent capacity is developed. Some of these wastestreams can be very large, and therefore tanks may not be a viable or realistic option to handle such volumes; however, tanks could be a viable option for small volume wastestreams. For dry CCR, EPA expects the owner or operator to evaluate the option of transporting the CCR to landfills. The owner or operator must provide documentation of this evaluation of on and off-site capacity for each wastestream. Additionally, the owner or operator must cease receipt of each wastestream when alternative capacity for each wastestream becomes available. This documentation requirement has been incorporated into the requirements of section one of the workplan. The other requirements for the workplan are discussed later in this preamble. This documentation requirement is at § 257.103(f)(1)(iv)(A).

Consistent with the proposal, the costs or the inconvenience of existing capacity will not be considered as part of determining whether the facility qualifies for this alternative. As discussed in unit IV, EPA lacks the authority to include such considerations in this regulation. See USWAG, 901 F.3d at 448–449.

Need to continue using the CCR surface impoundment. EPA proposed that the owner or operator must demonstrate that CCR and/or non-CCR wastestreams must continue to be managed in the CCR surface impoundment due to the technical infeasibility of alternative capacity being available sooner than November 30, 2020.

EPA received one comment about the inclusion of this requirement, on the grounds that the word feasibility could be construed to permit the consideration of cost. According to the commenter, one dictionary defines the word feasibility to mean ''not possible to do easily or conveniently; impracticable,'' and criticized EPA for failing to include a regulatory definition of feasibility. As an initial matter, EPA notes that other dictionaries define feasible to mean ''capable of being done or carried out'' (Merriam website (*https://www.merriam-webster.com/dictionary/feasible*)) and ''possible to do and likely to be successful'' (Cambridge English Dictionary (*https://dictionary.cambridge.org/us/dictionary/english/feasible*)). EPA also disagrees that the proposed rule was unclear on whether cost could be considered as part of this determination. EPA proposed explicit language that clearly stated that costs were not relevant. Nevertheless, to avoid any potential ambiguity EPA will include regulatory definitions of technically feasible and technically infeasible. Specifically, the final rule defines technically feasible to mean ''possible to do in a way that would likely be successful,'' and technically infeasible to mean ''not possible to do in a way that would likely be successful.'' These definitions clearly exclude those circumstances in which a facility could have completed construction but chose not to do so in order to save money, while capturing the full range of force majeure situations in which circumstances beyond a facility's control cause delays. For example, this definition would allow a facility to obtain an extension in response to delays in obtaining a permit as a result of State furloughs or resulting from the COVID–19 public health emergency. However, it would not allow a facility to obtain an extension where the delays were caused by mismanagement or could be overcome by the expenditure of additional resources; for example, where the facility delayed ordering geomembrane, and as a consequence it arrived too close to the end of the construction season.

EPA received no other substantive comments raising concern about the inclusion of this criterion. Therefore, EPA is finalizing this requirement with one minor revision to the regulatory text. As discussed in unit V.B.3, the deadline to cease receipt of waste is now April 11, 2021, so the deadline in § 257.103(f)(1)(ii) will be updated accordingly.

Documentation requirements of need to continue using the CCR surface impoundment. This line of evidence must include an analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use.

EPA received comments stating that EPA failed to identify any evidence that the lack of capacity alternative closure provision is necessary. They stated that EPA claimed that the 2015 CCR Rule would cause potentially significant disruptions to plant operations and thus the provision of electricity to customers; however, EPA failed to identify any evidence of such risks or identify a single power plant in the country that would be at risk of shutdown if its non-CCR wastestreams could no longer be disposed of in the CCR surface impoundments.

Other commenters stated that the inclusion of an analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use is a very important factor in the evaluation of a facility's extension request. They stated that the rulemaking record makes clear that their ability to continue providing power to the public could be impacted if facilities are unable to use these surface impoundments (for CCR and/or non-CCR waste management) before they have time to develop alternative disposal capacity.

EPA disagrees that there is no evidence that power plants could be affected if they were forced to prematurely stop using their CCR surface impoundments before alternative capacity is available. The rulemaking record contains submissions from numerous utilities documenting the potential effects of such premature closures. Moreover, EPA proposed to require facilities to include an analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use. Therefore, each individual demonstration would include the evidence of the adverse impact to each plant's operations, which is the exact evidence the commenters assert is lacking. EPA continues to believe that an analysis of the adverse impact to plant operations if the CCR surface impoundment were to no longer be available for use is directly relevant to the question of whether the facility actually needs to continue using the unit. As a consequence, EPA is retaining this requirement in the final rule without revision.

This documentation requirement has been incorporated into section one of the workplan. The other requirements for the workplan are discussed later in this preamble. This documentation requirement is represented in § 257.103(f)(1)(iv)(A).

Compliance certification and documentation requirements. In the proposal, EPA discussed compliance in three separate places in the regulatory text but only one section in the preamble. In the regulatory text EPA required a certificate of compliance, a narrative compliance strategy and that the owner or operator remain in compliance with the applicable requirements of subpart D of part 257 at all times. Furthermore, the proposed fourth line of evidence of the § 257.103(f)(1) demonstration reiterated the requirement for a narrative compliance strategy for the CCR surface impoundment. The preamble laid out some specific information that EPA believed was critical to determine if the facility was in compliance. EPA proposed that the compliance strategy must discuss the most recent groundwater monitoring data results, the statistical analyses conducted to obtain the results, and the next steps for the groundwater monitoring. EPA also proposed that if the unit has exceeded any of the Appendix IV groundwater protection standards, the owner or operator must provide a copy of any assessment of corrective measures conducted to date. The current regulations require facilities to conduct an assessment of corrective measures followed by selection of a remedy as soon as is feasible, and thus do not permit waiting to implement a remedy until initiation of closure of the unit. As such, if the facility is in the process of remedy selection, a thorough discussion of the evaluation of possible remedies for corrective action must be included in the compliance strategy. The proposal also stated that the facility's publicly accessible CCR internet site must be completely up-to-date and contain all the necessary postings.

Several commenters agreed that compliance with the CCR rule should be a prerequisite to obtain approval for an alternative closure deadline. Others disagreed stating that being in compliance with the CCR rule should not be a prerequisite. EPA continues to believe that compliance should be a prerequisite.

Some commenters expressed concern that some facilities acting in good faith could be found non-compliant by EPA. Specifically, USWAG raised concerns that since the rule is self-implementing and some regulatory text lacks specificity and/or may be ambiguous, there could be differences in opinion on what constitutes compliance. Therefore, USWAG believes that differences in interpretation should be discussed during EPA's review process and any non-compliance issues be addressed as part of a facility's completion of its demonstration. Talen Energy echoed this sentiment stating that there should be a mechanism in place to assist facilities to come into compliance after the alternative closure extension was granted. Finally, USWAG commented that past non-compliance that has been corrected should not penalize a facility in their demonstration process and that, therefore, the compliance status should be as of the date of the demonstration's submission. These comments are also addressed in unit V.C.5 since these comments discuss the process in which to resolve any possible questions of compliance.

Some commenters stated that EPA has known that facilities are violating the groundwater monitoring requirements because the use of intrawell statistical analysis violates the plain language of the CCR rule and is therefore impermissible. They also raised other allegations of non-compliance such as violations of location restrictions, non-compliant liner determinations, violations of annual inspection requirements and various groundwater monitoring requirements or associated posting requirements. The commenters went on to say that EPA's failure to evaluate existing non-compliance with the CCR rule increases the risk to health and the environment and that the Part A proposal does not effectively require owners and operators receiving extensions to comply fully with the CCR rule. Finally, some commenters stated that since the alternative closure extensions fail to address non-compliance, the extensions are arbitrary and capricious and fail to meet the RCRA protectiveness standard.

EPA does not agree that intrawell statistical analysis is per se prohibited by the CCR regulations. The regulations at § 257.93(f) and (g) establish the allowable statistical approaches and the performance standards that must be met. There are some circumstances in which intra-well comparison can meet these requirements. Additional information about these approaches may be found in the Unified Guidance, which EPA relied upon, as well as 40 CFR 258, in crafting these regulations (see 80 FR 21402). The Unified Guidance at page 1–4 contains procedures for both the intrawell and interwell methods: ''Groundwater detection monitoring involves either a comparison between different monitoring stations (*i.e.,* downgradient compliance wells *vs.* upgradient wells) or a contrast between past and present data within a given station (*i.e.,* intrawell comparisons).'' The Unified Guidance further identifies specific circumstances in which intrawell comparison may be the *preferred* method, for example; evidence of spatial variation should drive the selection of an intrawell statistical approach if observed among wells known to be uncontaminated (*e.g.,* among a group of upgradient background locations) (page 5–6). The Unified Guidance says intrawell comparison can also be used when the groundwater flow gradient is uncertain or unstable (page 8–3). EPA has also found that unique hydrogeological conditions at some sites preclude meaningful interwell comparison—for example where the uppermost aquifer is spatially limited and is absent upgradient of the CCR unit. Therefore, simply using intrawell analysis does not mean a facility is out of compliance.

However, if a facility is using intrawell analysis in an inappropriate scenario, the facility would be out of compliance with the CCR rule. For example, see the Unified Guidance at page 5–6: ''Intrawell background measurements should be selected from the available historical samples at each compliance well and should include only those observations thought to be uncontaminated.''

EPA continues to believe that requiring facilities to document compliance with the subpart D of part 257 requirements is an important part of the demonstration. Compliance with the rule provides some guarantee that the risks at the facility are properly managed and adequately mitigated. For example, if a facility has placed or constructed groundwater monitoring wells incorrectly it is quite possible that contamination could go undetected. By contrast, if a facility is properly pursuing corrective action remedies and their wells have been properly placed and constructed, EPA expects the overall risk at the facility will be appropriately managed. Consequently, this determination provides critical support for a decision to allow continued operation of the unlined impoundment. This means that EPA must be able to affirmatively conclude that the facility meets this criterion prior to authorizing any continued operation of the unlined impoundment. It also means that EPA cannot grant facilities additional time to cure any noncompliance. However, EPA's determination will be prospective only; accordingly, EPA is only interested in the state of a facility's current compliance rather than any instances of historic non-compliance.

In response to commenters who requested that EPA provide greater specificity about what constitutes a complete submission, EPA has revised the proposal to identify specific documents that facilities must provide to demonstrate their current compliance with the requirements of part 257. These documents should already exist because they are required to have been developed under the existing regulations.

First, EPA will review a facility's current compliance with the requirements governing groundwater monitoring systems. In order to conduct this review, the Agency will need copies of the following documents: (1) Map(s) of groundwater monitoring well locations (these maps should identify the CCR units as well); (2) Well construction diagrams and drilling logs for all groundwater monitoring wells; (3) Maps that characterize the direction of groundwater flow accounting for seasonal variation; (4) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event; and (5) Description of site hydrogeology including stratigraphic cross-sections.

Second, EPA will also require and examine a facility's corrective action documentation, structural stability documents and other pertinent compliance information. A facility must submit the following documentation: The corrective measures assessment required at § 257.96, progress reports on remedy selection and design; the report of final remedy selection required at § 257.97(a); the most recent structural stability assessment required at § 257.73(d), and; the most recent safety factor assessment required at § 257.73(e). EPA's intention to review these items was discussed in the proposed rule when discussing the types of information to be included in the facility's compliance strategy. See FR 84 65955–56. EPA will document the results of its review and that record will be available for public comment with the rest of the alternative closure demonstration materials, consistent with the procedures applicable to this review discussed in unit V.C.5.

Therefore, based on comments, EPA has decided that the certification of compliance and the requirement to remain in compliance with the regulations are necessary in this final rule. This approach will prevent non-compliant unlined surface impoundments from operating for an extended period of time into the future. Requiring that only compliant surface impoundments can be approved for an alternative closure deadline provides additional support for EPA's conclusion that this final rule meeting the statutory standard.

In light of the requirement to submit the specific compliance documentation noted above, EPA is not including the proposed compliance narrative that was proposed as the fourth line of evidence for a demonstration, in the final rule.

The compliance certification and documentation requirements are represented in § 257.103(f)(1)(iv)(B). The requirement to remain in compliance with RCRA subpart D is represented in § 257.103(f)(1)(viii).

Workplan Criteria. EPA proposed owner or operators submit a detailed workplan explaining how alternative capacity is being developed and the amount of time required. EPA proposed to require the submission of a workplan that contains four elements: (1) A narrative discussion of the steps and process that remain necessary to complete development of alternative capacity for the wastestream(s); (2) a visual timeline depicting the remaining steps needed to obtain alternative capacity; (3) a discussion of the timeline and the processes that occur during each step; and (4) a discussion of the steps already taken to achieve alternative capacity, including what steps have been completed and what steps remain. EPA sought comment on whether the proposed elements of the workplan were sufficient or if more evidence was necessary in order for EPA to determine the correct amount of time the facility will need to obtain alternative capacity.

EPA received several comments that the proposed workplan elements should provide EPA with ample information to issue a decision on the extension request. They further stated that the information would allow EPA to determine whether the demonstration represented the shortest technically feasible amount of time required for the facility to cease receipt of the waste and to complete the development of alternative disposal capacity.

EPA agrees with the commenters that the elements proposed in the workplan provide the necessary information and are sufficient for its intended purpose. Therefore, EPA is finalizing the proposed workplan elements without revision from the proposal at § 257.103(f)(1)(iv)(A).

Workplan Documentation

As previously mentioned, EPA proposed the workplan containing four sections. Below is a detailed discussion of what EPA proposed for each section to contain.

Section One: The narrative discussion of the workplan was designed to explain precisely how alternative capacity will be developed, along with an explanation as to why that method was chosen. EPA has not required the owner or operator to choose any particular means of obtaining alternative capacity, such as building a new disposal unit, construction of a wastewater treatment facility, converting to dry handling, etc. However, EPA is requiring that the narrative describe each option that was considered, the timeframe under which each could be implemented, and why the facility selected the option that it did. The discussion must include an in-depth analysis of the site and any site-specific conditions that led to the decision to implement the selected alternative capacity. Inclusion of visuals such as a facility map, facility process flow diagram, the design of the new capacity, etc. would be beneficial to any discussion on the new capacity and of the facility as a whole. The narrative must also provide a detailed explanation and justification for the amount of time being requested and how it is the fastest feasible time to complete the development of the alternative capacity.

Section Two: The second section of the workplan is a visual timeline, such as a Gantt chart, depicting the necessary steps required to obtain the alternative capacity discussed in the narrative. The visual timeline must clearly indicate how each phase and the steps within that phase interact with or are dependent on each other and the other phases. It must also include any possible overlap of the steps and phases that can be completed concurrently. This timeline must show the total time needed to obtain the alternative capacity and how long each phase and step is expected to take. Such phases must at a minimum include: Engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation. Within each phase, the time to complete each step must also be broken out. For example, if the engineering and design phase is 4 months, the following steps to complete the phase should be shown: Site selection and survey, design of the impoundment, process flow diagram edits, and piping design then the time each of those steps take should be represented on the timeline. This level of detail is expected for each phase and each step of each phase in obtaining the alternative capacity. The timeline also acts as a visual assistant to the third section of the work plan, a narrative of the timeline.

Section Three: The third section for the workplan is a detailed narrative of the schedule and the timeline discussing all the necessary phases and steps in the workplan, in addition to the overall timeframe that will be required to obtain capacity and cease receipt of waste. This section of the workplan must discuss why the length of time for each phase and step is needed, including a discussion of the tasks that occur during the specific stage of obtaining alternative capacity. It must also discuss the tasks that occur during each of the steps within the phase. For example, rather than simply stating an individual step as ''order and fabrication of impoundment liner,'' this section is required to explain what material must be ordered, where the fabrication takes place, and how long it takes to fabricate and deliver the new liner material. The workplan must explain why each phase and step shown on the chart must happen in the order it is occurring and include a justification for the overall length of the phase. Other major discussion items required on the overall time of the schedule include anticipated worker schedule, and any anticipated areas for which the schedule could slip. The anticipated areas of delays could include items outside of the facility's control, such as severe weather events or delays in fabrication of materials. For example, if the facility is commonly impacted by hurricanes or flooding, the discussion should indicate what month(s) of the schedule that is most likely to disrupt. The schedule must also indicate the time limiting factors in completing the plan, such as having to take boilers off-line or if a certain step can only happen during a specific time of year. This overall discussion of the schedule assists EPA in understanding why the time requested is accurate.

Section Four: The fourth section of the workplan contains a narrative of the steps the facility has already taken to initiate closure and develop alternative capacity for CCR and/or non-CCR wastestreams. This section must discuss all of the steps taken, starting from when the owner or operator initiated the design phase all the way up to the current steps occurring while the workplan is being drafted. In addition, this discussion must indicate where the facility currently is on the timeline and the processes that are currently being undertaken at the facility to develop alternative capacity. This section of the workplan and the level of detail required is necessary for EPA to determine whether the submitted schedule for obtaining alternative capacity is accurate.

Comments on workplan documentation requirements. EPA received several comments from utilities stating concerns that the level of detail proposed to be included in the workplan is unnecessary and in some areas excessive. Some utilities viewed the workplan as overly burdensome and some parts as unnecessary. Some commenters found the proposed narrative discussion of the workplan invasive of the utility's decision-making process. They further commented that EPA should respect the facility's business decisions and that this information could show that the facility is taking cost into consideration. The commenters stated that the discussion should focus on how the facility selected the most appropriate technically feasible alternative capacity for the site, even though it may not be theoretically the fastest feasible to implement. They stated that the work plan should only focus on the engineering and construction elements of obtaining alternative capacity rather than being concerned with reasons for why the capacity was selected. These commenters additionally stated that this type of discussion and many of the work plan elements would contain Confidential Business Information (CBI) related to why a particular approach for developing alternative capacity was selected and therefore requested the opportunity to be able designate and withhold the CBI from the posting on their publicly accessible CCR internet site.

EPA disagrees with the comments that the workplan requirements are invasive of the utility's decision-making process and should only focus on engineering and construction. While the workplan should provide engineering and construction information to explain how long the alternative capacity will take to develop; it is equally important for EPA to understand why that method of alternative capacity was selected. EPA recognizes there are several factors that go into selecting the method for alternative capacity, and that the decision is not solely based on whether the method is theoretically the fastest feasible to implement. Many of those factors are based on what can be technically implemented based on site-specific conditions at the facility, and how the facility plans on maintaining compliance with various state and federal regulations. These are the factors the facility should focus on in their discussion. EPA understands that not every method of alternative capacity is a viable option for a given facility, but the facility will need to explain to EPA how and what site-specific factors affected the selection of the option chosen, or that led the facility to eliminate particular options from consideration. Accordingly, EPA continues to believe that these workplan elements are necessary in order to fully understand the effort to obtain alternative capacity and maintain compliance for the facility as a whole. EPA understands that some of the pieces of the workplan may be considered CBI. However, utilities must have a CBI free version of the workplan that they are able to post to their publicly accessible CCR internet site and to be put out for public comment. EPA has revised the regulations to specify that when a workplan contains some CBI, utilities must submit both the CBI-free version of the workplan and a full version of the workplan that contains the CBI. All information submitted to EPA pursuant to the recordkeeping and reporting requirements for which a claim of confidentiality is made is safeguarded according to Agency policies set forth in 40 CFR part 2, subpart B.

For the reasons described above, EPA is finalizing the requirements on the workplan as described above with minor clarifying modifications. As previously discussed, EPA is incorporating the documentation requirements for the lack of alternative capacity on or off-site and the need to continue using the CCR surface impoundment into section one of the workplan. Thus, the first section of the workplan must include the discussion on the lack of alternative capacity on or off-site for each wastestream, the technical infeasibility of alternative capacity being available prior to April 11, 2021, as well as the narrative discussed above in section one (the discussion of how the alternative capacity will be developed and the discussion of how the capacity was selected).

The other change that EPA is making from proposed to final is in section three, the narrative discussion of the timeline. EPA will not require the inclusion of anticipated areas of where the schedule could slip. EPA is not taking final action on this requirement because it is not critical information for EPA to evaluate and issue a determination on the demonstration.

The workplan documentation requirements are at § 257.103(f)(1)(iv)(A).

Maximum Time Allowed. EPA proposed that a maximum of 5 years from the *USWAG* mandate could be granted under this alternative closure provision; therefore, no extension would extend past October 15, 2023. EPA selected 5 years in the proposal since it is currently the time allowed under § 257.103(a).

EPA received comments that extensions should not be limited to October 15, 2023. Commenters stated that a maximum time is unnecessary because the facility is required to submit a workplan showing the time they need, and EPA should accept that as the time that is needed. Therefore, the commenters asserted, establishing a maximum amount of time sooner than a facility demonstrates is technically feasible requires the impossible. They claimed that the data used in the rule making record does not support limiting the extension to no later than October 15, 2023 and is two years shorter than the current deadline in §§ 257.103(a) and (b) of October 31, 2025. Commenters stated that if EPA does establish a maximum amount of time, then EPA should establish the time that is currently allowed which is October 31, 2025.

Environmental groups stated that the maximum amount of time, until October 15, 2023, is not protective of human health and the environment because it delays the closure of the CCR surface impoundments.

EPA disagrees with these commenters. EPA believes there should be a maximum amount of time for the alternative closure provision, if only to ensure that facilities understand that operation of the unit may not continue indefinitely. With one exception, EPA believes that the proposed date of October 15, 2023 is a reasonable deadline for all facilities to achieve. EPA did not receive and does not have any evidence that facilities will require until October 2025 to complete development of alternative capacity. Accordingly, EPA does not believe facilities need the same five-year deadline in § 257.103(a). Additionally, this deadline will encourage facilities to move expeditiously.

EPA received several comments from industry stakeholders stating that the eligible unlined CCR surface impoundments triggered into closure due to the *USWAG* decision could need more time than other unlined surface impoundments to develop alternative capacity. Data submitted by several owners and operators of eligible unlined CCR surface impoundments showed that the fastest they could cease receipt of all wastes extends into 2024.

After reviewing these comments and the data submitted by utility companies, EPA agrees that it is possible that some eligible unlined CCR surface impoundments that were forced into closure unexpectedly by the *USWAG* decision could need additional time beyond October 15, 2023 to complete the development of alternative capacity. Therefore, in this final rule EPA is providing that eligible unlined CCR surface impoundments can request an alternative compliance deadline no later than October 15, 2024. This does not mean that all eligible unlined CCR surface impoundments can continue to operate until October 15, 2024; each unit must still cease receipt of waste as soon as feasible, and may only have the amount of time they can demonstrate is genuinely necessary. A facility claiming to have an eligible unlined CCR surface impoundment and requesting time beyond October 15, 2023 must demonstrate that they were not forced into closure for any reason other than the *USWAG* decision. This maximum timeframe is represented in § 257.103(f)(1)(vi).

Extensions of Alternative Compliance Deadlines. EPA proposed to allow a facility to request an extension to a deadline approved under the site-specific alternative under § 257.103(f)(1). If at any point a facility becomes aware that they cannot meet the approved alternative deadline, they would need to notify EPA or the Participating State Director as soon as possible. Depending on the nature and severity of the event, additional time may be granted provided it would not extend past October 15, 2023. EPA proposed that the facility must submit updated demonstration materials to EPA or the Participating State Director with a detailed discussion of why an extension is necessary. The owner or operator must also discuss the measures taken to limit the additional amount of time needed. An explanation of any problems that caused this delay would be further discussed in the semi-annual progress report as described in the next section.

EPA received no comments regarding this provision in the proposal. Therefore, EPA is finalizing this provision without substantive revision. EPA will not grant an extension longer than the maximum amount of time allowed either October 15, 2023 or October 15, 2024. This provision is represented in § 257.103(f)(1)(vii).

(b) Semi-Annual Progress Report

To provide transparency to the public, EPA proposed to require posting of semi-annual progress reports on the facility's publicly accessible CCR internet site. The proposed reports would contain two main sections: (1) Discussion on progress toward obtaining alternative capacity and (2) discussion of any planned operational changes at the facility. EPA believed that since these units could be operating and receiving waste for a few additional years, it would be important to keep EPA and the public aware of the facility's progress on obtaining alternative capacity and if facilities are on track to meet their new alternative compliance deadline. Currently in § 257.103(c) there is the requirement for annual progress reports for the units that have certified for alternative deadlines under § 257.103(a) and (b). EPA believed that for the site-specific alternative deadline, semi-annual rather than annual progress reports are more appropriate. The time allowed under this new alternative closure provision, will vary site to site and could be shorter than the deadline alternative granted for § 257.103(a) and (b). Therefore, EPA proposed a new semi-annual progress report requirement for the units that successfully demonstrate and are approved for the site-specific alternative to cease receipt of waste deadline.

EPA proposed for the semi-annual progress report to heavily rely on the workplan and the timeline submitted with the workplan. The first section of the report would discuss the progress the facility has made since the previous report or since approval of the alternative compliance deadline if it is the first report. It would be required to discuss the following: (1) The current stage of obtaining alternative capacity in reference to the timeline required in the workplan; (2) whether the owner or operator is on schedule for obtaining alternative capacity; (3) any problems encountered and a description of the actions taken to resolve the problems; and (4) the goals and major milestones to be achieved for the next 6 months.

EPA proposed the second section of the progress reports would discuss any planned operational changes at the facility. It is possible while the facility is working to achieve alternative capacity, a decision is made to either permanently shut down the plant or switch to an alternate fuel source such as natural gas or biomass. Any such decisions or other changes that could impact the schedule or closure would be indicated in this section of the semi-annual progress report.

EPA proposed that the semi-annual reports be completed and placed in the facility's operating record and posted on the facility's publicly accessible CCR internet site on April 1st and October 1st of each year until the alternative compliance deadline. The first report would be due on whichever posting deadline is soonest after approval of the alternative compliance deadline by EPA.

EPA sought comment regarding whether a facility that is fully on schedule or ahead of schedule with their approved timeline and had no significant problems or changes in operational status, should be afforded a relaxation of the reporting requirements in the first two subsections of the first section. This would allow a report for a facility on schedule or ahead of schedule to be significantly more condensed than the full reporting requirements.

EPA received comments from industry stating that facilities should be focusing on obtaining alternative capacity rather than completing progress reports. Furthermore, they support that if a facility is on or ahead of schedule for developing alternative capacity, they should be able to complete a condensed version of the semi-annual progress reports. Industry additionally commented that the progress reports should be annual for facilities with an alternative deadline longer than two years past the deadlines in § 257.101(a) and (b). Industry groups additionally commented that they do not oppose the semi-annual submission dates of April 1 and October 1, with the first submission being due on whichever posting deadline is soonest after approval of the alternative compliance deadline. However, they did indicate that a facility should not have to complete a report until they have a minimum of six months of progress from approval to report.

EPA agrees with the commenters that facilities should be focusing on obtaining alternative capacity. However, it is also important to update EPA or the Participating State Director on their progress for obtaining alternative capacity. EPA disagrees that the progress reports should be annual for the facilities with a longer alternative deadline. Facilities with a longer deadline have more progress to make and therefore may have a greater change of experiencing delays. Frequent progress reports are all the more useful in these circumstances. EPA further agrees that it is important that the first report be properly timed so that the facility has progress to report.

EPA received comments from environmental groups supporting the progress reports. They commented that there should be the additional requirement of certifying the facility is in compliance with all other aspects of the CCR rule in each progress report.

EPA has decided that additional certifications of compliance would not provide any added benefit. The final rule already requires the facility to remain in compliance with all the requirements of this subpart as a condition of the extension, and expressly provides that failure to do so will result in automatic revocation of the extension. Moreover, as previously discussed, EPA is requiring a more in-depth compliance certification in the demonstration in order to obtain approval. Finally, under the existing regulations the facility is required to post several items throughout the year including the annual groundwater monitoring and corrective action report, notifications for changes in groundwater monitoring, and semiannual reports on selection of remedy. EPA considers that the combination of all these requirements is more than sufficient to ensure a facility remains in compliance without the need for a further certification.

After reviewing the public comments EPA believes it is important to maintain public transparency and for facilities to focus on completing the development of alternative disposal capacity. Therefore, EPA is finalizing the requirement for progress reports to be completed on a semi-annual basis and to allow those facilities that are on or ahead of schedule to complete a condensed progress report. As such EPA is finalizing the semi-annual progress report requirements with only the revision that facilities on or ahead of schedule may complete a condensed and more streamlined progress report.

Facilities on or ahead of schedule, in relation to their approved timeline, will need to complete only the first two subsections within the first section. Therefore, the first section of the reports will only need to contain: (1) The current stage of obtaining alternative capacity in reference to the timeline required in the workplan; (2) whether the owner or operator is on schedule for obtaining alternative capacity.

All facilities must still complete the second section of the progress reports, discussing any planned operational changes of the facility. If there is nothing for the facility to report in this section, then the facility should simply state ''No planned operational changes''.

The semi-annual progress reports are to be completed on April 30 and October 31 of each year for the duration of the approved alternative initiation of closure deadline. EPA has selected these months because they correlate to when the facility was supposed to cease receipt of waste. Therefore, the facility should have at least six months of progress to report since applying for an alternative compliance deadline. The facility then has 30 days to place the report in their operating record and to their publicly accessible CCR internet site. The requirements for the semi-annual progress reports are shown in § 257.103(f)(1)(x).

4. Requirements for Permanent Cessation of Coal-Fired Boiler(s) by a Date Certain (§ 257.103(f)(2))

In the December 2, 2019 proposal EPA proposed to adopt a comparable version of § 257.103(b). This proposed provision allows facilities permanently ceasing operation of coal-fired boiler(s) to continue to receive both CCR and/or non-CCR wastestreams, upon a showing of a continued need to use the surface impoundment due to lack of capacity. Consistent with the existing provision § 257.103(b), EPA proposed to provide that an increase in costs or the inconvenience of existing capacity would not support qualification under this section. A further requirement EPA proposed, that is not in § 257.103(b), is a risk mitigation plan, in which the owner or operator would describe how the facility planned to mitigate any potential risks from the continued operation of the CCR surface impoundment. This proposal would have allowed the unit to continue receiving CCR and/or non-CCR wastestreams, provided the facility completed closure of the unit by the dates specified: October 17, 2023 or October 17, 2028 for surface impoundments 40 acres and smaller or more than 40 acres, respectively. In contrast to the provision under § 257.103(f)(1), the owner or operator does not need to develop alternative capacity because of the impending closure of the coal-fired boiler. Since the coal-fired boiler will shortly cease power generation, it would be illogical to require these facilities to construct new capacity to manage CCR and non-CCR wastestreams. Additionally, the groundwater monitoring and corrective action requirements remain in place. EPA proposed that facilities would need to submit a demonstration to EPA or the Participating State Director for approval. The majority of the proposed demonstration requirements are generally the same as are currently required under § 257.103(b), including the annual progress report and other recordkeeping requirements. The demonstration and criteria are described below.

EPA received comments requesting clarification on whether a facility could use the provision if they are converting their boilers to natural gas or a different fuel source. EPA believes facilities that are converting their boilers to natural gas or a different fuel source (non-coal) are eligible for the provision.

(a) Criteria and Documentation

EPA proposed that in order to obtain the § 257.103(f)(2) extension, the owner or operator needs to meet and maintain all of the following criteria: (1) That no alternative disposal capacity is available on or off-site, (2) the facility must submit a risk mitigation plan to show that potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated, (3) the facility is in compliance with all other requirements of this subpart and, (4) closure of the impoundment will be completed within the dates specified: October 17, 2023 or October 17, 2028 for surface impoundments 40 acres or smaller or more than 40 acres, respectively. As discussed in more detail below, EPA is adopting the same criteria in the final rule without significant revision. Further discussion on each criterion is below.

No alternative capacity on or off-site. The first line of evidence EPA proposed is the same that was required in § 257.103(b) and § 257.103(f)(1). The owner or operator must demonstrate the lack of alternative capacity available on or off-site.

EPA received no substantive comments on the inclusion of this requirement. Therefore, EPA has included this provision in the final rule without revision.

Documentation requirements of no alternative capacity on or off-site. The first demonstration requirement is to show that the facility does not have any other disposal capacity available either on or off-site. Consistent with the proposal, the fact that a potential alternative result in an increase in cost or inconvenience is not sufficient to meet this requirement. This requirement is the same as the requirement as described previously for the demonstration requirements in § 257.103(f)(1). This documentation requirement is represented in § 257.103(f)(2)(v)(A).

Risk mitigation plan. The second line of evidence EPA proposed to include in this demonstration was a risk mitigation plan. This proposed requirement was not previously required under § 257.103(b). EPA added this requirement in the proposal to address the potential risks of continued operation of the CCR surface impoundment while the facility moves towards closure of their coal-fired boiler(s), to be consistent with the court's holding in *USWAG* that RCRA requires EPA to set minimum criteria for sanitary landfills that prevent harm to either human health or the environment. 42 U.S.C. 6944(a). 901 F.3d at 430.

EPA received comments stating that the provision violates RCRA because it relies on owners and operators to submit a risk mitigation plan. They explained that this requirement violates the RCRA protectiveness standard because it acknowledges that there is risk present from the unit and RCRA is structured to prevent risk. Therefore, a risk mitigation plan admits that there is risk to human health and the environment and makes the unit an open dump.

EPA disagrees with the suggestion that reliance on the submission of a risk mitigation plan violates RCRA. Contrary to the commenter's view, section 4004(a) does not require the elimination of all risk. Rather the provision expressly contemplates the potential for there to be some risk, requiring EPA to determine there ''is no reasonable probability of adverse effects.'' 42 U.S.C. 6944(a). Or in other words, EPA must determine that the facility's solid waste management present only reasonable risks, which EPA has long interpreted to be risks ranging from 1×10^{-4} and 1×10^{-6}. Submission of the plan as part of the package for EPA approval will allow the agency to ensure that risks at the facility remain within these acceptable levels.

Some groups commented that facilities should not be required to submit a risk mitigation plan for approval in their demonstration, especially for the surface impoundments closing due to the *USWAG* decision. They believe that eligible unlined CCR surface impoundments do not pose a potential risk to human health or the environment and should not be required to prepare a plan to mitigate potential risks that do not exist. They view this requirement as an unnecessary paperwork burden.

EPA disagrees that the risk mitigation plan is unnecessary, even for units closing in response to the *USWAG* decision. Although it is true these units may not be currently leaking, that means only that they are not currently causing harm. But that does not mean that they do not pose any risk nor that continued operation of the unit necessarily meets the section 4004(a) standard. *See,* 901 F.3d at 427–430. As the court noted, ''It is inadequate under RCRA for the EPA to conclude that a major category of impoundments that the Agency's own data show are prone to leak pose 'no reasonable probability of adverse effects on health or the environment,' 42 U.S.C. 6944(a), simply because they do not already leak.'' *Id.* The risk mitigation plan will provide critical information to address the risks of continued operation of the unit, prior to the initiation of unit closure. This will provide a significant supplement to the Agency's qualitative assessment that the risks of continued operation will be outweighed by the risk mitigation from the expedited closure of the unit.

For example, for units that are not leaking the facility could begin identification of remedial technologies that would potentially be appropriate based on site data, including groundwater chemistry, groundwater elevation and flow rates, and the presence of surface water features that would influence rate and direction of contamination movement in the event of a leak. Gathering this information and beginning an assessment of technology options if a leak should occur will expedite any corrective action that subsequently becomes necessary. The plan could also address any interim measures that the facility would take to remediate contamination or to achieve source control in the event of a leak, which was one issue that the court faulted EPA for failing to adequately consider. By expediting the cleanup, EPA will also ensure that facility addresses the risk during the expedited closure.

EPA has concluded that the risk mitigation plan is a necessary requirement for this demonstration. Therefore, EPA is finalizing that facilities will be required to submit a risk mitigation plan as part of their demonstration.

Risk mitigation plan documentation. EPA proposed that the risk mitigation plan explain actions the facility may take to mitigate any potential risks to human health or the environment from the CCR surface impoundment. EPA also sought comment on whether the owner or operator should be required to submit a more in-depth site-specific risk assessment of the CCR surface impoundment as part of their plan to mitigate the risk from continued operation of the unit.

EPA received comments from industry groups that they view the information requested to be included in the plan redundant of information required in other reports and therefore find the risk mitigation plan as an unnecessary paperwork burden. They contend that all the information requested is already being compiled by the facility in other reports, so it is readily available on the publicly accessible CCR internet sites and additionally must demonstrate that the facility is in compliance with the other parts of the CCR rule. Therefore, the commenter finds this requirement redundant. These groups commented further stating that if EPA decides to finalize the risk mitigation plan, the suggested requirements for the risk mitigation plan are sufficient and a more in-depth risk analysis is not necessary.

EPA also received comments from the National Ground Water Association on what should be included in the risk mitigation plan. They provided a list of 12 items that they viewed as important to include in the plan. EPA found that all of the suggested items from the National Ground Water Association were already included in the items proposed or in other reports required by the CCR rule.

EPA disagrees that this plan is merely an unnecessary paperwork burden for the reasons discussed previously. Facilities in full compliance with all aspects of the regulations that have not initiated corrective action can still develop a plan that will expedite the implementation of corrective action, in the event it become necessary. EPA considers this to provide a substantial complement to the record supporting continued operation of the unit.

In response to the comments, requesting greater specificity about what would constitute an adequate submission, the final rule requires that the risk mitigation plan include three pieces of information. First, a discussion of any physical or chemical measures a facility can take to limit any future releases to groundwater during operation. This might include stabilization of waste prior to disposition in the impoundment or adjusting the pH of the impoundment waters to minimize solubility of contaminants. This discussion should take into account the potential impacts of these measures on Appendix IV constituents.

Second, a discussion of the surface impoundment's groundwater monitoring data and any found exceedances; the delineation of the plume (if necessary based on the groundwater monitoring data); identification of any nearby receptors that might be exposed, to current or future groundwater contamination; and how such exposures could be promptly mitigated.

And finally, a plan to expedite and maintain the containment of any contaminant plume that is either present or identified during continued operation of the unit. The purpose of this plan is to demonstrate that a plume can be fully contained and to define how this could be accomplished in the most accelerated timeframe feasible to prevent further spread and eliminate any potential for exposures. This plan will be based on relevant site data, which may include groundwater chemistry, the variability of local hydrogeology, groundwater elevation and flow rates, and the presence of any surface water features that would influence rate and direction of contamination movement. For example, based on the rate and direction of groundwater flow and potential for diffusion of the plume, this plan could identify the design and spacing of extraction wells necessary to prevent further downgradient migration of contaminated groundwater.

If additional mitigation measures are necessary to ensure the statutory standard is met, EPA will require those as a condition of granting the extension. The risk mitigation plan documentation requirement is at § 257.103(f)(2)(v)(B).

Compliance certification and narrative. EPA proposed that the owner or operator must certify that it remains in compliance with all other requirements of this subpart including corrective action. EPA is finalizing the same compliance certification and documentation as that in § 257.103(f)(1). The compliance documentation requirement is at § 257.103(f)(2)(v)(C). The requirement to remain in compliance with subpart D is represented in § 257.103(f)(2)(vi).

Maximum time to complete closure. EPA proposed that the facility must complete closure of the CCR surface impoundment, and the coal-fired boiler must cease operation no later than October 17, 2023 for surface impoundments 40 acres or smaller and October 17, 2028 for surface impoundments larger than 40 acres. These are the same deadlines as required in § 257.103(b).

EPA received comments from environmental groups stating that since EPA does not establish a set deadline for these units to cease receipt of waste and initiate closure the provision is unlawful. Some further elaborated that this provision would delay the initiation and completion of closure of these units for several years. These commenters further stated that developing alternative disposal capacity is not as complex as the proposed rule made it seem and believe that it is possible for facilities to obtain alternative capacity in a few weeks and therefore cease receipt of waste much earlier. The commenters additionally stated that EPA did not provide rationale for why this provision is protective of human health and the environment.

Industry groups commented that this provision provides important environmental benefits by requiring closure far earlier than would be otherwise required. They agree that the expedited closure of these units addresses the *USWAG* court decision by addressing the potential risks from unlined CCR surface impoundments during closure. A few utility companies commented that the deadlines for closure should not depend on the size of the CCR surface impoundment. Rather all CCR surface impoundments should be eligible for the October 2028 deadline. They also explained that having the size distinction has no environmental benefit because it forces facilities to develop new disposal capacity. They acknowledged EPA's rationale that smaller surface impoundments are able to close faster but contended that smaller surface impoundments represent smaller risk. One utility company stated that the CCR surface impoundment may be less than 40 acres, but the site has unique characteristics that makes closure more complex and the surface impoundment is of unusual shape causing the closure time to be just as long as a larger surface impoundment. Another utility company commented that if a facility had multiple surface impoundments under 40 acres, they should be able to aggregate the acreage of the surface impoundments to qualify for the later deadline of 2028. One other utility commented that the deadlines should be delayed a few years because the original deadlines were established in 2015 for § 257.103(b), therefore there was more time to complete closure under the original provision. One other utility commented that it is possible that they may be directed to cease their coal fired boiler in 2023 or 2024 which would make the alternative closure provision unusable for them.

Several commenters misunderstood EPA's proposal and commented that this provision significantly delays closure by allowing facilities to operate their CCR surface impoundments until 2028. The proposed regulation does not authorize continued operation until 2023 or 2028; rather it requires the *completion of closure* by those dates. These represent substantially more expedited time frames to complete closure of the unit, and in order to meet those timeframes facilities will need to stop receiving waste into the unit much sooner than those dates. In order to meet these timeframes, EPA expects that many facilities closing pursuant to this provision will need to cease receiving CCR and non-CCR wastestreams sooner than they would under the maximum amount of time in the site-specific alternative closure provision in § 257.103(f)(1). Consequently, the overall risk will be lower. As a consequence, EPA decided that it was not necessary to specify a particular deadline by which facilities must cease receiving waste into the unit. As a practical matter the length of time the unit can continue to operate will necessarily be limited by the amount of time needed to ensure that all closure activities are completed by the deadline. Instead the provision provides facilities with the flexibility to determine precisely when they will need to stop operation in order to achieve expedited closure deadlines.

EPA is not modifying the proposed closure deadlines to allow the extended operation of units 40 acres and smaller. As explained in the proposed rule, EPA relied upon a risk-risk tradeoff to support this provision. Specifically, EPA acknowledged there could be greater risk in the short term because this provision allows a longer period for unlined impoundments to operate; however, over the long-term EPA estimated that the risks would be lower because the final closure of the unit will be expedited. Under the commenters' suggested approaches there is nothing against which to balance the risks from the extended operation of the unit. The commenters provided no data to support their contentions or on which EPA could rely to model the risks associated with allowing impoundments less than 40 acres to continue to operate for the amount of time they are proposing. EPA proposed multiple options for facilities to address the variety of circumstances presented by these kinds of sites. Not all of them will be appropriate for every site. This provision was designed to address a very specific set of circumstances in which a facility knows it will be closing by a date certain and as a consequence can expedite its closure of the unit. Finally, EPA disagrees that there would be no environmental benefit in the provision as structured. There is a significant environmental benefit in requiring the expedited closure of unlined surface impoundments, and in requiring facilities to expedite corrective action. As the record from the 2015 rule and the results of the groundwater monitoring data from numerous facilities demonstrate, operation of these units presents significant risks.

The commenters did not provide a compelling argument for changing the deadlines from the proposal. Therefore, EPA is finalizing the deadlines as proposed.

Maximum Time Documentation. EPA did not receive substantive comments on the documentation necessary to demonstrate that the deadlines will be met. EPA is finalizing that in the demonstration submitted for approval the facility will need to specify and justify the date by which they intend to cease receipt of waste into the unit. If the amount of time the facility is seeking to operate the unit is disproportionate to the amount of time needed for closure of the unit, such that it appears unlikely the facility could meet the closure deadlines, EPA will deny the request. Additionally, facilities are required to amend their closure plan whenever there is a change in the operation of the CCR unit that would substantially affect the written closure plan or before or after closure actives have commenced as required by § 257.102(b)(3). As such, a facility should update their closure plan when applying for this extension. The documentation requirements for meeting the time requirements are represented § 257.103(f)(2)(iv)(D)

(b) Annual Closure Progress Reports

EPA proposed maintaining the annual progress report requirement that is currently required under § 257.103(b). EPA proposed that the owner or operator must prepare an annual progress report documenting the continued lack of alternative capacity and the progress towards the closure of the CCR surface impoundment.

EPA received no substantive comments concerning this requirement in the documentation for a site-specific alternative for cessation of coal-fired boiler(s).

EPA concluded from the lack of comments, to finalize the requirement. Therefore, owners or operators must prepare and place an annual progress report documenting the continued lack of alternative capacity and the progress towards the closure of the CCR surface impoundment. This progress report must include any delays in the anticipated cease receipt of waste date and closure completion date that was submitted in the demonstration materials. This requirement is found in § 257.103(f)(2)(x) of the regulation.

5. Procedures for Approval and Denial of Alternative Compliance Deadlines

EPA proposed to require that the demonstrations for an alternative compliance deadline under § 257.103(f)(1) (''development of alternative capacity infeasible'') or under § 257.103(f)(2) (''permanent cessation of coal-fired boiler(s) by a date certain'') be submitted to EPA or the Participating State Director for approval no later than two months prior to the facility's deadline to cease receiving waste. EPA believed that two months should normally provide sufficient time for EPA to evaluate the request and complete its review process. Although two months prior to the current deadline is the latest date to submit a request, EPA encouraged submissions at the earliest point at which the facility knows further time to complete its arrangements is needed.

EPA proposed that upon receiving the demonstration for an alternative compliance deadline, EPA or the Participating State Director would evaluate the demonstration and could ask for additional information to complete its review and/or discuss the demonstration with the facility. Submission of a complete demonstration would toll the facility's deadline to cease receipt of waste until issuance of a final decision. This ensures that a facility that has submitted a package in good faith would not be penalized by any inadvertent administrative delays. However, EPA proposed that incomplete submissions would not toll the facility's deadline.

EPA proposed that when the owner or operator submits the demonstration to EPA or the Participating State Director for approval, the owner or operator must prepare and place into the facility's operating record and on their publicly accessible CCR internet site a notification that the facility has applied for a site-specific alternative deadline to cease receipt of waste. EPA would then post a proposed decision to grant or deny the request in whole or in part on EPA's website for public notice and comment. EPA proposed that the public will have 15 days to comment on the proposed decision. If the demonstration is particularly complex, EPA would provide a longer comment period of 20 to 30 days. EPA proposed that it would evaluate the comments, amend its decision if appropriate, and post the final decision on the demonstrations on EPA's website. EPA proposed that the agency would finalize the decision on the alternative compliance deadline no later than 4 months after receiving a complete demonstration. If no substantive comments are received on a proposed decision, EPA proposed that it would become effective 5 days from the close of the comment period. Alternatively, EPA proposed that if a facility develops or identifies the necessary alternative capacity prior to approval from EPA, then the facility should notify EPA and withdraw their demonstration. Lastly, EPA proposed that the facility must post an approved or denied demonstration and the alternative compliance deadline decision on the facility's publicly accessible CCR internet site. EPA sought comment on whether a Participating State Director (*i.e.,* a state director with an approved State CCR Permit Program) should also have the authority to grant approvals.

EPA received numerous comments on the time frames in the proposed process. Some commenters stated that the proposed demonstration deadlines of May 15, 2020 for the cessation of boiler alternative and June 30, 2020 for the lack of alternative capacity are unreasonable. Specifically, these commenters were concerned that as a final rule will not be issued before May 2020 it will be impossible to comply with the May 15, 2020 deadline. They further stated that there should be an option for submitting the demonstrations for the cessation of boiler alternative later and not on a set date. A facility may not know they will be shutting down their coal fired boilers until later but will still be able to meet the compliance deadlines in the proposed provision for that alternative. They further stated that it will take facilities three months to successfully compile all the required elements for the demonstration. Therefore, the commenters believe that EPA needs to factor in this three-month timeframe prior to the deadline to submit the demonstrations to EPA (which was proposed to be two months prior to the deadline to cease receipt of waste). They additionally state that facilities should be able to switch between the two alternative deadline extensions. A facility should be able to submit an initial demonstration and receive approval for an extension under lack of capacity and then at a later date should be able to submit a demonstration and switch to a cessation of boiler extension if it is shutting down its coal-fired boilers and can achieve the deadlines. Additionally, it should be able to switch from a cessation of boiler extension to a lack of capacity demonstration if it is no longer going to be shutting down their boilers. These commenters also stated that the demonstration submission deadlines should be flexible enough to allow facilities to transition between the extensions provided in § 257.103(f)(1) and (f)(2).

EPA also received comments on the tolling of the deadline to cease receipt of waste while the demonstration for an alternative deadline is under review. All commenters supported the proposal that tolling of the deadline only occurs after a demonstration is determined to be complete. However, some commenters requested that EPA revise the proposed regulatory text to clearly provide what will constitute a complete demonstration to avoid any misunderstandings. Several commenters raised concern that, as the proposed regulations were drafted, a facility could get a free four-month extension during the tolling of the deadline after a complete demonstration is received. According to these commenters, a facility could submit a complete demonstration despite having the ability to cease receipt of waste and continue to operate while it is being reviewed because the demonstration completion determination does not depend on showing infeasibility.

Some commenters believe that the proposed review period is overly ambitious and requested that EPA clarify that after four months and no final determination is made, that the deadline continues to toll for the facility.

EPA also received comments on issues relating to the situations in which an extension request is denied by EPA. Some commenters claimed that EPA did not discuss what would occur if a facility's request was denied. These commenters state that EPA needs to establish a uniform timeframe for those facilities whose complete demonstration request is denied by EPA to cease receipt of waste and initiate closure. They explained that as the deadline for this facility is tolling, it would be unreasonable for EPA to expect that the facility can immediately cease receipt of waste. They believe that this timeframe should not be less than six months as that was the timeframe originally established in the CCR rule.

Industry groups supported the proposal that a Participating State Director should have the authority to grant extensions in an approved state program.

Additionally, several groups commented that the public comment period on the demonstrations is too short for the public to be able to review, evaluate, and provide meaningful input on the decision. These commenters also raised concern that EPA fails to define what it considers a substantive versus non-substantive comment and makes no provision to consider comments received after this 15-day window. These commenters claimed that this short period fails to provide 30-day notice and does not give interested parties sufficient time to consider EPA's decision, or to collect and submit written data, views, or arguments, and therefore violates RCRA and the Administrative Procedure Act (APA).

EPA is adopting procedures that largely track the procedures laid out in the proposed rule.

(a) Deadline for Submissions

Demonstrations for an alternative compliance deadline under § 257.103(f)(1) (development of alternative capacity infeasible) must be submitted to EPA for approval no later than November 30, 2020. This deadline should provide EPA with sufficient time to review the submission and determine whether it is complete prior to the April 11, 2021 deadline to cease receipt of waste. Moreover, this submission deadline is more than adequate for facilities to compile the necessary documentation, even assuming the commenters are correct that it would take three months to compile all the necessary documents. Although November 30, 2020 is the latest date to submit a request, EPA encourages submissions at the earliest point at which the facility knows further time to complete its arrangements is needed. This requirement is found at § 257.103(f)(3)(i)(A).

An owner or operator that seeks an extension to an approved alternative closure deadline must submit a new demonstration to EPA within fourteen days of determining that they no longer will meet the approved cease receipt of waste deadline. This requirement is found at § 257.103(f)(3)(i)(B).

Requests for additional time to operate a CCR surface impoundment under § 257.103(f)(2) (''permanent cessation of coal-fired boiler(s) by a date certain'') must be submitted to EPA for approval no later than November 30, 2020. EPA has received numerous submissions from utilities stating that the decision to shut down a boiler is not reached quickly and can require approvals from (or at least coordination with) state regulatory officials, among others. EPA, therefore, expects that facilities know now (or will decide shortly) whether they will seek to rely upon these provisions. This requirement is found at § 257.103(f)(3)(i)(C).

EPA also received comments from Luminant Generating Company LLC (EPA–HQ–OLEM–2019–0172–0098) requesting clarification on whether an owner or operator may apply to use both § 257.103(f)(1) and (f)(2) at one site for different impoundments based on site-specific constraints. The commenter stated this would apply, for example, to a facility that has determined it will retire its coal-fired boilers by October 17, 2028, but has multiple small impoundments (40 acres or less) that would be retrofitted by October 15, 2023, under § 257.103(f)(1) and one large impoundment (larger than 40 acres) that would close by October 17, 2028, under § 257.103(f)(2). If the smaller impoundments were subject to the closure deadlines provided under § 257.103(f)(2) for cessation of coal fired boilers, the ponds would be required to close (not retrofit) by October 17, 2023. EPA agrees with the commenter and believes that this situation is possible. EPA will allow an owner or operator to apply for both alternative deadlines if they can demonstrate that it is necessary. This explanation must be incorporated into the narrative required at § 257.103(f)(1)(iv)(A). The facility should submit the application for each alternative together as one application. EPA strongly discourages a facility to submit applications for both § 257.103(f)(1) and (f)(2) if they do not intend to use both provisions.

The proposal did not clearly indicate whether a facility that had been approved under one extension provision could seek to subsequently obtain approval to operate under an alternative extension. EPA agrees that if the facility meets the criteria for either extension, there is no reason that they should be precluded from seeking to change the alternative under which they operate. The procedures for this are described in more detail below.

(b) EPA Review and Decision

Upon receiving the demonstration for an alternative compliance deadline, EPA will evaluate the demonstration to determine whether it is complete. EPA may request additional, clarifying information to complete its review and/or discuss the demonstration with the facility. Submission of a demonstration will toll the facility's deadline to cease receipt of waste until issuance of one of the decisions described below. This ensures that a facility that has submitted a package in good faith is not penalized by any inadvertent administrative delays. EPA is committed to processing submissions as expeditiously as possible.

Consistent with the proposed rule, submissions that EPA determines to be incomplete will be rejected without further process, at which point any tolling of the facility's deadline will end. (EPA anticipates that the question of tolling for incomplete submissions should not generally arise, as the agency anticipates making these determinations before April 11, 2021.) No commenter disagreed that this was appropriate. As described in more detail below, incomplete submissions include both the situation in which the submission does not include all of the required material, and the situation in which EPA is unable to determine from the submission whether the facility or the unit meets the criteria for the extension.

EPA received several comments on its proposal that submission of a complete application would toll a facility's deadline. Some commenters raised concern that the review period is overly ambitious and requested that EPA clarify that if, after four months, no final determination has been made, the deadline would continue to be tolled for the facility. These commenters also requested that EPA revise the proposed regulatory text to clearly provide what will constitute a complete demonstration to avoid any misunderstandings. Other commenters raised concern that as a consequence of the decision to toll deadlines during the review period, and because, in their view, the proposed process would not weed out non-compliant facilities, the four-month time frame effectively creates a four-month extension for all facilities.

EPA agrees that the time frames are ambitious but continues to believe that they can be met. As discussed in more detail below, the Agency has limited the issues to be resolved during this process, and, as requested by commenters, has amended the proposed regulation to specify in detail the information needed for a submission to be considered complete. Consequently, EPA anticipates it will be able to make most decisions without further requests for information. Nevertheless, to avoid penalizing a facility that has submitted a demonstration in good faith, the final rule provides that the deadline to cease receipt of waste will be tolled until the Agency determines that the submission is incomplete or reaches a final decision on whether the facility meets the criteria for the extension, even if it takes longer than four months. EPA disagrees that this will in essence grant all submitters a de facto four-month extension. The new deadline for submission is over four months in advance of the deadline to cease receipt of waste, and EPA anticipates being able to evaluate submissions prior to this deadline.

Once the owner or operator submits the demonstration to EPA for approval, the owner or operator must place a copy into the facility's operating record and on its publicly accessible CCR internet site. EPA will also post who has submitted a demonstration on EPA's website. After reviewing the submission, EPA will either post a determination that the submission is incomplete on EPA's website or a proposed decision to grant or to deny the request in whole or in part on *www.regulations.gov* for public notice and comment.

Consistent with the proposal, the public will have at least 15 days to comment on the proposed decision. If the demonstration is particularly complex, EPA would provide a longer comment period of 20 to 30 days. EPA will evaluate the comments received and amend its decision as warranted. EPA will post all decisions on its website, in the relevant docket and notify the facility. EPA proposed that decisions would become automatically effective 5 days from the close of the comment period if EPA received no substantive comments. EPA is not finalizing this approach because it would be too difficult to implement.

EPA acknowledges that the public comment periods are short but disagrees with the suggestion that they will be too short to be meaningful. EPA is requiring facilities to post all submissions on their publicly accessible CCR internet site at the same time they submit them to EPA. The public can start their review at the same time as EPA and begin to gather information and prepare their comments. In most cases, the issues to be resolved will be limited largely to whether the deadlines proposed to complete all activities are supported by the available information, and whether the facility remains in compliance with the regulations. EPA disagrees with the proposition that a 15- to 30-day comment period violates either section 7004(b) of RCRA or the APA. This process is not a rulemaking, but an informal adjudication. Such adjudications do not typically include an opportunity for public comment and therefore the provision of a 15 to 30-day comment period meets the mandate in RCRA section 7004(b) to promote public participation. Moreover, the APA imposes neither a requirement to provide an opportunity for public comment nor any minimum time for a comment period for such procedures. Finally, EPA notes that the same commenters requesting longer comment periods have also raised concern that the process grants facilities too much additional time to continue operating. EPA is also interested in not granting undue amounts of additional time for facilities to continue operating and is expediting all aspects of this process, including the comment period.

EPA will post all final decisions on EPA's website and in the appropriate docket. The decision will specify the facility's deadline to cease receipt of waste; for example, a decision rejecting a submission as incomplete prior to April 11, 2021 will specify that the deadline remains April 11, 2021. The facility must post, along with a copy of its demonstration, the Agency's final decision on the facility's publicly accessible CCR internet site. EPA intends to reach a final decision no later than four months after receiving a complete demonstration. If at any point in this process, a facility no longer needs an extension—*e.g.,* because it has completed construction of alternative capacity prior to approval from EPA—the facility must notify EPA and withdraw its demonstration.

Some commenters raised concern that EPA had neglected to propose the procedures associated with denial of extension requests and requested that EPA elaborate on these procedures in the final rule. EPA disagrees that the procedures in the proposed rule apply exclusively to situations in which EPA grants the request. While EPA anticipates there will be several possible responses to a request for an extension, the procedures associated with each are the same procedures that were outlined in the proposal.

One possible outcome is that EPA will grant the requested extension. In this case the procedure will follow the process outlined in the proposed rule and discussed above. EPA will post a proposed decision on *www.regulations.gov* for at least a 15-day comment period and will subsequently publish its final decision on EPA's website and in the relevant docket.

Another potential outcome is that no extension is granted. Some commenters requested that if EPA denies a request, the facility be granted an additional six months in which to continue receiving waste. EPA envisions that the circumstances under which a request is entirely denied will be limited and disagrees that it would be appropriate to universally grant a further six months in these situations. The most likely situation in which an extension is not granted will be where EPA rejects the submission as incomplete or determines that one or more of the criteria for the extension have not been met. In neither situation would authorizing additional time for the facility to operate be warranted.

As explained previously, EPA will reject incomplete submissions without further process. This could include situations in which EPA cannot determine from the submission whether the criteria have been met (*e.g.,* the submitted information does not clearly address whether the downgradient monitoring system has been installed at the waste boundary or whether alternative capacity is available). No commenter disagreed that this was appropriate, and EPA continues to believe that in the absence of any showing that all regulatory criteria have been met no additional time could—and should—be authorized.

Another possibility is that EPA will propose to deny the application on the grounds that one or more of the criteria have not been met. For example, EPA may determine that the amount of time that the facility requested to complete the construction of the alternative capacity is not supported by the record. In this case all of the procedures described previously with respect to approvals will apply. And in this circumstance the amount of time that will be granted to the facility will be determined by the factual record that has been developed through this process. Whatever additional amount of time is determined to be appropriate based on the factual record before the agency at the time—which may be none—will necessarily be more appropriate than the commenter's proposed six-month period. For example, if a facility requests two additional years of operation and EPA determines that the submission only supports one year of continued operation, a six-month timeframe would be too short. Similarly, in some situations the facts may demonstrate that six months is too long. As another example, EPA may determine alternative capacity exists and can be feasibly utilized. EPA recognizes that the mere fact that disposal capacity exists somewhere does not necessarily constitute feasibility for purposes of this analysis. Nevertheless, there may be instances where disposal capacity is available off-site and within a reasonable distance. In this circumstance, as well, a six-month period of continued operation would be equally inappropriate.

Some commenters raised the argument that because part 257 is self-implementing and because certain regulatory provisions might be viewed as ambiguous, there could be differences in opinion on what constitutes compliance. These commenters felt that differences in interpretation should be discussed during EPA's review process and corrected as warranted as part of a facility's completion of its demonstration.

EPA is establishing an expedited process to resolve requests for continued operation under § 257.103; in order to meet these time frames EPA has limited the issues to be resolved in this proceeding. Thus, under the two new alternatives in § 257.103, in many cases one of the primary issues to be resolved will be whether the facility is in compliance with the regulations. Although EPA does not agree that the regulations are ambiguous, EPA may be able to engage in a limited amount of discussion with a facility before the submission deadline. To address concerns raised by commenters that the tolling period would grant de facto extensions for all facilities, such discussions would need to occur before the deadline for final submission of the request to avoid extending the tolling period. In addition, as explained previously, documentation that a facility remains in compliance with the requirements of subpart D provides critical support for a decision to allow continued operation of the unlined impoundment. This means that EPA must be able to affirmatively conclude that the facility meets this criterion prior to authorizing any continued operation of the unlined impoundment. As a consequence, any opportunity to correct the demonstration is limited to the period before the deadline for submission. Given that the final rule has been published well in advance of the deadline to cease receipt of waste, facilities will have sufficient time to raise these issues to the Agency in advance of submitting their application.

Finally, note that any determinations made in evaluating compliance aspects of submitted demonstrations will be made solely for the purpose of determining whether an extension of the deadline to cease receipt of waste is warranted. In making these determinations the Agency generally expects to consider and rely on the information in a submission, information contained in submitted comments to a proposed decision and any other information the Agency has at the time of the determination. These determinations may not be applicable or relevant in any other context. Should the facility's compliance status be considered outside of this context in the future, the Agency may reach a contrary conclusion based, for example, on new information or information that was not considered as part of this process.

(c) Transferring Between Site-Specific Alternatives (§ 257.103(f)(1) and (f)(2))

In the December 2019 proposal, EPA proposed that a facility could not utilize both the short-term extension § 257.103(e) and the site-specific longer extensions § 257.103(f). However, in the proposal EPA did not discuss whether a facility could switch between the site-specific extensions. Several comments discussed this issue explaining the importance of being able to switch between the lack of alternative capacity extension in § 257.103(f)(1) and the cessation of coal-fired boiler(s) in § 257.103(f)(2) and vice versa.

Several of these commenters stated that it is possible for a utility to determine that they will shut down their coal-fired boiler(s) after being approved under § 257.103(f)(1) and still be able to meet the deadlines under § 257.103(f)(2). They continued on to state that were this to happen a facility should be able to subsequently make the demonstration and switch extensions. Commenters also pointed out that allowing facilities to switch from § 257.103(f)(1) to § 257.103(f)(2) would expedite the closure of the CCR surface impoundment in question and also reduce the overall risk, consistent with subtitle D protectiveness standard.

These commenters additionally stated that the opposite is also possible where a facility will learn that they are unable to retire their coal-fired boilers and will need to develop alternative capacity. As such a facility should be able to make the demonstration and switch extensions. Therefore, EPA should provide a process for owners and operators to exercise this flexibility.

EPA agrees with the commenters that a situation may arise where a facility needs to change course due to unexpected business decisions and that there should be a process for a facility to switch between the site-specific alternative closure provisions. Therefore, EPA is adding regulations at § 257.103(f)(4) to allow the transfer between site-specific alternatives. The process of obtaining approval will be the same as it would be under the initial application for approval.

6. Conforming Amendments to § 257.103(a), (b), (c) and (d)

To conform with the new provisions for CCR surface impoundments, EPA proposed a series of amendments to the § 257.103 introductory paragraph and at § 257.103(a), (b), and (c). Additionally, EPA proposed amending § 257.103(a) and (b) to only be applicable to CCR landfills.

(a) Amendments to § 257.103(a) and (b)

EPA proposed to revise the introductory paragraph to § 257.103 to add the phrase ''and/or non-CCR wastestreams'' and to add references to the proposed new paragraphs (e) and (f) to § 257.103 for the short-term alternative and the alternative compliance deadlines respectively. EPA also proposed conforming revisions to § 257.103(a) and (b) to reflect the proposed alternative closure deadlines for surface impoundments. The current § 257.103(a) and (b) apply to both CCR landfills and CCR surface impoundments undergoing closure under § 257.101 that need additional time to find alternative capacity for only CCR wastestreams. To be consistent with the proposals, EPA proposed amending § 257.103(a) and (b) to only apply to CCR landfills.

Consistent with the decisions discussed previously, EPA has decided to finalize the proposed conforming amendments to § 257.103(a) and (b) so that those provisions only apply to CCR landfills. In addition, to address the concerns that proposed revisions to the introductory paragraph could be read to authorize all units to receive non-CCR wastestreams, EPA is revising the introductory paragraph to § 257.103 to provide that the owner or operator may continue to receive the waste specified in paragraphs (a), (b) or (f). Additionally, the references to § 257.101(a) and (b)(1) are being removed from § 257.103(a) and (b), as those sections apply only to CCR surface impoundments. EPA is also revising the term ''CCR unit'' to ''CCR landfill'' to ensure clarity that § 257.103(a) and (b) apply only to CCR landfills.

(b) Amendments to § 257.103(c) and (d)

In the December 2, 2019 proposal, EPA proposed to amend § 257.103(c) to make conforming changes to the notification requirements. When EPA amended the cease receipt of waste date in the July 2018 rule in § 257.101(a) and (b)(1), EPA neglected to make the conforming changes to the notification requirements in § 257.103(c). EPA proposed to amend § 257.103(c)(1) by adding new paragraphs (i) through (iii) for CCR units closing pursuant to § 257.101(a), (b)(1), and (d), respectively. Each respective subparagraph then requires the owner or operator to prepare the notification no later than the cease receipt of waste date according to § 257.101(a), (b)(1), and (d). The current text of § 257.103(c)(1) requires the owner or operator to prepare a notification within six months of becoming subject to closure pursuant to § 257.101(a), (b)(1), or (d). In light of the *USWAG* decision and the revisions adopted in this rule, this language no longer makes sense.

EPA received very few comments related to this section. Most comments stated generic support or disagreement for amending § 257.103(a) and (b) to only apply to landfills. There were no specific comments on the proposed modifications to the regulatory text in § 257.103(c).

In the December 2, 2019 proposal EPA did not make the correct conforming changes to § 257.103(c). EPA did not need to add the new notification deadlines for the units closing pursuant to § 257.101(a) and (b)(1) because of the restructuring of § 257.103(a) and (b). As § 257.103(a) and (b) will now only apply to CCR landfills, § 257.103(c) only needs to contain the notification date associated with CCR landfills closing pursuant to § 257.101(d). Therefore, EPA will not be finalizing the proposed amendments to § 257.103(c)(1) by adding new paragraphs (i), (ii), and (iii). Rather, EPA is amending the regulatory text of § 257.103(c)(1) by removing the citations for § 257.101(a) and (b)(1). This amendment to the regulatory text clarifies the notification requirements for § 257.103(a) and (b). Additionally, EPA is replacing the term ''CCR unit'' with ''CCR landfill'' throughout § 257.103(c) to add clarity that the provision only applies to CCR landfills. This change is represented in § 257.103(c).

EPA is also replacing the term ''CCR unit'' with ''CCR landfill'' in § 257.103(d). EPA did not propose this amendment however EPA believes it adds further clarity to the regulation. This change is represented in § 257.103(d).

VI. What final action is EPA taking on the August 14, 2019 proposal?

A. Revisions to the Annual Groundwater Monitoring and Corrective Action Report Requirements

Currently, § 257.90(e) requires owners and operators of CCR units to prepare an annual groundwater monitoring and corrective action report (''annual report''). This annual report must document the status of the groundwater monitoring and corrective action program for the CCR unit, summarize key actions completed, describe any problems encountered, discuss actions to resolve the problems, and project key activities for the upcoming year. The CCR regulations also specify the minimum information that must be included in the annual report. For example, one of the current requirements is to provide all the monitoring data obtained under the groundwater monitoring and corrective action program for the year covered by the report. The CCR regulations further require the owner or operator to include a data summary in the report with information such as the number of groundwater samples that were collected for analysis for each background and downgradient well, the dates the samples were collected, and whether the samples were required by the detection monitoring or assessment monitoring programs. See, § 257.90(e)(3). Except for certain inactive CCR surface impoundments, owners and operators must prepare the initial annual report no later than January 31, 2018 and post the report to its publicly accessible CCR internet site within 30 days of preparing the report. See, §§ 257.90(e) and 257.107(d). For eligible inactive CCR surface impoundments,[40] the deadline to prepare the initial annual report is August 1, 2019. See, § 257.100(e)(5)(ii).

The Agency reviewed the annual reports available on facilities' publicly accessible CCR internet sites that were due by January 31, 2018 and January 31, 2019 and observed that some facilities did not provide groundwater monitoring data in formats that were clear and easy for the public to understand. EPA found instances where it was difficult to determine whether the analytical results corresponded to background or downgradient wells, whether the CCR unit was operating under the detection or assessment monitoring program, when the assessment monitoring program was initiated for the CCR unit, or whether the facility had initiated corrective action for the unit. In addition, several facilities only provided hundreds or thousands of pages of laboratory printouts of the data, making it difficult for the public and other stakeholders to put the results into context within the overall groundwater monitoring program.

The purpose of requiring posting of the annual reports is to allow the public, states and EPA to easily see and understand the groundwater monitoring data. To accomplish this purpose, the Agency is finalizing one revision to the annual groundwater monitoring and corrective action reporting requirements and providing more explanation of another revision included in the preamble of the August 2019 proposed rule. See 84 FR 40365–40366.

[40] For more information on eligible inactive CCR surface impoundments, see the preamble to the direct final rule published on August 5, 2016 (81 FR 51802).

First, EPA is amending § 257.90 by adding new paragraph (e)(6) requiring a summary to be included at the beginning of the annual report. EPA received many comments on this proposal, most of which were supportive of the addition of the proposed provisions at § 257.90(e)(6).

Environmental groups and most private citizens who commented supported the inclusion of an upfront summary because a summary would be helpful for the public to understand the reports. They also said the summaries should include and not misrepresent or gloss over the conclusions based on the data. Specifically Earthjustice et al. commented that proper oversight and enforcement of the CCR regulations can only happen if owners and operators include a clear summary of the status of groundwater monitoring and corrective action, each statistically significant increase (SSI) over background levels (for Appendix III constituents) or groundwater protection standards (for Appendix IV constituents). They further commented that the report should include the dates when assessment monitoring was initiated, when an assessment of corrective measures was initiated, when an assessment of corrective measures was completed, and when a remedy was selected, where applicable. Earthjustice et al. also commented that clear summaries of all groundwater monitoring data are necessary, not just the data associated with an SSI.

Multiple states commented on this issue. The Alabama Department of Environmental Management commented that the report should include whether a facility began or ended the reporting cycle in detection or assessment monitoring (as well as provide the dates for the transition), and specify if and when a facility has moved to the corrective action stage of the groundwater monitoring program. The Virginia Department of Environmental Quality also supported the minimum set of requirements included in the proposal.

Many industry stakeholder and electric utility commenters supported the inclusion of an upfront summary setting forth certain information to help readers understand the data contained in the report and to provide more specificity and transparency as to what the report contains. Some industry group commenters did not support repeating information in the annual reports that is already required by the groundwater sampling and analysis plan at § 257.93. Some industry commenters wanted clarification that these requirements would not apply retroactively to past annual reports.

In light of these comments, the Agency is finalizing the new requirements at § 257.90(e)(6). This new provision establishes a minimum set of requirements to be addressed in the summary discussion of the status of the groundwater monitoring and corrective action programs for the CCR unit at the beginning of the annual report (*e.g.,* as part of the report's executive summary). The minimum requirements for this summary include stating whether the CCR unit was operating pursuant to the detection monitoring program under § 257.94 or the assessment monitoring program under § 257.95; identifying those constituents and the corresponding wells, if any, for which the facility had determined that there is a statistically significant increase over background levels for constituents listed in Appendix III (or if operating under the assessment monitoring program, constituents in Appendix IV that were detected at statistically significant levels above the groundwater protection standard); the date when the assessment monitoring program was initiated for the CCR unit; and a description and the dates of any corrective measures initiated or completed, including the remedy, during the annual reporting period. These requirements will only apply to future annual reports, starting with the next report completed after the effective date of this final rule. EPA believes the elements finalized are sufficient to give a snapshot of the groundwater monitoring and corrective action activities in the previous year but are not repetitive with other rule requirements.

Second, the Agency solicited comment on whether to amend § 257.90 to require the groundwater monitoring analytical results and related information to be presented in a standardized format, such as multiple tables, in the annual report. Possible examples of standard formats are available for review in the docket of the August 2019 proposal.[41] The Agency also requested comment on formats that could be used.

Information about the groundwater wells was proposed to include the following data elements: Well identification number, sampling date, latitude and longitude in decimal degrees, groundwater elevation including well depth to groundwater and total depth of groundwater, and whether the groundwater well is upgradient or downgradient of the CCR unit. This information is already collected and reported in the groundwater sampling and analysis plan under § 257.93 and so the information is readily available to the facility.

Sample information was proposed to be provided in a table that contains fields including sampling date, sampling time, sampling phase (*i.e.,* background, detection monitoring, assessment monitoring, corrective action), whether the groundwater well is upgradient or downgradient of the CCR unit, and analytical methods listed separately for every method used to analyze the constituent concentrations. Data for Appendix III to part 257—Constituents for Detection Monitoring was proposed to contain concentrations in milligrams per liter (unless otherwise specified) of the following: Boron, calcium, chloride, fluoride, pH (standard units), sulfate, and total dissolved solids (TDS). Data for Appendix IV to part 257—Constituents for Assessment Monitoring was proposed to contain concentrations in milligrams per liter (unless otherwise specified) of the following: Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, lead, lithium, mercury, molybdenum, radium 226–228 combined (pCi/L), selenium, and thallium. It was proposed that each constituent concentration identify the detection limit for the analytical method used with data qualifiers specified for non-detect samples.

EPA believed that a required standardized format would increase transparency and enable the general public, as well as Federal, state, and local officials, to more easily understand the groundwater monitoring data and thus plan for and evaluate the appropriate next steps to protect public health and the environment.

The Agency received many comments on the groundwater monitoring data standardized format. In general, environmental organizations and citizens supported the inclusion of data in a standardized format for ease of understanding and for the reasons included in the proposal. Many commenters requested the data to be presented in a machine-readable and preferably spreadsheet format. Some commenters, including Earthjustice, said EPA should require elements beyond those included in the proposal to satisfy the RCRA section 4004 protectiveness standard, and include the location of the groundwater well, groundwater elevation, and whether each well is upgradient, downgradient, sidegradient, or something else. These

[41] See EPA memorandum titled ''Annual Groundwater Monitoring Report Data Examples''; dated July 1, 2019. (EPA–HQ–OLEM–2018–0524–0013)

comments also said that access to the full data set should be included without having to wade through thousands of pages of laboratory reports to provide the public, state and Federal agencies with an opportunity to independently evaluate the data. Some commenters recommended that a summary of historical detections would also be helpful, especially if groundwater protection standards are established based on background concentrations at a given site.

While state commenters were generally supportive of requiring groundwater monitoring analytical results in a standardized format, the Agency received comment from only two states on this issue. Alabama Department of Environmental Management supported the requirement that groundwater analytical results for each sampling event be summarized, preferably in tabular format, for ease of the reader. The state found it has been extremely difficult, even for a trained individual, to review groundwater monitoring reports given the complex nature of the sites and the magnitude of data being presented. The state recommended a summary of historical detections would also be helpful, especially if groundwater protection standards are established based on background concentrations at a given site. The Virginia Department of Environmental Quality (VDEQ) generally supported the inclusion of a minimum set of requirements in a summary of the groundwater monitoring and corrective action programs. However, VDEQ stated that the standardized format and elements should only be a minimum standard so that states may require additional elements or information in state reporting without requiring separate reports to be generated.

Overall, industry commenters did not support the addition of standardized formats for groundwater monitoring data and analytical results. Industry commenters did support EPA's desire to make information decipherable to the public but believe the regulations should maintain flexibility for states and for facilities to determine how best to present the data. Some said a standardized format could be problematic in that certain facilities may not be able to display site-specific well networks sufficiently to meet the requirements of the CCR regulations. Other industry commenters said EPA should not require additional information beyond what is currently required by § 257.90(e) for the annual reports. Many industry commenters expressed concern about requiring information about groundwater wells including latitude and longitude of the wells in decimal degrees. These commenters said such information poses a security concern for the facility. They believe that providing a map of the monitoring wells is sufficient to be in compliance with the CCR regulations.

After considering the comments, EPA is not finalizing a requirement for owners and operators of CCR units to present groundwater monitoring analytical results in a standardized format. EPA is not convinced that such a requirement is necessary to serve the purposes of ensuring greater transparency. The Agency is also concerned about prescribing a standardized format which may not be consistent with existing state reporting requirements, especially given that only two states provided comments on this issue. The new requirement for a summary will ensure that the critical information is presented up front in the report, where it can be readily accessed by the public. EPA believes the current groundwater monitoring requirements of § 257.90 are sufficient as a minimum set of criteria to show the groundwater monitoring activities of the previous year. EPA also agrees with the commenters that allowing states the flexibility in requiring certain data elements and formats because of the use of certain software or what is required by the state regulations for consistency is important. Additionally, EPA is maintaining flexibility for facilities to report groundwater monitoring data in ways that are publicly accessible for all stakeholders. If, however, it becomes clear that the summaries are insufficient to ensure that the annual reports provide the public with useful information EPA will revisit this issue.

In this regard, it should be noted, however, that the annual reports should not only contain thousands of pages of groundwater monitoring data directly from the laboratory. Many commenters said this data is difficult to sift through, even for trained environmental specialists. That format is not easy to understand for the public, either. Data should be presented in a way that clearly communicates the required information to the general public in order to ensure proper oversight and enforcement of the CCR regulations by the public, states, and Federal agencies. The data could be presented in a tabular format, include historical detections, or include elements in the proposal that are not being finalized in this action.

B. Revisions to the Publicly Accessible CCR Internet Site Requirements

In the 2015 CCR rule, pursuant to RCRA section 7004(b)(2), the Agency promulgated a requirement for owners and operators of any CCR unit to establish and maintain a publicly accessible internet site, titled ''CCR Rule Compliance Data and Information.'' Section 7004(b)(3) directs EPA to provide for, encourage, and assist ''[p]ublic participation in the development, revision, implementation, and enforcement of any regulation, guideline, information, or program under this chapter.'' To achieve these ends, internet postings are required for various elements identified in the following sections of the CCR regulations: Location restrictions; design criteria; operating criteria; groundwater monitoring and corrective action; and closure and post closure care. Consistent with the statutory directive, the websites are important to make the notices and relevant information required by the regulations available to the public in a manner that will encourage and assist public participation in the implementation of the regulations. This means, for example, that the posted documents must be clearly identifiable as documents, reports, demonstrations, etc., to those attempting to access them. The internet is a widely accessible and effective means for gathering and disseminating information to the public and the states.

EPA has observed that some of the publicly accessible internet sites that owners and operators of CCR facilities have established in response to the CCR regulations, fail to make the posted documents publicly accessible. For example, a number of publicly accessible CCR internet sites require either some sort of registration whereby personal information identifying the user must be provided before members of the public are granted ''access'' to the website. Other websites require a user to submit a request for each document individually and the requested document is subsequently emailed to the user. Still other websites have been designed such that the posted documents cannot be downloaded or printed from the website. EPA does not consider these kinds of practices to be consistent with the requirement that the information be made publicly available. EPA acknowledges that the current regulation does not define the term ''publicly available,'' or contain detailed requirements that such websites must meet, nor are the practices described above explicitly prohibited. To avoid any further confusion, EPA proposed to amend the current regulation to clearly specify that facilities must ensure that all information required to be on the websites must be made available to any member of the public, including through printing and downloading, without any requirement that the public wait to be ''approved'', or provide information in order to access the website.

States, industry and environmental groups submitted comments that agreed with this proposal. Specifically, the states of Alabama and Virginia commented that they agreed with this proposed requirement. Earthjustice, Arizona Electric Power Cooperative Incorporated, the American Public Power Association, Labadie Environmental Organization, Sierra Club and the Blue Ridge Environmental Defense Fund also submitted comments stating that they agreed with the proposed requirement to make information and documents on the publicly accessible CCR internet site immediately accessible (including downloading and printing). One commenter said that EPA should not completely prohibit registration features on CCR websites because those features can alert the companies that users are having trouble accessing the data and allows the facility to contact those individuals to assist them. The Agency believes that requiring some sort of mechanism for users to contact the facility if there are issues with accessing the information on the site is a more effective mechanism to address those types of problems. Another company commented that EPA should not view these security approaches as inappropriately limiting access to utilities' publicly available CCR sites, as they are needed to protect the security interests of the utilities. This commenter did not provide details on how or why these practices are needed to address security concerns. In the absence of any explanation of the commenter's concerns and given that the vast majority of publicly accessible CCR internet sites do not require registration or permission to access the information, EPA does not believe this is enough justification to limit or restrict access to the information. Therefore, EPA is finalizing this revision to the regulations as proposed.

Another issue EPA has noticed is that the internet addresses for many of the publicly accessible CCR internet sites have changed; for some sites, more than once. It is very difficult for the public, states, and EPA to access the information required to be posted on these websites if the URLs change without notice. In response, the Agency proposed to amend the regulations to require that facilities notify EPA within 14 days of changing their publicly accessible CCR internet site address, to allow EPA to update the Agency's website with the correct URL address. Commenters generally agreed with this requirement and one commenter suggested that facilities also notify the state director when the URL for the facility's website changes. EPA agrees with this suggestion and is finalizing the requirement that when a facility changes the URL for its publicly accessible CCR internet site, they must notify EPA and the state director within 14 days of the new website address.

Another issue EPA has noted is that when there is a question or problem with a publicly accessible CCR internet site, such as a broken link or a document that will not download, it can be difficult to reach the appropriate contact at the facility in order to gain access to the information. Therefore, the Agency requested comment on whether each publicly accessible CCR internet site should be required to have a mechanism (*e.g.,* a ''contact us'' electronic form on the CCR website) for the public to contact the facility about issues of information accessibility. Commenters generally agreed with the idea of having some way for the public to easily contact the correct person to report problems with the website. One commenter said that EPA should require owners and operators to post a contact email address rather than a contact form. Several commenters suggested that the specific mechanism for the public to bring issues of information accessibility to the facility should be left up to the facility. EPA agrees that some sort of ''contact us'' mechanism is warranted; for example this could include either a ''contact us'' form much like the one EPA uses on the EPA CCR website or an email address for a specific contact at the facility who can address issues related to the accessibility on the website. The Agency is adding this requirement to the regulations in § 257.107(a).

One commenter also mentioned that even though § 257.107(c) requires that the information posted to the website must be made available to the public for at least five years, some documents are being removed from the websites after they are posted. EPA would like to reiterate that the regulations require that posted documents remain on the websites for at least five years. Section 257.107(c). If the documents are revised or updated, the original documents must still remain on the website. The same requirement exists if a unit is closed or consolidated with another unit; the original documents that were required for that unit must remain on the website for at least five years.

VII. Rationale for 30-Day Effective Date

The effective date of this rule is 30 days after publication in the **Federal Register**. The Administrative Procedure Act (APA) provides that publication of a substantive rule shall be made not less than 30 days before its effective date and that this provision applies in the absence of a specific statutory provision establishing an effective date. See 5 U.S.C. 553(d) and 559. EPA has determined there is no specific provision of RCRA addressing the effective date of regulations that would apply here, and thus the APA's 30-day effective date applies.

EPA has previously interpreted section 4004(c) of RCRA to generally establish a six-month effective date for rules issued under subtitle D. See 80 FR 37988, 37990 (July 2, 2015). After further consideration, EPA interprets section 4004(c) to establish an effective date solely for the regulations that were required to be promulgated under subsection (a). Section 4004(c) is silent as to subsequent revisions to those regulations; EPA therefore believes section 4004(c) is ambiguous.

Section 4004(c) states that the prohibition in subsection (b) shall take effect six months after promulgation of regulations under subsection (a). Subsection (a), in turn provides that ''[n]ot later than one year after October 21, 1976 . . . [EPA] shall promulgate regulations containing criteria for determining which facilities shall be classified as sanitary landfills and which shall be classified as open dumps within the meaning of this chapter.'' As noted, section 4004(c) is silent as to revisions to those regulations.

In response to Congress's mandate in section 4004(a), EPA promulgated regulations on September 13, 1979. 44 FR 53438. EPA interprets section 4004(c) to establish an effective date applicable only to that action, and not to future regulations the Agency might issue under this section. In the absence of a specific statutory provision establishing an effective date for this rule, APA section 553(d) applies.

EPA considers that its interpretation is reasonable because there is no indication in RCRA or its legislative history that Congress intended for the agency to have less discretion under RCRA subtitle D than it would have under the APA to establish a suitable effective date for subsequent rules issued under section 4004(c). Consistent with EPA's interpretation of the express language of section 4004, EPA interprets statements in the legislative history, explaining that section 4004(c) provides that the effective date is to be 6 months after the date of promulgation of regulations, as referring to the initial set of regulations required by Congress to be promulgated not later than 1 year after October 21, 1976. These statements do not mandate a 6 month effective date for every regulatory action that EPA takes under this section. This rule contains specific, targeted revisions to the 2015 rule and the legislative history regarding section 4004 speaks only to these initial 1976 mandated regulations.

This reading allows the Agency to establish an effective date appropriate for the nature of the regulation promulgated, which is what EPA believes Congress intended. EPA further considers that the minimum 30-day effective date under the APA is reasonable in this circumstance where none of the provisions being finalized require an extended period of time for regulated entities to comply.

VIII. State CCR Programs

A. Effect on This Final Rule on States With Approved CCR Programs

This final rule has impacts on states with an approved program. The effects depend on whether the state has received approval for the provisions that have been amended in this rule. As of this final rule, EPA has granted approvals to the states of Oklahoma and Georgia.

On June 28, 2018, EPA granted Oklahoma full program approval. However, on April 15, 2020, the U.S. District Court for the District of Columbia vacated part of that approval. *Waterkeeper Alliance Inc.* v. *Wheeler*, No. 18–02230, 2020 WL 1873564 (D.D.C. Apr. 15, 2020). Specifically, the court vacated those portions of the Oklahoma program approval that mirrored those portions of the federal program that had been vacated by the D.C. Circuit in *USWAG—i.e.,* the provisions that allowed unlined impoundments to continue to operate until they leak; the provisions that treated ''clay-lined'' units as lined units; and the provisions that excluded legacy units. As a consequence, the federal requirements that correspond to those provisions will now apply in Oklahoma. Two of these provisions have been revised in this rulemaking, and those revisions will take effect in Oklahoma because these federal requirements continue to operate. These are the revisions to 40 CFR 257.101(a) and section 257.71(a)(1)(i).

However, Oklahoma was granted approval for § 257.103, and their regulations continue to operate without change in lieu of the federal program. In essence this means that the revisions promulgated in this rule making will not take effect in Oklahoma until such time as Oklahoma revises the program to adopt them. However, Oklahoma must revise its CCR regulations within three years of any revisions to the federal regulations that are more stringent, in order to maintain their program approval. See, RCRA section 4005(d)(1)(D)(i)(II). EPA determined that parts of the amendments to § 257.103 are more stringent than the previous regulations. The modifications that allow the continued disposal of non-CCR wastestreams are arguably less stringent; however, the maximum amount of time allowed under the new provisions in § 257.103 is less than that allowed under the previous regulations and therefore these revisions are considered to be more stringent.

The same is true with respect to the amendments to the annual groundwater monitoring and corrective action report and to the publicly accessible CCR internet sites requirements in §§ 257.90 and 257.107. EPA considers these revisions to be more stringent because they impose new substantive requirements. However, because the state provisions that correspond to these federal requirements have been approved the federal revisions will not take effect unless the state adopts the revisions.

To maintain their program approval, Oklahoma will have to update its state CCR regulations and submit the modified portions for EPA approval. The process for approving Oklahoma's modifications is the same as for the initial program approval: EPA will propose to approve or deny the program modification and hold a public hearing during the comment period. EPA will then issue the final program determination within 180 days of determining that the state's submission is complete.

Similarly, Georgia did not apply for approval of four provisions in their permit program; as a consequence, the federal requirements that correspond to those four provisions continue to apply in Georgia. Two of these four provisions have been revised in this rulemaking, and those revisions will take effect in Georgia because these federal requirements continue to operate. These are the revisions to §§ 257.101(a) and 257.71(a)(1)(i). For the same reason, the state is not required to modify these parts of their program within the three years in order to maintain program approval. However, Georgia was granted approval for §§ 257.90, 257.103, 257.107, and because the state regulations operate in lieu of the federal regulations the revisions made to these provisions in this rule will not take effect in Georgia unless the state amends its regulations to adopt them.

As discussed above, because the amended provisions are more stringent than the previous regulations, Georgia will need to amend its regulations to incorporate the new timeframes within three years of the effective date of this final rule and submit a program modification to EPA for approval.

IX. Economic Impacts of This Action

A. Introduction

EPA estimated the costs and benefits of this action in a Regulatory Impact Analysis (RIA), which is available in the docket for this action. The RIA estimates the incremental costs and cost savings attributable to the provisions of this action against the baseline costs and practices in place as a result of the 2015 CCR final rule, and the 2018 CCR Phase One final rule.

EPA updated the 2015 CCR final rule baseline to account for the 2018 Phase One final rule and also to account for two developments. These are the availability of publicly accessible universe data and the effect of the 2018 court decisions. These updates increase the baseline costs estimated for the CCR program against which the RIA estimates the incremental effects of this final rulemaking action.

The RIA estimates that the net annualized impact of this final regulation will be annual cost savings of $26.1 million at 7 percent or an estimated annualized net cost savings of $16.7 million per year when discounting at 3 percent. This action is not considered an economically significant action under Executive Order 12866.

B. Affected Universe

This final rulemaking action affects coal fired electric utility plants (assigned to the utility sector North American Industry Classification System (NAICS) code 22). The rule is estimated to potentially impact 523 surface impoundments at 229 facilities.

C. Costs, Cost Savings, and Benefits of the Final Rule

The costs attributable to this final rule arise from the reporting and documentation that must be completed by regulated entities and submitted to EPA in order to qualify for some of the closure deadline extension provisions of the rule as well as other reporting requirements related to the annual groundwater monitoring and corrective action reports, publicly accessible CCR internet sites, and the closure of CCR units. These costs are estimated to amount to an annualized $0.2 million per year when discounting at 7 percent and an annualized $0.02 million per year when discounting at 3 percent.

The cost savings attributable to this final rule include cost savings from extending the deadlines by which units must cease receiving waste and initiate closure. Cost savings also follow from the avoided cost of new unit construction for CCR units associated with qualified coal fired boilers which are closing by 2023 or 2028. Overall, the final rule is expected to result in net cost savings of an annualized $26.1 million when discounting at 7 percent or an estimated annualized net cost savings of $16.7 million per year when discounting at 3 percent.

The RIA accompanying the 2015 CCR Rule monetized 11 categories of benefits attributable to the national minimum criteria. EPA expects to retain the vast majority of these monetized benefits under the provisions of the Part A rule. Some benefit categories, such as reduced future CCR impoundment releases, are unaffected by the provisions of the Part A rule. Other benefit categories, such as reduced groundwater contamination and other human health and environmental benefits should be largely retained because EPA is requiring units that take advantage of the alternative closure provisions in § 257.103(f)(1) and § 257.103(f)(2) to certify to EPA that they are in full compliance with the 2015 CCR rule. Units unable to make this certification must instead close by the earliest possible date, which EPA identifies as April 11, 2021. A discussion of the impact to each category of monetized benefits is available in Section 3.4 of the Part A RIA.

X. Statutory and Executive Order (E.O.) Reviews

Additional information about these statutes and Executive Orders can be found at *http://www2.epa.gov/laws-regulations/laws-and-executive-orders.*

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

This is a significant regulatory action that was submitted to the Office of Management and Budget (OMB) for review because it raises novel legal or policy issues. Any changes made in response to OMB recommendations have been documented in the docket. EPA prepared an analysis of the potential costs and benefits associated with this action. This analysis is available in the docket and is summarized in section IX of this preamble.

B. Executive Order 13771: Reducing Regulation and Controlling Regulatory Costs

This action is considered an Executive Order 13771 deregulatory action. Details on the estimated costs of this final rule can be found in EPA's analysis of the potential costs and benefits associated with this action.

C. Paperwork Reduction Act (PRA)

The information collection activities in this final rule have been submitted for approval to the Office of Management and Budget (OMB) under the PRA. The Information Collection Request (ICR) document that EPA prepared has been assigned EPA ICR number 1189.32. You can find a copy of the ICR in the docket for this rule, and it is briefly summarized here.

The information to be collected as a part of this rule includes demonstrations that must be made to EPA by owners and operators of units that seek to obtain a § 257.103(f)(1) extension. These demonstrations will show that the unit in question meets the necessary criteria to receive the extension. Units that operate under this extension will also be required to publish semi-annual progress reports on their publicly accessible CCR internet sites to keep EPA and the public appraised of their progress and any operational changes at the facility. Similarly, units that seek to obtain a § 257.103(f)(2) extension must demonstrate to EPA that they meet the necessary criteria to receive the extension. The criteria are generally the same as the criteria for § 257.103(f)(1) with the addition of a risk mitigation plan. Units that obtain an extension under § 257.103(f)(2) must publish annual progress reports on their publicly accessible CCR internet sites.

Information to be collected also include the addition of a summary at the beginning of the required annual groundwater monitoring and corrective action reports. These summaries will make the information in the reports more easily accessible to the public.

EPA is also revising the requirements for publicly accessible CCR internet sites to ensure that all information required to be on the websites be made available to any member of the public in multiple formats, in a timely way, and not requiring any information be submitted in exchange for access.

Respondents/affected entities: Coal-fired electric utility plants that will be affected by the rule.

Respondent's obligation to respond: The recordkeeping, notification, and posting are mandatory as part of the minimum national criteria being promulgated under Sections 1008, 4004, and 4005(a) of RCRA.

Estimated number of respondents: 299.

Frequency of response: The frequency of response varies.

Total estimated burden: EPA estimates the total annual burden to respondents to be an increase in burden of approximately 9,820 hours from the currently approved burden. Burden is defined at 5 CFR 1320.3(b).

Total estimated cost: $722,000 (per year), includes $0 annualized capital or operation & maintenance costs.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number. The OMB control numbers for EPA's regulations in 40 CFR are listed in 40 CFR part 9.

D. Regulatory Flexibility Act (RFA)

I certify that this action will not have a significant economic impact on a substantial number of small entities under the RFA. In making this determination, EPA believes that the impact of concern is any significant adverse economic impact on small entities, and that an agency may certify that a rule will not have a significant economic impact on a substantial number of small entities if the rule relieves regulatory burden, has no net burden or otherwise has a positive economic effect on the small entities subject to the rule. The rule is estimated to potentially impact 77 facilities that are considered small.

This action is expected to result in net cost savings of an annualized $26.1 million per year. These cost savings will accrue to all regulated entities. We have therefore concluded that this action will relieve regulatory burden for all directly regulated small entities.

E. Unfunded Mandates Reform Act (UMRA)

This action does not contain any unfunded mandate of $100 million or more as described in UMRA, 2 U.S.C. 1531–1538, and does not significantly or uniquely affect small governments. This action imposes no enforceable duty on any state, local or tribal governments or the private sector.

F. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

G. Executive Order 13175: Consultation and Coordination With Indian Tribal Governments

This action does not have tribal implications as specified in Executive Order 13175. For the ''Final Rule: Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities'' published April 17, 2015 (80 FR 21302), EPA identified three of the 414 coal-fired electric utility plants (in operation as of 2012) as being located on tribal lands. However, this action does not impose substantial direct compliance costs or otherwise have a substantial direct effect on one or more Indian tribes, to the best of EPA's knowledge. Neither will it have substantial direct effects on the relationship between the federal government and Indian tribes, or on the distribution of power and responsibilities between the Federal government and Indian tribes. Thus, Executive Order 13175 does not apply to this action.

H. Executive Order 13045: Protection of Children From Environmental Health Risk and Safety Risks

This action is not subject to Executive Order 13045 because it is not economically significant as defined in Executive Order 12866, and because EPA does not believe the environmental health risks or safety risks addressed by this action present a disproportionate risk to children. This action's health and risk assessments are contained in the document titled ''Human and Ecological Risk Assessment of Coal Combustion Residuals,'' which is available in the docket for the final rule as docket item EPA–HQ–RCRA–2009–0640–11993.

As ordered by E.O. 13045 Section 1–101(a), for the ''Final Rule: Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities'' published April 17, 2015 (80 FR 21302), EPA identified and assessed environmental health risks and safety risks that may disproportionately affect children in the revised risk assessment. The results of the screening assessment found that risks fell below the criteria when wetting and run-on/runoff controls required by the rule are considered. Under the full probabilistic analysis, composite liners required by the rule for new waste management units showed the ability to reduce the 90th percentile child cancer and non-cancer risks for the groundwater to drinking water pathway to well below EPA's criteria. Additionally, the groundwater monitoring and corrective action required by the rule reduced risks from current waste management units. This action does not adversely affect these requirements and EPA believes that this rule will be protective of children's health.

I. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution or Use

This action is not a ''significant energy action'' because it is not likely to have a significant adverse effect on the supply, distribution or use of energy. For the 2015 CCR rule, EPA analyzed the potential impact on electricity prices relative to the ''in excess of one percent'' threshold. Using the Integrated Planning Model (IPM), EPA concluded that the 2015 CCR Rule may increase the weighted average nationwide wholesale price of electricity between 0.18 percent and 0.19 percent in the years 2020 and 2030, respectively. As the proposed rule represents a cost savings rule relative to the 2015 CCR rule, this analysis concludes that any potential impact on wholesale electricity prices will be lower than the potential impact estimated of the 2015 CCR rule; therefore, this proposed rule is not expected to meet the criteria of a ''significant adverse effect'' on the electricity markets as defined by Executive Order 13211.

J. National Technology Transfer and Advancement Act (NTTAA)

This rulemaking does not involve technical standards.

K. Executive Order 12898: Federal Actions To Address Environmental Justice in Minority Populations and Low-Income Populations

EPA believes that this action does not have disproportionately high and adverse human health or environmental effects on minority populations, low-income populations and/or indigenous peoples, as specified in Executive Order 12898 (59 FR 7629, February 16, 1994). The documentation for this decision is contained in EPA's Regulatory Impact Analysis (RIA) for the CCR rule which is available in the docket for the 2015 CCR final rule as docket item EPA–HQ–RCRA–2009–0640–12034.

EPA's risk assessment did not separately evaluate either minority or low-income populations. However, to evaluate the demographic characteristics of communities that may be affected by the CCR rule, the RIA for the 2015 CCR Rule compares the demographic characteristics of populations surrounding coal-fired electric utility plants with broader population data for two geographic areas: (1) One-mile radius from CCR management units (*i.e.,* landfills and impoundments) likely to be affected by groundwater releases from both landfills and impoundments; and (2) watershed catchment areas downstream of surface impoundments that receive surface water run-off and releases from CCR impoundments and are at risk of being contaminated from CCR impoundment discharges (*e.g.,* unintentional overflows, structural failures, and intentional periodic discharges).

For the population as a whole 24.8 percent belong to a minority group and 11.3 percent falls below the Federal Poverty Level. For the population living within one mile of plants with surface impoundments 16.1 percent belong to a minority group and 13.2 percent live below the Federal Poverty Level. These minority and low-income populations are not disproportionately high compared to the general population. The percentage of minority residents of the entire population living within the catchment areas downstream of surface impoundments is disproportionately high relative to the general population, *i.e.,* 28.7 percent, versus 24.8 percent for the national population. Also, the percentage of the population within the catchment areas of surface impoundments that is below the Federal Poverty Level is disproportionately high compared with the general population, *i.e.,* 18.6 percent versus 11.3 percent nationally.

L. Congressional Review Act (CRA)

This action is subject to the CRA, and EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action is not a ''major rule'' as defined by 5 U.S.C. 804(2).

List of Subjects in 40 CFR Part 257

Environmental protection, Beneficial use, Coal combustion products, Coal combustion residuals, Coal combustion waste, Disposal, Hazardous waste, Landfill, Surface impoundment.

Andrew Wheeler,
Administrator.

For the reasons set out in the preamble, EPA amends title 40, chapter

I, of the Code of Federal Regulations as follows:

PART 257—CRITERIA FOR CLASSIFICATION OF SOLID WASTE DISPOSAL FACILITIES AND PRACTICES

■ 1. The authority citation for part 257 is revised to read as follows:

Authority: 42 U.S.C. 6907(a)(3), 6912(a)(1), 6944, 6945(a) and (d); 33 U.S.C. 1345(d) and (e).

■ 2. Amend § 257.53 by adding definitions in alphabetical order for ''Eligible unlined CCR surface impoundment,'' ''Technically feasible,'' and ''Technically infeasible'' to read as follows:

§ 257.53 Definitions.

* * * * *

Eligible unlined CCR surface impoundment means an existing CCR surface impoundment that meets all of the following conditions:

(1) The owner or operator has documented that the CCR unit is in compliance with the location restrictions specified under §§ 257.60 through 257.64;

(2) The owner or operator has documented that the CCR unit is in compliance with the periodic safety factor assessment requirements under § 257.73(e) and (f); and

(3) No constituent listed in Appendix IV to this part has been detected at a statistically significant level exceeding a groundwater protection standard defined under § 257.95(h).

* * * * *

Technically feasible means possible to do in a way that would likely be successful.

Technically infeasible means not possible to do in a way that would likely be successful.

* * * * *

■ 3. Amend § 257.71 by removing and reserving paragraph (a)(1)(i) and revising paragraphs (a)(3)(i) and (ii).

The revisions read as follows:

§ 257.71 Liner design criteria for existing CCR surface impoundments.

(a) * * *

(3) * * *

(i) The owner or operator of the CCR unit determines that the CCR unit is not constructed with a liner that meets the requirements of paragraph (a)(1)(ii) or (iii) of this section; or

(ii) The owner or operator of the CCR unit fails to document whether the CCR unit was constructed with a liner that meets the requirements of paragraph (a)(1)(ii) or (iii) of this section.

* * * * *

■ 4. Amend § 257.90 by adding paragraph (e)(6) to read as follows:

§ 257.90 Applicability.

* * * * *

(e) * * *

(6) A section at the beginning of the annual report that provides an overview of the current status of groundwater monitoring and corrective action programs for the CCR unit. At a minimum, the summary must specify all of the following:

(i) At the start of the current annual reporting period, whether the CCR unit was operating under the detection monitoring program in § 257.94 or the assessment monitoring program in § 257.95;

(ii) At the end of the current annual reporting period, whether the CCR unit was operating under the detection monitoring program in § 257.94 or the assessment monitoring program in § 257.95;

(iii) If it was determined that there was a statistically significant increase over background for one or more constituents listed in appendix III to this part pursuant to § 257.94(e):

(A) Identify those constituents listed in appendix III to this part and the names of the monitoring wells associated with such an increase; and

(B) Provide the date when the assessment monitoring program was initiated for the CCR unit.

(iv) If it was determined that there was a statistically significant level above the groundwater protection standard for one or more constituents listed in appendix IV to this part pursuant to § 257.95(g) include all of the following:

(A) Identify those constituents listed in appendix IV to this part and the names of the monitoring wells associated with such an increase;

(B) Provide the date when the assessment of corrective measures was initiated for the CCR unit;

(C) Provide the date when the public meeting was held for the assessment of corrective measures for the CCR unit; and

(D) Provide the date when the assessment of corrective measures was completed for the CCR unit.

(v) Whether a remedy was selected pursuant to § 257.97 during the current annual reporting period, and if so, the date of remedy selection; and

(vi) Whether remedial activities were initiated or are ongoing pursuant to § 257.98 during the current annual reporting period.

* * * * *

§ 257.91 [Amended]

■ 5. Amend § 257.91 by removing and reserving paragraph (d)(2).

■ 6. Amend § 257.95 by revising paragraph (g)(5) to read as follows:

§ 257.95 Assessment monitoring program.

* * * * *

(g) * * *

(5) The owner or operator must prepare a notification stating that an assessment of corrective measures has been initiated.

* * * * *

■ 7. Amend § 257.101 by revising paragraphs (a)(1) and (b)(1)(i) to read as follows:

§ 257.101 Closure or retrofit of CCR units.

(a) * * *

(1) Except as provided by paragraph (a)(3) of this section, as soon as technically feasible, but not later than April 11, 2021, an owner or operator of an existing unlined CCR surface impoundment must cease placing CCR and non-CCR wastestreams into such CCR surface impoundment and either retrofit or close the CCR unit in accordance with the requirements of § 257.102.

* * * * *

(b) * * *

(1)(i) *Location standard under § 257.60.* Except as provided by paragraph (b)(4) of this section, the owner or operator of an existing CCR surface impoundment that has not demonstrated compliance with the location standard specified in § 257.60(a) must cease placing CCR and non-CCR wastestreams into such CCR unit as soon as technically feasible, but no later than April 11, 2021, and close the CCR unit in accordance with the requirements of § 257.102.

* * * * *

■ 8. Revise § 257.103 to read as follows:

§ 257.103 Alternative closure requirements.

The owner or operator of a CCR landfill, CCR surface impoundment, or any lateral expansion of a CCR unit that is subject to closure pursuant to § 257.101(a), (b)(1), or (d) may nevertheless continue to receive the wastes specified in either paragraph (a), (b), (f)(1), or (f)(2) of this section in the unit provided the owner or operator meets all of the requirements contained in the respective paragraph.

(a) *CCR landfills*—(1) *No alternative CCR disposal capacity.* Notwithstanding the provisions of § 257.101(d), a CCR landfill may continue to recieve CCR if the owner or operator of the CCR landfill certifies that the CCR must continue to be managed in that CCR landfill due to the absence of alternative disposal capacity both on and off-site of the facility. To qualify under this paragraph, the owner or operator of the CCR landfill must document that all of the following conditions have been met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section;

(ii) The owner or operator has made, and continues to make, efforts to obtain additional capacity. Qualification under this paragraph (a) lasts only as long as no alternative capacity is available. Once alternative capacity is identified, the owner or operator must arrange to use such capacity as soon as feasible;

(iii) The owner or operator must remain in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action; and

(iv) The owner or operator must prepare the annual progress report specified in paragraph (c) of this section documenting the continued lack of alternative capacity and the progress towards the development of alternative CCR disposal capacity.

(2) Once alternative capacity is available, the CCR landfill must cease receiving CCR and initiate closure following the timeframes in § 257.102(e).

(3) If no alternative capacity is identified within five years after the initial certification, the CCR landfill must cease receiving CCR and close in accordance with the timeframes in § 257.102(e) and (f).

(b) *CCR landfills*—(1) *Permanent cessation of a coal-fired boiler(s) by a date certain.* Notwithstanding the provisions of § 257.101(d), a CCR landfill may continue to receive CCR if the owner or operator certifies that the facility will cease operation of the coal-fired boilers within the timeframe specified in paragraph (b)(4) of this section, but in the interim period (prior to closure of the coal-fired boiler), the facility must continue to use the CCR landfill due to the absence of alternative disposal capacity both on and off-site of the facility. To qualify under this paragraph, the owner or operator of the CCR landfill must document that all of the following conditions have been met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section.

(ii) The owner or operator must remain in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action; and

(iii) The owner or operator must prepare the annual progress report specified in paragraph (c) of this section documenting the continued lack of alternative capacity and the progress towards the closure of the coal-fired boiler.

(2)–(3) [Reserved]

(4) For a CCR landfill, the coal-fired boiler must cease operation, and the CCR landfill must complete closure no later than April 19, 2021.

(c) *Required notices and progress reports for CCR landfills.* An owner or operator of a CCR landfill that closes in accordance with paragraph (a) or (b) of this section must complete the notices and progress reports specified in paragraphs (c)(1) through (3) of this section.

(1) Within six months of becoming subject to closure pursuant to § 257.101(d), the owner or operator must prepare and place in the facility's operating record a notification of intent to comply with the alternative closure requirements of this section. The notification must describe why the CCR landfill qualifies for the alternative closure provisions under either paragraph (a) or (b) of this section, in addition to providing the documentation and certifications required by paragraph (a) or (b) of this section.

(2) The owner or operator must prepare the periodic progress reports required by paragraph (a)(1)(iv) or (b)(1)(iii) of this section, in addition to describing any problems encountered and a description of the actions taken to resolve the problems. The annual progress reports must be completed according to the following schedule:

(i) The first annual progress report must be prepared no later than 13 months after completing the notification of intent to comply with the alternative closure requirements required by paragraph (c)(1) of this section.

(ii) The second annual progress report must be prepared no later than 12 months after completing the first annual progress report. Subsequent annual progress reports must be prepared within 12 months of completing the previous annual progress report.

(iii) The owner or operator has completed the progress reports specified in this paragraph (c)(2) when the reports are placed in the facility's operating record as required by § 257.105(i)(11).

(3) An owner or operator of a CCR landfill must also prepare the notification of intent to close a CCR landfill as required by § 257.102(g).

(d) *CCR landfill recordkeeping.* The owner or operator of the CCR landfill must comply with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the internet requirements specified in § 257.107(i).

(e) [Reserved]

(f) *Site-specific alternative deadlines to initiate closure of CCR surface impoundments.* Notwithstanding the provisions of § 257.101(a) and (b)(1), a CCR surface impoundment may continue to receive the waste specified in paragraph (f)(1) or (2) of this section, provided the owner or operator submits a demonstration that the criteria in either paragraph (f)(1) or (2) of this section have been met. The demonstration must be submitted to the Administrator or the Participating State Director no later than the relevant deadline in paragraph (f)(3) of this section. The Administrator or the Participating State Director will act on the submission in accordance with the procedures in paragraph (f)(3) of this section.

(1) *Development of alternative capacity is technically infeasible.* Notwithstanding the provisions of § 257.101(a) and (b)(1), a CCR surface impoundment may continue to receive the waste specified in paragraph (f)(1)(ii)(A) or (B) of this section, provided the owner or operator demonstrates the wastestream(s) must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to provide alternative disposal capacity on or off-site of the facility by April 11, 2021. To obtain approval under this paragraph all of the following criteria must be met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section;

(ii)(A) For units closing pursuant to § 257.101(a) and (b)(1)(i), CCR and/or non-CCR wastestreams must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021.

(B) For units closing pursuant to § 257.101(b)(1)(ii), CCR must continue to be managed in that CCR surface impoundment because it was technically infeasible to complete the measures necessary to obtain alternative disposal capacity either on or off-site of the facility by April 11, 2021.

(iii) The facility is in compliance with all of the requirements of this subpart.

(iv) The owner or operator of the CCR surface impoundment must submit documentation that the criteria in paragraphs (f)(1)(i) through (iii) of this section have been met by submitting to the Administrator or the Participating State Director all of the following:

(A) To demonstrate that the criteria in paragraphs (f)(1)(i) and (ii) of this section have been met the owner or operator must submit a workplan that contains all of the following elements:

(*1*) A written narrative discussing the options considered both on and off-site to obtain alternative capacity for each CCR and/or non-CCR wastestreams, the technical infeasibility of obtaining alternative capacity prior to April 11, 2021, and the option selected and justification for the alternative capacity selected. The narrative must also include all of the following:

(*i*) An in-depth analysis of the site and any site-specific conditions that led to the decision to select the alternative capacity being developed;

(*ii*) An analysis of the adverse impact to plant operations if the CCR surface impoundment in question were to no longer be available for use; and

(*iii*) A detailed explanation and justification for the amount of time being requested and how it is the fastest technically feasible time to complete the development of the alternative capacity;

(*2*) A detailed schedule of the fastest technically feasible time to complete the measures necessary for alternative capacity to be available including a visual timeline representation. The visual timeline must clearly show all of the following:

(*i*) How each phase and the steps within that phase interact with or are dependent on each other and the other phases;

(*ii*) All of the steps and phases that can be completed concurrently;

(*iii*) The total time needed to obtain the alternative capacity and how long each phase and step within each phase will take; and

(*iv*) At a minimum, the following phases: Engineering and design, contractor selection, equipment fabrication and delivery, construction, and start up and implementation.;

(*3*) A narrative discussion of the schedule and visual timeline representation, which must discuss all of the following:

(*i*) Why the length of time for each phase and step is needed and a discussion of the tasks that occur during the specific step;

(*ii*) Why each phase and step shown on the chart must happen in the order it is occurring;

(*iii*) The tasks that occur during each of the steps within the phase; and

(*iv*) Anticipated worker schedules; and

(*4*) A narrative discussion of the progress the owner or operator has made to obtain alternative capacity for the CCR and/or non-CCR wastestreams. The narrative must discuss all the steps taken, starting from when the owner or operator initiated the design phase up to the steps occurring when the demonstration is being compiled. It must discuss where the facility currently is on the timeline and the efforts that are currently being undertaken to develop alternative capacity.

(B) To demonstrate that the criteria in paragraph (f)(1)(iii) of this section have been met, the owner or operator must submit all of the following:

(*1*) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;

(*2*) Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:

(*i*) Map(s) of groundwater monitoring well locations in relation to the CCR unit(s);

(*ii*) Well construction diagrams and drilling logs for all groundwater monitoring wells; and

(*iii*) Maps that characterize the direction of groundwater flow accounting for seasonal variations;

(*3*) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;

(*4*) A description of site hydrogeology including stratigraphic cross-sections;

(*5*) Any corrective measures assessment conducted as required at § 257.96;

(*6*) Any progress reports on corrective action remedy selection and design and the report of final remedy selection required at § 257.97(a);

(*7*) The most recent structural stability assessment required at § 257.73(d); and

(*8*) The most recent safety factor assessment required at § 257.73(e).

(v) As soon as alternative capacity for any CCR or non-CCR wastestream is available, the CCR surface impoundment must cease receiving that CCR or non-CCR wastestream. Once the CCR surface impoundment ceases receipt of all CCR and/or non-CCR wastestreams, the CCR surface impoundment must initiate closure following the timeframes in § 257.102(e) and (f).

(vi) *Maximum time frames.* All CCR surface impoundments covered by this section must cease receiving waste by the deadlines specified in paragraphs (f)(1)(vi)(A) and (B) of this section and close in accordance with the timeframes in § 257.102(e) and (f).

(A) Except as provided by paragraph (f)(1)(vi)(B) of this section, no later than October 15, 2023.

(B) An eligible unlined CCR surface impoundment must cease receiving CCR and/or non-CCR wastestreams no later than October 15, 2024. In order to continue to operate until October 15, 2024, the owner or operator must demonstrate that the unit meets the definition of an eligible unlined CCR surface impoundment.

(vii) An owner or operator may seek additional time beyond the time granted in the initial approval by making the showing in paragraphs (f)(1)(i) through (iv) of this section, provided that no facility may be granted time to operate the impoundment beyond the maximum allowable time frames provided in § 257.103(f)(1)(vi).

(viii) The owner or operator at all times bears responsibility for demonstrating qualification under this section. Failure to remain in compliance with any of the requirements of this subpart will result in the automatic loss of authorization under this section.

(ix) The owner or operator must:

(A) Upon submission of the demonstration to the Administrator or the Participating State Director, prepare and place in the facility's operating record a notification that it has submitted the demonstration, along with a copy of the demonstration. An owner or operator that claims CBI in the demonstration may post a redacted version of the demonstration to its publicly accessible CCR internet site provided that it contains sufficient detail so that the public can meaningfully comment on the demonstration.

(B) Upon receipt of a decision pursuant to paragraph (f)(3) of this section, must prepare and place in the facility's operating record a copy of the decision.

(C) If an extension of an approved deadline pursuant to paragraph (f)(1)(vii) of this section has been requested, place a copy of the request submitted to the Administrator or the Participating State Director in the facility's operating record.

(x) The owner or operator must prepare semi-annual progress reports. The semi-annual progress reports must contain all of the following elements:

(A) Discussion of the progress made to date in obtaining alternative capacity, including:

(*1*) Discussion of the current stage of obtaining the capacity in reference to the timeline required under paragraph (f)(1)(iv)(A) of this section;

(*2*) Discussion of whether the owner or operator is on schedule for obtaining alternative capacity;

(*3*) If the owner or operator is not on or ahead of schedule for obtaining alternative capacity, the following must be included:

(*i*) Discussion of any problems encountered, and a description of the actions taken or planned to resolve the problems and get back on schedule; and

(*ii*) Discussion of the goals for the next six months and major milestones to be achieved for obtaining alternative capacity; and

(B) Discussion of any planned operational changes at the facility.

(xi) The progress reports must be completed according to the following schedule:

(A) The semi-annual progress reports must be prepared no later than April 30 and October 31 of each year for the duration of the alternative cease receipt of waste deadline.

(B) The first semi-annual progress report must be prepared by whichever date, April 30 or October 31, is soonest after receiving approval from the Administrator or the Participating State Director; and

(C) The owner or operator has completed the progress reports specified in paragraph (f)(1)(x) of this section when the reports have been placed in the facility's operating record as required by § 257.105(i)(17).

(xii) The owner or operator must prepare the notification of intent to close a CCR surface impoundment as required by § 257.102(g).

(xiii) The owner or operator must comply with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the internet posting requirements in § 257.107(i).

(2) *Permanent cessation of a coal-fired boiler(s) by a date certain.* Notwithstanding the provisions of § 257.101(a), and (b)(1), a CCR surface impoundment may continue to receive CCR and/or non-CCR wastestreams if the facility will cease operation of the coal-fired boiler(s) and complete closure of the impoundment within the timeframes specified in paragraph (f)(2)(iv) of this section, but in the interim period (prior to closure of the coal-fired boiler), the facility must continue to use the CCR surface impoundment due to the absence of alternative disposal capacity both on and off-site of the facility. To qualify under this paragraph all of the following criteria must be met:

(i) No alternative disposal capacity is available on or off-site. An increase in costs or the inconvenience of existing capacity is not sufficient to support qualification under this section.

(ii) Potential risks to human health and the environment from the continued operation of the CCR surface impoundment have been adequately mitigated;

(iii) The facility is in compliance with all other requirements of this subpart, including the requirement to conduct any necessary corrective action; and

(iv) The coal-fired boilers must cease operation and closure of the impoundment must be completed within the following timeframes:

(A) For a CCR surface impoundment that is 40 acres or smaller, the coal-fired boiler(s) must cease operation and the CCR surface impoundment must complete closure no later than October 17, 2023.

(B) For a CCR surface impoundment that is larger than 40 acres, the coal-fired boiler(s) must cease operation, and the CCR surface impoundment must complete closure no later than October 17, 2028.

(v) The owner or operator of the CCR surface impoundment must submit the following documentation that the criteria in paragraphs (f)(2)(i) through (iv) of this section have been met as specified in paragraphs (f)(2)(v)(A) through (D) of this section.

(A) To demonstrate that the criteria in paragraph (f)(2)(i) of this section have been met the owner or operator must submit a narrative that explains the options considered to obtain alternative capacity for CCR and/or non-CCR wastestreams both on and off-site.

(B) To demonstrate that the criteria in paragraph (f)(2)(ii) of this section have been met the owner or operator must submit a risk mitigation plan describing the measures that will be taken to expedite any required corrective action, and that contains all of the following elements:

(*1*) A discussion of any physical or chemical measures a facility can take to limit any future releases to groundwater during operation.

(*2*) A discussion of the surface impoundment's groundwater monitoring data and any found exceedances; the delineation of the plume (if necessary based on the groundwater monitoring data); identification of any nearby receptors that might be exposed to current or future groundwater contamination; and how such exposures could be promptly mitigated.

(*3*) A plan to expedite and maintain the containment of any contaminant plume that is either present or identified during continued operation of the unit.

(C) To demonstrate that the criteria in paragraph (f)(2)(iii) of this section have been met, the owner or operator must submit all of the following:

(*1*) A certification signed by the owner or operator that the facility is in compliance with all of the requirements of this subpart;

(*2*) Visual representation of hydrogeologic information at and around the CCR unit(s) that supports the design, construction and installation of the groundwater monitoring system. This includes all of the following:

(*i*) Map(s) of groundwater monitoring well locations in relation to the CCR unit;

(*ii*) Well construction diagrams and drilling logs for all groundwater monitoring wells; and

(*iii*) Maps that characterize the direction of groundwater flow accounting for seasonal variations;

(*3*) Constituent concentrations, summarized in table form, at each groundwater monitoring well monitored during each sampling event;

(*4*) Description of site hydrogeology including stratigraphic cross-sections;

(*5*) Any corrective measures assessment required at § 257.96;

(*6*) Any progress reports on remedy selection and design and the report of final remedy selection required at § 257.97(a);

(*7*) The most recent structural stability assessment required at § 257.73(d); and

(*8*) The most recent safety factor assessment required at § 257.73(e).

(D) To demonstrate that the criteria in paragraph (f)(2)(iv) of this section have been met, the owner or operator must submit the closure plan required by § 257.102(b) and a narrative that specifies and justifies the date by which they intend to cease receipt of waste into the unit in order to meet the closure deadlines.

(vi) The owner or operator at all times bears responsibility for demonstrating qualification for authorization under this section. Failure to remain in compliance with any of the requirements of this subpart will result in the automatic loss of authorization under this section.

(vii) The owner or operator must comply with the recordkeeping requirements specified in § 257.105(i), the notification requirements specified in § 257.106(i), and the internet posting requirements in § 257.107(i).

(viii) Upon submission of the demonstration to the Administrator or the Participating State Director the owner or operator must prepare and place in the facility's operating record and on its publicly accessible CCR internet site a notification that is has submitted a demonstration along with a copy of the demonstration.

(ix) Upon receipt of a decision pursuant to paragraph (f)(3) of this section, the owner or operator must place a copy of the decision in the facility's operating record and on the facility's publicly accessible CCR internet site.

(x) The owner or operator must prepare an annual progress report documenting the continued lack of alternative capacity and the progress towards the closure of the CCR surface impoundment. The owner or operator has completed the progress report when the report has been placed in the facility's operating record as required by § 257.105(i)(20).

(3) *Process to Obtain Authorization.* (i) *Deadlines for Submission.* (A) The owner or operator must submit the demonstration required under paragraph (f)(1)(iv) of this section, for an alternative cease receipt of waste deadline for a CCR surface impoundment pursuant to paragraph (f)(1) of this section, to the Administrator or the Participating State Director for approval no later than November 30, 2020.

(B) An owner or operator may seek additional time beyond the time granted in the initial approval, in accordance with paragraph (f)(1)(vii) of this section, by submitting a new demonstration, as required under paragraph (f)(1)(iv) of this section, to the Administrator or the Participating State Director for approval, no later than fourteen days from determining that the cease receipt of waste deadline will not be met.

(C) The owner or operator must submit the demonstration required under paragraph (f)(2)(v) of this section to the Administrator for approval no later than November 30, 2020.

(ii) EPA will evaluate the demonstration and may request additional information to complete its review. Submission of a complete demonstration will toll the facility's deadline to cease receipt of waste until issuance of a decision under paragraph (f)(3)(iv) of this section. Incomplete submissions will not toll the facility's deadline and will be rejected without further process. All decisions issued under this paragraph or paragraph (f)(3)(iv) of this section will contain the facility's deadline to cease receipt of waste.

(iii) EPA will publish its proposed decision on a complete demonstration in a docket on *www.regulations.gov* for a 15-day comment period. If the demonstration is particularly complex, EPA will provide a comment period of 20 to 30 days.

(iv) After consideration of the comments, EPA will issue its decision on the alternative compliance deadline within four months of receiving a complete demonstration.

(4) *Transferring between site-specific alternatives.* An owner or operator authorized to continue operating a CCR surface impoundment under this section may at any time request authorization to continue operating the impoundment pursuant to another paragraph of subsection (f), by submitting the information in paragraph (f)(4)(i) or (ii) of this section.

(i) *Transfer from § 257.103(f)(1) to § 257.103(f)(2).* The owner or operator of a surface impoundment authorized to operate pursuant to paragraph (f)(1) of this section may request authorization to instead operate the surface impoundment in accordance with the requirements of paragraph (f)(2) of this section, by submitting a new demonstration that meets the requirements of paragraph (f)(2)(v) of this section to the Administrator or the Participating State Director. EPA will approve the request only upon determining that the criteria at paragraphs (f)(2)(i) through (iv) have been met.

(ii) *Transfer from § 257.103(f)(2) to § 257.103(f)(1).* The owner or operator of a surface impoundment authorized to operate pursuant to paragraph (f)(2) of this section may request authorization to instead operate the surface impoundment in accordance with the requirements of paragraph (f)(1) of this section, by submitting a new demonstration that meets the requirements of paragraph (f)(1)(iv) of this section to the Administrator or the Participating State Director. EPA will approve the request only upon determining that the criteria at paragraphs (f)(1)(i) through (iii) and (vi) of this section have been met.

(iii) The procedures in paragraph (f)(3) of this section will apply to all requests for transfer under this paragraph.

■ 9. Amend § 257.105 by adding paragraphs (i)(14) through (20) to read as follows:

§ 257.105 Recordkeeping requirements.

* * * * *

(i) * * *

(14) The notification of intent to comply with the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by § 257.103(f)(1)(ix)(A).

(15) The approved or denied demonstration for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by § 257.103(f)(1)(ix)(B).

(16) The notification for requesting additional time to the alternative cease receipt of waste deadline as required by § 257.103(f)(1)(ix)(C).

(17) The semi-annual progress reports for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by § 257.103(f)(1)(xi).

(18) The notification of intent to comply with the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.103(f)(2)(viii).

(19) The approved or denied demonstration for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.103(f)(2)(ix).

(20) The annual progress report for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.103(f)(2)(x).

* * * * *

■ 10. Amend § 257.106 by adding paragraphs (i)(14) through (20).

§ 257.106 Notification requirements.

* * * * *

(i) * * *

(14) Provide the notification of intent to comply with the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(14).

(15) Provide the approved or denied demonstration for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by as specified under § 257.105(i)(15).

(16) Provide the notification for requesting additional time to the alternative cease receipt of waste deadline as required by § 257.105(i)(16).

(17) The semi-annual progress reports for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(17).

(18) Provide the notification of intent to comply with the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as specified under § 257.105(i)(18).

(19) Provide the approved or denied demonstration for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(19).

(20) The annual progress report for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(20).

* * * * *

■ 11. Amend § 257.107 by revising paragraph (a) and adding paragraphs (i)(14) through (20) to read as follows:

§ 257.107 Publicly accessible internet site requirements.

(a) Each owner or operator of a CCR unit subject to the requirements of this subpart must maintain a publicly accessible internet site (CCR website) containing the information specified in this section. The owner or operator's website must be titled ''CCR Rule Compliance Data and Information.'' The website must ensure that all information required to be posted is immediately available to anyone visiting the site, without requiring any prerequisite, such as registration or a requirement to submit a document request. All required information must be clearly identifiable and must be able to be immediately printed and downloaded by anyone accessing the site. If the owner/operator changes the web address (*i.e.,* Uniform Resource Locator (URL)) at any point, they must notify EPA via the ''contact us'' form on EPA's CCR website and the state director within 14 days of making the change. The facility's CCR website must also have a ''contact us'' form or a specific email address posted on the website for the public to use to submit questions and issues relating to the availability of information on the website.

* * * * *

(i) * * *

(14) The notification of intent to comply with the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(14).

(15) The approved or denied demonstration for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as required by as specified under § 257.105(i)(15).

(16) The notification for requesting additional time to the alternative cease receipt of waste deadline as required by § 257.105(i)(16).

(17) The semi-annual progress reports for the site-specific alternative to initiation of closure due to development of alternative capacity infeasible as specified under § 257.105(i)(17).

(18) The notification of intent to comply with the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as specified under § 257.105(i)(18).

(19) The approved or denied demonstration for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(19).

(20) The annual progress report for the site-specific alternative to initiation of closure due to permanent cessation of a coal-fired boiler(s) by a date certain as required by § 257.105(i)(20).

* * * * *

[FR Doc. 2020–16872 Filed 8–27–20; 8:45 am]

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ATTACHMENT 3

United States
Environmental Protection
Agency

Office of
Solid Waste and
Emergency Response

EPA

DIRECTIVE NUMBER: 9200.4-17P

TITLE: Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites

APPROVAL DATE: April 21, 1999

EFFECTIVE DATE: April 21, 1999

ORIGINATING OFFICE: OSWER

[X] **FINAL**

[ ] **DRAFT**

STATUS:

REFERENCE (other documents):

OSWER OSWER OSWER
DIRECTIVE DIRECTIVE DIRECTIVE

EPA	United States Environmental Protection Agency Washington, DC 20460 **OSWER Directive Initiation Request**		1. Directive Number 9200.4-17P
2. Originator Information			
Name of Contact Person Hal White	Mail Code 5403G	Office OUST	Telephone Code (703)-603-7177

3. Title
Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites

4. Summary of Directive (include brief statement of purpose)
The purpose of this Directive is to clarify EPA's policy regarding the use of monitored natural attenuation (MNA) for the remediation of contaminated soil and groundwater at sites administered by EPA's Office of Solid Waste and Emergency Response (OSWER).

5. Keywords
natural attenuation, remediation, soil, groundwater, contamination

6a. Does This Directive Supersede Previous Directive(s)?
☒ No ☐ Yes What Directive (number, title)

b. Does It Supplement Previous Directive(s)?
☒ No ☐ Yes What Directive (number, title)

7. Draft Level
☒ A - Signed by AA/DAA ☐ B - Signed by Office Director ☐ C -For Review and Comment ☐ D - In Development

8. Document to be distributed to States by Headquarters? ☒ Yes ☐ No

This Requests Meets OSWER Directives System Format Standards	
9. Signature of Lead Office Directives Coordinator Shushona Clark	Date 3/29/99
10. Name and Title of Approving Official Timothy Fields, Jr., Acting AA/OSWER	Date 4/21/99

EPA Form 1315-17 (Rev 5-87) Previous editions are obsolete

OSWER DIRECTIVE OSWER DIRECTIVE OSWER DIRECTIVE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

APR 21 1999

OFFICE OF
SOLID WASTE AND EMERGENCY
RESPONSE

MEMORANDUM

SUBJECT: Final OSWER Directive "Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites" (OSWER Directive Number 9200.4-17P)

FROM: Elizabeth Cotsworth, Acting Director
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Stephen D. Luftig, Director
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James E. Woolford, Director
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TO: Addressees

Purpose

This memorandum accompanies a copy of the Final OSWER Directive regarding the use of monitored natural attenuation for the remediation of contaminated soil and groundwater at sites regulated under all Office of Solid Waste and Emergency Response (OSWER) programs. A draft Interim Final version of this Directive was released on December 1, 1997 for use, and for general public review and comment. In response to comments received on that draft, EPA has incorporated several changes in this final version dealing with topics such as contaminants of concern, cross-media transfer, plume migration, and remediation time frame.

Implementation

This Directive is being issued in Final form and should be used immediately as guidance for proposing, evaluating, and approving Monitored Natural Attenuation remedies. This Final Directive will be available from the Superfund, RCRA, and OUST dockets and through the RCRA, Superfund & EPCRA Hotline (800-424-9346 or 703-412-9810). The directive will also be available in electronic format from EPA's home page on the Internet (the address is http://www.epa.gov/swerust1/directiv/d9200417.htm).

Questions/Comments

If you need more information about the Directive please feel free to contact any of the appropriate EPA staff listed on the attachment.

Addressees: Federal Facility Forum
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OSWER Natural Attenuation Workgroup
RCRA Corrective Action EPA Regional and State Program Managers
State LUST Fund Administrators
State LUST Program Managers
UST/LUST Regional Program Managers
UST/LUST Regional Branch Chiefs
State Superfund Program Managers
Superfund Regional Policy Managers

attachment

Attachment
EPA Contacts

January 1999

If you have any questions regarding this policy, please first call the RCRA/Superfund Hotline at (800) 424-9346. If you require further assistance, please contact the appropriate staff from the list below:

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USE OF MONITORED NATURAL ATTENUATION AT SUPERFUND, RCRA CORRECTIVE ACTION, AND UNDERGROUND STORAGE TANK SITES

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Directive 9200.4-17P

April 1999

USE OF MONITORED NATURAL ATTENUATION AT SUPERFUND, RCRA CORRECTIVE ACTION, AND UNDERGROUND STORAGE TANK SITES

Contents

NOTICE: This document provides guidance to EPA and state staff. It also provides guidance to the public and to the regulated community on how EPA intends to exercise its discretion in implementing its regulations. The guidance is designed to implement national policy on these issues. The document does not, however, substitute for EPA's statutes or regulations, nor is it a regulation itself. Thus, it does not impose legally-binding requirements on EPA, States, or the regulated community, and may not apply to a particular situation based upon the circumstances. EPA may change this guidance in the future, as appropriate.

PURPOSE AND OVERVIEW

The purpose of this Directive is to clarify EPA's policy regarding the use of monitored natural attenuation (MNA) for the cleanup of contaminated soil and groundwater[1] in the Superfund, RCRA Corrective Action, and Underground Storage Tank programs. These programs are administered by EPA's Office of Solid Waste and Emergency Response (OSWER) which include the Office of Emergency and Remedial Response (OERR), Office of Solid Waste (OSW), Office of Underground Storage Tanks (OUST), and the Federal Facilities Restoration and Reuse Office (FFRRO). Statutory authority for these remediation programs is provided under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Resource Conservation and Recovery Act (RCRA).

EPA remains fully committed to its goals of protecting human health and the environment by remediating contaminated soils, restoring contaminated groundwaters to their beneficial uses, preventing migration of contaminant plumes[2], and protecting groundwaters and other environmental resources[3]. EPA advocates using the most appropriate technology for a given site. EPA does not consider MNA to be a "presumptive" or "default" remedy—it is merely one option that should be evaluated with other applicable remedies. EPA does not view MNA to be a "no action[4]" or "walk-away" approach, but rather

[1] Although this Directive does not address remediation of contaminated sediments, many of the same principles would be applicable. Fundamental issues such as having source control, developing lines of evidence, monitoring and contingency plans are also appropriate for sediments. However, the Agency is developing the policy and technical aspects for sediments, specifically.

[2] The outer limits of contaminant plumes are typically defined for each contaminant of concern based on chemical concentrations above which the overseeing regulatory authority has determined represent an actual or potential threat to human health or the environment.

[3] Environmental resources to be protected include groundwater, drinking water supplies, surface waters, ecosystems and other media (air, soil and sediments) that could be impacted by site contamination.

[4] For the Superfund program, Section 300.430(e)(6) of the National Contingency Plan (NCP) directs that a "no action alternative" (or no further action) "shall be developed" for all feasibility studies (USEPA, 1990a, p. 8849). The "no action" alternative can include monitoring but generally not other remedial actions, where such actions are defined in Section 300.5 of the NCP. In general, the "no action" alternative is selected when there is no current or potential threat to human health or the environment or when CERCLA exclusions preclude taking an action (USEPA, 1991a). As explained in this Directive, a remedial alternative that relies on monitored natural attenuation to attain site-specific remediation objectives is **not** the same as the "no action" alternative.

considers it to be an alternative means of achieving remediation objectives[5] that may be appropriate for specific, well-documented site circumstances where its use meets the applicable statutory and regulatory requirements. As there is often a variety of methods available for achieving remediation objectives at any given site, MNA may be evaluated and compared to other viable remediation methods (including innovative technologies) during the study phases leading to the selection of a remedy. As with any other remedial alternative, MNA should be selected only where it meets all relevant remedy selection criteria, and where it will meet site remediation objectives within a timeframe that is reasonable compared to that offered by other methods. In the majority of cases where MNA is proposed as a remedy, its use may be appropriate as one component of the total remedy, that is, either in conjunction with active remediation or as a follow-up measure. MNA should be used very cautiously as the sole remedy at contaminated sites. Furthermore, the availability of MNA as a potential remediation tool does not imply any lessening of EPA's longstanding commitment to pollution prevention. Waste minimization, pollution prevention programs, and minimal technical requirements to prevent and detect releases remain fundamental parts of EPA waste management and remediation programs.

Use of MNA does not signify a change in OSWER's remediation objectives. These objectives (discussed in greater detail under the heading "Implementation") include control of source materials[6], prevention of plume migration, and restoration of contaminated groundwaters, where appropriate. Thus, EPA expects that source control measures (see section on "Remediation of Sources") will be evaluated for all sites under consideration for any proposed remedy. As with other remediation methods, selection of MNA as a remediation method should be supported by detailed site-specific information that demonstrates the efficacy of this remediation approach. In addition, the progress of MNA toward a site's remediation objectives should be carefully monitored and compared with expectations. Where MNA's ability to meet these expectations is uncertain and based predominantly on predictive analyses, decision makers should incorporate contingency measures into the remedy.

The scientific understanding of natural attenuation processes continues to evolve. EPA recognizes that significant advances have been made in recent years, but there is still a great deal to be learned regarding the mechanisms governing natural attenuation processes and their ability to address different types of contamination problems. Therefore, while EPA believes MNA may

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[5] In this Directive, remediation objectives are the overall objectives that remedial actions are intended to accomplish and are not the same as chemical-specific cleanup levels. Remediation objectives could include preventing exposure to contaminants, preventing further migration of contaminants from source areas, preventing further migration of the groundwater contaminant plume, reducing contamination in soil or groundwater to specified cleanup levels appropriate for current or potential future uses, or other objectives. The term "remediation" as used in this Directive is not limited to "remedial actions" defined in CERCLA §101(24), and includes CERCLA "removal actions", for example.

[6] "**Source material** is defined as material that includes or contains hazardous substances, pollutants or contaminants that act as a reservoir [either stationary or mobile] for migration of contamination to the ground water, to surface water, to air, [or other environmental media,] or acts as a source for direct exposure. Contaminated ground water generally is not considered to be a source material although non-aqueous phase liquids (NAPLS [occurring either as residual- or free-phase]) may be viewed as source materials." (USEPA, 1991b).

be used where circumstances are appropriate, it should be used with caution commensurate with the uncertainties associated with the particular application. Furthermore, largely due to the uncertainty associated with the potential effectiveness of MNA to meet remediation objectives that are protective of human health and the environment, EPA expects that **source control and long-term performance monitoring will be fundamental components of any MNA remedy**.

This Directive is a policy document and as such is not intended to provide detailed technical guidance on evaluating MNA remedies. EPA recognizes that at present there are relatively few EPA guidance documents concerning appropriate implementation of MNA remedies. Chapter IX of OUST's alternative cleanup technologies manual (USEPA, 1995a) addresses the use of natural attenuation at leaking UST sites. The Office of Research and Development (ORD) has recently published a protocol for evaluating MNA at chlorinated solvent sites (USEPA, 1998a). Additional technical resource documents for evaluating MNA in groundwater, soils, and sediments are being developed by ORD. Supporting technical information regarding the evaluation of MNA as a remediation alternative is available from a variety of other sources, including those listed at the end of this Directive. "References Cited" lists those EPA documents that were specifically cited within this Directive. The list of "Additional References" includes documents produced by EPA as well as non-EPA entities. Finally, "Other Sources of Information" lists sites on the World Wide Web (Internet) where additional information can be obtained. Non-EPA documents may provide regional and state site managers, as well as the regulated community, with useful technical information. However, these non-EPA guidances are not officially endorsed by EPA, EPA does not necessarily agree with all their conclusions, and all parties involved should clearly understand that such guidances do not in any way replace current EPA or OSWER guidances or policies addressing the remedy selection process in the Superfund, RCRA, or UST programs.

BACKGROUND

The term "monitored natural attenuation", as used in this Directive, refers to the reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The "natural attenuation processes" that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These *in-situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants. When relying on natural attenuation processes for site remediation, EPA prefers those processes that degrade or destroy contaminants. Also, EPA generally expects that MNA will only be appropriate for sites that have a low potential for contaminant migration. Additional discussion of criteria for "Sites Where Monitored Natural Attenuation May Be Appropriate" may be found later in this Directive. Other terms associated with natural attenuation in the literature include "intrinsic remediation", "intrinsic bioremediation", "passive bioremediation", "natural recovery", and "natural assimilation". While some of these terms are synonymous with "natural attenuation," others refer strictly to biological processes, excluding chemical and physical processes. Therefore, it is recommended that for clarity and consistency, the term "monitored natural attenuation" be used throughout OSWER remediation programs unless a specific process (*e.g.,* reductive dehalogenation) is being referenced.

Natural attenuation processes are typically occurring at all sites, but to varying degrees of effectiveness depending on the types and concentrations of contaminants present and the physical, chemical, and biological characteristics of the soil and groundwater. Natural attenuation processes may reduce the potential risk posed by site contaminants in three ways:

(1) Transformation of contaminant(s) to a less toxic form through destructive processes such as biodegradation or abiotic transformations;

(2) Reduction of contaminant concentrations whereby potential exposure levels may be reduced; and

(3) Reduction of contaminant mobility and bioavailability through sorption onto the soil or rock matrix.

Where conditions are favorable, natural attenuation processes may reduce contaminant mass or concentration at sufficiently rapid rates to be integrated into a site's soil or groundwater remedy. Following source control measures, natural attenuation may be sufficiently effective to achieve remediation objectives at some sites without the aid of other (active) remedial measures. Typically, however, MNA will be used in conjunction with active remediation measures. For example, active remedial measures could be applied in areas with high concentrations of contaminants while MNA is used for low concentration areas; or MNA could be used as a follow-up to active remedial measures. EPA also encourages the consideration of innovative technologies for source control or "active" components of the remedy, which may offer greater confidence and reduced remediation time frames at modest additional cost.

While MNA is often dubbed "passive" remediation because natural attenuation processes occur without human intervention, its use at a site does **not** preclude the use of "active" remediation or the application of enhancers of biological activity (*e.g.,* electron acceptors, nutrients, and electron donors). However, by definition, a remedy that includes the introduction of an enhancer of any type is no longer considered to be "natural" attenuation. Use of MNA does not imply that activities (and costs) associated with investigating the site or selecting the remedy (*e.g.,* site characterization, risk assessment, comparison of remedial alternatives, performance monitoring, and contingency measures) have been eliminated. These elements of the investigation and cleanup must still be addressed as required under the particular OSWER program, regardless of the remedial approach selected.

Contaminants of Concern

It is common practice in conducting remedial actions to focus on the most obvious contaminants of concern, but other contaminants may also be of significant concern in the context of MNA remedies. In general, since engineering controls are not used to control plume migration in an MNA remedy, decision makers need to ensure that MNA is appropriate to address **all contaminants** that represent an actual or potential threat to human health or the environment. Several examples are provided below to illustrate the need to assess both the obvious as well as the less obvious contaminants of concern when evaluating an MNA remedial option.

- Mixtures of contaminants released into the environment often include some which may be amenable to MNA, and others which are not addressed sufficiently by natural attenuation processes to achieve remediation objectives. For example, Benzene, Toluene, Ethylbenzene and Xylenes (BTEX) associated with gasoline have been shown in many circumstances to be effectively remediated by natural attenuation processes. However, a common additive to gasoline (*i.e.*, methyl tertiary-butyl ether [MTBE]) has been found to migrate large distances and threaten downgradient water supplies at the same sites where the BTEX component of a plume has either stabilized or diminished due to natural attenuation. In general, compounds that tend not to degrade readily in the subsurface (*e.g.*, MTBE and 1,4-dioxane) and that represent an actual or potential threat should be assessed when evaluating the appropriateness of MNA remedies.

- Analyses of contaminated media often report chemicals which are identified with a high degree of certainty, as well other chemicals labeled as "tentatively identified compounds" (TICs). It is often assumed that TICs will be addressed by a remedial action along with the primary contaminants of concern. This may be a reasonable assumption for an active remediation system (*e.g.*, pump and treat) which is capturing all contaminated groundwater, but might not be acceptable for an MNA remedy that is relying on natural processes to prevent contaminant migration. Where MNA is being proposed for sites with TICs, it may be prudent to identify the TICs and evaluate whether they too will be sufficiently mitigated by MNA.

- At some sites the same geochemical conditions and processes that lead to biodegradation of chlorinated solvents and petroleum hydrocarbons can chemically transform naturally occurring minerals (*e.g.*, arsenic and manganese compounds) in the aquifer matrix to forms that are more mobile and/or more toxic than the original materials (USEPA, 1998). A comprehensive assessment of an MNA remedial option should include evaluation of whether naturally occurring metals will become contaminants of concern.

Addressing the above concerns does not necessarily require sampling and analysis of extensive lists of parameters at every monitoring location in all situations. The location and number of samples collected and analyzed for this purpose should be determined on a site-specific basis to ensure adequate characterization and protection of human health and the environment.

Transformation Products

It also should be noted that some natural attenuation processes may result in the creation of transformation products[7] that are more toxic and/or mobile than the parent contaminant (*e.g.*, degradation of trichloroethylene to vinyl chloride). The potential for creation of toxic transformation products is more likely to occur at non-petroleum release sites (*e.g.*, chlorinated solvents or other volatile organic spill sites) and should be evaluated to determine if implementation of a MNA remedy is appropriate and protective in the long term.

Cross-Media Transfer

Natural attenuation processes may often result in transfer of some contaminants from one medium to another (*e.g.*, from soil to groundwater, from soil to air or surface water, and from groundwater to surface water). Processes that result in degradation of contaminants are preferable to those which rely predominantly on the transfer of contamination from one medium to another. MNA remedies involving cross-media transfer of contamination should include a site-specific evaluation of the potential risk posed by the contaminant(s) once transferred to a particular medium. Additionally, long-term monitoring should address the media to which contaminants are being transferred.

[7] The term “transformation products” in the Directive includes intermediate products resulting from biotic or abiotic processes (*e.g.*, TCE, DCE, vinyl chloride), decay chain daughter products from radioactive decay, and inorganic elements that become methylated compounds (*e.g.*, methyl mercury) in soil or sediment. Some transformation products are quickly transformed to other products while others are longer lived.

Petroleum-Related Contaminants

Natural attenuation processes, particularly biological degradation, are currently best documented at petroleum fuel spill sites. Under appropriate field conditions, the regulated compounds benzene, toluene, ethylbenzene, and xylene (BTEX) may naturally degrade through microbial activity and ultimately produce non-toxic end products (*e.g.*, carbon dioxide and water). Where microbial activity is sufficiently rapid, the dissolved BTEX contaminant plume may stabilize (*i.e.*, stop expanding), and contaminant concentrations in both groundwater and soil may eventually decrease to levels below regulatory standards. Following degradation of a dissolved BTEX plume, a residue consisting of heavier petroleum hydrocarbons of relatively low solubility and volatility will typically be left behind in the original source (spill) area. Although this residual contamination may have relatively low potential for further migration, it still may pose a threat to human health or the environment either from direct contact with soils in the source area or by continuing to slowly leach contaminants to groundwater. For these reasons, MNA alone is generally not sufficient to remediate petroleum release sites. Implementation of source control measures in conjunction with MNA is almost always necessary. Other controls (*e.g.*, institutional controls[8]), in accordance with applicable state and federal requirements, may also be necessary to ensure protection of human health and the environment.

Chlorinated Solvents

Chlorinated solvents[9], such as trichloroethylene, represent another class of common contaminants. These compounds are more dense than water and are referred to as DNAPLs (dense non-aqueous phase liquids). Recent research has identified some of the mechanisms potentially responsible for degrading these solvents, furthering the development of methods for estimating biodegradation rates of these chlorinated compounds. However, the hydrologic and geochemical conditions favoring significant biodegradation of chlorinated solvents sufficient to achieve remediation objectives within a reasonable timeframe are anticipated to occur only in limited circumstances. DNAPLs tend to sink through the groundwater column toward the bottom of the aquifer. However, they can also occur as mixtures with other less dense contaminants. Because of the varied nature and distribution of chlorinated compounds, they are typically difficult to locate, delineate, and remediate even with active measures. In the subsurface, chlorinated solvents represent source materials that can continue to contaminate groundwater for decades or longer. Cleanup of solvent spills is also complicated by the fact that a typical spill includes

[8] The term "institutional controls" refers to non-engineering measures—usually, but not always, legal controls—intended to affect human activities in such a way as to prevent or reduce exposure to hazardous substances. Examples of institutional controls cited in the National Contingency Plan (USEPA, 1990a, p.8706) include land and resource (*e.g.*, water) use and deed restrictions, well-drilling prohibitions, building permits, well use advisories, and deed notices.

[9] Chlorinated solvents are only one type of halogenated compound. Chlorinated solvents are specifically referenced in this Directive because they are commonly found at contaminated sites. The discussion in this Directive regarding chlorinated solvents may also apply to other halogenated compounds to be remediated.

multiple contaminants, including some that tend not to degrade readily in the subsurface.[10] Extremely long dissolved solvent plumes have been documented that may be due to the existence of subsurface conditions that are not conducive to natural attenuation.

Inorganics

MNA may, under certain conditions (*e.g.*, through sorption or oxidation-reduction reactions), effectively reduce the dissolved concentrations and/or toxic forms of inorganic contaminants in groundwater and soil. Both metals and non-metals (including radionuclides) may be attenuated by sorption[11] reactions such as precipitation, adsorption on the surfaces of soil minerals, absorption into the matrix of soil minerals, or partitioning into organic matter. Oxidation-reduction (redox) reactions can transform the valence states of some inorganic contaminants to less soluble and thus less mobile forms (*e.g.*, hexavalent uranium to tetravalent uranium) and/or to less toxic forms (*e.g.*, hexavalent chromium to trivalent chromium). Sorption and redox reactions are the dominant mechanisms responsible for the reduction of mobility, toxicity, or bioavailability of inorganic contaminants. It is necessary to know what specific mechanism (type of sorption or redox reaction) is responsible for the attenuation of inorganics so that the stability of the mechanism can be evaluated. For example, precipitation reactions and absorption into a soil's solid structure (*e.g.*, cesium into specific clay minerals) are generally stable, whereas surface adsorption (*e.g.*, uranium on iron-oxide minerals) and organic partitioning (complexation reactions) are more reversible. Complexation of metals or radionuclides with carrier (chelating) agents (*e.g.*, trivalent chromium with EDTA) may increase their concentrations in water and thus enhance their mobility. Changes in a contaminant's concentration, pH, redox potential, and chemical speciation may reduce a contaminant's stability at a site and release it into the environment. Determining the existence, and demonstrating the irreversibility, of these mechanisms is important to show that a MNA remedy is sufficiently protective.

In addition to sorption and redox reactions, radionuclides exhibit radioactive decay and, for some, a parent-daughter radioactive decay series. For example, the dominant attenuating mechanism of tritium (a radioactive isotopic form of hydrogen with a short half-life) is radioactive decay rather than sorption. Although tritium does not generate radioactive daughter products, those generated by some radionulides (*e.g.*, Am-241 and Np-237 from Pu-241) may be more toxic, have longer half-lives, and/or be more mobile than the parent in the decay series. Also, it is

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[10] For example, 1,4-dioxane, which is used as a stabilizer for some chlorinated solvents, is more highly toxic, less likely to sorb to aquifer solids, and less biodegradable than some other solvent constituents under the same environmental conditions.

[11] When a contaminant is associated with a solid phase, it is usually not known if the contaminant is precipitated as a three-dimensional molecular coating on the surface of the solid, adsorbed onto the surface of the solid, absorbed into the structure of the solid, or partitioned into organic matter. "Sorption" will be used in this Directive to describe, in a generic sense (*i.e.*, without regard to the precise mechanism) the partitioning of aqueous phase constituents to a solid phase.

important that the near surface or surface soil pathways be carefully evaluated and eliminated as potential sources of external direct radiation exposure[12].

Inorganic contaminants persist in the subsurface because, except for radioactive decay, they are not degraded by the other natural attenuation processes. Often, however, they may exist in forms that have low mobility, toxicity, or bioavailability such that they pose a relatively low level of risk. Therefore, natural attenuation of inorganic contaminants is most applicable to sites where immobilization or radioactive decay is demonstrated to be in effect and the process/mechanism is irreversible.

Advantages and Disadvantages of Monitored Natural Attenuation

MNA has several potential advantages and disadvantages, and the factors listed below should be carefully considered during site characterization and evaluation of remediation alternatives before selecting MNA as the remedial alternative. **Potential advantages** of MNA include:

- As with any *in situ* process, generation of lesser volume of remediation wastes, reduced potential for cross-media transfer of contaminants commonly associated with *ex situ* treatment, and reduced risk of human exposure to contaminants, contaminated media, and other hazards, and reduced disturbances to ecological receptors;
- Some natural attenuation processes may result in *in-situ* destruction of contaminants;
- Less intrusion as few surface structures are required;
- Potential for application to all or part of a given site, depending on site conditions and remediation objectives;
- Use in conjunction with, or as a follow-up to, other (active) remedial measures; and
- Potentially lower overall remediation costs than those associated with active remediation.

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[12] External direct radiation exposure refers to the penetrating radiation (*i.e.,* primarily gamma radiation and x-rays) that may be an important exposure pathway for certain radionuclides in near surface soils. Unlike chemicals, radionuclides can have deleterious effects on humans without being taken into or brought in contact with the body due to high energy particles emitted from near surface soils. Even though the radionuclides that emit penetrating radiation may be immobilized due to sorption or redox reactions, the resulting contaminated near surface soil may not be a candidate for a MNA remedy as a result of this exposure risk.

The **potential disadvantages** of MNA include:

- Longer time frames may be required to achieve remediation objectives, compared to active remediation measures at a given site;

- Site characterization is expected to be more complex and costly;

- Toxicity and/or mobility of transformation products may exceed that of the parent compound;

- Long-term performance monitoring will generally be more extensive and for a longer time;

- Institutional controls may be necessary to ensure long term protectiveness;

- Potential exists for continued contamination migration, and/or cross-media transfer of contaminants;

- Hydrologic and geochemical conditions amenable to natural attenuation may change over time and could result in renewed mobility of previously stabilized contaminants (or naturally occurring metals), adversely impacting remedial effectiveness; and

- More extensive education and outreach efforts may be required in order to gain public acceptance of MNA.

IMPLEMENTATION

The use of MNA is not new in OSWER programs. For example, in the Superfund program, use of natural attenuation as an element in a site's groundwater remedy is discussed in "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites" (USEPA, 1988a). Use of MNA in OSWER programs has slowly increased over time with greater program experience and scientific understanding of the processes involved. Recent advances in the scientific understanding of the processes contributing to natural attenuation have resulted in a heightened interest in this approach as a potential means of achieving remediation objectives for soil and groundwater. However, EPA expects that reliance on MNA as the sole remedy will only be appropriate at relatively few contaminated sites. This Directive is intended to clarify OSWER program policies regarding the use of MNA and ensure that MNA remedies are selected and implemented appropriately. Topics addressed include the role of MNA in OSWER remediation programs, site characterization, the types of sites where MNA may be appropriate, reasonable remediation timeframes, source control, performance monitoring, and contingency remedies where MNA will be employed.

Role of Monitored Natural Attenuation in OSWER Remediation Programs

Under OSWER programs, remedies selected for contaminated media (such as contaminated soil and groundwater) must protect human health and the environment. Remedies may achieve this level of protection using a variety of methods, including treatment, containment, engineering controls, and other means identified during the remedy selection process.

The regulatory and policy frameworks for corrective actions under the UST, RCRA, and Superfund programs have been established to implement their respective statutory mandates and to promote the selection of technically defensible, nationally consistent, and cost effective solutions for the cleanup of contaminated media. EPA recognizes that MNA may be an appropriate remediation option for contaminated soil and groundwater under certain circumstances. However, determining the appropriate mix of remediation methods at a given site, including when and how to use MNA, can be a complex process. Therefore, MNA should be carefully evaluated along with other viable remedial approaches or technologies (including innovative technologies) within the applicable remedy selection framework. **MNA should not be considered a default or presumptive remedy at any contaminated site.**

Each OSWER program has developed regulations and policies to address the particular types of contaminants and facilities within its purview[13]. Although there are differences among

[13] Existing program guidance and policy regarding MNA can be obtained from the following sources: For Superfund, see "Guidance on Remedial Actions for Contaminated Groundwater at Superfund Sites," (USEPA, 1988a; pp. 5-7 and 5-8); the Preamble to the 1990 National Contingency Plan (USEPA, 1990a, pp.8733-34); and "Presumptive Response Strategy and Ex-Situ Treatment Technologies for Contaminated Ground Water at CERCLA Sites, Final Guidance" (USEPA, 1996a; p. 18). For the RCRA program, see the Subpart S Proposed Rule (USEPA, 1990b, pp.30825 and 30829), and the Advance Notice of Proposed Rulemaking (USEPA, 1996b, pp.19451-52). For the UST program, refer to Chapter IX in "How to Evaluate Alternative Cleanup Technologies for Underground Storage Tank Sites: A Guide for Corrective Action Plan Reviewers;" (USEPA, 1995a).

these programs, they share several key principles that should generally be considered during selection of remedial measures, including:

- Source control measures should use treatment to address "principal threat" wastes (or products) wherever practicable, and engineering controls such as containment for waste (or products) that pose a relatively low long-term threat, or where treatment is impracticable.[14]

- Contaminated groundwaters should be returned to "their beneficial uses[15] wherever practicable, within a timeframe that is reasonable given the particular circumstances of the site." When restoration of groundwater is not practicable, EPA "expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction."[16]

- Contaminated soil should be remediated to achieve an acceptable level of risk to human and environmental receptors, and to prevent any transfer of contaminants to other media (*e.g.*, surface or groundwater, air, sediments) that would result in an unacceptable risk or exceed required cleanup levels.

- Remedial actions in general should include opportunity(ies) for public involvement that serve to both educate interested parties and to solicit feedback concerning the decision making process.

Consideration or selection of MNA as a remedy or remedy component does not in any way change or displace these (or other) remedy selection principles. Nor does use of MNA

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[14] Principal threat wastes are those **source materials** that are "highly toxic or highly mobile that generally cannot be reliably contained or would present a significant risk to human health or the environment should exposure occur. They include liquids and other highly mobile materials (*e.g.*, solvents) or materials having high concentrations of toxic compounds." (USEPA, 1991b). Low level threat wastes are "source materials that generally can be reliably contained and that would present only a low risk in the event of release." (USEPA, 1991b). Since contaminated groundwater is not source material, it is neither a principal nor a low-level threat waste.

[15] **Beneficial uses** of groundwater could include uses for which water quality standards have been promulgated, (*e.g.*, drinking water supply, discharge to surface water), or where groundwater serves as a source of recharge to either surface water or adjacent aquifers, or other uses. These or other types of beneficial uses may be identified as part of a Comprehensive State Groundwater Protection Program (CSGWPP). For more information on CSGWPPs, see USEPA, 1992a and USEPA, 1997b, or contact your state implementing agency.

[16] This is a general expectation for remedy selection in the Superfund program, as stated in §300.430 (a)(1)(iii)(F) of the National Contingency Plan (USEPA, 1990a, p.8846). The NCP Preamble also specifies that cleanup levels appropriate for the expected beneficial use (*e.g.*, MCLs for drinking water) "should generally be attained throughout the contaminated plume, or at and beyond the edge of the waste management area when waste is left in place" (USEPA, 1990a, p.8713). The RCRA Corrective Action program has similar expectations (see USEPA, 1996b, pp.19448-19450).

diminish EPA's or the regulated party's responsibility to achieve protectiveness or to satisfy long-term site remediation objectives. EPA expects that **MNA will be an appropriate remediation method only where its use will be protective of human health and the environment and it will be capable of achieving site-specific remediation objectives within a timeframe that is reasonable compared to other alternatives.** The effectiveness of MNA in both near-term and long-term timeframes should be demonstrated to EPA (or other overseeing regulatory authority) through: 1) sound technical analyses which provide confidence in natural attenuation's ability to achieve remediation objectives; 2) performance monitoring; and 3) contingency (or backup) remedies where appropriate. **In summary, use of MNA does not imply that EPA or the responsible parties are "walking away" from the cleanup or financial responsibility at a site.**

It also should be emphasized that the selection of MNA as a remedy does **not** imply that active remediation measures are infeasible, or are "technically impracticable" from an engineering perspective. Technical impracticability (TI) determinations are used to justify a departure from cleanup levels that would otherwise be required at a Superfund site or RCRA facility based on the inability to achieve such cleanup levels using available remedial technologies (USEPA, 1993a). Such a TI determination does not imply that there will be no active remediation at the site, nor that MNA will be used at the site. Rather, such a TI determination simply indicates that the cleanup levels and objectives which would otherwise be required cannot practicably be attained using available remediation technologies. In such cases, an alternative cleanup strategy that is fully protective of human health and the environment must be identified. Such an alternative strategy may still include engineered remediation components, such as recovery of free phase NAPLs and containment of residual contaminants, in addition to approaches intended to restore some portion of the contaminated groundwater to beneficial uses. Several remedial approaches could be appropriate to address the dissolved plume, one of which could be MNA under suitable conditions. However, the evaluation of natural attenuation processes and the decision to rely upon MNA for the dissolved plume should be distinct from the recognition that restoration of a portion of the plume is technically impracticable (*i.e.*, MNA should **not** be viewed as a direct or presumptive outcome of a technical impracticability determination.)

Demonstrating the Efficacy of Natural Attenuation Through Site Characterization

Decisions to employ MNA as a remedy or remedy component should be thoroughly and adequately supported with site-specific characterization data and analysis. In general, the level of site characterization necessary to support a comprehensive evaluation of MNA is more detailed than that needed to support active remediation. Site characterizations for natural attenuation generally warrant a quantitative understanding of source mass; groundwater flow (including preferential pathways); contaminant phase distribution and partitioning between soil, groundwater, and soil gas; rates of biological and non-biological transformation; and an understanding of how all of these factors are likely to vary with time. This information is generally necessary since contaminant behavior is governed by dynamic processes which must be well understood before MNA can be appropriately applied at a site. Demonstrating the efficacy of

MNA may require analytical or numerical simulation of complex attenuation processes. Such analyses, which are critical to demonstrate natural attenuation's ability to meet remediation objectives, generally require a detailed conceptual site model[17] as a foundation.

EPA recommends the use of conceptual site models to integrate data and guide both investigative and remedial actions. However, program implementors should be cautious and collect sufficient field data to test conceptual hypotheses and not "force-fit" site data into a pre-conceived, and possibly inaccurate, conceptual representation. For example, a common mechanism for transport of contaminants is advection-dispersion, by which contaminants dissolved in groundwater migrate away from a source area. An alternative mechanism of contaminant transport (*i.e.*, NAPL migration) could be associated with a relatively large release of NAPL into the subsurface such that the NAPL itself has the potential to migrate significant distances along preferential pathways. Since NAPL migration pathways are often difficult to locate in the subsurface, one may incorrectly conclude that only the dissolved transport model applies to a site, when a combined NAPL and dissolved phase migration model would be more accurate. Applying a wrong conceptual model, in the context of evaluating an MNA (or any other) remedy, could result in a deficient site characterization (*e.g.*, did not use tools and approaches designed to find NAPLs or NAPL migration pathways), and inappropriate selection of an MNA remedy where long-term sources were not identified nor considered during remedy selection. NAPL present as either free- or residual phase represents a significant mass of contamination that will serve as a long-term source. Sources of contamination are more appropriately addressed by engineered removal, treatment or containment technologies, as discussed later in this Directive. Where the sources of contamination have been controlled, dissolved plumes may be amenable to MNA because of the relatively small mass of contaminants present in the plume.

Site characterization should include collecting data to define (in three spatial dimensions over time) the nature and distribution of contaminants of concern and contaminant sources as well as potential impacts on receptors (see "Background" section for further discussion pertaining to "Contaminants of Concern"). However, where MNA will be considered as a remedial approach, certain aspects of site characterization may require more detail or additional elements. For

[17] A conceptual site model (CSM) is a three-dimensional representation that conveys what is known or suspected about contamination sources, release mechanisms, and the transport and fate of those contaminants. The conceptual model provides the basis for assessing potential remedial technologies at the site. "Conceptual site model" is **not** synonymous with "computer model"; however, a computer model may be helpful for understanding and visualizing current site conditions or for predictive simulations of potential future conditions. Computer models, which simulate site processes mathematically, should in turn be based upon sound conceptual site models to provide meaningful information. Computer models typically require a lot of data, and the quality of the output from computer models is directly related to the quality of the input data. Because of the complexity of natural systems, models necessarily rely on simplifying assumptions that may or may not accurately represent the dynamics of the natural system. Calibration and sensitivity analyses are important steps in appropriate use of models. Even so, the results of computer models should be carefully interpreted and continuously verified with adequate field data. Numerous EPA references on models are listed in the "Additional References" section at the end of this Directive.

example, to assess the contributions of sorption, dilution, and dispersion to natural attenuation of contaminated groundwater, a very detailed understanding of aquifer hydraulics, recharge and discharge areas and volumes, and chemical properties is necessary. Where biodegradation will be assessed, characterization also should include evaluation of the nutrients and electron donors and acceptors present in the groundwater, the concentrations of co-metabolites and metabolic by-products, and perhaps specific analyses to identify the microbial populations present. The findings of these, and any other analyses pertinent to characterizing natural attenuation processes, should be incorporated into the conceptual model of contaminant fate and transport developed for the site.

MNA may not be appropriate as a remedial option at many sites for technological or economic reasons. For example, in some complex geologic systems, technological limitations may preclude adequate monitoring of a natural attenuation remedy to ensure with a high degree of confidence that potential receptors will not be impacted. This situation typically occurs in many karstic, structured, and/or fractured rock aquifers where groundwater moves preferentially through discrete pathways (*e.g.*, solution channels, fractures, joints, foliations). The direction of groundwater flow through such heterogeneous (and often anisotropic) materials can not be predicted directly from the hydraulic gradient, and existing techniques may not be capable of identifying the pathway along which contaminated groundwater moves through the subsurface. MNA will not generally be appropriate where site complexities preclude adequate monitoring. In some other situations where it may be technically feasible to monitor the progress of natural attenuation, the cost of site characterization and long-term monitoring required for the implementation of MNA may be higher than the cost of other remedial alternatives. Under such circumstances, MNA may not be less costly than other alternatives.

A related consideration for site characterization is how other remedial activities at the site could affect natural attenuation. For example, the capping of contaminated soil could alter both the type of contaminants leached to groundwater, as well as their rate of transport and degradation. Another example could be where there is co-mingled petroleum and chlorinated solvent contamination. In such cases, degradation of the chlorinated solvents is achieved, in part, through the action of microbes that derive their energy from the carbon in the petroleum. Recovery of the petroleum removes some of the source of food for these microbes and the rate of degradation of the chlorinated solvents is decreased. Therefore, the impacts of any ongoing or proposed remedial actions should be factored into the analysis of the effectiveness of MNA.

Once site characterization data have been collected and a conceptual model developed, the next step is to evaluate the potential efficacy of MNA as a remedial alternative. This involves collection of site-specific data sufficient to estimate with an acceptable level of confidence both the rate of attenuation processes and the anticipated time required to achieve remediation objectives. A three-tiered approach to such an evaluation is becoming more widely practiced and accepted. In this approach, successively more detailed information is collected as necessary to provide a specified level of confidence on the estimates of attenuation rates and remediation timeframe. These three tiers of site-specific information, or “lines of evidence”, are:

(1) Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend[18] of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. (In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. In the case of inorganic contaminants, the primary attenuating mechanism should also be understood.)

(2) Hydrogeologic and geochemical data that can be used to demonstrate **indirectly** the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.

(3) Data from field or microcosm studies (conducted in or with actual contaminated site media) which **directly** demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

Unless EPA or the overseeing regulatory authority determines that historical data (Number 1 above) are of sufficient quality and duration to support a decision to use MNA, data characterizing the nature and rates of natural attenuation processes at the site (Number 2 above) should be provided. Where the latter are also inadequate or inconclusive, data from microcosm studies (Number 3 above) may also be necessary. In general, more supporting information may be required to demonstrate the efficacy of MNA at those sites with contaminants which do not readily degrade through biological processes (*e.g.*, most non-petroleum compounds, inorganics), or that transform into more toxic and/or mobile forms than the parent contaminant, or where monitoring has been performed for a relatively short period of time. The amount and type of information needed for such a demonstration will depend upon a number of site-specific factors, such as the size and nature of the contamination problem, the proximity of receptors and the potential risk to those receptors, and other characteristics of the environmental setting (*e.g.*, hydrogeology, ground cover, climatic conditions).

Note that those parties responsible for site characterization and remediation should ensure that all data and analyses needed to demonstrate the efficacy of MNA are collected and evaluated by capable technical specialists with expertise in the relevant sciences. Furthermore, EPA expects that documenting the level of confidence on attenuation rates will provide more technically defensible predictions of remedial timeframes and form the basis for more effective performance monitoring programs.

[18] For guidance on statistical analysis of environmental data, please see USEPA, 1989, USEPA, 1993b, USEPA, 1993d, and Gilbert, 1987, listed in the “References Cited” section at the end of this Directive.

Sites Where Monitored Natural Attenuation May Be Appropriate

MNA is appropriate as a remedial approach where it can be demonstrated capable of achieving a site's remediation objectives within a timeframe that is reasonable compared to that offered by other methods and where it meets the applicable remedy selection criteria (if any) for the particular OSWER program. **EPA expects that MNA will be most appropriate when used in conjunction with other remediation measures (*e.g.*, source control, groundwater extraction), or as a follow-up to active remediation measures that have already been implemented**.

In determining whether MNA is an appropriate remedy for soil or groundwater at a given site, EPA or other regulatory authorities should consider the following:

- Whether the contaminants present in soil or groundwater can be effectively remediated by natural attenuation processes;
- Whether or not the contaminant plume is stable and the potential for the environmental conditions that influence plume stability to change over time;
- Whether human health, drinking water supplies, other groundwaters, surface waters, ecosystems, sediments, air, or other environmental resources could be adversely impacted as a consequence of selecting MNA as the remediation option;
- Current and projected demand for the affected resource over the time period that the remedy will remain in effect;
- Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources;
- Whether the estimated timeframe of remediation is reasonable (see section on "Reasonable Timeframe for Remediation") compared to timeframes required for other more active methods (including the anticipated

effectiveness of various remedial approaches on different portions of the contaminated soil and/or groundwater);

- The nature and distribution of sources of contamination and whether these sources have been, or can be, adequately controlled;

- Whether the resulting transformation products present a greater risk, due to increased toxicity and/or mobility, than do the parent contaminants;

- The impact of existing and proposed active remediation measures upon the MNA component of the remedy, or the impact of remediation measures or other operations/activities (*e.g.*, pumping wells) in close proximity to the site; and

- Whether reliable site-specific mechanisms for implementing institutional controls (*e.g.*, zoning ordinances) are available, and if an institution responsible for their monitoring and enforcement can be identified.

Of the above factors, the most important considerations regarding the suitability of MNA as a remedy include: whether the contaminants are likely to be effectively addressed by natural attenuation processes, the stability of the groundwater contaminant plume and its potential for migration, and the potential for unacceptable risks to human health or environmental resources by the contamination. MNA should not be used where such an approach would result in either plume migration[19] or impacts to environmental resources that would be unacceptable to the overseeing regulatory authority. **Therefore, sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be the most appropriate candidates for MNA remedies.**

An example of a situation where MNA may be appropriate is a remedy that includes source control, a pump-and-treat system to mitigate the highly-contaminated plume areas, and MNA in the lower concentration portions of the plume. In combination, these methods would maximize groundwater restored to beneficial use in a timeframe consistent with future demand on the aquifer, while utilizing natural attenuation processes to reduce the reliance on active remediation methods and reduce remedy cost. If, at such a site, the plume was either expanding

[19] In determining whether a plume is stable or migrating, users of this Directive should consider the **uncertainty** associated with defining the limits of contaminant plumes. For example, a plume is typically delineated for each contaminant of concern as a 2- or 3-dimensional feature. Plumes are commonly drawn by computer contouring programs which estimate concentrations between actual data points. EPA recognizes that a plume boundary is more realistically defined by a zone rather than a line. Fluctuations within this zone are likely to occur due to a number of factors (*e.g*., analytical, seasonal, spatial, etc.) which may or may not be indicative of a trend in plume migration. Therefore, site characterization activities and performance monitoring should focus on collection of data of sufficient quality to enable decisions to be made with a high level of confidence. See USEPA, 1993b, USEPA, 1993c, USEPA, 1994b, and USEPA, 1998b, for additional guidance.

or threatening downgradient wells or other environmental resources, then MNA would **not** be an appropriate remedy.

Reasonable Timeframe for Remediation

EPA recognizes that determination of what timeframe is "reasonable" for **attaining remediation objectives** is a site-specific determination. The NCP preamble suggests that a "reasonable" timeframe for a remedy relying on natural attenuation is generally a "...timeframe **comparable** to that which could be achieved through active restoration" (USEPA, 1990a, p.8734; emphasis added). The NCP preamble further states that "[t]he most appropriate timeframe must, however, be determined through an analysis of alternatives" (USEPA, 1990a, p.8732). To ensure that these estimates are comparable, assumptions should be consistently applied for each alternative considered. Thus, determination of the most appropriate timeframe is achieved through a comparison of estimates of remediation timeframe for **all** appropriate remedy alternatives.

If **restoring groundwaters to beneficial uses** is a remediation objective, a comparison of restoration alternatives from most aggressive to passive (*i.e.*, MNA) will provide information concerning the approximate range of time periods needed to attain groundwater cleanup levels. An excessively long restoration timeframe, using the most aggressive restoration method, **may** indicate that groundwater restoration is technically impracticable from an engineering perspective (USEPA, 1993a). Where restoration **is** technically **practicable** using either aggressive or passive methods, the longer restoration timeframe required by the passive alternative may be reasonable in comparison with the timeframe needed for more aggressive restoration alternatives (USEPA, 1996a).

The advantages and disadvantages of each remedy alternative, including the timeframe, should be evaluated in accordance with the remedy selection criteria used by each OSWER program. Whether a particular remediation timeframe is appropriate and reasonable for a given site is determined by balancing tradeoffs among many factors which include:

- Classification of the affected resource (*e.g.*, drinking water source, agricultural water source) and value of the resource[20];

[20] In determining whether an extended remediation timeframe may be appropriate for the site, EPA and other regulatory authorities should consider state groundwater resource classifications, priorities and/or valuations where available, in addition to relevant federal guidelines. Individual states may provide information and guidance relevant to groundwater classifications or use designations as part of a Comprehensive State Groundwater Protection Program (CSGWPP). (See USEPA, 1992a and USEPA, 1997b).

- Relative timeframe in which the affected portions of the aquifer might be needed for future water supply (including the availability of alternate supplies);

- Subsurface conditions and plume stability which can change over an extended timeframe;

- Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources;

- **Uncertainties** regarding the mass of contaminants in the subsurface and predictive analyses (*e.g.*, remediation timeframe, timing of future demand, and travel time for contaminants to reach points of exposure appropriate for the site);

- Reliability of monitoring and of institutional controls over long time periods;

- Public acceptance of the timeframe required to reach remediation objectives; and

- Provisions by the responsible party for adequate funding of monitoring and performance evaluation over the time period required for remediation.

It should be noted that the timeframe required for MNA remedies is often longer than that required for more active remedies. **As a consequence, the uncertainty associated with the above factors increases dramatically. Adequate performance monitoring and contingency remedies (both discussed in later sections of this Directive) should be utilized because of this higher level of uncertainty.** When determining reasonable timeframes, the uncertainty in estimated timeframes should be considered, as well as the ability to establish performance monitoring programs capable of verifying the performance expected from natural attenuation in a timely manner (*e.g.*, as would be required in a Superfund five-year remedy review).

A decision on whether or not MNA is an appropriate remedy for a given site is usually based on estimates of the rates of natural attenuation processes. Site characterization (and monitoring) data are typically used for estimating attenuation rates. These calculated rates may be expressed with respect to either time or distance from the source. Time-based estimates are used to predict the time required for MNA to achieve remediation objectives and distance-based estimates provide an evaluation of whether a plume will expand, remain stable, or shrink. For environmental decision-making, EPA requires that the data used be of "adequate quality and usability for their intended purpose." (USEPA, 1998b). Therefore, where these rates are used to evaluate MNA, or predict the future behavior of contamination, they must also be of "adequate quality and usability." Statistical confidence intervals should be estimated for calculated attenuation rate constants (including those based on methods such as historical trend data analysis, analysis of attenuation along a flow path in groundwater, and microcosm studies). When predicting remedial timeframes, sensitivity analyses should also be performed to indicate the dependence of the calculated remedial timeframes on uncertainties in rate constants and other factors (McNab and Dooher, 1998). A statistical evaluation of the rate constants estimated from site characterization studies of natural attenuation of groundwater contamination often reveals that the estimated rate constants contain considerable uncertainty. For additional guidance on data quality, see USEPA, 1993c, 1994c, 1995b, and 1995c.

As an example, analysis of natural attenuation rates from many sites indicates that a measured decrease in contaminant concentrations of at least one order of magnitude is necessary to determine the appropriate rate law to describe the rate of attenuation, and to demonstrate that the estimated rate is statistically different from zero at a 95% level of confidence (Wilson, 1998). Due to variability resulting from sampling and analysis, as well as plume variability over time, smaller apparent reductions are often insufficient to demonstrate (with 95% level of confidence) that attenuation has in fact occurred at all.

Thus, EPA or other regulatory authorities should consider a number of factors when evaluating reasonable timeframes for MNA at a given site. These factors, on the whole, should allow the overseeing regulatory authority to determine whether a natural attenuation remedy (including institutional controls where applicable) will fully protect potential human and environmental receptors, and whether the site remediation objectives and the time needed to meet them are consistent with the regulatory expectation that contaminated groundwaters will be restored to beneficial uses within a reasonable timeframe. **When these conditions cannot be met using MNA, a remedial alternative that more likely would meet these expectations should be selected.**

Remediation of Sources

Source control measures should be evaluated as part of the remedy decision process at **all** sites, particularly where MNA is under consideration as the remedy or as a remedy component. Source control measures include removal, treatment, or containment, or a combination of these approaches. EPA prefers remedial options which remove free-phase NAPLs and treat those source materials determined to constitute "principal threat wastes" (see Footnote 13).

Contaminant sources that are not adequately addressed complicate the long-term cleanup effort. For example, following free product recovery, residual contamination from a petroleum fuel release may continue to leach significant quantities of contaminants into the groundwater as well as itself posing unacceptable risks to humans or environmental resources. Such a lingering source often unacceptably extends the time necessary to reach remediation objectives. This leaching can occur even while contaminants are being naturally attenuated in other parts of the plume. If the rate of attenuation is lower than the rate of replenishment of contaminants to the groundwater, the plume can continue to expand thus contaminating additional groundwater and potentially posing a threat to downgradient receptors.

Control of source materials is the most effective means of ensuring the timely attainment of remediation objectives. **EPA, therefore, expects that source control measures will be evaluated for all contaminated sites and that source control measures will be taken at most sites where practicable.** At many sites it will be appropriate to implement source control measures during the initial stages of site remediation ("phased remedial approach"), while collecting additional data to determine the most appropriate groundwater remedy.

Performance Monitoring and Evaluation

Performance monitoring to evaluate remedy effectiveness and to ensure protection of human health and the environment is a critical element of all response actions. Performance monitoring is of even greater importance for MNA than for other types of remedies due to the potentially longer remediation timeframes, potential for ongoing contaminant migration, and other uncertainties associated with using MNA. This emphasis is underscored by EPA's reference to "monitored natural attenuation".

The monitoring program developed for each site should specify the location, frequency, and type of samples and measurements necessary to evaluate whether the remedy is performing as expected and is capable of attaining remediation objectives. In addition, all monitoring programs should be designed to accomplish the following:

- Demonstrate that natural attenuation is occurring according to expectations;
- Detect changes in environmental conditions (*e.g.*, hydrogeologic, geochemical, microbiological, or other changes) that may reduce the efficacy of any of the natural attenuation processes[21];
- Identify any potentially toxic and/or mobile transformation products;
- Verify that the plume(s) is not expanding (either downgradient, laterally or vertically);

[21] Detection of changes will depend on the proper siting and construction of monitoring wells/points. Although the siting of monitoring wells is a concern for any remediation technology, it is of even greater concern with MNA because of the lack of engineering controls to control contaminant migration.

- Verify no unacceptable impact to downgradient receptors;
- Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy;
- Demonstrate the efficacy of institutional controls that were put in place to protect potential receptors; and
- Verify attainment of remediation objectives.

The frequency of monitoring should be adequate to detect, in a timely manner, the potential changes in site conditions listed above. At a minimum, the monitoring program should be sufficient to enable a determination of the rate(s) of attenuation and how that rate is changing with time. When determining attenuation rates, the uncertainty in these estimates and the associated implications should be evaluated (see McNab and Dooher, 1998). Flexibility for adjusting the monitoring frequency over the life of the remedy should also be included in the monitoring plan. For example, it may be appropriate to decrease the monitoring frequency at some point in time, once it has been determined that natural attenuation is progressing as expected and very little change is observed from one sampling round to the next. In contrast, the monitoring frequency may need to be increased if unexpected conditions (*e.g.*, plume migration) are observed.

Performance monitoring should continue until remediation objectives have been achieved, and longer if necessary to verify that the site no longer poses a threat to human health or the environment. Typically, monitoring is continued for a specified period (*e.g.*, one to three years) after remediation objectives have been achieved to ensure that concentration levels are stable and remain below target levels. The institutional and financial mechanisms for maintaining the monitoring program should be clearly established in the remedy decision or other site documents, as appropriate.

Details of the monitoring program should be provided to EPA or the overseeing regulatory authority as part of any proposed MNA remedy. Further information on the types of data useful for monitoring natural attenuation performance can be found in the ORD publications (*e.g.*, USEPA, 1997a, USEPA, 1994a) listed in the “References Cited” section of this Directive. Also, USEPA (1994b) published a detailed document on collection and evaluation of performance monitoring data for pump-and-treat remediation systems.

Contingency Remedies

A contingency remedy is a cleanup technology or approach specified in the site remedy decision document that functions as a "backup" remedy in the event that the "selected" remedy fails to perform as anticipated. A contingency remedy may specify a technology (or technologies) that is (are) different from the selected remedy, or it may simply call for modification of the selected technology, if needed. Contingency remedies should generally be flexible—allowing for the incorporation of new information about site risks and technologies.

Contingency remedies are not new to OSWER programs. Contingency remedies should be included in the decision document where the selected technology is not proven for the specific site application, where there is significant uncertainty regarding the nature and extent of contamination at the time the remedy is selected, or where there is uncertainty regarding whether a proven technology will perform as anticipated under the particular circumstances of the site (USEPA, 1990c).

It is also recommended that one or more criteria ("triggers") be established, as appropriate, in the remedy decision document that will signal unacceptable performance of the selected remedy and indicate when to implement contingency remedies. Such criteria should generally include, but not be limited to, the following:

- Contaminant concentrations in soil or groundwater at specified locations exhibit an increasing trend not originally predicted during remedy selection;
- Near-source wells exhibit large concentration increases indicative of a new or renewed release;
- Contaminants are identified in monitoring wells located outside of the original plume boundary;
- Contaminant concentrations are not decreasing at a sufficiently rapid rate to meet the remediation objectives; and
- Changes in land and/or groundwater use will adversely affect the protectiveness of the MNA remedy.

In establishing triggers or contingency remedies, however, care is needed to ensure that sampling variability or seasonal fluctuations do not unnecessarily trigger a contingency. For example, an anomalous spike in dissolved concentration(s) at a well(s) might not be a true indication of a change in trend.

EPA recommends that remedies employing MNA be evaluated to determine the need for including one or more contingency measures that would be capable of achieving remediation objectives. EPA believes that contingency remedies should generally be included as part of a MNA remedy which has been selected based primarily on predictive analyses rather than documented trends of decreasing contaminant concentrations.

SUMMARY

EPA remains fully committed to its goals of protecting human health and the environment by remediating contaminated soils, restoring contaminated groundwaters to their beneficial uses, preventing migration of contaminant plumes, and protecting groundwaters and other environmental resources. EPA does not view MNA to be a "no action" remedy, but rather considers it to be a means of addressing contamination under a limited set of site circumstances where its use meets the applicable statutory and regulatory requirements. MNA is not a "presumptive" or "default" remediation alternative, but rather should be evaluated and compared to other viable remediation methods (including innovative technologies) during the study phases leading to the selection of a remedy. The decision to implement MNA should include a comprehensive site characterization, risk assessment where appropriate, and measures to control sources. In addition, the progress of natural attenuation towards a site's remediation objectives should be carefully monitored and compared with expectations to ensure that it will meet site remediation objectives within a timeframe that is reasonable compared to timeframes associated with other methods. Where MNA's ability to meet these expectations is uncertain and based predominantly on predictive analyses, decision-makers should incorporate contingency measures into the remedy.

EPA is confident that MNA will be, at many sites, a reasonable and protective component of a broader remediation strategy. However, EPA believes that there will be many other sites where either the uncertainties are too great or there is a need for a more rapid remediation that will preclude the use of MNA as a stand-alone remedy. This Directive should help promote consistency in how MNA remedies are proposed, evaluated, and approved.

REFERENCES CITED

Gilbert, R.O. 1987. Statistical Methods for Environmental Pollution Monitoring. Van Nostrand Reinhold Co., New York, NY, 320p.

McNab, W.W., Jr. and B.P. Dooher. 1998. A critique of a steady-state analytical method for estimating contaminant degradation rates. *Ground Water* 36, no.6:983-87.

United States Environmental Protection Agency (USEPA). 1988a. Section 5.3.3.1. Natural attenuation with monitoring. *Guidance on remedial actions for contaminated groundwater at Superfund sites*, OSWER Directive 9283.1-2, EPA/540/G-88/003, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1989. *Methods for evaluation attainment of cleanup standards, Vol. 1: Soils and solid media*, EPA/230/02-89-042, Office of Solid Waste. Washington, D.C.

United States Environmental Protection Agency. 1990a. National oil and hazardous substances pollution contingency plan (NCP); final rule, *Federal Register* 55, no. 46:8706 and 8733-34. Washington, D.C.

United States Environmental Protection Agency. 1990b. Corrective action for releases from solid waste management units at hazardous waste management facilities; proposed rule, *Federal Register* 55, no. 145:30825 and 30829. Washington, D.C.

United States Environmental Protection Agency. 1990c. *Suggested ROD language for various ground water remediation options*, OSWER Directive 9283.1-03, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1991a. *Guide to developing Superfund no action, interim action, and contingency remedy RODs*, Superfund Publication 9355.3-02FS (Fact Sheet), Office of Emergency Remedial Response. Washington, D.C.

United States Environmental Protection Agency. 1991b. *A guide to principal threat and low level threat wastes*, Superfund Publication 9380.3-06FS (Fact Sheet, November version), Office of Emergency Remedial Response. Washington, D.C.

United States Environmental Protection Agency. 1992a. *Final comprehensive state ground water protection program guidance*, EPA 100-R-93-001, Office of the Administrator. Washington, D.C.

United States Environmental Protection Agency. 1993a. *Guidance for evaluating the technical impracticability of ground-water restoration*, OSWER Directive 9234.2-25, EPA/540-R-93-080, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1993b. *Guidance document on the statistical analysis of ground-water monitoring data at RCRA facilities*, Office of Solid Waste. Washington, D.C.

United States Environmental Protection Agency. 1993c. *Data quality objectives process for Superfund: Interim final guidance*, EPA/540-R-93-071, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1993d. *Methods for evaluation attainment of cleanup standards, Vol. 2: Ground Water*, EPA/230/R-92/014, Office of Policy, Planning, and Evaluation. Washington, D.C.

United States Environmental Protection Agency. 1994a. Proceedings of *symposium on natural attenuation of groundwater*, EPA/600/R-94/162, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1994b. *Methods for monitoring pump-and-treat performance*, EPA/600/R-94/123, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1994c. *EPA requirements for quality assurance project plans (QAPP) for environmental data operations*, EPA/QA/R-5, Office of Water. Washington, D.C.

United States Environmental Protection Agency. 1995a. Chapter IX: Natural attenuation. *How to evaluate alternative cleanup technologies for underground storage tank sites: A guide for corrective action plan reviewers,* EPA 510-B-95-007, Office of Underground Storage Tanks. Washington, D.C.

United States Environmental Protection Agency. 1995b. *Guidance for data quality assessment*, EPA/QA/G-9, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1995c. *Guidance for the preparation of standard operating procedures (SOPs) for quality-related documents*, EPA/QA/G-6, Quality Assurance Division. Washington, D.C.

United States Environmental Protection Agency. 1996a. *Presumptive response strategy and ex-situ treatment technologies for contaminated ground water at CERCLA sites*, Final Guidance, OSWER Directive 9283.1-12, EPA 540-R-96-023, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1996b. Corrective action for releases from solid waste management units at hazardous waste management facilities; advance notice of proposed rulemaking, *Federal Register* 61, no. 85:19451-52.

United States Environmental Protection Agency. 1997a. *Proceedings of the symposium on natural attenuation of chlorinated organics in groundwater*; Dallas, Texas, September 11-13, EPA/540/R-97/504, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1997b. *The role of CSGWPPs in EPA remediation programs*, OSWER Directive 9283.1-09, EPA F-95-084, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1998a. *Technical protocol for evaluating natural attenuation of chlorinated solvents in ground water,* EPA/600/R-98/128, National Risk Management Research Laboratory, Ada, Oklahoma.

United States Environmental Protection Agency. 1998b. *Policy and program requirements for the mandatory agency-wide quality system,* EPA Order 5360.1 CHG 1, Office of Research and Development, Washington, D.C.

Wilson, John T. 1998. Personal communication, U.S. EPA, NRMRL, Ada, Oklahoma.

ADDITIONAL REFERENCES

American Academy of Environmental Engineers. 1995. *Innovative site remediation technology, Vol. 1: Bioremediation*, ed. W.C. Anderson. Annapolis, Maryland.

American Society for Testing and Materials. 1998. *Standard guide for accelerated site characterization for confirmed or suspected petroleum releases*, ASTM E 1912-98. Conshohocken, Pennsylvania.

American Society for Testing and Materials. 1998. *Standard guide for remediation of ground water by natural attenuation at petroleum release sites*, ASTM E 1943-98. Conshohocken, Pennsylvania.

Black, H. 1995. Wisconsin gathers evidence to support intrinsic bioremediation. *The bioremediation report*, August:6-7.

Borden, R.C., C.A. Gomez, and M.T. Becker. 1995. Geochemical indicators of intrinsic bioremediation. *Ground Water* 33, no.2:180-89.

Hinchee, R.E., J.T. Wilson, and D.C. Downey. 1995. *Intrinsic bioremediation.* Columbus, Ohio: Battelle Press.

Klecka, G.M., J.T. Wilson, E. Lutz, N. Klier, R. West, J. Davis, J. Weaver, D. Kampbell, and B. Wilson. 1996. Intrinsic remediation of chlorinated solvents in groundwater. *Proceedings of intrinsic bioremediation conference*, London W1, United Kingdom, March 18-19.

McAllister, P.M., and C.Y. Chiang. 1993. A practical approach to evaluating natural attenuation of contaminants in groundwater. *Groundwater Monitoring & Remediation* 14, no.2:161-73.

New Jersey Department of Environmental Protection. 1996. *Site remediation program, technical requirements for site remediation*, proposed readoption with amendments: N.J.A.C. 7:26E, authorized by Robert J. Shinn, Jr., Commissioner.

Norris, R.D., R.E. Hinchee, R.A. Brown, P.L. McCarty, L. Semprini, J.T. Wilson, D.H. Kampbell, M. Reinhard, E.J. Bouwer, R.C. Borden, T.M. Vogel, J.M. Thomas, and C.H. Ward. 1994. *Handbook of bioremediation*. Boca Raton, Florida: Lewis Publishers.

Salanitro, J.P. 1993. The role of bioattenuation in the management of aromatic hydrocarbon plumes in aquifers. *Groundwater Monitoring & Remediation* 13, no. 4:150-61.

United States Department of the Army. 1995. Interim Army policy on natural attenuation for environmental restoration, (12 September) Memorandum from the Assistant Chief of Staff for Installation Management. Washington, D.C.: the Pentagon.

United States Environmental Protection Agency. 1978. *Radionuclide interactions with soil and rock media, Vol. 1: Element chemistry and geochemistry*, EPA 520/6-78-007, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1988b. *Groundwater modeling: an overview and status report*, EPA/600/2-89/028, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1992c. *Quality assurance and control in the development and application of ground-water models*, EPA/600/R-93/011, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1993e. *Compilation of ground-water models*, EPA/600/R-93/118, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1994d. *The hydrocarbon spill screening model (HSSM), Vol. 1: User's guide*, EPA/600/R-94-039a, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1994e. *Assessment framework for ground-water model applications*, OSWER Directive 9029.00, EPA 500-B-94-003, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1994f. *Ground-water modeling compendium*, EPA 500-B-94-004, Office of Solid Waste and Emergency Response. Washington, D.C.

United States Environmental Protection Agency. 1994g. *A technical guide to ground-water model selection at sites contaminated with radioactive substances*, EPA 402-R-94-012, Office of Air and Radiation. Washington, D.C.

United States Environmental Protection Agency. 1994h. *Guidance for conducting external peer review of environmental models*, EPA 100-B-94-001, Office of Air and Radiation. Washington, D.C.

United States Environmental Protection Agency. 1994i. *Report of the agency task force on environmental regulatory modeling*, EPA 500-R-94-001, Office of Air and Radiation. Washington, D.C.

United States Environmental Protection Agency. 1995a. *The hydrocarbon spill screening model (HSSM), Vol. 2: Theoretical background and source codes*, EPA/600/R-94-039b, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1996c. *Documenting ground-water modeling at sites contaminated with radioactive substances*, EPA 540-R-96-003, Office of Air and Radiation. Washington, D.C.

United States Environmental Protection Agency. 1996d. *Three multimedia models used at hazardous and radioactive waste sites*, EPA 540-R-96-004, Office of Air and Radiation. Washington, D.C.

United States Environmental Protection Agency. 1996e. Notes of Seminar--*Bioremediation of hazardous waste sites: Practical approaches to implementation*, EPA 510-B-95-007, Office of Research and Development. Washington, D.C.

United States Environmental Protection Agency. 1997c. (Draft) *Geochemical processes affecting sorption of selected contaminants*, Office of Radiation and Indoor Air. Washington, D.C.

United States Environmental Protection Agency. 1997d. (Draft) *The* K_D *model and its use in contaminant transport modeling*, Office of Radiation and Indoor Air. Washington, D.C.

United States Environmental Protection Agency, Air Force, Army, Navy, and Coast Guard. 1996a. *Commonly asked questions regarding the use of natural attenuation for chlorinated solvent spills at federal facilities*, Fact Sheet, Federal Facilities Restoration and Re-Use Office. Washington, D.C.

United States Environmental Protection Agency, Air Force, Army, Navy, and Coast Guard. 1996b. *Commonly asked questions regarding the use of natural attenuation for petroleum contaminated sites at federal facilities*, Fact Sheet, Federal Facilities Restoration and Re-Use Office. Washington, D.C.

Wiedemeier, T.H., J.T. Wilson, D.H. Kampbell, R.N. Miller, and J.E. Hansen. 1995. *Technical protocol for implementing intrinsic remediation with long-term monitoring for natural attenuation of fuel contamination dissolved in groundwater*. United States Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks Air Force Base, San Antonio, Texas.

Wiedemeier, T.H., J.T. Wilson, D.H. Kampbell, J.E. Hansen, and P. Haas. 1996. Technical protocol for evaluating the natural attenuation of chlorinated ethenes in groundwater. *Proceedings of the petroleum hydrocarbons and organic chemicals in groundwater: Prevention, detection, and remediation conference,* Houston, Texas, November 13-15.

Wilson, J.T., D.H. Kampbell, and J. Armstrong. 1993. Natural bioreclamation of alkylbenzenes (BTEX) from a gasoline spill in methanogenic groundwater. *Proceedings of the second international symposium on in situ and on site bioremediation*, San Diego, California, April 5-8.

Wisconsin Department of Natural Resources. 1993. ERRP issues guidance on natural biodegradation. *Release News*, Emergency and Remedial Response Section, February, vol. 3, no. 1.

OTHER SOURCES OF INFORMATION

http://www.epa.gov/ORD/WebPubs/biorem/
EPA Office of Research and Development, information on passive and active bioremediation

http://www.epa.gov/ada/kerrlab.html
EPA Office of Research and Development, R.S. Kerr Environmental Research Laboratory

http://www.epa.gov/OUST/cat/natatt.htm
EPA Office of Underground Storage Tanks, information on natural attenuation

http://www.epa.gov/swerffrr/chlorine.htm
EPA Federal Facilities Restoration and Reuse Office, fact sheet on natural attenuation of chlorinated solvents

http://www.epa.gov/swerffrr/petrol.htm
EPA Federal Facilities Restoration and Reuse Office, Fact sheet on natural attenuation of petroleum contaminated sites

http://www.epa.gov/hazwaste/ca/subparts.htm
EPA Office of Solid Waste, information on RCRA Subpart S

http://www.epa.gov/swerosps/bf/
EPA Office of Outreach Programs, Special Projects, and Initiatives, information on Brownfields

http://www.epa.gov/oerrpage/superfnd/web/programs/clp/quality.htm
EPA Office of Emergency and Remedial Response, information on data quality

http://es.epa.gov/ncerqa/qa/qatools.html
EPA Office of Research and Development, National Center for Environmental Research and Quality Assurance, information on data quality, quality assurance and quality control

http://clu-in.com
EPA Technology Innovation Office, information on hazardous site cleanups

ATTACHMENT 4

Directive 9283.1-36
August 2015
Office of Solid Waste and Emergency Response

USE OF MONITORED NATURAL ATTENUATION FOR INORGANIC CONTAMINANTS IN GROUNDWATER AT SUPERFUND SITES

U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Directive 9283.1-36

August 2015

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ACRONYMS AND ABBREVIATIONS

Acronym	Definition
α	Alpha
Am	Americium
ARAR	Applicable or relevant and appropriate requirement
As	Arsenic
AVS	Acid volatile sulfide
Bq	Becquerel
Br	Bromine
β	Beta
C	Celsius
Ca	Calcium
Cd	Cadmium
CEC	Cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CH_4	Methane
Cl	Chlorine
ClO_4	Perchlorate
C_o	Initial groundwater concentration
CO_2	Carbon dioxide
COC	Contaminant of concern
Cr	Chromium
Cs	Cesium
CSM	Conceptual site model
Cu	Copper
DO	Dissolved oxygen
DOC	Dissolved organic carbon
DOE	U.S. Department of Energy
DQO	Data quality objective
EDTA	Ethylenediamine tetraacetic acid
Eh	Redox potential
EPA	U.S. Environmental Protection Agency
ESD	Explanation of significant differences
F	Flourine
Fe	Iron
FR	Federal Register
FS	Feasibility study
γ	Gamma
H_2	Hydrogen
H_2S	Hydrogen sulfide
HS^-	Bisulfide

HTRW	Hazardous, Toxic, and Radioactive Waste
I	Iodine
IC	Institutional control
ITRC	Interstate Technical Regulatory Council
K	Potassium
K_d	Distribution/partition coefficient
kg	Kilogram
K_{oc}	Organic carbon soil-water partition coefficient
MCL	Maximum contaminant level
MCLG	Maximum contaminant level goal
MeV	Megaelectronvolt
Mg	Magnesium
mg	Milligram
µg/L	Micrograms per liter
µs	Microsecond
$\mu S/cm^2$	Microsecond per square centimeter
MNA	Monitored natural attenuation
ms	Millisecond
mV	Megavolt
Na	Sodium
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
Ni	Nickel
NO_2^-	Nitrite
NO_3	Nitrate
Np	Neptunium
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
OE	Ordnance and explosives
ORP	Oxidation-reduction potential
OSWER	Office of Solid Waste and Emergency Response
Pa	Protactinium
Pb	Lead
pCi	Picocurie
pCi/L	Picocurie per liter
PRG	Preliminary remediation goal
Pu	Plutonium
QA	Quality assurance
Ra	Radium
RAO	Remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI	Remedial investigation
Rn	Radon
ROD	Record of decision

SCM	Surface complexation model
SDWA	Safe Drinking Water Act
Se	Selenium
SEM	Simultaneously extracted metals
SEP	Sequential extraction procedure
Sr	Strontium
Tc	Technetium
Th	Thorium
TI	Technical impracticability
TIC	Total inorganic carbon
TOC	Total organic carbon
TPP	Technical project planning
U	Uranium
UMTRCA	Uranium Mill Tailings Radiation Control Act of 1978
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
VOC	Volatile organic compounds
Xe	Xenon

NOTICE/DISCLAIMER

This document was developed through the cooperative efforts of a team of Headquarters and regional staff inside the U.S. Environmental Protection Agency (EPA) and relies on peer-reviewed literature, EPA reports, Web sources, current research, and other pertinent information. This document has been through a thorough internal EPA peer-review process, which included comments from the Office of Solid Waste and Emergency Response (OSWER) and the Office of General Counsel. References and Web links are provided for readers interested in additional information; these Web links, verified as accurate at the time of publication, are subject to change by Web sponsors. Note that the mention of trade names or commercial products does not constitute endorsement or recommendation for use.

This guidance is designed to help promote consistent national approach for implementation of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) response actions at private party and federal facility sites. It does not, however, substitute for CERCLA or EPA's regulations, nor is it a regulation itself. Thus, it does not impose legally binding requirements on EPA, states, tribes or the regulated community, and may not apply to a particular situation based on the circumstances. EPA, state, tribal and local decision-makers retain the discretion to adopt approaches on a case-by-case basis that differ from this guidance where appropriate. Any decisions regarding a particular facility will be made based on the applicable statutes and regulations.

In working with other federal agencies to make cleanup decisions for groundwater at sites where the other federal agency is lead for cleanup, EPA Regions should use the recommendations in this document to the same extent as at non-federal facility sites. Section 120(a)(2) of CERCLA provides that all guidelines, rules, regulations, and criteria for preliminary assessments, site investigations, National Priorities List (NPL) listing, and remedial actions are applicable to federal facilities to the same extent as they are applicable to other facilities. It states the following: "No department, agency or instrumentality of the United States may adopt or utilize any such guidelines, rules, regulations, or criteria which are inconsistent with the guidelines, rules, regulations, and criteria established by the Administrator under this Act."

EXECUTIVE SUMMARY

This new monitored natural attenuation (MNA) policy document for inorganic contaminants ("2015 MNA guidance") expands on and is designed to be a companion to the 1999 MNA guidance.[1] The 1999 MNA guidance, which clarified "EPA's policy regarding the use of monitored natural attenuation (MNA) for the cleanup of contaminated soil and groundwater1 in the Superfund, RCRA Corrective Action, and Underground Storage Tank programs,[2]" focused primarily on *organic contaminants*; however, the 1999 MNA guidance does address inorganic contaminants to some extent (*see for example,* pp. 8-9). Together, these two policy documents provide guidance on the consideration of MNA for a broad range of contaminants at Superfund sites. The two MNA policy documents are supported by a three-volume set of technical reports issued by the U.S. Environmental Protection Agency's (EPA) Office of Research and Development (2007-2010).[3]

Regions should continue to consider the overall recommendations in the 1999 MNA guidance when evaluating all sites (those with organic and inorganic contaminants). Consistent with the 1999 MNA guidance, the 2015 MNA guidance document discusses in more detail below that MNA for inorganic contaminants: (1) is not intended to constitute a treatment process for inorganic contaminants; (2) when appropriately implemented, can help to restore an aquifer to beneficial uses by immobilizing contaminants onto aquifer solids and providing the primary means for attenuation of contaminants in groundwater; and (3) is not intended to be a "do nothing" response.

Furthermore, as discussed in the 1999 MNA guidance and in more detail below, the Agency's longstanding policy is that MNA is generally not an appropriate response action if a receptor is currently being exposed to a contaminant or the contaminant plume is expanding. In addition, MNA, whether selected as the sole remedial action or as a finishing step, may be appropriate when it can achieve a site's remedial action objectives in a reasonable timeframe; thus, MNA remedies should not extend over very long timeframes, and the anticipated timeframes should be reasonable compared with other potential alternatives being considered. However, the document acknowledges that longer timeframes may be needed for some contaminants that degrade or decay over a long time period.

As also discussed in the 1999 MNA guidance and in more detail below, an MNA approach for groundwater may not be appropriate for ensuring protectiveness of human health and the environment at Superfund sites. Regions should evaluate specific site conditions in determining

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1 *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (OSWER Directive 9200.4-17P, April 21, 1999) (EPA 1999c).

2 1999 MNA guidance (page 1).

3 To the extent it is consistent with CERCLA, the NCP and this and other EPA CERCLA guidance documents, Regions also may find useful information in the Interstate Technical Regulatory Council (ITRC) Guidance on MNA for metals and radionuclides (2010).

whether MNA can be a viable cleanup approach (for example, the groundwater plume should be stable or shrinking, geochemical evidence of attenuation should be documented in the administrative record, there should be no exposure to the contaminated groundwater, and the source of contaminants should be identified and addressed).

This 2015 MNA guidance, consistent with the 1999 MNA guidance, indicates that multiple "lines of evidence" should be obtained to evaluate whether MNA should be considered as part of the site's selected response action. As a related matter, the 1999 MNA guidance also recommends use of a tiered analysis approach for considering MNA, which typically involves a detailed analysis of site characteristics that control and sustain attenuation. The 2015 MNA guidance builds on this tiered approach and recommends a phased analytical approach tailored specifically for inorganic contaminants. Where natural attenuation leads to daughter products that are more toxic than the parent compounds, Regions should ensure protectiveness of human health and the environment by taking steps to make sure that the more toxic compounds do not increase over time or are addressed by changes to the existing remedy.

In conclusion, while the 1999 MNA guidance continues to provide overall recommendations on evaluating MNA, the 2015 MNA guidance (generally) offers more specific recommendations intended to assist the Regions in evaluating whether MNA for *inorganic contaminants* is appropriate. If MNA is considered as an appropriate cleanup approach at Superfund sites, the guidance can assist in identifying steps that can be taken to ensure that the risk to human health and the environment is adequately reduced and managed in a timely manner.

1.0 INTRODUCTION

This guidance document provides recommendations for evaluating monitored natural attenuation (MNA) as a potential component of a remedial action approach for cleaning up inorganic contaminants (including radionuclides) in groundwater at Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites. This document uses "inorganic contaminants" as a generic term for metals and metalloids (such as arsenic); the phrase also refers to radioactive as well as non-radioactive isotopes. The purpose of this document is to provide additional guidance, generally consistent with the 1999 MNA guidance, on considering the use of MNA for inorganic contaminants (as well as nitrate and perchlorate) in groundwater as a way to ensure protectiveness of human health and the environment. With regard to inorganic contaminant plumes in groundwater, it describes the primary processes that typically govern MNA and offers a recommended framework for assessing the potential effectiveness of MNA as a cleanup approach.

More detailed discussion of the scientific principles and processes described in this policy may be found in the following three documents, which are referenced frequently in this guidance:

- *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume I – Technical Basis for Assessment,* EPA 600-R-07-139 (EPA 2007a).
- *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume II – Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium,* EPA 600-R-07-140 (EPA 2007b).
- *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume III – Assessment for Radionuclides Including Americium, Cesium, Iodine, Plutonium, Radium, Radon, Strontium, Technetium, Thorium, Tritium, and Uranium,* EPA 600-R-10-093 (EPA 2010a).

As discussed in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) and in various associated EPA CERCLA guidance documents, "[t]he EPA expects to return usable groundwaters to their beneficial uses whenever practicable, within a timeframe that is reasonable given the particular circumstances of the site" (see 40 Code of Federal Regulations [CFR] §300.430(a)(1)(iii)(F)).

In general, five key principles stem from the overarching expectations for groundwater restoration.[4] As discussed in "Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration" (OSWER Directive Number 9283.1-33, June 26, 2009), these expectations are as follows:

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[4] See "Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration" (OSWER Directive Number 9283.1-33, June 26, 2009) (See pages 3-4.) at www.epa.gov/superfund/health/conmedia/gwdocs/pdfs/9283_1-33.pdf.

(1) "If groundwater that is a current or potential source of drinking water[5] is contaminated above protective levels (that is, for drinking water aquifers, contamination exceeds federal or state maximum contaminant levels [MCLs] or non-zero maximum contaminant level goals [MCLGs]), a remedial action under CERCLA should seek to restore the aquifer to beneficial use (that is, drinking water standards) wherever practicable.

(2) "Groundwater contamination should not be allowed to migrate and further contaminate the aquifer or other media (for example, indoor air via vapor intrusion into buildings; sediment; surface water; or wetland).

(3) "Technical impracticability waivers and other waivers may be considered and, under appropriate circumstances, granted if the statutory criteria are met, when groundwater cleanup is impracticable. The waiver decision should be scientifically supported and clearly documented.

(4) "Early actions[6] (such as source removal, plume containment or provision of an alternative water supply[7]) should be considered as soon as possible. Institutional controls (ICs) related to groundwater use or even surface water use may be useful to protect the public in the short term, as well as in the long term.

(5) "ICs should not be relied on as the only response to contaminated groundwater or as a justification for not taking action under CERCLA.[8] To ensure protective remedies, CERCLA response action cleanup levels for contaminated groundwater should generally address all pathways of exposure that pose an actual or potential risk to human health and the environment."

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[5] The EPA generally considers potential source for drinking water as Class II under EPA's Groundwater Classification System in "Guidelines for Groundwater Classification Under the EPA Groundwater Protection Strategy" (Final Draft, December 1986) and the National Contingency Plan (NCP) where Class I and II generally are considered to be current and potential drinking water aquifers (See 55 FR [Federal Register] 8732 (March 8, 1990).

[6] See "Considerations in Groundwater Remediation at Superfund Sites and RCRA Facilities – Update" (Directive Number 9283.1-06, May 27, 1992) for a more complete discussion of early actions. (See pages 6-8.) at www.epa.gov/superfund/policy/remedy/pdfs/92-83106-s.pdf.

[7] See 55 FR 8865 (March 8, 1990) for a list of potential ways of providing an alternative water supply (Appendix D).

[8] See 40 CFR § 300.430(a)(iii)(D) ("The use of institutional controls shall not substitute for active response measures (for example, treatment and/or containment of source material, restoration of groundwaters to their beneficial uses) as the sole remedy unless such active measures are determined not to be practicable, based on the balancing of trade-offs among alternatives that is conducted during the selection of remedy"). Also see 40 CFR § 300.430(a)(iii)(A) related to the expectation for treatment.

Cleanup levels for response actions under CERCLA generally are developed based on applicable or relevant and appropriate requirements (ARARs) where they are available and sufficiently protective of human health,[9] and on site-specific risk assessments where ARARs do not exist. The determination of whether a requirement is an ARAR, as stated in the NCP, is made on a site-specific basis (see 40 CFR§300.400(g)). In general, drinking water standards provide relevant and appropriate cleanup levels for groundwater that is a current or potential source of drinking water; drinking water standards include federal or state MCLs or non-zero MCLGs established under the Safe Drinking Water Act (SDWA) or more stringent state drinking water standards.[10] Depending on site-specific circumstances, however, drinking water standards may not be relevant and appropriate for groundwater that is not a current or potential source of drinking water (see 55 Federal Register [FR] 8732, March 8, 1990).

Selection of Contaminants

The series of technical resource documents addressing MNA for inorganic contaminants referenced in this policy includes a discussion of a specific list of contaminants. The contaminants addressed in the technical resource documents were selected based on the frequency of occurrence at contaminated sites and to represent the range of contaminant properties that can influence the efficiency of natural attenuation processes to achieve site cleanup goals. The recommendations in this guidance should be considered for all non-radiological or radiological inorganic contaminants in groundwater, regardless of their inclusion in the technical resource documents.

The non-radionuclide contaminants addressed in the technical documents include the following: arsenic, cadmium, chromium, copper, lead, nickel, nitrate, perchlorate and selenium. These contaminants are commonly found at Superfund sites throughout the nation and reflect toxicity, industrial use, and frequency of occurrence at Superfund sites. They represent a broad range of geochemical traits such as the following: ion charge (cation vs. anion), transport behavior (conservative vs. non-conservative) and oxidation-reduction (redox) chemistry (EPA 1999a, 1999b and 2004c). Conservative behavior typically is exhibited by non-reactive contaminants that tend to move readily with groundwater flow, while non-conservative behavior typically is exhibited by contaminants whose transport is retarded by any number of different mechanisms. Finally, the EPA regional staff members were asked to nominate inorganic contaminants that occurred frequently or that were problematic in their Regions. The above list of nine inorganic contaminants reflects this process.

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9 *See e.g.,* "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA," OSWER Directive No. 9200.4-23 (August 22, 1997) ("It remains EPA's policy that ARARs will generally be considered protective absent multiple contaminants or pathways of exposure. However, this Directive clarifies that, in rare situations, EPA regional offices should establish PRGs at levels more protective than required by a given ARAR, even absent multiple pathways or contaminants, where application of the ARAR would not be protective of human health or the environment.").

10 Other regulations may also be ARARs for purposes of CERCLA §121(d)(2)(B).

A similar process was used to identify the radionuclide contaminants in the technical documents, including the following: americium, cesium, iodine, neptunium, plutonium, radium, radon, technetium, thorium, tritium, strontium and uranium. These radionuclides are daughter and fission products that result from radioactive decay and are commonly found at Superfund sites. The decay of radioisotopes can produce daughter products that may differ both physically and chemically from parent isotopes. The radionuclide contaminants addressed in the technical document also represent a broad range of geochemical traits and environmental characteristics.

1.1 Intended Use of Document

Users of this document may include the EPA and state cleanup program personnel and their contractors, especially those individuals responsible for evaluating alternative cleanup methods for a given site or facility. Depending on site-specific circumstances (for example, which hazardous substances are being addressed), the recommendations in both this 2015 MNA guidance and the 1999 MNA guidance may be useful. For more information on MNA for groundwater cleanups, see www.epa.gov/superfund/health/conmedia/gwdocs/monit.htm. Additional guidance may also be found at www.cluin.org/techfocus/default.focus/sec/Natural_Attenuation/cat/Guidance.

The potential attenuation processes affecting inorganic contaminants generally should be the same for both radioactive and non-radioactive inorganic contaminants contaminant types, except for radioactive decay. As a result, the decision-making approach and process for establishing cleanup levels at CERCLA sites normally should be the same for sites with radioactive and non-radioactive inorganic contaminants, except where there are technical differences between the two types of contaminants (such as external exposure from gamma radiation vs. dermal exposure).

1.2 Tiered Analysis Approach for Developing Multiple Lines of Evidence

As discussed in the 1999 MNA guidance (pp. 15-16):

> Once site characterization data have been collected and a conceptual model developed, the next step is to evaluate the potential efficacy of MNA as a remedial alternative. This involves collection of site-specific data sufficient to estimate with an acceptable level of confidence both the rate of attenuation processes and the anticipated time required to achieve remediation objectives. A three-tiered approach to such an evaluation is becoming more widely practiced and accepted. In this approach, successively more detailed information is collected as necessary to provide a specified level of confidence on the estimates of attenuation rates and remediation timeframe. These three tiers of site-specific information, or “lines of evidence”, are:

(1) Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend [footnote in original deleted] of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. (In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. In the case of inorganic contaminants, the primary attenuating mechanism should also be understood.)

(2) Hydrogeologic and geochemical data that can be used to demonstrate **indirectly** the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.

(3) Data from field or microcosm studies (conducted in or with actual contaminated site media) which **directly** demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

For inorganic contaminant plumes, the evaluation and selection of MNA as part of a cleanup action in groundwater typically involves a detailed analysis of site-specific data and characteristics that control and sustain attenuation. Developing multiple lines of evidence (as discussed in the 1999 MNA guidance) to support this analysis can require significant resource outlays. Thus, site characterization should be approached in a step-wise manner to collect data for inclusion in the administrative record that support the evaluation of existing natural attenuation processes within the aquifer and the analysis of potential long-term effectiveness. The 2015 MNA guidance builds on the *tiered analysis approach* discussed in the 1999 MNA guidance for inorganic contaminants as a way to provide a cost-effective way to screen sites for MNA because it is designed to prioritize and focus the characterization needs for decision making at each screening step. Conceptually, a tiered analysis approach is designed to progressively reduce uncertainty as more and more site-specific data are collected. The recommended tiered analysis approach is discussed in more detail in Section 3 of this document involves obtaining progressively more information. The recommended approach is designed to acquire lines of evidence that can be used to assess the likely effectiveness of MNA as a remedial action alternative for inorganic contaminants in groundwater. The EPA generally recommends following the tiered approach outlined in this document for inorganic contaminants.

1.3 Conceptual Site Model

As stated in the 1999 MNA guidance (p. 14), "EPA recommends the use of conceptual site models to integrate data and guide both investigative and remedial actions."

Assessing the suitability of MNA as a component of a groundwater response action for sites with inorganic contaminants is helped by development of a conceptual site model[11] (CSM). Regions should refer to existing EPA guidance on CSMs (see, for example, *Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model*, EPA 542-F-11-011, OSWER, July 2011; *Performance Monitoring of MNA Remedies for VOCs in Ground Water,* EPA/600/R-04/027 April 2004; *A Guide To Preparing Superfund Proposed Plans, Records Of Decision, and other Remedy Selection Decision Documents,* OSWER 9200.1-23P, July 1999; *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. EPA 600-R-98-128, Office of Research and Development, 1998).

Generally, the CSM is a representation (written, graphical or pictorial) of the environmental system at a site and the biological, physical, and chemical processes (and relationships between them) that affect contaminant transport. The CSM is designed to identify potential pathways that may expose receptors to site contaminants. The CSM should also quantify fluxes of contaminants and describe the conditions that may affect or alter the MNA processes. The CSM should include an understanding of the attenuation mechanisms, the geochemical conditions governing these mechanisms, the capacity of the aquifer to sustain attenuation of the contaminant mass and prevent future contaminant migration, and indicators that can be used to monitor MNA performance. Uncertainties and assumptions should be listed with specific strategies to describe and minimize their impact on qualitative and quantitative models. Data collection should be focused on complete or potentially complete exposure pathways, based on both current and reasonably anticipated future land use, to avoid collecting unnecessary data that do not contribute to site closeout. A well-formed CSM can be important in the development of sound data quality objectives (DQOs). DQOs should be developed to ensure that all appropriate data are collected with sufficient quantity, sensitivity, and precision to meet the needs of the project (EPA 2002b and 2006a). Finally, the CSM serves as a planning instrument and data interpretation aid as well as a communication device between and among project staff and the public.[12]

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11 As stated in the 1999 MNA guidance, A conceptual site model (CSM) is a three-dimensional representation that conveys what is known or suspected about contamination sources, release mechanisms, and the transport and fate of those contaminants. The conceptual model provides the basis for assessing potential remedial technologies at the site. “Conceptual site model” is **not** synonymous with “computer model”; however, a computer model may be helpful for understanding and visualizing current site conditions or for predictive simulations of potential future conditions. Computer models, which simulate site processes mathematically, should in turn be based on sound conceptual site models to provide meaningful information. Computer models typically require a lot of data, and the quality of the output from computer models is directly related to the quality of the input data. Because of the complexity of natural systems, models necessarily rely on simplifying assumptions that may or may not accurately represent the dynamics of the natural system. Calibration and sensitivity analyses are important steps in appropriate use of models. Even so, the results of computer models should be carefully interpreted and continuously verified with adequate field data.

12 To the extent it is consistent with CERCLA, the NCP and existing EPA CERCLA guidance documents, Regions may find useful information in documents prepared by the U.S. Army Corps of Engineers (USACE 1998 and 2003) and the Interstate Technical Regulatory Council (ITRC) (ITRC 2003).

Although the focus of this document is on groundwater, the vadose zone often is another source of contaminants to groundwater at CERCLA sites. Thus, both the vadose and saturated zones normally should both be carefully characterized. Regions should consider developing a CSM that adequately characterizes both the saturated and vadose zone.

Initially, the CSM is developed based on existing knowledge of groundwater and vadose zone fate and transport characteristics, as well as known properties of the specific contaminants potentially present at the site. The CSM should be updated in an iterative fashion as progressively more is learned about the site.

1.4 Definition of MNA in Groundwater

The term "monitored natural attenuation," as used in the 1999 MNA guidance and this document, refers to

> " ...[t]he reliance on natural attenuation processes (within the context of a carefully controlled and monitored site cleanup approach) to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods. The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These *in-situ* processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants." (EPA 1999c, page 3)

1.5 Overview of the 1999 OSWER Directive

The 1999 MNA guidance provides recommendations related to the consideration of MNA generally (for example, for both organic and inorganic contaminants). This 2015 MNA guidance provides additional information and recommendations regarding site characterization, data quality and attenuation processes related specifically to inorganic contaminants.

Although several physical, chemical and biological processes are included in the definition of MNA mentioned above, the 1999 MNA guidance recommends using processes that permanently degrade or destroy contaminants and using MNA only for stable or shrinking plumes, as noted below:

> When relying on natural attenuation processes for site remediation, the EPA prefers those processes that degrade or destroy contaminants. Also, the EPA generally expects that MNA will only be appropriate for sites that have a low potential for contaminant migration. (EPA 1999c, page 3)

> MNA should not be used where such an approach would result in either plume migration[13] or impacts to environmental resources that would be unacceptable to the overseeing regulatory authority. Therefore, sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be the most appropriate candidates for MNA remedies. (EPA 1999c, page 18)

Control of contaminant sources also is an important aspect of the 1999 MNA guidance:

> Control of source materials is the most effective means of ensuring the timely attainment of remediation objectives. EPA, therefore, expects that source control measures will be evaluated for all contaminated sites and that source control measures will be taken at most sites where practicable. At many sites it will be appropriate to implement source control measures during the initial stages of site remediation ('phased remedial approach'), while collecting additional data to determine the most appropriate groundwater remedy. (EPA 1999c, page 22)

The 1999 MNA guidance (*see for example,* pp. 8 – 9) provides a few general recommendations for use of MNA as a remedial approach for inorganic contaminants. For example, these general recommendations include (1) the specific mechanisms responsible for attenuation of inorganic contaminants should be known at a particular site; (2) the stability of the process should be evaluated and shown to be protective under anticipated changes in site conditions; and (3) fate and transport characteristics of any daughter products should be understood. Thus:

> MNA may, under certain conditions (*e.g.,* through sorption or oxidation-reduction reactions), effectively reduce the dissolved concentrations and/or toxic forms of inorganic contaminants in groundwater and soil. Both metals and non-metals (including radionuclides) may be attenuated by sorption[14] reactions such as precipitation, adsorption on the surfaces of soil minerals, absorption into the matrix of soil minerals, or partitioning into organic matter. Oxidation-reduction

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[13] As stated on p. 18 of the 1999 MNA guidance: "In determining whether a plume is stable or migrating, users of this Directive should consider the **uncertainty** associated with defining the limits of contaminant plumes. For example, a plume is typically delineated for each contaminant of concern as a 2- or 3-dimensional feature. Plumes are commonly drawn by computer contouring programs which estimate concentrations between actual data points. The EPA recognizes that a plume boundary is more realistically defined by a zone rather than a line. Fluctuations within this zone are likely to occur as a result of a number of factors (such as analytical, seasonal, or spatial), which may or may not be indicative of a trend in plume migration. Therefore, site characterization activities and performance monitoring should focus on collection of data of sufficient quality to enable decisions to be made with a high level of confidence."

[14] As stated on p. 8 of the 1999 MNA guidance: "When a contaminant is associated with a solid phase, it is usually not known if the contaminant is precipitated as a three-dimensional molecular coating on the surface of the solid, adsorbed onto the surface of the solid, absorbed into the structure of the solid, or partitioned into organic matter. "Sorption" will be used in this Directive to describe, in a generic sense (*i.e.*, without regard to the precise mechanism) the partitioning of aqueous phase constituents to a solid phase."

(redox) reactions can transform the valence states of some inorganic contaminants to less soluble and thus less mobile forms (*e.g.*, hexavalent uranium to tetravalent uranium) and/or to less toxic forms (*e.g.*, hexavalent chromium to trivalent chromium). Sorption and redox reactions are the dominant mechanisms responsible for the reduction of mobility, toxicity, or bioavailability of inorganic contaminants. It is necessary to know what specific mechanism (type of sorption or redox reaction) is responsible for the attenuation of inorganics so that the stability of the mechanism can be evaluated. For example, precipitation reactions and absorption into a soil's solid structure (*e.g.*, cesium into specific clay minerals) are generally stable, whereas surface adsorption (*e.g.,* uranium on iron-oxide minerals) and organic partitioning (complexation reactions) are more reversible. Complexation of metals or radionuclides with carrier (chelating) agents (*e.g.*, trivalent chromium with EDTA) may increase their concentrations in water and thus enhance their mobility. Changes in a contaminant's concentration, pH, redox potential, and chemical speciation may reduce a contaminant's stability at a site and release it into the environment. Determining the existence and demonstrating the irreversibility, of these mechanisms is important to show that a MNA remedy is sufficiently protective.

In addition to sorption and redox reactions, radionuclides exhibit radioactive decay and, for some, a parent-daughter radioactive decay series. For example, the dominant attenuating mechanism of tritium (a radioactive isotopic form of hydrogen with a short half-life) is radioactive decay rather than sorption. Although tritium does not generate radioactive daughter products, those generated by some radionuclides (*e.g.*, Am-241 and Np-237 from Pu-241) may be more toxic, have longer half-lives, and/or be more mobile than the parent in the decay series. Also, it is important that the near surface or surface soil pathways be carefully evaluated and eliminated as potential sources of external direct radiation exposure.[15] (EPA 1999c, pages 8-9)

The 1999 MNA guidance provides context for the Agency's recommendations regarding the feasibility of employing MNA as part of a cleanup for contaminated groundwater. As indicated by the sections transcribed above, the 1999 MNA guidance also points out some key specific issues associated with what constitutes natural attenuation for inorganic contaminants:

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15 As stated on p. 9 of the 1999 MNA guidance: "External direct radiation exposure refers to the penetrating radiation (*i.e.,* primarily gamma radiation and x-rays) that may be an important exposure pathway for certain radionuclides in near surface soils. Unlike chemicals, radionuclides can have deleterious effects on humans without being taken into or brought in contact with the body due to high energy particles emitted from near surface soils. Even though the radionuclides that emit penetrating radiation may be immobilized due to sorption or redox reactions, the resulting contaminated near surface soil may not be a candidate for a MNA remedy as a result of this exposure risk."

> Inorganic contaminants persist in the subsurface because, except for radioactive decay, they are not degraded by the other natural attenuation processes. Often, however, they may exist in forms that have low mobility, toxicity or bioavailability such that they pose a relatively low level of risk. Therefore, natural attenuation of inorganic contaminants is most applicable to sites where immobilization or radioactive decay is demonstrated to be in effect and the process/mechanism is irreversible. (EPA 1999c, page 9)

1.6 Relationship of MNA to Remedial Action Objectives

Existing guidance on the development of remedial action objectives (RAOs) and the relationship of MNA to RAOs may be found in the EPA's 1999 record of decision (ROD) guidance titled, *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decisions Documents*, OSWER Directive 9200.1-23P, page 6-26 (EPA 1999d).

If the ROD includes an RAO that addresses restoration of groundwater for sites with inorganic contaminants in groundwater it may be appropriate to include MNA as a component of a general remedial approach. However, MNA may not be an appropriate response action to ensure protectiveness at the site if the ROD does not include an RAO addressing restoration of groundwater but rather includes RAOs addressing exposure control and prevention of migration. Where the RAOs include restoring groundwater to beneficial use by meeting ARARs or MCLs and the lines of evidence supporting MNA are documented sufficiently in the administrative record, then MNA may be a viable option used in conjunction with other remedial actions or independently to meet the restoration RAO.

1.7 MNA vs. Treatment as a Response Action for Inorganic Contaminants

As stated in the 1999 MNA guidance on p. 3: "The 'natural attenuation processes' that are at work in such a remediation approach include a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater." Inorganic contaminants can be transferred between solid, liquid or gaseous phases and these phase transfers may reduce the aqueous concentration and mobility of inorganic contaminants in groundwater.

Mass reduction through degradation generally is not a viable process for most of the inorganic contaminants discussed in this document. The exception is radioactive decay, which is a well-understood attenuation process that may result in decreased contaminant mass, as described in Section 5.4. There are also limited examples where degradation of nonradiological inorganic contaminants may reduce contaminant mass (for example, biological degradation of nitrate or perchlorate). Thus, while attenuation can reduce the aqueous concentration and mobility of inorganic contaminants in groundwater, it should not be considered a treatment process for most inorganic contaminants, such as zinc and cadmium.

1.8 Primary Differences between Organic and Inorganic MNA

As discussed in the 1999 MNA guidance (p. 13): "**Decisions to employ MNA as a remedy or remedy component should be thoroughly and adequately supported with site-specific characterization data and analysis**" (emphasis in original).

When the potential use of an MNA approach is evaluated, site characterization for organic contaminants typically is focused on evaluating the mechanism of contaminant degradation, quantifying the risks associated with transformation products[16], and calculating the capacity of site conditions to sustain degradation of contaminant mass to achieve cleanup levels throughout the plume. Much of the emphasis on site characterization for MNA of *organic* contaminants has been directed toward collection and analysis of groundwater samples.

Characterization of the solid substrate within the aquifer normally plays a more significant role during site assessment for *inorganic* contaminants (other than nitrate and tritium), where immobilization onto aquifer solids provides the primary means for attenuation of the groundwater plume. In this case, concentrations in groundwater typically are reduced through sorption of the inorganic contaminant onto aquifer solids in combination with the long-term stability of the immobilized contaminant to resist remobilization because of changes in groundwater chemistry. Precipitation also can be a primary attenuation mechanism for inorganic contaminants, whereas it generally is an insignificant mechanism for organic contaminants. The approach and data and information supporting site characterization for nonradiological inorganic contaminants subject to degradation or reductive transformation processes (for example, nitrate) will likely be consistent with the approach employed to assess MNA for organic contaminant plumes (EPA 1998 and 2001). Figure 1.1 illustrates the conceptual distinction between organic and inorganic plume behavior and the degradation of organic contaminants versus immobilization of inorganic contaminants on aquifer solids. When contaminants of concern (COCs) include radionuclides, it generally is important to identify specific isotopes and associated daughter products present in site groundwater and to include both in the assessment of plume stability.

[16] As discussed on p. 6 of the 1999 MNA guidance: "The term "transformation products" in the Directive includes intermediate products resulting from biotic or abiotic processes (*e.g.*, TCE, DCE, vinyl chloride), decay chain daughter products from radioactive decay, and inorganic elements that become methylated compounds (*e.g.*, methyl mercury) in soil or sediment. Some transformation products are quickly transformed to other products while others are longer lived."

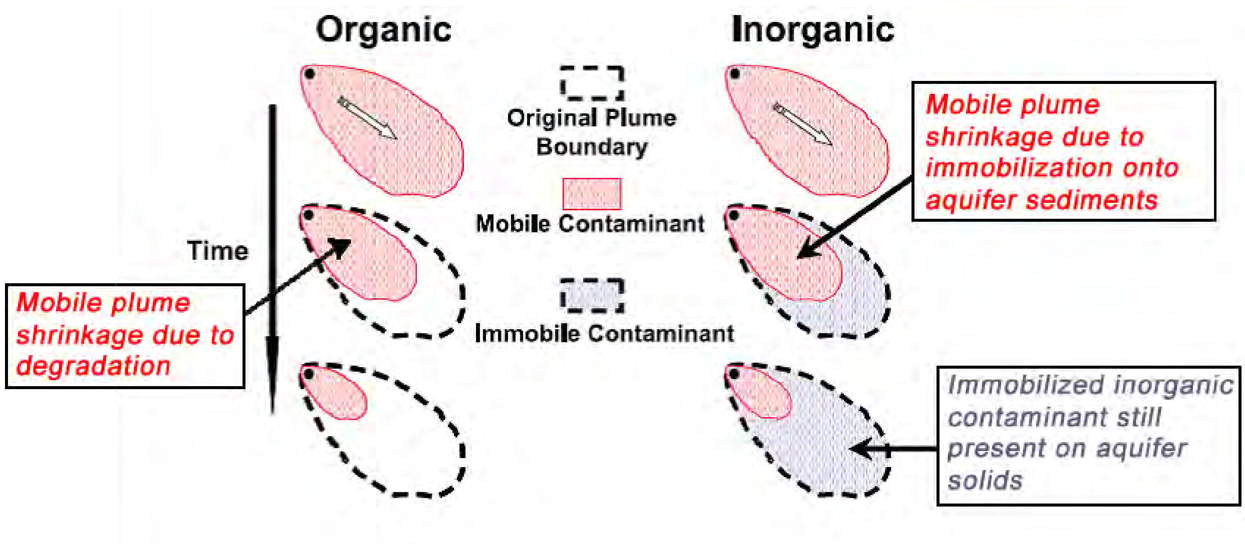

Figure 1.1. Conceptual distinction between organic and inorganic plume behavior illustrating degradation of organic contaminants and immobilization of inorganic contaminants. Immobilization of inorganic contaminants generally may be a viable component of an MNA where the immobilized contaminant remains stable and resistant to remobilization if there are any changes in groundwater chemistry.

2.0 IMPLEMENTATION

Implementation of MNA typically incorporates and balances several factors. It generally is critical to understand the subsurface geologic system and avoid conditions where MNA is not suitable. The Region should obtain data and information to adequately support multiples lines of evidence and a determination of plume stability, which indicate an MNA approach will ensure protectiveness of human health and the environment within a reasonable timeframe.

2.1 Plume Management

As discussed on p. 5 of the 1999 MNA guidance:

> It is common practice in conducting remedial actions to focus on the most obvious contaminants of concern, but other contaminants may also be of significant concern in the context of MNA remedies. In general, since engineering controls are not used to control plume migration in an MNA remedy, decision makers need to ensure that MNA is appropriate to address **all contaminants** that represent an actual or potential threat to human health or the environment (emphasis in original).

Furthermore, as discussed on p. 18 of the 1999 MNA guidance:

> MNA should not be used where such an approach would result in either plume migration[17] or impacts to environmental resources that would be unacceptable to the overseeing regulatory authority. **Therefore, sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be the most appropriate candidates for MNA remedies** (emphasis in original).

MNA may be implemented in a variety of ways for inorganic contaminants, depending on the nature of the chemical composition of the contaminant plumes, subsurface geology and potential exposures that are addressed. EPA policy allows MNA to be selected as a response action for one plume or comingled plumes; addressing commingled plumes may be significantly more

[17] "In determining whether a plume is stable or migrating, users of this [1999 MNA guidance] Directive should consider the **uncertainty** associated with defining the limits of contaminant plumes. For example, a plume is typically delineated for each contaminant of concern as a 2- or 3-dimensional feature. Plumes are commonly drawn by computer contouring programs which estimate concentrations between actual data points. The EPA recognizes that a plume boundary is more realistically defined by a zone rather than a line. Fluctuations within this zone are likely to occur due to a number of factors (*e.g.*, analytical, seasonal, spatial, etc.) which may or may not be indicative of a trend in plume migration. Therefore, site characterization activities and performance monitoring should focus on collection of data of sufficient quality to enable decisions to be made with a high level of confidence." See USEPA, 1993b, USEPA, 1993c, USEPA, 1994b and USEPA, 1998b, for additional guidance (citations in original).

complex than addressing similar separate plumes and may involve additional risk management considerations and expertise.

It may also be appropriate to select MNA for a particular contaminant while another response action is selected for other contaminants within the same plume. Likewise, it may be appropriate to select MNA for a particular contaminant in a portion of the plume and another remedy for the same contaminant in another portion of the plume. For example, enhanced bioremediation of a plume containing petroleum hydrocarbons can produce reducing conditions if bioremediation results in consumption of dissolved oxygen and other electron acceptors in the aquifer. These reducing conditions may result in the increased mobilization or solubility of redox-sensitive inorganic contaminants such as iron or manganese, which may also be associated with arsenic.

MNA may be an appropriate response action for the inorganic plume where it can be shown that the geochemistry downgradient of the hydrocarbon plume reverts to oxidizing conditions that would immobilize the inorganic contaminants. Similarly, an active remedy may be selected for one portion of a plume (for example, near a source area) while MNA may be selected for the same contaminant at the lower-concentration portion of the same plume farther downgradient.

2.2 Dispersion and Dilution

As discussed on p. 18 of the 1999 MNA guidance:

> An example of a situation where MNA may be appropriate is a remedy that includes source control, a pump-and-treat system to mitigate the highly-contaminated plume areas, and MNA in the lower concentration portions of the plume. In combination, these methods would maximize groundwater restored to beneficial use in a timeframe consistent with future demand on the aquifer, while utilizing natural attenuation processes to reduce the reliance on active remediation methods and reduce remedy cost. If, at such a site, the plume was either expanding or threatening downgradient wells or other environmental resources, then MNA would **not** be an appropriate remedy (emphasis in original).

Dispersion and dilution resulting from mixing with influent precipitation, up- or cross-gradient groundwater or leakage from overlying surface water bodies may be elements of an MNA response action for inorganic contaminants. **However, dilution and dispersion generally are not appropriate as primary MNA mechanisms because they reduce concentrations through dispersal of contaminant mass rather than destruction or immobilization of contaminant mass.** Dilution and dispersion may be appropriate as a "polishing step" for distal portions of a plume when an active remedy is being used at a site, source control is complete and appropriate land use and ground water use controls are in place. Results of conservative tracer studies can be used to estimate the contribution of dilution and dispersion to contaminant attenuation rates.

2.3 Site Monitoring

As discussed on p. 20 of the 1999 MNA guidance:

> It should be noted that the timeframe required for MNA remedies is often longer than that required for more active remedies. **As a consequence, the uncertainty associated with the above factors increases dramatically. Adequate performance monitoring and contingency remedies (both discussed in later sections of this Directive) should be utilized because of this higher level of uncertainty** (emphasis in original).

Furthermore, as discussed in the 1999 MNA guidance (pp. 22-23):

> Performance monitoring to evaluate remedy effectiveness and to ensure protection of human health and the environment is a critical element of all response actions. Performance monitoring is of even greater importance for MNA than for other types of remedies due to the potentially longer remediation timeframes, potential for ongoing contaminant migration, and other uncertainties associated with using MNA. This emphasis is underscored by EPA's reference to "monitored natural attenuation."
>
> The monitoring program developed for each site should specify the location, frequency, and type of samples and measurements necessary to evaluate whether the remedy is performing as expected and is capable of attaining remediation objectives. In addition, all monitoring programs should be designed to accomplish the following:
>
> - Demonstrate that natural attenuation is occurring according to expectations;
> - Detect changes in environmental conditions (e.g., hydrogeologic, geochemical, microbiological or other changes) that may reduce the efficacy of any of the natural attenuation processes [footnote in original deleted];
> - Identify any potentially toxic and/or mobile transformation products;
> - Verify that the plume(s) is not expanding (either downgradient, laterally or vertically);
> - Verify no unacceptable impact to downgradient receptors;
> - Detect new releases of contaminants to the environment that could impact the effectiveness of the natural attenuation remedy;
> - Demonstrate the efficacy of institutional controls that were put in place to protect potential receptors; and
> - Verify attainment of remediation objectives.

In addition to the 1999 MNA guidance, other existing EPA CERCLA guidance discusses development of a performance monitoring framework and monitoring plan (see *Performance Monitoring of MNA Remedies for VOCs* [volatile organic compounds] *in Ground Water* [EPA 2004b]). Although that guidance focuses on attenuation of common organic contaminants, the recommended framework and many of the recommendations regarding plan development also may be useful at sites with inorganic constituents.

The performance of an MNA response action should be monitored to determine whether site-specific RAOs identified in remedy decision documents are achieved.[18] Where the time horizons for successful implementation of an MNA response action are expected to be long, Regions should pay particular attention to long-term monitoring plans. Monitoring trends in groundwater COCs through time and space in a carefully designed monitoring network typically is a key part of informed decision making for both (1) selecting MNA as an appropriate response action for a site, and (2) assessing the effectiveness of MNA over time.

Initial assessments of whether the aquifer is generally oxidizing or reducing, shallow or deep, and whether it is influenced by external hydrologic forces (for example, interactions between groundwater and surface water, recharge from meteoric precipitation or episodic regional withdrawals from the aquifer) should be considered in designing the dimensions of the monitoring network and the frequency of data collection to characterize site chemistry and hydrology (EPA 2008).

With the exception of nitrate, perchlorate and radioactive decay, inorganic contaminant mass generally is not reduced with most attenuation mechanisms. Therefore, performance monitoring for these chemicals typically is designed to demonstrate geochemical alteration of COCs to lower-risk or lower-mobility compounds or species (for example, Fe^{2+} to Fe^{3+}). A determination that cleanup levels have been achieved should be based on data and information contained in the administrative record that demonstrate degradation and immobilization, in addition to showing that decreasing concentrations are within the risk level or in compliance with ARARs specified in the remedy decision (for example, MCLs attained throughout the plume). The data and information collected by the Region also should demonstrate that site conditions and contaminant concentrations have long-term stability (so that there will be no remobilization of contamination in the future).

Much of the monitoring to evaluate performance of MNA usually falls into three basic categories: (1) ambient monitoring to assess background contaminant levels and the status of relevant ambient geochemical indicators (for example, redox potential [Eh] and pH); (2) monitoring to assure the viability and efficacy of attenuation processes; and (3) monitoring to

[18] As stated on p. 23 of the 1999 MNA guidance: "**Performance monitoring should continue until remediation objectives have been achieved, and longer if necessary to verify that the site no longer poses a threat to human health or the environment"** (emphasis in original).

detect any plume expansion (EPA 2007a). Identifying the solid phase components' contribution to attenuation of the contaminant plume often can be critical to reducing the level of uncertainty in selecting MNA for sites where immobilization is the dominant attenuation process. These solid-phase components can be grouped into the following three categories: (1) components that serve as a source of contaminants within the plume; (2) components (biotic and abiotic) that participate directly or indirectly during the attenuation process; and (3) the chemical form of the immobilized contaminant and its long-term stability considering future changes in groundwater chemistry.

The specific recommended objectives for an MNA performance monitoring program discussed in the 1999 MNA guidance usually can be met by implementing a performance monitoring program that measures contaminant concentrations, geochemical parameters and hydrologic parameters (for example, hydraulic gradients). Much of the monitoring typically focuses on groundwater and should be used to evaluate changes in plume distribution in three dimensions as well as changes in redox state that may affect the rate and extent of natural attenuation. Data on groundwater can often be used to evaluate mobile contaminant mass and concentration reductions that would indicate progress toward RAOs (EPA 2007a). However, periodic sampling of aquifer solids, through soil coring, generally will be warranted in most situations to evaluate potential reduction in the capacity of aquifer materials to immobilize contaminants.

Ultimately, monitoring programs should be designed to demonstrate continued stability of the plume over time and to identify changes in groundwater chemistry that may lead to decreases in rates or capacity of the aquifer to attenuate the contaminant of concern or changes that may lead to re-mobilization of attenuated compounds. Changes in indicator parameters or compounds such as pH, dissolved iron, or sulfate may indicate dissolution of important sorptive phases within the aquifer. These changes may be detected before observed changes in concentrations of COCs and thus often serve as indicators of potential MNA failure.

Demonstrating that the inorganic contaminant immobilized onto aquifer solids will not remobilize typically depends on identifying the chemical speciation of the inorganic contaminant partitioned to the solid phase. This information often is critical for identifying the mechanism controlling attenuation and evaluating the long-term stability of the immobilized contaminant in light of observed or anticipated changes in groundwater chemistry.

2.4 Plume Stability

As stated on p. 18 of the 1999 MNA guidance:

> Of the above factors, the most important considerations regarding the suitability of MNA as a remedy include: whether the contaminants are likely to be effectively addressed by natural attenuation processes, the stability of the groundwater contaminant plume and its potential for migration, and the potential for unacceptable risks to human health or environmental resources by the contamination. MNA should not be used where such an approach would result in

> either plume migration[19] or impacts to environmental resources that would be unacceptable to the overseeing regulatory authority. **Therefore, sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be the most appropriate candidates for MNA remedies** (emphasis in original).

Demonstration of plume stability generally is a critical factor for selecting MNA and typically involves delineating a plume in all three dimensions and designing a monitoring network to assess the plume over time. In general, a plume may be considered stable if the monitoring network shows that groundwater contaminant concentrations (in unfiltered samples) do not increase in space or time. The demonstration of plume stability normally should consider both the aqueous mobile and the enhanced colloid transport phases, if present, throughout the plume.

If the attenuation rate is less than the rate of concentration increase within the plume, then the plume could expand. MNA normally would not be considered suitable for an expanding plume. It is possible that expanding plume conditions could develop over time because of formation of daughter products or unforeseen geochemical or other site changes. (See Section 5 for additional information on conditions that affect plume stability.) Such a situation would warrant further or additional sampling and analysis to determine if MNA is still a suitable action. Therefore, MNA remedies for stable plumes should be evaluated systematically (that is, quarterly to yearly), and an appropriate contingency remedy should be identified if conditions no longer conform to those defined as necessary for MNA.

As discussed on p. 22 of the 1999 MNA guidance:

> Control of source materials is the most effective means of ensuring the timely attainment of remediation objectives. **EPA, therefore, expects that source control measures will be evaluated for all contaminated sites and that source control measures will be taken at most sites where practicable.** At many sites it will be appropriate to implement source control measures during the initial stages of site remediation ("phased remedial approach"), while collecting additional data to determine the most appropriate groundwater remedy (emphasis in original).

Although source control will likely reduce contaminant mass flux, the plume may still continue to expand or migrate. It is therefore generally not appropriate to demonstrate plume stability after source control has been accomplished only by showing a decrease in contaminant mass flux. Instead, plume stability generally should be demonstrated by showing decreasing concentration trends at all wells and static or contracting plume boundaries. See Sections 3 and 4 of this document for further discussion of mass flux.

MNA is generally not appropriate for plumes that are considered stable, yet there is confirmed discharge to surface water bodies or potential human or ecological receptor exposure.

2.5 Complex Geologic Regimes

As discussed on p. 15 of the 1999 MNA guidance:

> MNA may not be appropriate as a remedial option at many sites for technological or economic reasons. For example, in some complex geologic systems, technological limitations may preclude adequate monitoring of a natural attenuation remedy to ensure with a high degree of confidence that potential receptors will not be impacted. This situation typically occurs in many karstic, structured, and/or fractured rock aquifers where groundwater moves preferentially through discrete pathways (*e.g.*, solution channels, fractures, joints, foliations). The direction of groundwater flow through such heterogeneous (and often anisotropic) materials cannot be predicted directly from the hydraulic gradient, and existing techniques may not be capable of identifying the pathway along which contaminated groundwater moves through the subsurface. MNA will not generally be appropriate where site complexities preclude adequate monitoring. In some other situations where it may be technically feasible to monitor the progress of natural attenuation, the cost of site characterization and long-term monitoring required for the implementation of MNA may be higher than the cost of other remedial alternatives. Under such circumstances, MNA may not be less costly than other alternatives

MNA generally should not be considered at sites with zones where groundwater flow is rapid or overwhelms biotic and abiotic attenuation mechanisms. The particular situation may be problematic in specific fractured rock and karst environments because of high flow regimes and inadequate reaction times. Sites with these conditions generally are characterized by very rapid groundwater transport and, thus, attenuation mechanisms are unlikely to occur at a rate commensurate with or exceeding the rate of contaminant transport. MNA generally will not be effective or protective under these conditions. In addition, technological limitations in such complex geologic systems may preclude adequate monitoring of MNA to ensure with a high degree of confidence that potential receptors will not be affected.

2.6 Reasonable Timeframe

The 1999 MNA guidance (p. 2) states that natural attenuation should “achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods” (EPA 1999c). In the “Reasonable Timeframe for Remediation” section, the 1999 MNA guidance (p. 19) goes on to state that “determination of the most appropriate timeframe is achieved through a comparison of estimates of remediation timeframe for all appropriate remedy alternatives.”

Furthermore, the 1999 MNA guidance states (on pp. 19 – 20) states:

> Whether a particular remediation timeframe is appropriate and reasonable for a given site is determined by balancing tradeoffs among many factors which include:
>
> - Classification of the affected resource (*e.g.*, drinking water source, agricultural water source) and value of the resource[19];
> - Relative timeframe in which the affected portions of the aquifer might be needed for future water supply (including the availability of alternate supplies);
> - Subsurface conditions and plume stability which can change over an extended timeframe;
> - Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources;
> - **Uncertainties** regarding the mass of contaminants in the subsurface and predictive analyses (*e.g.*, remediation timeframe, timing of future demand, and travel time for contaminants to reach points of exposure appropriate for the site);
> - Reliability of monitoring and of institutional controls over long time periods;
> - Public acceptance of the timeframe required to reach remediation objectives; and
> - Provisions by the responsible party for adequate funding of monitoring and performance evaluation over the time period required for remediation (emphasis in original).

In evaluating what is a "reasonable timeframe" for achieving RAOs at a site with inorganic contaminants in groundwater, Regions should consider a number of factors that may affect the timeframe. The EPA recommends that Regions also consider additional factors, including contaminant properties, exposure risk, classification of the protected resource (for example, a source of drinking water), the potential for plume stability and the relative timeframe for active remediation methods to achieve RAOs.

Some radionuclides have long decay half-lives, and substantially longer timeframes generally will be required that may exceed both the remediation timeframe and active treatment if radioactive decay is used as the primary natural attenuation mechanism. In these situations,

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[19] "In determining whether an extended remediation timeframe may be appropriate for the site, the EPA and other regulatory authorities should consider state groundwater resource classifications, priorities and/or valuations where available, in addition to relevant federal guidelines. Individual states may provide information and guidance relevant to groundwater classifications or use designations as part of a Comprehensive State Groundwater Protection Program (CSGWPP)." (See USEPA, 1992a and USEPA, 1997b) (citations in original).

MNA may not be reasonable for radionuclides that have a long half-life and decay daughters that are long lived, have other properties affecting mobility or that emit other particles that increase risk.

While remediation timeframes for organic plumes may be on the order of a few tens of years to more than a hundred years, remediation timeframes for inorganic plumes may be substantially longer. Ultimately, the timeframe for remediation will be based on site-specific conditions and chemical characteristics. The longer timeframes for inorganic plumes may be reasonable if the source term has already been addressed, the plume is stable or shrinking, the exposure risks for the source term and daughter products are acceptable, and when active measures have similar timeframes. Multiple lines of evidence are recommended for demonstrating "reasonable timeframe" considering the above factors in conjunction with the following: source control or removal is complete; there is high confidence in the attenuation mechanisms, rates and capacity identified; and contingency plans are included for both the monitoring program and containment or treatment approaches. Ultimately, consistent with CERCLA and the NCP, an MNA remedial action must be protective of human health and the environment over the selected timeframe of the site cleanup (until RAOs are met).

MNA may be particularly useful for radionuclides that have a short half-life (that is, less than 50 years), depending on the total timeframe required for MNA to achieve RAOs and reach cleanup levels. The initial concentrations of the radionuclides and daughter products should be considered and reflected in the Region's evaluation of MNA as a potential response action. Using the equation below normally should be useful in evaluating the reasonableness of the time required to reach the MCL (or, in the absence of an MCL, the risk-based number) using the total radionuclide contaminant concentration from groundwater (or selected media). Depending on the initial groundwater concentration (C_o), many half-lives may be required to reach the MCL (or risk-based cleanup level). Failure to account for this potential lag may lead to inappropriate consideration of MNA as a potential response action (that is, a longer response action timeframe than is reasonable or the groundwater plume migrates and contaminates a larger area).

The time required to reach the cleanup concentration for radionuclides in groundwater generally may be calculated as follows:

$$t = 3.323 * t_{1/2} * \log \frac{C_o}{C} \qquad \text{Eq. 1}$$

where $t_{1/2}$ is the half-life of the radionuclide, C represents the target cleanup level, and C_o represents the initial chemical concentration in groundwater (Smith and Smith 1971). For example, if the initial concentration of uranium-234 ($t_{1/2}$=2.4x10^5 yrs) in groundwater was 700 micrograms per liter (µg/L), the time required to reach the 30 µg/L MCL for uranium-234 would be more than 1 million years, clearly not generally considered a reasonable timeframe. This example was calculated using mass concentration units but may be calculated using activity units (picocuries per liter, for example). This recommended simple equation can allow time required to reach a desired concentration *C* to be estimated; it also may be rearranged to determine the final concentration at a specified time *t*. Note that additional calculations would be needed to quantify concentrations of daughter products generated and their associated decay timeframes.

In the event of long-duration MNA remediation timeframes, ICs may be needed to help ensure protectiveness of human health as a short-term tool to supplement MNA, consistent with CERCLA and the NCP (40 CFR 300.430(a)(1)(iii)). ICs generally should remain in place and be maintained and enforced effectively until the groundwater concentrations allow for an acceptable level of risk for all resources uses (EPA 2012).

2.7 Cleanup Levels for MNA

As discussed in the 1999 MNA guidance (p. 12):

> The NCP Preamble also specifies that cleanup levels appropriate for the expected beneficial use (*e.g*., MCLs for drinking water) "should generally be attained throughout the contaminated plume, or at and beyond the edge of the waste management area when waste is left in place" (USEPA, 1990a, p.8713) (citation in original).

An MNA remedial action should attain the same cleanup levels that would be defined for active remedies and be consistent with the NCP's expectation for achieving restoration of groundwater to beneficial use;[20] site-specific decision documents typically include RAOs, preliminary remediation goals (PRGs), and cleanup levels that reflect groundwater restoration when that is the selected remedy.[21] MCLs defined in the Safe Drinking Water Act are typically used as ARARs and cleanup levels for groundwater. The groundwater standards for uranium-234 and 238 under the Uranium Mill Tailings Radiation Control Act of 1978 (UMTRCA) generally are potential ARARs (see Table 1 of Subpart A, 40 CFR 192). If promulgated ARARs do not exist for the inorganic compound being remediated, risk-based cleanup levels should be established such that exposure to the contaminant will not result in unacceptable risk to human health or the environment at the calculated cleanup level.[22]

To help evaluate the performance of an MNA remedial action, a site-specific groundwater exit strategy should be developed early in the cleanup process.[23]

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20 *See* "Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration" (OSWER Directive Number 9283.1-33, June 26, 2009).

21 *See* "A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents," OSWER Directive 9200.1-23P, 1999).

22 *See* "Clarification of the Role of Applicable, or Relevant and Appropriate Requirements in Establishing Preliminary Remediation Goals under CERCLA," OSWER Directive No. 9200.4-23 (August 22, 1997).

23 More detailed OSWER guidance regarding development of an exit strategy at CERCLA sites is currently under development.

2.8 Relationship to Technical Impracticability (TI) Waiver

The 1999 MNA guidance discusses TI waivers on p. 13 as follows:

> It also should be emphasized that the selection of MNA as a remedy does **not** imply that active remediation measures are infeasible, or are "technically impracticable" from an engineering perspective. Technical impracticability (TI) determinations are used to justify a departure from cleanup levels that would otherwise be required at a Superfund site or RCRA facility based on the inability to achieve such cleanup levels using available remedial technologies (USEPA, 1993a) (citation in original). Such a TI determination does not imply that there will be no active remediation at the site, nor that MNA will be used at the site. Rather, such a TI determination simply indicates that the cleanup levels and objectives which would otherwise be required cannot practicably be attained using available remediation technologies. In such cases, an alternative cleanup strategy that is fully protective of human health and the environment must be identified. Such an alternative strategy may still include engineered remediation components, such as recovery of free phase NAPLs and containment of residual contaminants, in addition to approaches intended to restore some portion of the contaminated groundwater to beneficial uses. Several remedial approaches could be appropriate to address the dissolved plume, one of which could be MNA under suitable conditions. However, the evaluation of natural attenuation processes and the decision to rely upon MNA for the dissolved plume should be distinct from the recognition that restoration of a portion of the plume is technically impracticable (*i.e.*, MNA should **not** be viewed as a direct or presumptive outcome of a technical impracticability determination.) (emphasis in original).

The EPA's response actions may be designed to achieve several objectives, including to remove or treat source materials, contain non-restorable source areas, and restore contaminated groundwater to beneficial uses at CERCLA sites with inorganic contaminants in the groundwater. Complete restoration of the contaminated groundwater (for example, achieving MCLs throughout the plume) may not be technically practicable at some sites, however. Depending on site conditions, groundwater restoration may be impractical because of a combination of hydrogeologic factors (such as fractured rock or karst conditions, or matrix diffusion) and contaminant-related factors (such as low solubility).

Under CERCLA and the NCP, one of the potentially available ARAR waivers in such circumstances is a technical impracticability (TI) waiver. EPA's TI guidance[24] discusses the circumstances where it may be appropriate for Regions to consider a TI waiver, as well as the data and information that should be collected to ensure the administrative record contains sufficient information and data to support the Agency's determination.

The utilization of a TI waiver for a portion of the site does not preclude the use of MNA at the site where MNA would potentially being appropriate outside of the TI zone. Data collected as part of the overall site characterization for contaminant and hydrogeologic factors may be helpful in evaluating whether MNA may be an appropriate approach at another area of the site. Both TI waiver and MNA decisions should be supported by sufficient data and information in the administrative record (multiple lines of evidence).

2.9 Documentation

As discussed in the 1999 MNA guidance (pp. 13-14):

> **Decisions to employ MNA as a remedy or remedy component should be thoroughly and adequately supported with site-specific characterization data and analysis.** In general, the level of site characterization necessary to support a comprehensive evaluation of MNA is more detailed than that needed to support active remediation. Site characterizations for natural attenuation generally warrant a quantitative understanding of source mass; groundwater flow (including preferential pathways); contaminant phase distribution and partitioning between soil, groundwater, and soil gas; rates of biological and non-biological transformation; and an understanding of how all of these factors are likely to vary with time. This information is generally necessary since contaminant behavior is governed by dynamic processes which must be well understood before MNA can be appropriately applied at a site. Demonstrating the efficacy of MNA may require analytical or numerical simulation of complex attenuation processes. Such analyses, which are critical to demonstrate natural attenuation's ability to meet remediation objectives, generally require a detailed conceptual site model as a foundation (emphasis in original).

Consideration of MNA in the remedy selection process at a site where inorganic contaminants are present in the groundwater should be documented and supported like any other CERCLA response action, consistent with the statute, NCP and existing guidance (such as the 1999 ROD guidance). Thus, for example, data and information to support evaluation and selection of MNA

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[24] *Guidance for evaluating the technical impracticability of ground-water restoration*, OSWER Directive 9234.2-25, EPA/540-R-93-080 (1993). *See also A Guide To Preparing Superfund Proposed Planned, Records Of Decision, and other Remedy Selection Decision Documents,* OSWER 9200.1-23P July 1999 (section 9.5).

should be collected and documented in the administrative record, starting with the remedial investigation (RI) phase of a project and continuing throughout the remedy selection and remedy implementation phases of the cleanup. [25] MNA typically should be identified as a potential response action in the feasibility study (FS) and included as a free-standing alternative or as a component of an alternative that involves other technologies (for example, source removal via excavation, in situ chemical oxidation in high concentration areas, or ICs). Supporting rationale for selecting MNA, if it is part of the preferred alternative, should be included in the proposed plan, and final selection should be documented in the ROD for a site. In general, when MNA is selected, contingency ROD language may be appropriate (see 1999 MNA guidance, p. 24).

2.10 Five Year Reviews

Consistent with CERCLA § 121(c), the NCP at 40 CFR § 300.430(f)(4)(ii), states:

> If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after the initiation of the selected remedial action.

At sites where MNA is selected in the ROD, five-year reviews evaluate the continued protectiveness of the remedy until cleanup levels are met because MNA does not immediately allow for unlimited use and unrestricted exposure of groundwater. In general, it is important to understand the attenuation mechanisms so that the risk for contaminant mobilization or remobilization can be anticipated, incorporated into the long-term monitoring plan, and addressed in a manner that ensures protectiveness of human health and the environment.

[25] Refer to Subpart I of the NCP and the EPA guidance (EPA 2010b) regarding preparation of the administrative record.

3.0 RECOMMENDED TIERED ANALYSIS APPROACH TO DEVELOP MULTIPLE LINES OF EVIDENCE

As discussed earlier, the 1999 MNA guidance recommends a three- tiered evaluation approach. A tiered analysis approach to site characterization to develop multiple lines of evidence for evaluation of MNA may have the advantage of potentially saving significant resources because it is designed to prioritize and focus the data used for decision making at each screening step. Uncertainty typically also is reduced as site-specific data are collected. Information and data collection and evaluation within the tiered analysis approach typically should be developed in the following four phases:

- Phase I: Demonstration that the groundwater plume is *not expanding*.[26]
- Phase II: Determination that the *mechanism and rate* of the attenuation process are sufficient.[27]
- Phase III: Determination that the *capacity* of the aquifer is sufficient to attenuate the mass of contaminant within the plume and the *stability* of the immobilized contaminant is sufficient to resist re-mobilization.[28]
- Phase IV: Design of a *performance monitoring program* based on an understanding of the mechanism of the attenuation process, and establishment of contingency remedies tailored to site-specific characteristics. This phase in effect reflects recommendations in the 1999 MNA guidance, but consolidated into a single, additional phase.[29]

Obtaining data and information for inclusion in the administrative record to support a demonstration that a groundwater plume is *not expanding* (Phase I) and determination that the *mechanism and rate* of attenuation are sufficient (Phase II) are the recommended initial steps in evaluating MNA. Successful demonstration of Phase III generally involves predicting future MNA performance, which may be difficult to accomplish with confidence at sites with complex hydrogeology and contaminant geochemistry. Developing multiple lines of evidence reflecting

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[26] In the 1999 MNA guidance, this tier is described as: "Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points."

[27] In the 1999 MNA guidance, this tier is described as: "Hydrogeologic and geochemical data that can be used to demonstrate **indirectly** the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels." (emphasis in original).

[28] In the 1999 MNA guidance, this tier is described as: "Data from field or microcosm studies (conducted in or with actual contaminated site media) which **directly** demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only)" (emphasis in original).

[29] Refer to Table 1.1 in *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume I – Technical Basis for Assessment,* EPA 600-R-07-139 (EPA 2007a).

these three phases should be considered at any site with inorganic contaminants in the groundwater where MNA is evaluated as a component of the groundwater remedy. The technical knowledge obtained through the first three phases generally may be useful in designing a monitoring program (Phase IV) that tracks MNA performance.

In discussing the three tiers, the 1999 MNA guidance (p. 16) states:

> **Unless the EPA or the overseeing regulatory authority determines that historical data (Number 1 above) are of sufficient quality and duration to support a decision to use MNA, data characterizing the nature and rates of natural attenuation processes at the site (Number 2 above) should be provided. Where the latter are also inadequate or inconclusive, data from microcosm studies (Number 3 above) may also be necessary.[30]** In general, more supporting information may be required to demonstrate the efficacy of MNA at those sites with contaminants which do not readily degrade through biological processes (*e.g.*, most non-petroleum compounds, inorganics), or that transform into more toxic and/or mobile forms than the parent contaminant, or where monitoring has been performed for a relatively short period of time. The amount and type of information needed for such a demonstration will depend upon a number of site-specific factors, such as the size and nature of the contamination problem, the proximity of receptors and the potential risk to those receptors, and other characteristics of the environmental setting (*e.g.*, hydrogeology, ground cover, climatic conditions) (emphasis in original).

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[30] As stated on p. 16 of the 1999 MNA guidance:

(1) Historical groundwater and/or soil chemistry data that demonstrate a clear and meaningful trend18 of decreasing contaminant mass and/or concentration over time at appropriate monitoring or sampling points. (In the case of a groundwater plume, decreasing concentrations should not be solely the result of plume migration. In the case of inorganic contaminants, the primary attenuating mechanism should also be understood.)

(2) Hydrogeologic and geochemical data that can be used to demonstrate **indirectly** the type(s) of natural attenuation processes active at the site, and the rate at which such processes will reduce contaminant concentrations to required levels. For example, characterization data may be used to quantify the rates of contaminant sorption, dilution, or volatilization, or to demonstrate and quantify the rates of biological degradation processes occurring at the site.

(3) Data from field or microcosm studies (conducted in or with actual contaminated site media) which **directly** demonstrate the occurrence of a particular natural attenuation process at the site and its ability to degrade the contaminants of concern (typically used to demonstrate biological degradation processes only).

Furthermore, as discussed in the "Reasonable Timeframe for Remediation" section of the 1999 MNA guidance (p. 21):

> Thus, the EPA or other regulatory authorities should consider a number of factors when evaluating reasonable timeframes for MNA at a given site. These factors, on the whole, should allow the overseeing regulatory authority to determine whether a natural attenuation remedy (including institutional controls where applicable) will fully protect potential human and environmental receptors, and whether the site remediation objectives and the time needed to meet them are consistent with the regulatory expectation that contaminated groundwaters will be restored to beneficial uses within a reasonable timeframe. **When these conditions cannot be met using MNA, a remedial alternative that more likely would meet these expectations should be selected** (emphasis in original).

Consistent with the 1999 MNA guidance, MNA may normally be considered a feasible groundwater alternative if data and information obtained pursuant to Phases I through III suggest cleanup goals can be achieved within a reasonable time frame. Recommended objectives that generally should be addressed and the types of site-specific data that generally should be collected under each successive phase are described below (EPA 2007a).

The primary objectives of progressing through the tiered site analysis are to reduce uncertainty in the MNA remedy selection process and to compile data and information in the administrative record supporting the Agency's remedy selection decision. The recommended tiered analysis process can provide a means to organize the data collection effort in a cost-effective manner that allows sites to be evaluated at intermediate stages of the site characterization effort. A general synopsis of the recommended objectives along with possible analysis approaches and data types to collect under each phase is provided in Table 3.1. Data collected for assessment of MNA are often similar to data collected to evaluate engineered remedies such as pump and treat or in situ treatment methods. This recommended approach is designed to optimize site characterization and data collection, facilitate development of multiple lines of evidence, and ensure adequate administrative record support for remedy selection decisions.

Table 3.1. Synopsis of the recommended site characterization objectives to address throughout the tiered analysis process and potential supporting data types and analysis approaches associated with each phase.

PHASE	RECOMMENDED OBJECTIVE	POTENTIAL DATA TYPES AND ANALYSIS
I	Demonstrate plume stability	• Groundwater flow direction (calculation of hydraulic gradients); aquifer hydrostratigraphy • Contaminant concentrations in groundwater • General groundwater chemistry data for preliminary

PHASE	RECOMMENDED OBJECTIVE	POTENTIAL DATA TYPES AND ANALYSIS
		evaluation of contaminant degradation
II	Determine mechanism and rate of attenuation	• Detailed characterization of system hydrology (spatial and temporal heterogeneity; flow model development) • Detailed characterization of groundwater chemistry • Subsurface mineralogy and microbiology • Contaminant speciation (groundwater and aquifer solids) • Evaluate reaction mechanism (site data, laboratory testing, develop chemical reaction model)
III	Determine system capacity and stability	• Determine contaminant and dissolved reactant fluxes (concentration data and water flux determinations) • Determine mass of available solid phase reactants • Laboratory testing of immobilized contaminant stability (ambient groundwater; sequential extraction solutions) • Perform model analyses to characterize aquifer capacity and to test immobilized contaminant stability (hand calculations, chemical reaction models, reaction-transport models)
IV	Design performance monitoring program and identify alternative remedy	• Select monitoring locations and frequency consistent with site heterogeneity • Select monitoring parameters to assess consistency in hydrology, attenuation efficiency, and attenuation mechanism • Select monitored conditions that "trigger" re-evaluation of adequacy of monitoring program (frequency, locations, data types) • Select alternative remedy best suited for site-specific conditions

3.1 Phase I: Demonstration that the groundwater plume is not expanding

As stated in the 1999 MNA guidance (p. 18): "Therefore, sites where the contaminant plumes are no longer increasing in extent, or are shrinking, would be the most appropriate candidates for MNA remedies."

The recommended objective under Phase I analysis is to obtain data and information that can be used to evaluate whether MNA should be eliminated from further consideration for sites where the groundwater plume is not stable or continuing to expand. Efforts generally should focus on delineating the areal and vertical extent of plume boundaries. Time-series data collected from monitoring wells normally can be used to evaluate whether concentrations are increasing or decreasing at monitoring locations downgradient from a source area. An increasing concentration trend generally indicates that sufficient attenuation is not occurring and the groundwater plume is expanding and, as a result, MNA is generally not appropriate. However, short-term increases in contaminant concentration may not automatically indicate an expanding groundwater plume and should be evaluated in the context of a longer-term monitoring trend analysis. This approach is recommended to account for variations in groundwater contaminant concentration because of natural subsurface variability and seasonal fluctuations.

3.2 Phase II: Determination that the mechanism and rate of the attenuation process are sufficient

As discussed in the 1999 MNA guidance (p. 20): "A decision on whether or not MNA is an appropriate remedy for a given site is usually based on estimates of the rates of natural attenuation processes. Site characterization (and monitoring) data are typically used for estimating attenuation rates."

Furthermore, the 1999 MNA guidance states (p. 21):

> As an example, analysis of natural attenuation rates from many sites indicates that a measured decrease in contaminant concentrations of at least one order of magnitude is necessary to determine the appropriate rate law to describe the rate of attenuation, and to demonstrate that the estimated rate is statistically different from zero at a 95% level of confidence (Wilson, 1998) (citation in original). Due to variability resulting from sampling and analysis, as well as plume variability over time, smaller apparent reductions are often insufficient to demonstrate (with 95% level of confidence) that attenuation has in fact occurred at all.

The recommended objectives under Phase II analysis are to obtain data and information that can be used to accomplish the following: (1) evaluate the mechanism and rate of the attenuation process or processes, and (2) evaluate whether MNA should be eliminated from further consideration. This second consideration normally is appropriate for sites where further analysis shows that attenuation rates are insufficient for attaining site cleanup objectives within a timeframe that is reasonable compared with other remedial alternatives (EPA 1999c). Data should be collected to define groundwater chemistry, aquifer solids composition and mineralogy, and the chemical speciation of the contaminant in groundwater and associated aquifer solids to evaluate the attenuation mechanism. Radioisotopes and associated daughter products should be identified for radionuclide-contaminated sites, as these may have different fate and transport properties. This site-specific data collection effort may be significant, but it is intended ultimately to provide the underpinning for further evaluation of MNA performance to be addressed in subsequent stages of site characterization. Data collection efforts may include water quality data collected in the field (for example, pH, dissolved oxygen, alkalinity, ferrous iron and dissolved sulfide); laboratory measurements of groundwater and aquifer solids chemical composition; microbial characteristics and mineralogy of the aquifer solids (as relevant to degradation or immobilization); and determination of contaminant speciation in groundwater and the aquifer solids (EPA 2007a). Contaminant speciation for this recommended analysis refers to both oxidation state characterizations (for example, As[III] vs. As[V]; U[IV] vs. U[VI]) as well as specific associations with chemical constituents in aquifer solids (for example, precipitation of lead carbonate vs. adsorption of lead to iron oxides). Evaluation of subsurface microbiology may be necessary in situations where biotic processes play a direct or indirect role in governing contaminant attenuation. Microbial influences may be predominant in plumes where readily degradable organic contaminants, such as hydrocarbons, also are present. Ultimately, knowledge of the attenuation process along with a detailed knowledge of the groundwater flow field can provide the basis for subsequent evaluations to assess the long-term capacity of the aquifer to sustain contaminant attenuation.

An estimate of attenuation rates for inorganic contaminants typically will involve calculations of apparent mass transfer from the aqueous to the solid phase, based on sampling of groundwater or aquifer solids.[31] These estimates should be based as much as possible on field measurements rather than on modeling predictions (EPA 2007a). Where radioactive decay is a primary attenuation process, both intermediate and terminal decay products should be identified, and the time to reach cleanup levels should be estimated as described in Section 2.1 of this document.

3.3 Phase III: Determination that the capacity of the aquifer is sufficient to attenuate the mass of contaminant within the plume and the stability of the immobilized contaminant is sufficient to resist re-mobilization

Sites that possess insufficient capacity to adequately attenuate the groundwater plume generally are not suitable candidates for MNA.

The recommended objective under Phase III is to obtain data and information that can be used to evaluate whether MNA should be eliminated from further consideration for sites where there is insufficient capacity in the aquifer to attenuate contaminant mass to groundwater cleanup levels. Likewise, the data may show that the stability of the immobilized contaminant is insufficient to prevent re-mobilization caused by future changes in groundwater chemistry (EPA 2007a). Possible factors that could result in an insufficient capacity for attenuation include the following: (1) changes in groundwater chemistry that result in slower rates of attenuation or re-mobilization of contaminants, and (2) insufficient mass of solid constituents in the aquifer solids that participate in the attenuation reaction. These factors may apply to situations where either degradation or immobilization is the primary attenuation process. For example, contaminant desorption could be caused by changes in groundwater pH, because the degree of adsorption typically is sensitive to this parameter.

[31] With regard to consideration of modeling as a general matter, the following preamble language may be useful in the context of MNA specifically: “However, limited fate and transport modeling and site information may be used to establish cleanup levels for contaminated soils and waste materials remaining at the site. For example, the ground-water route of exposure would be protected by determining a level in the soils that would be consistent with the levels established for ground water. Typically, monitoring will be necessary after the completion of the remedial measure to verify that the levels established at the site are protective of ground water and other routes of exposure” (53 Fed. Reg. at p. 51446, December 21, 1988).

Assessment of attenuation capacity usually depends on knowledge of the mass flux of contaminants and associated reactants in groundwater, as well as the mass distribution of reactive aquifer solids along groundwater flow paths. Mass flux for this recommended analysis is defined as the contaminant mass per time passing by a plume transect perpendicular to groundwater flow (Farhat and others 2006). The general approach that can be taken is to estimate the attenuation capacity within the plume boundaries and compare this capacity with the estimated mass flux of aqueous-phase contaminants emanating from source areas, assuming source zone removal or containment has been completed to the extent practicable (EPA 2007a). It is recommended that a detailed characterization of the site's hydrology be performed to ensure that sufficient data are available to determine system capacity in the subsurface environment.

The stability of an immobilized contaminant can be evaluated through a combination of laboratory testing and chemical reaction modeling considering existing and anticipated site conditions. Both analysis approaches normally can be developed based on the information gathered during recommended Phase II efforts to characterize the specific attenuation process active within the groundwater plume (EPA 2007a).

The sensitivity to contaminant re-mobilization typically can be assessed with laboratory tests employing aquifer solids collected from within the plume boundaries. These solids can be exposed to solutions that mimic anticipated groundwater chemistries (for example, ambient groundwater samples or laboratory-created solutions in which the concentrations of specific dissolved constituents can be varied). A supplementary approach to test contaminant stability could include use of chemical reaction models to efficiently explore contaminant solubility under a range of hypothetical groundwater conditions to identify the groundwater parameters to which the attenuation reaction may be most sensitive.

3.4 Phase IV: Design of a performance monitoring program based on an understanding of the mechanism of the attenuation process, and establishment of contingency remedies tailored to site-specific characteristics

As discussed in the 1999 MNA guidance (p. 20):

> It should be noted that the timeframe required for MNA remedies is often longer than that required for more active remedies. **As a consequence, the uncertainty associated with the above factors increases dramatically. Adequate performance monitoring and contingency remedies (both discussed in later sections of this Directive) should be utilized because of this higher level of uncertainty.** When determining reasonable timeframes, the uncertainty in estimated timeframes should be considered, as well as the ability to establish performance monitoring programs capable of verifying the performance expected from natural attenuation in a timely manner (*e.g.*, as would be required in a Superfund five-year remedy review) (emphasis in original).

The recommended objective under Phase IV analysis is to develop a monitoring program to assess long-term performance of MNA and to identify alternative remedies that could be implemented in case MNA fails. Site data collected during the previous phases should focus on identification of alternative remedies that best match site-specific conditions.

The 1999 MNA guidance includes recommendations in the section on Performance Monitoring and Evaluation (pp. 22-23). The monitoring program for inorganic contaminants should consist of establishing a network of wells that meet the following criteria: (1) can provide adequate areal and vertical coverage to verify that the groundwater plume remains static or shrinks, and (2) can provide the ability to monitor groundwater chemistry throughout the zones where contaminant attenuation is occurring. The monitoring program generally should include an assessment of groundwater flow patterns so the monitoring network can be adjusted to evaluate the influence of potential flow changes within the plume. Monitoring should include continued verification of contaminant removal from groundwater, but also should include tracking trends in other reactants that participate in the attenuation reaction (for example, pH, alkalinity, ferrous iron, oxidation-reduction potential and sulfate). Where radioactive decay is a contributing attenuation process, the monitoring program should also track concentrations of daughter products in groundwater. Periodic collection of aquifer solids may be warranted to verify consistency in reaction mechanisms for sites where contaminant immobilization is the primary attenuation process. Groundwater parameters should be selected to monitor constituents that provide information on continued stability of the solid phase that is associated with an immobilized contaminant. Examples include ferrous iron or sulfate to track dissolution of iron oxides or sulfide precipitates. Non-contaminant performance parameters such as these are likely to serve as “triggers” to alert site managers to potential remedy failure or performance losses, since the attenuation reaction should respond to these changed conditions. Monitoring these indicator parameters may improve the ability of site managers to evaluate and address the potential for groundwater plume expansion because increases in mobile contaminant concentrations may be delayed relative to changes in site conditions.

With regard to developing contingency remedies as part of the Phase IV analysis, please refer to the Contingency Remedies section of the 1999 MNA guidance (pp. 24-25).

4.0 SITE CHARACTERIZATION

As discussed in the 1999 MNA guidance (pp. 13-14):

> Site characterization should include collecting data to define (in three spatial dimensions over time) the nature and distribution of contaminants of concern and contaminant sources as well as potential impacts on receptors (see "Background" section for further discussion pertaining to "Contaminants of Concern"). However, where MNA will be considered as a remedial approach, certain aspects of site characterization may require more detail or additional elements. For example, to assess the contributions of sorption, dilution, and dispersion to natural attenuation of contaminated groundwater, a very detailed understanding of aquifer hydraulics, recharge and discharge areas and volumes, and chemical properties is necessary. Where biodegradation will be assessed, characterization also should include evaluation of the nutrients and electron donors and acceptors present in the groundwater, the concentrations of co-metabolites and metabolic byproducts, and perhaps specific analyses to identify the microbial populations present. The findings of these, and any other analyses pertinent to characterizing natural attenuation processes, should be incorporated into the conceptual model of contaminant fate and transport developed for the site.

The primary objective of site characterization at sites with inorganic contaminants in the groundwater generally is to obtain data and information that can be used to identify attenuation mechanisms at a given site. This characterization effort should emphasize direct measurements of groundwater conditions and the associated solid phase characteristics of the aquifer. Measurements or tests conducted with subsurface samples retrieved within the zones where attenuation occurs should provide the most direct means to evaluate ongoing reaction processes. This knowledge may guide approaches to assess the capacity of the aquifer to sustain contaminant attenuation within the plume and to evaluate the long-term stability of immobilized contaminants. Evaluations conducted on subsurface samples also have the potential advantage of incorporating actual characteristics and factors of groundwater and aquifer solids that may be difficult to adequately parameterize within geochemical models.

Delineation of the inorganic plume in three dimensions and subsequent monitoring of the groundwater plume with time generally should be a central component of the recommended tiered analysis. The following sections describe some of the key site characterization objectives relevant to evaluating the potential use of MNA for inorganic contaminants.

4.1 Hydrogeologic and Contaminant Distribution Characterization

The recommended first step (Phase I) in any natural attenuation evaluation is obtaining a thorough working knowledge of site hydrogeology, including direction and rate of groundwater flow, potential impact of interactions between groundwater and surface water or sediment, and potential impact of active pumping, if applicable (EPA 2007a). Information on the nature and extent of contamination and potential contaminant loading to groundwater also is needed, including the existence and distribution of both organic and inorganic plumes in soil and groundwater. These data then may be used to create or update a three-dimensional CSM describing site conditions.

4.2 Determination of Attenuation Rates

The plume should be demonstrated to be stable or shrinking for MNA to be viable for inorganic contaminants in groundwater. The hydrogeologic and contaminant distribution data recommended above (collected during the recommended Phase I evaluations) normally can be used to estimate attenuation rates during Phase II evaluations. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies* discusses the following two methods to determine rate estimates: (1) plume concentration vs. distance from a source, and (2) plume concentration measured over time at a point (EPA 2002c). Estimates of mass flux may be used as additional supporting information in determining the rate of contaminant attenuation because these estimates may be affected by changing directions and rates of groundwater flow. It is important to note that determination of mass flux normally is constrained by the same limitations that exist for determining attenuation rate estimates, namely that groundwater flow rates can change in both space and time. An additional factor is that mass flux generally is estimated only for horizontal flow. If vertical gradients are present, the typical estimates of mass flux will likely be incorrect. Multiple lines of evidence should be used to identify whether attenuation is occurring. **Therefore, neither the attenuation rate nor the mass flux estimates should be used as the primary supporting evidence that attenuation is occurring. Demonstration of decreasing concentrations is the primary supporting evidence that attenuation is occurring.**

Both direct measurements and indirect evidence may be used to identify the mechanism and rate of attenuation in groundwater. For example, decreased nickel concentrations collocated with decreased ferrous iron or sulfide concentrations in groundwater would suggest potential co-precipitation of nickel with iron sulfide. Various types of data can provide multiple lines of evidence to assess the likelihood of inorganic attenuation and the viability of MNA. An analysis of groundwater concentration data alone generally will not be adequate to confirm any precipitation or co-precipitation mechanism of attenuation (EPA 2007a).

4.3 Geochemical Considerations

Generally, hydrogeology and groundwater and aquifer geochemistry together form the framework for understanding contaminant fate and transport at a site. Evaluation of aquifer mineralogy and solid-phase contaminant speciation is typically an important part of identification of the contaminant immobilization process (EPA 2007a) for inorganic contaminants. Both groundwater and aquifer solids samples collected using methods that preserve the in situ integrity of the samples help to support this evaluation. Appendices 1 and 2 summarize the recommended physical and chemical analyses and data uses for development of a CSM to support an MNA evaluation for inorganic contaminants. Appendices 3 and 4 provide recommended analytical methods and data quality objectives and goals for the analyses suggested in Appendices 1 and 2. Determining aquifer capacity and the stability of reactions likely will include use of laboratory-based tests using site groundwater and aquifer solids.

4.4 Groundwater Geochemistry Characterization

Data collected during the recommended Phase II evaluation for geochemical characterization of groundwater generally should include pH, oxidation-reduction potential and dissolved oxygen, dissolved organic and inorganic carbon, major cations and anions, and chemical speciation of the contaminants and key reactants in groundwater. Sufficient data should be collected to understand both the temporal and spatial variability of these parameters (EPA 2007a).

4.5 Solid Phase Characterization

Solid phase characterization often is an important aspect of evaluating natural attenuation of inorganic contaminants during the recommended Phase II and Phase III analysis. Procedures for characterizing aquifer materials include the following: X-ray diffraction or X-ray fluorescence for characterizing mineralogy; sequential extraction procedures (SEP) for characterizing the solid-phase components the contaminants are associated with; geochemical speciation analysis for determining the redox conditions of the aquifer; and laboratory batch and flow-through column tests for determining the sorptive capacity of the aquifer materials.

In SEP, contaminated soils are subjected to successively harsher solutions in an attempt to sequentially leach soil contaminants. While environmental risk may be assessed using the results of the water soluble or exchangeable soil fractions (step 1 of the multiple-step SEP process), such an approach will generally be inadequate for developing the necessary understanding of attenuation mechanisms and long-term contaminant behavior to support selection of MNA (EPA 2007a). As a result, partial SEP analyses are not the sole line of evidence that can be used to demonstrate inorganic attenuation. Therefore, the results should not be accepted without question because of the wide variety of methods used to implement the SEP.[32]

If redox processes are believed to be an important component of attenuation mechanisms, special attention should be given to preserving the redox status of materials after they are retrieved from the subsurface. For example, if anoxic materials are collected, they should be frozen after collection or stored in evacuated containers that have been purged with inert gas to preserve primary mineralogy (EPA 2002a and 2006b). Methods for characterizing the oxidation capacity and reducing capacity of aquifer solids are summarized in *Workshop on Monitoring Oxidation-Reduction Processes for Ground-water Restoration* (EPA 2002a).

[32] Refer to Section IIIB.2.4.2 in *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume I* (EPA 2007a) for a discussion of sequential extraction considerations.

Aquifer capacity for contaminant attenuation is often estimated during the Phase III evaluation. As thoroughly described in *Understanding Variation in Partitioning Coefficient, K_d Values, Volumes I-III* (EPA 1999a, 1999b and 2004c), there are multiple approaches to measure or estimate distribution/partition coefficient (K_d) values, such as laboratory batch tests, in situ batch tests or flow-through column tests. Each has its inherent advantages and limitations, and each involves a unique set of assumptions. The K_d, for this guidance, is considered the ratio of contaminant mass per unit mass of solid to the mass of contaminant remaining in solution at equilibrium (EPA 1999b).

Contaminant sorption behavior can be simulated by geochemical models. The use of the Langmuir and Freundlich isotherms (also known as empirical models) and surface complexation models (SCM, known as mechanistic models) can be used to develop the K_d value (EPA 1999a and 2007a). The predictive capability of empirical models (using empirically derived values of K_d) are limited to the range of experimental data when K_d is determined. However, mechanistic models like SCMs have the advantage of being able to modify input parameters and account for changes in groundwater chemistry, such as solution pH and the impact of major ions in solution on available sorption sites. Thus, SCMs are potentially more robust in their predictive capabilities to evaluate the impact of changing chemical conditions in the system. Further discussion of the use of models in the assessment of natural attenuation of inorganic contaminants may be found in Section 6 of this document.

It is normally important that solid samples be representative of aquifer materials and contaminant concentrations. Contaminant attenuation is not linear in that the attenuation rate does not increase in direct proportion to the concentration. Therefore, solid samples used to define solid-phase attenuation should contain a range of contaminant concentrations. In addition, they should represent a range of soil textures and other factors that affect attenuation. Measured contaminant concentrations represent a mean concentration of the soil volume sampled and can be determined for each of the contaminants of interest. SEP may be used to differentiate contaminant concentrations associated with different phases of soil (for example labile vs. sorbed vs. structural) in the designated representative sampling area based on the CSM. This same designated representative sampling area can be re-sampled during subsequent sampling events—again at random locations and depths below the water table and within the same lithology—and SEP results compared to determine if a significant change in concentrations has occurred over time. Ideally, this approach provides a representative and repeatable simulation of aquifer materials and minimizes the negative impact of soil heterogeneity on the evaluation of attenuation processes.

4.6 Special Considerations for Radionuclides

The amount of radioactive material in soil or water is typically measured in units of decay rate or activity and reported as picocuries (pCi) per mass of soil or volume of water — for example, picocuries per liter (pCi/L) (1 picocurie equals 0.037 becquerels [Bq]). Activity units are used to evaluate exposure risk that forms the basis for remediation, whereas mass-based concentration levels (for example, µg/L) are used in selecting and designing a remediation technology. The activity corresponding to a given mass of radioactive material varies depending on the radionuclide. For example, 1 gram of uranium-238 has an activity of 0.33 pCi, whereas 1 gram of uranium-234 has an activity of 6,200 pCi.

Decay rate-based activities are different than mass-based concentrations, and neither should be used alone to identify potential remedial components For example, transport models that are employed to understand the solid-liquid partitioning and fate and transport of a radionuclide are developed using mass concentration units and mass-action reaction expressions. Isotopic composition and activity of radioactive material generally are important for risk assessment and plume decay predictions (EPA 2010a).

5.0 ATTENUATION PROCESSES FOR INORGANIC CONTAMINANTS

The following sections briefly describe microbial, chemical and physical attenuation processes for metals and other inorganic contaminants, as well as radioactive decay as an attenuation process for radionuclides. These attenuation processes may act in isolation or together to retard or arrest migration of inorganic contaminants in an aquifer. Factors that can help evaluate which process is likely to dominate contaminant attenuation include chemical properties of the contaminant, chemical characteristics of the groundwater, and properties of the aquifer solids. Microbial activity may exert a significant but primarily indirect influence on contaminant attenuation for many of the inorganic contaminants discussed in this document; however, in the case of both nitrate and perchlorate, direct microbial degradation should be the controlling attenuation process (EPA 2007b). Redox conditions in an aquifer normally are a key controlling factor of contaminant fate and transport of inorganic contaminants in groundwater and will be mentioned repeatedly in the discussions that follow.

5.1 Microbial Degradation

Subsurface microbes typically play an important and dynamic role in controlling aquifer geochemistry and fate of inorganic contaminants in situ; they tend to alter most attenuation processes in groundwater. Subsurface microorganisms exhibit a remarkable array of metabolic capabilities. For example, microbes derive energy through oxidation of organic or inorganic compounds as electron donors. The electrons are transferred to an electron acceptor which, in the case of aerobic respiration, is oxygen. Anaerobic respiration is also possible, whereby chemically reducible inorganic compounds (such as nitrate, sulfate, ferric iron or iron/manganese oxyhydroxides) are used as electron acceptors (EPA 2007a). The coupled reactions of electron acceptors and donors are termed oxidation-reduction or “redox” reactions. These redox reactions are often mediated by microbes in situ. In general, microbes preferentially consume oxygen and nitrate as the most favorable electron acceptors, followed by manganese and iron oxyhydroxides, sulfate, and finally, carbon dioxide. An aquifer progresses from oxidizing (aerobic) to reducing (anaerobic) redox conditions as microbes consume this series of electron acceptors.

In some situations, intense local microbial activity may be entirely responsible for the redox status of the aquifer. The nature of the active microbial population (for example, iron-reducing, sulfate-reducing, or sulfur-oxidizing bacteria) can often be inferred from geochemical data. Thus, trends in the concentration of organic substrates (dissolved organic carbon) and their metabolites (for example, H_2, H_2S, CH_4, CO_2, NO_2^-, HS^- or Fe^{2+}) can indicate whether and which microorganisms are active in a particular subsurface region.

Conversion of dissolved organic carbon by microbial activity can create and replenish the reductive capacity of a site. In some instances, direct and specific determination of microbial population by culturing or genetic analysis (for example, messenger ribonucleic acid profiles) of aquifer solids extracts may be warranted.

Although metals and radionuclides may change valence state or form different anion complexes in response to microbial activity or redox conditions, they generally are not degraded. Microbial degradation involves breaking chemical bonds in a contaminant compound, the subsequent formation of new bonds and, ultimately, creation of another compound that may be more or less toxic.

Both nitrate and perchlorate are highly soluble and thus mobile contaminants in groundwater that may directly serve as electron acceptors for subsurface microorganisms in situ. However, subsurface microbes may be limited in situ by organic carbon, energy substrate, or trace nutrients. Given the high solubility and mobility of nitrate and perchlorate in groundwater under organic carbon-limited conditions, MNA by itself may not be appropriate for these contaminants. It may be appropriate to consider MNA in combination with active remedies such as in situ bioremediation through organic carbon substrate injections or other treatments, however.

Soil microbes may be responsible for the methylation of iodine-129 to form methyl-iodide in wetland environments under low redox conditions and in the presence of high concentrations of organic matter (EPA 2010a). Methyl-iodide is subject to volatilization. While the microbial activity is not directly responsible for destruction of the iodine, it is an example of the indirect impact of microbial activity on chemical fate. Failure to account for microbially induced methylation can result in misinterpretation of the volatilized iodine-129 as sorbed iodine-129, which in turn can result in an overestimation of contaminant mass sorbed to aquifer solids.

5.2 Chemical Transformation/Redox

An understanding of redox conditions in the aquifer often is important, as redox processes have a significant impact on the aqueous and solid phase speciation of inorganic contaminants. Although most metals generally are not degraded through microbial action, some can change oxidation state, which in turn significantly influences their solubility and transport in groundwater. Changes in oxidation state of a metal occur through abiotic or microbially mediated redox reactions where the metal serves as an electron acceptor or donor. This section is focused on redox transformations of inorganic contaminants (metals, metalloids and radionuclides).

Ferrous sulfide rich formations may promote abiotic reduction of soluble metal species to their less mobile lower oxidation states. Alternatively, microbes may deplete oxygen and other highly energetic electron acceptors from groundwater under organic carbon rich conditions. In this way, they promote anaerobic or reducing conditions that favor reduction and immobilization of some metals. Under iron- and sulfate-reducing conditions, metals such as chromium(VI), selenium(VI or IV), and copper(II) may be reduced to lower valence states, which may form sparingly soluble metal-oxide minerals or may co-precipitate with sulfides. Likewise, radionuclides such as uranium(VI) and technetium(VII) become favorable electron acceptors under iron- or sulfate-reducing conditions and may precipitate as radionuclide-oxide minerals or may co-precipitate with sulfides. These redox sensitive metals and radionuclides are generally less soluble and less mobile in their reduced oxidation states; however, there are exceptions to this generalization.

Studies have shown that addition of organic carbon to stimulate iron reduction results in transformation of some contaminants, such as U(VI), to less mobile forms and as a consequence result in decreased groundwater concentrations in metal or radionuclide contaminated plumes where organic carbon is limited (Anderson and others 2003; Istok and others 2004; Michalsen and others 2006). However, these same reduced metal- or radionuclide-oxide precipitates may be vulnerable to oxidation by nitrate and other oxidants, which could reverse the process, causing a related increase in contaminant concentrations in groundwater (Anderson and others 2003; Senko and others 2002). Shifts in groundwater pH or bulk geochemistry may affect the metal solubility and could reverse the attenuation process. Thus, the stability of the attenuated contaminant will ultimately be governed by the type of contaminant-solid phase association and by the stability of groundwater geochemistry.

It is important to recognize that reversals in oxidation state of inorganic contaminants may result from attempts to remediate other contaminants present at a site. For example, the use of in situ chemical oxidation methods to remediate high concentrations of hydrocarbon-based compounds may result in a related increase in soluble U(VI). Similarly, the injection of organic electron donors intended to create reducing conditions in an aquifer may result in the reductive dissolution of arsenic species, with a corresponding increase in groundwater concentrations. SEP analysis may also be used to assess changes in concentrations associated with different soil phases (for example, sorbed vs. precipitated).

5.3 Sorption and Precipitation

Physical partitioning of a contaminant from a soluble and mobile form in groundwater to a less mobile form on aquifer solids is a primary natural attenuation process for many metals and radionuclides. This partitioning process generally involves the following three primary mechanisms: (1) adsorption, which is the accumulation of a contaminant ion at the aqueous and solid phase adsorbent interface; (2) precipitation, which is the growth of solid phase containing repeated molecular units in three dimensions; and (3) absorption, which is diffusion of the aqueous or adsorbed contaminant ion into the solid phase (Sposito 1986). "Sorption" will be used in this guidance to describe, in a generic sense (that is, adsorption and absorption mechanisms), the partitioning of aqueous phase constituents to a solid phase. One or more sorption mechanisms are likely important if the inorganic contaminant of concern at a site is a metal or a radionuclide.

In general, adsorption or desorption of metal or radionuclide cations onto and off of aquifer materials is pH dependent and increases with increasing pH, typically reaching a maximum under circumneutral pH conditions, depending on groundwater chemistry and properties of the adsorbent surface (Sparks 2003). Important adsorbent phases commonly found in the environment include phyllosilicate minerals ("clays"), metal oxyhydroxide phases, and natural organic matter (Dixon and Schulze 2002; EPA 2007a, Section IIB.1.1). However, most clay minerals possess a permanent negative charge as a result of the substitution of lower valence cations within mineral layers of the clay. This permanent negative charge is unaffected by changes in groundwater pH and is typically balanced through ion exchange reactions involving major cations in groundwater (for example, Na^{+}, K^{+}, Ca^{2+} or Mg^{2+}) but potentially also contaminant metal or radionuclide ions.

Precipitation is another important attenuation mechanism for removal of metals and radionuclide contaminants from groundwater. Contaminant ions may precipitate as a pure phase (for example, $CdCO_3$[s]) or may co-precipitate by incorporation of the contaminant ion within the structure of another mineral phase. Examples of co-precipitation include Cr(III) in hydrous ferric oxide and Cd(II) in calcium carbonate. Strontium may co-precipitate during formation of calcium or ferrous iron carbonates (for example, in the presence of elevated alkalinity or ferrous iron formed during microbial degradation of organic compounds) (Fujita and others 2004; Roden and others 2002; EPA 2010a, Strontium Chapter). Precipitation is also an important attenuation pathway for radium, which may also co-precipitate as a sulfate mineral (for example, as $RaSO_4$ or $BaRa[SO_4]_2$, in the presence of moderate sulfate concentrations) (Langmuir and Reise 1985); however, under sulfate reducing conditions, these minerals may dissolve and result in radium release to groundwater (Huck and Anderson 1990; Pardue and Guo 1998; EPA 2010a, Radium Chapter).

Most precipitation reactions have a strong dependence on solution chemistry and pH. The tendency for a system to support a specific precipitation or dissolution reaction can be evaluated through comparison of the equilibrium solubility constant for a given solid phase mineral to the ion activity product calculated using the site groundwater geochemical data. The ion activity product is useful for evaluating the potential for contaminant precipitation; however, it is not unequivocal evidence that a given phase is at equilibrium or even present in the system (Sposito 1984; EPA 2007a, Section IIB.2.1).

Physical partitioning is a particularly important attenuation process for cadmium, lead, nickel, and copper because these metals are stable in their +2 valence state and are not subject to direct chemical transformation or changes in valence state, which can significantly alter the solubility of metals. However, these metals may form stable precipitates with redox-sensitive elements such as sulfur and iron; thus, the solubility and mobility of these metals are indirectly tied to redox conditions. For example, if sorption to iron oxides is a primary attenuation pathway and the redox conditions change such that reductive iron dissolution occurs, this process could mobilize or remobilize the metal of concern in groundwater. Likewise, if the primary attenuating phase of the metal of concern is a metal-sulfide precipitate and the groundwater redox conditions shift such that oxidative dissolution of sulfides occurs, this shift could also mobilize or remobilize the metal of concern in groundwater. Furthermore, shifts in groundwater pH or bulk geochemistry may alter the metal partitioning and could reverse the attenuation process. For example, sorption to carbonate minerals may be an important attenuation process for thorium (EPA 1999a) and americium (Shanbhag and Morse 1982; EPA 2010a, Americium-Strontium Chapter). However, decreases in pH can destabilize carbonate minerals and result in increased radionuclide concentrations in groundwater. Thus, the stability of the immobilized contaminant (precipitated or sorbed) will ultimately be governed by the type of contaminant-solid phase association and by groundwater geochemistry.

In general, the absorption of metal or radionuclide cations is limited to Group 1 (Alkali metals), mainly potassium, cesium and rubidium. These elements exhibit low hydration energy and unique hydrated radii that allow them to diffuse into the structure of vermiculite minerals. This process promotes the "fixation" of the cations by the subsequent collapse of the vermiculite into a mica-type structure.

5.4 Radioactive Decay

Radioactive contaminants share many fate and transport properties in common with metals, as illustrated in previous sections. However, radioactive decay is a unique attenuation process specific to this group of contaminants that warrants special discussion. Radioactive decay typically functions in conjunction with other attenuating processes as part of MNA, but it is the primary attenuating process for radon and tritium, as they are generally considered unreactive in groundwater and have relatively short half-lives (EPA 2010a).

Radioactive decay ultimately decreases the concentration of parent atoms or compounds in groundwater but can result in increased concentrations of *daughter products*, which are the products of parent isotope decay. Eventually, a stable daughter product is created and no further radioactive decay follows.

If the decay rate of the daughter product is less than the decay rate for the parent isotope or is infinite because the daughter is stable, then the daughter product may accumulate and affect the activity of the plume in a process called ingrowth. Ingrowth is a particularly important concept when use of MNA is evaluated for radionuclides because daughter products may exhibit increased toxicity and solubility, which may affect plume fate and transport (EPA 1999c). Radioactive decay can be simple (for example, decay of I-129 to stable Xe-129); however, radionuclides with complex, multi-step decay series (for example, decay of Ra-226 to Pb-210) are most commonly encountered at National Priorities List (NPL) sites (EPA 1993). Table 5.1 below provides a summary of radiochemical information for select radionuclides, including half-lives and energy levels of emitted radiation, as well as associated decay chains and terminal products. It is important to identify specific isotopes present in groundwater so that associated decay chains, intermediate daughter, and terminal daughter products can be identified and accounted for during remedy selection and monitoring program development.

Table 5.1. Radiochemical information for select radionuclide isotopes (EPA 1993 and 2000).

Select Radionuclides		Radiation Type (MeV)			Associated Decay Chain[33]	Terminal Nuclide or Radionuclide[34]	
Nuclide[35]	Half-life (yr)	α	β(avg)	γ		Nuclide	Half-life (yr)
Am-241	432	5.486		0.0595	-	Np-237	2.1E+6
Am-243+D	7,400	5.3	0.022	0.055	Np-239 (2d)	Pu-239	2.4E+4
Cs-134	2		0.1520	0.605	-	Ba-134 (~100%)	stable
Cs-135	3E+6		0.0570	0.787	-	Ba-135	stable
Cs-137+D	30		0.1950	0.662	Ba-137m (95%, 3min)	Ba-137	stable
H-3	12		0.0050		-	He-3	stable
I-129	1.6E+7		0.0400		-	Xe-129	stable
Pu-238	88	5.499			-	U-234	2.4E+5
Pu-239	2.4E+4	5.156		0.0516	-	U-235	7E+8
Pu-240	6,500	5.168			-	U-236	2.3E+6
Pu-244+D	9.3E+7	4.6	0.0071	0.0012	U-240 ~100% Np-240	Pu-240	6,500
Ra-226+D	1,600	4.784		0.1861	Rn-222 (4 d) Po-218 (3 min) Pb-214 (~100%, 27 min) Bi-214 (20 min) Po-214 (~100%, 1 min)	Pb-210	22
Ra-228+D	8		0.0140		Ac-228 (6 h)	Th-228	2
Rn-222	1.0E-2	5.490		0.5100	Po-218 (3 min) Po-214 (0.2 ms) Po-210 (138 d)	Pb-206	stable
Sr-90+D	29		0.2000		Y-90 (64 h)	Zr-90	stable
Tc-99	2.1E+5		0.0850		-	Ru-99	stable
Th-228+D	2	5.423			Ra-224 (4 d) Rn-220 (56 s) Po-216 (0.2 s) Pb-212 (11 h) Bi-212 (61 min) [Po-212 (64%, 0.3 μs) Tl-208 (36%, 3 min)]	Pb-208	stable
Th-229+D	7,300	4.9	0.12	0.096	Ra-225 (15d) Ac-225 (10 d)	Bi-209	stable

33 The chain of decay products of a principal radionuclide extending to (but not including) the next principal radionuclide or a stable nuclide. Half-lives are given in parentheses. Radioactive ingrowth branches are indicated by square brackets with branching ratios in parentheses.
34 The principal radionuclide or stable nuclide that terminates an associated decay chain.
35 "+D" designates radionuclides with associated decay chain.

Select Radionuclides		Radiation Type (MeV)			Associated Decay Chain[33]	Terminal Nuclide or Radionuclide[34]	
Nuclide[35]	Half-life (yr)	α	β(avg)	γ		Nuclide	Half-life (yr)
					Fr-22 (5 min) At-217 (32 ms) Bi-213 (46 min) [Po-213 (98%, 4 µs) Tl-209 (2%, 2 min)] Pd-209 (3 h)		
Th-230	7.7E+4	4.688		0.0677	-	Ra-226	1,600
Th-232	1.4E+10	4.013			-	Ra-228	6
U-234	2.4E+5	4.776		0.0532	-	Th-230	8E+4
U-235+D	7.0E+8	4.400		0.1857	Th-231 (26 h)	Pa-231	3.4E+4
U-238+D	4.5E+9	4.197			Th-234 (24 d) Pa-234m (99.8%, 1 min) Pa-234 (0.2%, 7 h)	U-234	2.4E+5

α Alpha
β Beta
γ Gamma
d day
h hour
s second
MeV Megaelectronvolt
min minute
µs microsecond
ms millisecond

Unstable parent radionuclides decay to form either unstable or stable radionuclide daughter products. The decay of an unstable radionuclide parent to a stable radionuclide daughter results in ingrowth. An unstable radionuclide daughter results in one of three equilibrium conditions, all exhibiting a period of ingrowth. The three parent/daughter equilibrium relationships are identified as "secular," "transient," and "no equilibrium." The "ingrowth only" example in Figure 5.1A demonstrates the decay of the unstable parent leading to the ingrowth in the stable daughter (for example, Cs-137 decay to stable Ba-137). The first of the equilibrium cases is the limiting "secular equilibrium," where the half-life of the parent is much larger (approximately 10^{-4}) than the daughter (for example, Ra-226 decay to Rn-222). The period of the daughter product's ingrowth occurs until its activity reaches that of the initial parent activity (Figure 5.1B).

Thereafter, the daughter decays at the same rate that it is formed. The second equilibrium case is "transient equilibrium," where the half-life of the parent is somewhat larger (approximately 10 times) than the daughter (for example, Th-227 decay to Ra-223). The period of the daughter product ingrowth initially reaches a maximum followed by a decrease until both parent and daughter decay become constant (Figure 5.1C). The last equilibrium case is "no equilibrium," where the half-life of the parent is smaller than the daughter (example, Am-241 decay to Np-.237). The period of daughter ingrowth peaks later than for "transient equilibrium" and eventually decays according to the daughter half-life characteristics (Figure 5.1D).

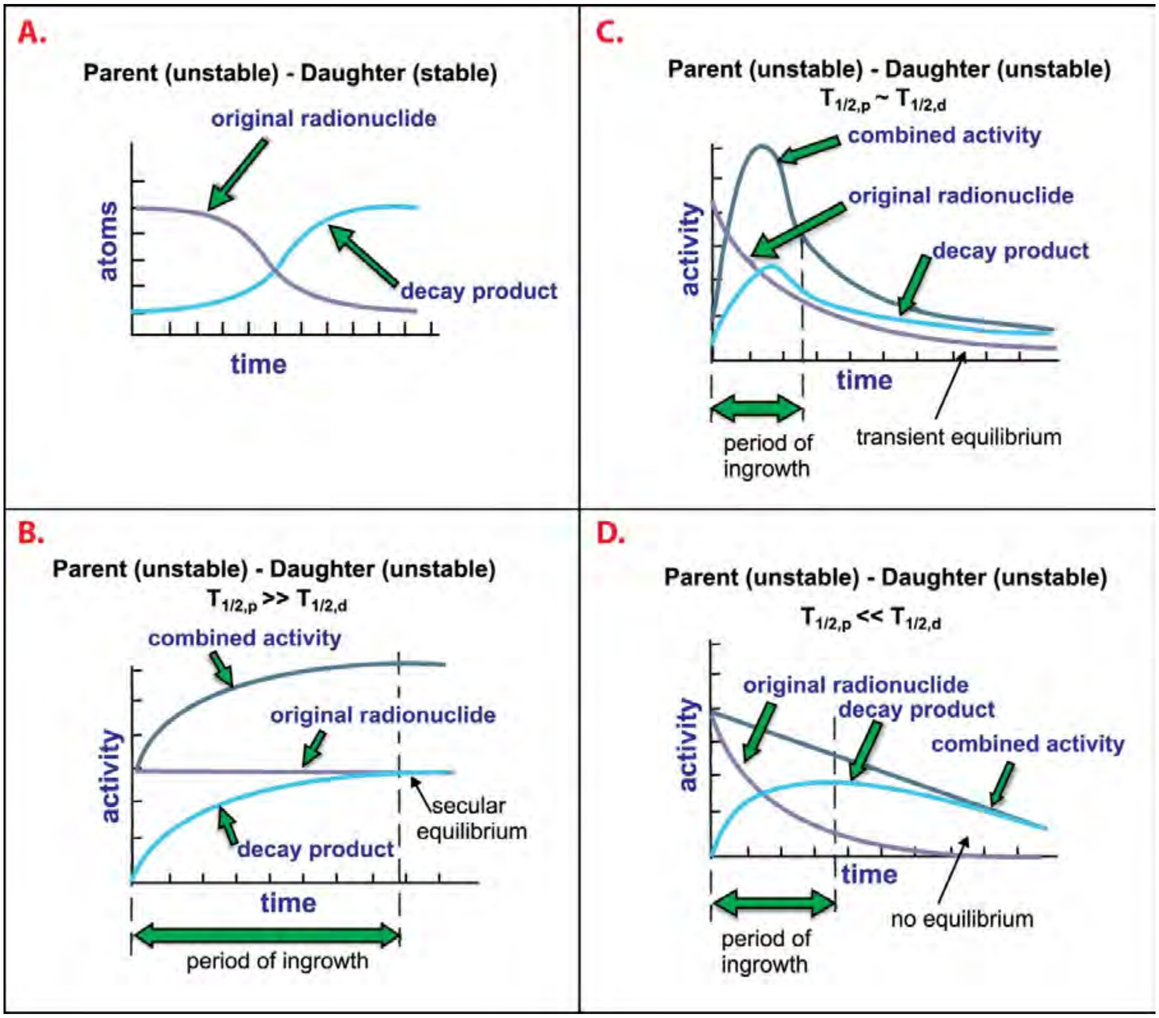


Figure 5.1. Illustration of four decay ingrowth scenarios in groundwater plumes contaminated with radionuclides. $T_{1/2,p}$=decay half-life of parent radionuclide, $T_{1/2,d}$=decay half-life of daughter radionuclide. Illustrations derived from the EPA website www.epa.gov/radiation/understand/equilibrium.html

It can be seen that the production of daughter products can influence plume composition, potential radiological risks, and the dimensions of the plume if, as is typical, the daughter product displays radiological or chemical risk and transport characteristics different from that of the parent radionuclide. It is important to note that, as with organics, daughter products of radionuclides may pose greater risk, be more mobile, and have longer half-lives than the parent in the decay series. Radionuclide ingrowth corrections may be important for accurate descriptions of plume characteristics over time because of the relatively low regulatory benchmarks for activity- (picocuries per liter, pCi/L) and mass-based concentrations (micrograms per liter, µg/L) in groundwater. Such radioactive decay relationships may be used to predict increases in decay products and activity or ingrowth, with or without consideration of groundwater transport.

Alpha recoil is a decay-related physical fractionation process that may impede achievement of groundwater cleanup levels for some radionuclides. Briefly, alpha recoil occurs when ejection of an alpha particle propels the daughter product away from the decay site (Kigoshi 1971; EPA 2010a, Front Matter, ID.1.3) — for example, from a mineral surface into groundwater. Ejection of an alpha particle can destabilize the host solid (Fleischer 1980; EPA 2010a, Front Matter, ID.1.3) and increase its susceptibility to dissolution (Eyal and Fleischer 1985). Potential influence of alpha recoil on contaminant fate is exemplified by the behavior of U-238 and U-234 solid-solution partitioning in groundwater systems, which results in U-234 enriched groundwater (Ivanovich 1994; EPA 2010a, Front Matter, ID.1.3). U-238 decay produces Th-234 plus an alpha particle of sufficient energy to cause ejection of Th-234 into groundwater. Subsequent serial decay of Th-234 (24.1 day half-life) to Pa-234 (6.7 hour half-life) and ultimately U-234 results in an elevated activity/concentration of U-234 relative to what would be anticipated based strictly on the solid-liquid partitioning for uranium or thorium. Additional examples of decay chains that may produce recoil effects include Th-228, Th-229, and Ra-226 (Sun and Semkow 1998; EPA 2010a, Front Matter, ID.1.3). In general, the impact of this process is difficult to predict in an aquifer and may play a minor role in contaminant plumes with concentrations that greatly exceed natural levels; however, alpha recoil may impart a large contribution to radioactive-enriched groundwater when concentrations of alpha emitters are large.

6.0 USE OF MODELS

Models that rely solely on estimated or computer-derived parameters, rather than on site-specific measured parameters, are generally inappropriate as the dominant justification for MNA. Modeling can be used to support or corroborate observed field conditions or can be used as another line of evidence in support of MNA. However, modeling simulations generally should not be the sole line of evidence used to support MNA. There should be site-specific monitoring data that provide evidence of contaminant attenuation, such as stable or declining groundwater concentrations or evidence of increasing contaminant concentrations in the solid phase (either via precipitation or sorption to aquifer solids). Site-specific information supporting continued attenuation of site contaminants should be obtained. Modeling should be supported with actual site data, and multiple lines of evidence should be used to indicate MNA is appropriate.

As noted previously, a CSM is not the same as a computer model, but a valid and sound CSM generally should be used to obtain meaningful computer modeling results. In the discussion that follows, the term “model” or “modeling” refers to a computer model or other mathematical representation of reality, whereas references to the CSM will be explicit. If a correct and robust CSM is not derived, any computer modeling results, no matter how detailed or extensive, may contribute little to understanding the site. EPA guidance generally recommends not relying on modeling as the sole criterion for determining whether MNA is an appropriate response action. Any model predictions should be substantiated by performance monitoring.

The modeling effort should begin with the careful identification of processes that can play significant roles in contaminant migration and attenuation at the site. Fundamental data regarding the rate and direction of groundwater flow, degree of aquifer heterogeneity, and current distribution of contamination typically should be included in the CSM. Identification of specific reaction mechanisms that may be active in the plume (for example, precipitation or sorption to solid surfaces, complexation with other chemical constituents, or microbially induced changes in groundwater chemistry) can provide the basis for developing models that allow projection of contaminant transport into the future.

Planning for computer modeling should occur early in the site assessment process so that the modeling can be integrated with the evaluation of the site and the appropriate data can be collected. In all the models, it is always important to characterize the assumptions, boundary conditions, and uncertainty. The EPA often uses a tiered modeling approach. Generally, more complex models require more site-specific data. When radionuclides are modeled, a model that can account for parent-daughter decay chains and the accompanying change in fate and transport parameters as the radionuclides change needs to be selected.

For further information on modeling at radioactively contaminated sites, see *Documenting Ground Water Modeling at Sites Contaminated with Radioactive Substances* [EPA 540-R-96-003] January, 1996. (www.epa.gov/rpdweb00/docs/cleanup/540-r-96-003.pdf) and the associated fact sheet (www.epa.gov/rpdweb00/docs/cleanup/540-f-96-002.pdf).

6.1 Types of Models

Several types of models may prove useful for characterizing attenuation processes at a site. Initiating the modeling effort with the simplest possible models is recommended. Highly complex models usually are difficult to work with, expensive to produce and difficult to interpret. A more efficient strategy normally is to begin with simple models of various aspects of the system, combining these as necessary into progressively more complex models, until a satisfactory final result has been reached, one that reproduces the salient aspects of the system's behavior without introducing unnecessary complexity.

Simple Calculations. Simple calculations performed by hand or via computer applications may serve as an important component of the overall modeling strategy. These calculations may be useful in any of the four phases in the tiered analysis approach. An example of a simplified approach would be calculation of the mass of contaminant and the mass of reactant within a predefined volume of the aquifer to assess whether sufficient reactant mass is available for an identified attenuation process. This calculation provides a general sense of the relative degree to which the aquifer could support attenuation and may provide some perspective as to the relative importance of investing resources to fully characterize reactant mass or flux. This calculation does not, however, likely provide any insight into the efficiency of the attenuation process.

Another example of simplified calculations that may be used is input parameters for more complex transport or reaction models using specific mathematical formulas. Several examples of these types of calculations are provided at the following the EPA website: www.epa.gov/athens/learn2model/part-two/onsite/index.html. These calculations may support analysis of the adequacy of monitoring network design in addition to estimating model input parameters and hence play an important role in the site characterization effort.

Mass Transport Models. Mass transport models seek to describe the flow of groundwater at a site and the transport of chemical species by the groundwater. Because mass transport models typically consider migration of non-reacting species, they seldom can be relied on to accurately describe natural attenuation. However, they can still be useful for estimating the transit time of contaminants within the site, absent attenuating processes. This "worst case" transport scenario has value in evaluating a site's potential for MNA. Mass transport models are best suited for application in Phase I or Phase II of the tiered analysis approach.

Speciation and Reaction Models. Speciation models seek to describe the distribution of chemical mass between solution, minerals, mineral surfaces, gases, and biomass. Models of this class are useful because they can predict the conditions that might attenuate contaminants by sequestration, and those in which they are likely to be mobile in the groundwater flow. For example, a speciation model might demonstrate that a contaminant is likely to adsorb to the surface of a component of the aquifer solids over the pH range of interest. Alternatively, the model might show that the contaminant will tend to complex strongly with dissolved chemical species, leaving it mobile and resistant to attenuation. Speciation models assume the modeled system is in partial or complete chemical equilibrium. One example of a speciation model is MINTEQA2, which can be found at www2.epa.gov/exposure-assessment-models/minteqa2.

Reaction models are similar to speciation models in that they consider the distribution of chemical mass, but have the additional ability of modeling the chemical evolution of the system with changing site conditions. Examples of uses for reaction models include estimating sequestration of contaminants onto a mineral surface as the mineral forms, or estimating precipitation of contaminant-bearing minerals as water chemistry changes.

Speciation models and reaction models would typically be used in Phase II or Phase III of the tiered analysis approach. However, they can also be helpful in Phase IV (monitoring) to identify critical chemical parameters to which the attenuation process is sensitive.

Reactive Transport Models. Reactive transport models, as the name suggests, couple reaction models to transport models. Unlike a reaction model, a reactive transport model predicts not only the reactions that occur as the groundwater flows, but how those reactions vary in space and change through time. A reactive transport model may have several advantages over a simple reaction model, including the ability to account for heterogeneity at the site, such as an uneven distribution of a sorbing mineral or variation in pH conditions.

Reactive transport modeling is a relatively complex and time-consuming undertaking, since it combines the data needs and uncertainties inherent in modeling reaction as well as transport of contaminants. As such, reactive transport models are typically reserved for use in Phase III analysis. It may be the capstone of the modeling effort but is seldom the best tool for initial scoping of the attenuation capabilities at a site. This modeling, on the other hand, may play an important role in the site characterization effort because it represents the integration of all of the components of the conceptual site model.

6.2 Model Calibration

Because of the uncertainties discussed above, it generally is important to calibrate a model to observations and to verify that the model behaves in a manner that adequately describes the natural system. Calibration is typically designed to bring the model into alignment with observed data. To have optimal confidence in results, models are recommended that (1) utilize to the greatest extent possible parameter values specific to the site, and (2) are calibrated to the observed evolution and distribution of the contaminant plume. It is further recommended that steps taken to calibrate the model application be documented and provided for review to build confidence in the use of the model as an assessment tool.

More direct lines of evidence should be included in the recommended tiered analysis process because of the complexity of modeling efforts and the potential level of uncertainty associated with model predictions. The acquisition of these data often depends on establishing a network of monitoring locations throughout the aquifer. The site-specific data collected from these monitoring locations should provide a reliable way to identify the attenuation process and assess the performance characteristics of MNA. As with any technology used as part of a cleanup, continued assessment of performance is normally important for ensuring cleanup goals will be attained.

6.3 Interpreting Model Results

It is generally not possible to account for all variability in a modeling study because of the heterogeneity of most geologic systems. Modeling results should therefore be interpreted in realistic rather than absolute terms. Modeling is often most helpful for identifying relative changes in contaminant speciation and distribution in response to geochemical changes in the system. Models can provide an indication of whether a particular reaction or system response is expected under specific conditions. When the potential for MNA of inorganic contaminants is evaluated, modeling should be validated with observational study to confirm whether the expected reactions occur. Discrepancies between modeled and actual conditions can lead to new insights into the geochemical system and may result in changes to the CSM.

Discrepancies between modeled and actual conditions can result from uncertainty introduced at several points in the modeling process. Geochemical modeling applications generally require complete chemical analyses, including not only the contaminants of interest, but the major ion chemistry, pH, and distribution of metals among their mobile redox states. Errors in chemical analysis may therefore alter model results. Similarly, errors in measuring hydrologic parameters may result in differences between measured and modeled distributions of chemical species.

Errors or omissions in sampling also affect model results. Sample choice and dataset size can introduce error through sampling bias. Fluid samples may be collected from monitoring wells completed in highly conductive layers, where they can be extracted rapidly, leaving unaccounted significant quantities of residual contamination in slightly less conductive layers. In addition, samples may not be collected from upgradient or downgradient stations located outside the immediate plume, which precludes an accurate evaluation of the groundwater chemistry of unaffected portions of the aquifer. Uncontaminated groundwater migrating onto a site can induce changes in groundwater chemistry that may affect the stability of attenuated compounds. Similarly, as contaminated groundwater mixes with uncontaminated groun dwater downgradient of a site, changes in groundwater chemistry may occur, with impacts to the stability of the attenuated compound. Collecting samples upgradient and downgradient of the site is recommended to accurately evaluate site-induced chemistry changes.

Geochemical models rely on thermodynamic databases that contain data on aqueous species and potential reactions between them. These databases, and the thermodynamic data contained within them, vary widely in breadth and accuracy. Modeling results will vary depending on the thermodynamic database used in the model.

For best results, data used as input in a model must be accurate and representative of site conditions. Inaccurate information will lead to skewed results. Where differences in modeled and measured site conditions are observed, changes in the CSM for a site may be needed or new information obtained.

6.4 Site-Specific Data

Site-specific data should be collected to define the physical, chemical, and biological characteristics of the aquifer to derive meaningful modeling results and test the validity of model predictions. It is important to calibrate models to observations and to verify that the model adequately describes the natural system. Steps taken to calibrate any models used to support selection of MNA should be documented and available for review to increase confidence in the use of the model.

7.0 SUMMARY

The EPA remains fully committed to its goals of protecting human health and the environment by remediating contaminated soils, restoring contaminated groundwaters to their beneficial uses, preventing migration of contaminant plumes, and protecting groundwater and other environmental resources. The EPA does not view MNA as a "no action" remedy, but rather considers it a potential means of addressing contamination under a limited set of site circumstances where its use is consistent with CERCLA and the NCP. In general, MNA should not be considered as a "presumptive" or "default" remediation alternative, but rather should be evaluated and compared with other viable remediation methods (including innovative technologies) during the assessment phases leading to the selection of a remedy. The evaluation of MNA should include a comprehensive site characterization, risk assessment where appropriate and measures to control sources. In addition, the progress of MNA toward a site's cleanup levels should be carefully monitored and compared with expectations to ensure that it will meet RAOs within a timeframe that is reasonable compared with timeframes associated with other methods. Where MNA's ability to meet these expectations is uncertain and based primarily on lines of evidence other than documented trends of decreasing contaminant concentrations, decision-makers should incorporate contingency measures into the remedy.

In summary, there are several key issues and ideas to note regarding MNA for inorganic contaminants:

- Because MNA does not use any active remedial measures, MNA does not constitute a treatment process for inorganic contaminants.
- Dilution and dispersion generally are not appropriate as primary MNA mechanisms because they accomplish concentration reduction through dispersal of contaminant mass rather than mass destruction or immobilization.
- MNA is generally not appropriate for plumes that are considered stable, yet there is confirmed discharge to surface water bodies or potential human or ecological receptor exposure.
- MNA should be supported by actual site data and information in the administrative record demonstrating a decreasing trend of the contaminant concentration.
- Attenuation rates and mass flux estimates can be used as supporting lines of evidence but should not be used as the primary supporting evidence that attenuation is occurring.
- Reliance on models without monitoring data to demonstrate continued attenuation would generally be inconsistent with this guidance.

The EPA is confident that MNA can be, at many sites, a reasonable and protective component of a broader remediation strategy. However, the EPA also believes that there may be many other sites where either the uncertainties are too great or there is a need for a more rapid remediation that precludes the use of MNA as a stand-alone remedy because it would not ensure protectiveness of human health and the environment. This guidance is intended to help promote consistency in how MNA remedies for inorganic contaminants are, evaluated, and if appropriate, proposed and selected as remedial actions.

8.0 REFERENCES

Anderson, R. T., H. A. Vrionis, I. Ortiz-Bernard, C. T. Resch, P. E. Long, R. Dayvault, K. Karp, S. Marutsky, D. R. Metzler, A. Peacock, D. C. White, M. Low, and D. R. Lovely. 2003. Stimulating the in situ activity of geobacter species to remove uranium from the groundwater of a uranium-contaminated aquifer. *Applied and Environmental Microbiology* **69**:5884-5891.

Dixon, J.B. and D.G. Schulze (Eds.). 2002. *Soil Mineralogy with Environmental Applications.* Soil Science Society of America, Madison, Wisconsin.

Eyal, Y. and R.L. Fleischer. 1985. Preferential leaching and the age of radiation damage from alpha decay in minerals. *Geochimica et Cosmochimica Acta* **49**:1155–1164.

Farhat, S.K., C.J. Newell, and E.M. Nichols. 2006. *User's Guide: Mass Flux Tool Kit*. Environmental Security Technology Certification Program, Washington, DC.

Fleischer, R.L. 1980. Isotopic disequilibrium of uranium: alpha-recoil damage and preferential solution effects. *Science* **207**:979-981.

Fujita, Y., G. D. Redden, J. C. Ingram, M. M. Cortez, F. G. Ferris, and R. W. Smith. 2004. Strontium incorporation into calcite generated by bacterial ureolysis. *Geochimica et Cosmochimica Acta* **68**:3261-3270.

Huck, P. M., and W. B. Anderson. 1990. "Removal of ^{226}Ra from Uranium Mining Effluents and Leaching from Sludges." In *The Environmental Behavior of Radium, Volume 2,* pp. 135-162, International Atomic Energy Agency, Vienna, Austria.

Interstate Technology and Regulatory Council (ITRC). 2003. *Technical and Regulatory Guidance for the Triad Approach: A New Paradigm for Environmental Project Management*. SCM-1. (www.itrcweb.org/Guidance/GetDocument?documentID=90)

ITRC. 2010. *A Decision Framework for Applying Attenuation Processes for Metals and Radionuclides*. (www.itrcweb.org/Guidance/GetDocument?documentID=5)

Istok, J. D., J. M. Senko, L. R. Krumholz, D. Watson, M. A. Bogle, A. Peacock, Y. J. Chang, and D. C. White. 2004. In situ bio-reduction of technetium and uranium in a nitrate-contaminated aquifer. *Environmental Science and Technology* **38**:468-475.

Ivanovich, M. 1994. Uranium series disequilibrium – concepts and applications. *Radiochimica Acta* **64**:81-94.

Kigoshi, K. 1971. Alpha-recoil ^{234}Th: dissolution into water and the ^{234}U/^{238}U disequilibrium in nature. *Science* **173**:47-48.

Langmuir, D. and A.C. Riese. 1985. The thermodynamic properties of radium. *Geochimica et Cosmochimica Acta* **49**:1593-1601.

Michalsen, M. M., B. A. Goodman, S. D. Kelly, K. M. Kemner, J. P. McKinley, J. W. Stucki, and J. D. Istok. 2006. Uranium and technetium bio-immobilzation in intermediate-scale physical models of an in situ bio-barrier. *Environmental Science and Technology* **40**:7048-7053.

Pardue, J. H., and T. Z. Guo. 1998. Biochemistry of ^{226}Ra in contaminated bottom sediments and oilfield waste pits. *Journal of Environmental Radioactivity* **39**:239-253.

Roden, E. E., M. R. Leonardo, and F. G. Ferris. 2002. Immobilization of strontium during iron biomineralization coupled to dissimilatory hydrous ferrous oxide reduction. *Geochimica et Cosmochimica Acta* **66**:2823-2839.

Shanbhag P. M. and J. W. Morse. 1982. Americium interaction with calcite and aragonite surfaces in seawater. *Geochimica et Cosmochimica Acta* **46**:241-246.

Senko, J. M., J. D. Istok, J. M. Suflita, and L. R. Krumholz. 2002. In-situ evidence for uranium immobilization and remobilization. *Environmental Science and Technology* **36**:1491-1496.

Smith, C. and N. Smith. 1971. *General Chemistry Workbook*, Nuclear Chemistry, Chapter 24 pp 308-309. W.H. Freeman and Co.

Sparks, D. L. 2003. *Environmental Soil Chemistry*. Academic Press, San Diego, California.

Sposito, G. 1984. *The Surface Chemistry of Soils.* Oxford University Press, New York, New York.

Sposito, G. 1986. Distinguishing adsorption from surface precipitation. In *Geochemical Processes at Mineral Surfaces*. J.A. Davis and K.F. Hayes (Eds.), American Chemical Society Symposium Series **323**:217-228.

Sun, H. and T.M. Semkow. 1998. Mobilization of thorium, radium and radon radionuclides in groundwater by successive alpha-recoils. *Journal of Hydrology* **205**:126-136.

Tessier, A., P. G. C. Campbell, and M. Bisson. 1979. Sequential Extraction Procedure for the Speciation of Particulate Trace Metals. *Analytical Chemistry* **51**:844-851.

U. S. Army Corps of Engineers (USACE). 1998. *Technical Project Planning (TPP) Process*. Engineer Manual 200-1-2, U.S. Army Corps of Engineers, Washington, DC.

USACE. 2003. *Conceptual Site Models for Ordnance and Explosives (OE) and Hazardous, Toxic, and Radioactive Waste (HTRW) Projects*. Engineer Manual 1110-1-1200, U.S. Army Corps of Engineers, Washington, DC. (www.epa.gov/tio/download/char/em1110-1-1200.pdf)

U.S. Environmental Protection Agency (EPA). 1993. *Environmental Characteristics of EPA NRC* [Nuclear Regulatory Commission]*, and DOE* [U.S. Department of Energy] *Sites Contaminated with Radioactive Substances.* EPA 402-R-93-011, Office of Radiation and Indoor Air, Washington, DC. (www.epa.gov/radiation/docs/cleanup/402-r-93-011.pdf)

EPA. 1998. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. EPA 600-R-98-128, Office of Research and Development, Washington, DC. (www.epa.gov/tio/download/remed/protocol.pdf)

EPA. 1999a. *Understanding Variation in Partition Coefficient, K_d, Values: Volume I—K_d Model, Measurement Methods, and Application of Chemical Reaction Codes*. EPA 402-R-99-004A, Office of Radiation and Indoor Air, Washington, DC. (www.epa.gov/radiation/docs/kdreport/vol1/402-r-99-004a.pdf)

EPA. 1999b. *Understanding Variation in Partition Coefficient, K_d, Values: Volume II—Geochemistry and Available K_d Values for Selected Inorganic Contaminants*. EPA 402-R-99-004B, Office of Radiation and Indoor Air, Washington, DC. (www.epa.gov/radiation/docs/kdreport/vol2/402-r-99-004b.pdf)

EPA. 1999c. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites*. OSWER Directive 9200.4-17P, Office of Solid Waste and Emergency Response, Washington DC. (www.epa.gov/swerust1/directiv/d9200417.pdf)

EPA. 1999d. *A Guide to Preparing Superfund Proposed Plans, Records of Decision, and Other Remedy Selection Decision Documents*. OSWER Directive 9200.1-23P, Office of Solid Waste and Emergency Response, Washington, DC. (www.epa.gov/superfund/policy/remedy/rods/pdfs/guide_decision_documents_071999.pdf)

EPA. 2000. *Soil Screening Guidance for Radionuclides: Technical Background Document*. OSWER Directive 9355.4-16, Office of Radiation and Indoor Air, Office of Solid Waste and Emergency Response, Washington, DC. (www.epa.gov/superfund/health/contaminants/radiation/pdfs/sstbd.pdf)

EPA. 2001. *Evaluation of the Protocol for Natural Attenuation of Chlorinated Solvents: Case Study at the Twin Cities Army Ammunition Plant*. EPA 600-R-01-025, Office of Research and Development, Washington, DC. (nepis.epa.gov/Adobe/PDF/P1000F25.pdf)

EPA. 2002a. *Workshop on Monitoring Oxidation-Reduction Processes for Ground-water Restoration*. EPA 600-R-02-002, Office of Research and Development, Cincinnati, Ohio. (nepis.epa.gov/Adobe/PDF/10003Z26.pdf)

EPA. 2002b. *Guidance for Quality Assurance Project Plans*. EPA QA/G-5, EPA 240-R-02-009, Office of Environmental Information, Washington, DC. (www.epa.gov/QUALITY/qs-docs/g5-final.pdf)

EPA. 2002c. *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies*. EPA 540-S-02-500, National Risk Management Research Laboratory, Cincinnati, Ohio).

EPA. 2004a. Multi-Agency Radiological Laboratory Analytical Protocols Volume II.

EPA. 2004b. *Performance Monitoring of MNA Remedies for VOCs in Ground Water*. EPA 600-R-04-027, Office of Research and Development, Washington, DC. (clu-in.org/download/contaminantfocus/dnapl/Treatment_Technologies/performance_monitoring_mns600R04027.pdf)

EPA. 2004c. *Understanding Variation in Partition Coefficient, Kd, Values: Volume III—Review of Geochemistry and Available K_d Values for Americium, Arsenic, Curium, Iodine, Neptunium, Radium, and Technetium*. EPA 402-R-04-002C, Office of Radiation and Indoor Air, Washington, DC. (www.epa.gov/radiation/docs/kdreport/vol3/402-r-04-002c.pdf)

EPA. 2006a. *Guidance on Systematic Planning Using the Data Quality Objectives Process*. EPA QA/G-4, EPA 240-B-06-001, Office of Environmental Information, Washington, DC. (www.epa.gov/quality/qs-docs/g4-final.pdf)

EPA. 2006b. *Mineralogical Preservation of Solid Samples Collected from Anoxic Subsurface Environments.* EPA 600-R-06-112, Office of Research and Development, Cincinnati, Ohio. (nepis.epa.gov/Adobe/PDF/600003I1.pdf)

EPA. 2006c. *Inventory of Radiological Methodologies*. EPA 402-R-06-007, Office of Radiation and Indoor Air, Montgomery, Alabama. (www.epa.gov/narel/IRM_Final.pdf)

EPA. 2007a. *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume I—Technical Basis for Assessment*. EPA 600-R-07-139, Office of Research and Development, Washington, DC. (nepis.epa.gov/Adobe/PDF/60000N4K.pdf)

EPA. 2007b. *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume II—Assessment for Non-Radionuclides Including Arsenic, Cadmium, Chromium, Copper, Lead, Nickel, Nitrate, Perchlorate, and Selenium*. EPA 600-R-07-140, Office of Research and Development, Washington, DC. (nepis.epa.gov/Adobe/PDF/60000N76.pdf)

EPA. 2008. *Ground Water Issue: Site Characterization to Support Use of Monitored Natural Attenuation for Remediation of Inorganic Contaminants in Ground Water*. EPA 600-R-08-114, National Risk Management Research Laboratory, Cincinnati, Ohio. (nepis.epa.gov/Adobe/PDF/P1002X3C.pdf)

EPA. 2009. *Standard Analytical Methods for Environmental Restoration following Homeland Security Events Volume 5.0*. (nepis.epa.gov/EPA/html/DLwait.htm?url=/Exe/ZyPDF.cgi?Dockey=P1005B4P.PDF)

EPA. 2010a. *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume III—Assessment for Radionuclides Including Americium, Cesium, Iodine, Plutonium, Radium, Radon, Strontium, Technetium, Thorium, Tritium, and Uranium*. EPA 600-R-10-093, Office of Research and Development, Washington, DC.

EPA. 2010b. *Revised Guidance on Compiling Administrative Records for CERCLA Response Actions*. Office of Solid Waste and Emergency Response, Washington, DC. (www.clu-in.org/conf/tio/CECOSC4_121813/AR-Guidance-dated-9.20.2010.pdf)

EPA. 2012. *Institutional Controls: A Guide to Planning, Implementing, Maintaining, and Enforcing Institutional Controls at Contaminated Sites*. OSWER 9355.0-89, EPA 540-R-09-001. Office of Solid Waste and Emergency Response, Washington, DC. December 2012. (www.epa.gov/superfund/policy/ic/guide/Final%20PIME%20Guidance%20December%202012.pdf)

APPENDIX A

RECOMMENDED GROUNDWATER ANALYSES

Appendix A. Recommended Groundwater Analyses (EPA 2007a and 2007b)

Analysis	Associated Phase	Data Use	Recommended Frequency of Analysis[1]	Comments
Water level data	I, II, III, IV	Can be used to determine groundwater flow directions and rate of flow.	Each sampling round	Water levels from a sufficient number of wells on a project should be collected to determine groundwater flow direction. Measurements should be taken over a time period to minimize impacts from changing hydrogeologic conditions (for example, tidal influences, pumping drawdown).
Total Metals	I, II, III, IV	Can be used in defining plume boundary, confirming static or shrinking plume conditions, modeling geochemical speciation/ environmental fate and transport, and determining overall appropriateness of MNA for meeting remediation objectives within the specified regulatory time frame. Data is ultimately useful to MNA performance/ compliance monitoring program.	Each sampling round	Exposure of samples to air should be prevented and samples should be preserved to prevent sample oxidation and potential metal co-precipitation with iron oxides. For further discussion of total and dissolved metal sampling, refer to *Monitored Natural Attenuation of Inorganic Contaminants in Ground Water, Volume I* (EPA 2007a).

Notes:

1. Recommended frequency of analysis may need to be adjusted to meet site-specific data needs.

Analysis	Associated Phase	Data Use	Recommended Frequency of Analysis[1]	Comments
Radionuclides	I, II, III, IV	Same as total metals in water. In addition, some analytical methods for radionuclides measure total mass while others measure specific isotopes or activity, which may be important for evaluating ingrowth contributions to plume activity and mobility.	Each sampling round	Same as total metals in water. Keep anaerobic samples anaerobic to prevent potential co-precipitation of target radionuclides with iron or other oxides. Measurement of activity is more appropriate for short half-life radionuclides where decay processes dominate, while measurement of total mass is more appropriate for long half-life radionuclides where attenuation is dominated by physicochemical processes such as sorption or precipitation.
pH	I, II, III, IV	Can be used in modeling geochemical speciation/ environmental fate and transport. Important in evaluating sorption capacity of soil.	Each sampling round	Improperly calibrated electrodes could impair results; should measure immediately or in a flow-through cell to prevent equilibration of groundwater with atmosphere.
Major Anions	II, III, IV	Includes Br, Cl, F, NO_3 / NO_2, o-PO_4 and SO_4. Used in modeling geochemical speciation and environmental fate and transport. Trends in nitrate/nitrite and sulfate/ sulfide concentrations also indicate redox conditions.	Each sampling round	Relative amounts of NO_3^- / NO_2^- and SO_4^{2-} / S^{2-} provide additional lines of evidence of oxidizing/ reducing conditions in the aquifer and provide data on changing aquifer conditions. Note: Br, F and o-PO_4 are typically present at trace concentrations and are not considered “major anions.”

Notes:

1. Recommended frequency of analysis may need to be adjusted to meet site-specific data needs.

Analysis	Associated Phase	Data Use	Recommended Frequency of Analysis[1]	Comments
Major Cations	II, III, IV	Includes Na, K, Ca, Mg and Fe. Used in modeling geochemical speciation/ environmental fate and transport. Ca and Mg in solution may compete with other metals for sorption sites and thereby reduce sorptive capacity of soils.	Each sampling round	Relative amounts of Fe(II)/Fe(III) provide additional lines of evidence of oxidizing/reducing conditions in the aquifer and provide data on changing aquifer conditions.
Ferrous iron and Sulfide	II, III, IV	Can be used to determine whether a system is reducing. Also used to determine the potential for contaminant precipitation or co-precipitation and for geochemical modeling.	Initial sampling round, then semi-annually	Field measurement. Can determine if ferric iron is present by subtracting ferrous iron concentration from total iron concentration.
Temperature	I, II, III, IV	Standard parameter; may be used to evaluate reaction kinetics.	Each sampling round	
Oxidation-Reduction Potential (ORP)	I, II, III, IV	Indicates whether oxidizing or reducing conditions prevail in site groundwater. Some redox-sensitive metals and radionuclides may form sparingly soluble complexes or precipitates under reducing conditions	Each sampling round	Groundwater system redox affects mineral solubility and relative concentrations of redox-sensitive elements in groundwater.
Dissolved Oxygen (DO)	I, II, III, IV	Use with ORP to determine if system is oxic or anoxic.	Each sampling round	Measure in a flow-through cell to prevent equilibration of groundwater with atmosphere.

Notes:

1. Recommended frequency of analysis may need to be adjusted to meet site-specific data needs.

Analysis	Associated Phase	Data Use	Recommended Frequency of Analysis[1]	Comments
Dissolved Organic Carbon (DOC)	II, III, IV	Elevated DOC may promote metal complexation with humic acids and affect sorption to soil; DOC may also promote reducing aquifer conditions that could impact speciation of redox-sensitive metals.	Initial sampling round, then annually	Can be used initially to help understand the attenuation process at work and aquifer capacity for contaminant reduction. Used during long-term monitoring to signify changes in water chemistry that may impact attenuation sustainability.
Total Inorganic Carbon (TIC)	II, IV	Can be used with pH data to determine carbonate speciation and buffering capacity of groundwater. Some metals may form sparingly soluble complexes with carbonates (for example, lead) while others become more mobile when complexed with carbonate (for example, uranium).	Initial sampling round, then semi-annually	Total inorganic carbon is similar to alkalinity, but includes additional species (for example, CO_2 or H_2CO_3) not typically accounted for in alkalinity measurement. Alkalinity may be an acceptable substitute for TIC. Used during long-term monitoring to signify changes in water chemistry that may impact attenuation.
Conductivity	I, II, III, IV	Conductivity can provide indications of ionic strength and total dissolved solids.	Each sampling round	

Notes:

1. Recommended frequency of analysis may need to be adjusted to meet site-specific data needs.

APPENDIX B

RECOMMENDED SOIL ANALYSES

Appendix B. Recommended Soil Analyses (EPA [2007a, 2007b])

Analysis	Associated Phase	Data Use	Recommended Frequency of Analysis[1]	Comments
Hydraulic conductivity	I	Can be used with groundwater level data to determine groundwater flow velocity.	Initial sampling round	Component in the development of the conceptual site model and sampling frequency.
Total Metals	II, III, IV	Can be used in determining the extent of soil contamination, contaminant mass present, and potential for source attenuation.	Initial site characterization and MNA evaluation	Frequency of soil sampling and analysis during MNA program should be established as part of the performance and compliance monitoring program.
Radionuclides	II, III, IV	Same as total metals in soils. In addition, some analytical methods for radionuclides measure total mass while others measure specific isotopes and/or activity. Mass measurements are collected for determining soil uptake capacity.	Initial site characterization and MNA evaluation	Analytical data should be adjusted to account for decay losses during the interval between sample collection and analysis for radionuclides with short half-lives. Measurement of activity for short half-life radionuclides or total mass for long half-life radionuclides is same as for groundwater.
Mineralogy	II, III	Can be used to evaluate attenuation capacity of aquifer; identification of site-specific metal and mineral associations may be used to evaluate long-term metal retention capacity of soil.	Initial site characterization and MNA evaluation	Both mineralogical composition and contaminant distribution in soil may be highly heterogeneous at the field scale. Data can also be used to support geochemical modeling of the site.

Notes:

1. Recommended frequency of analysis may need to be adjusted to meet site-specific data needs.

Analysis	Associated Phase	Data Use	Recommended Frequency of Analysis[1]	Comments
Cation Exchange Capacity (CEC)	II, III, IV	Provides relative indication of sorptive capacity of soil under specific solution conditions.	Initial site characterization and MNA evaluation	Dependent on pH and soil organic matter.
Total Organic Carbon (TOC)	II	Can be used along with cation exchange capacity to obtain relative indication of soil sorptive capacity.	Initial site characterization and MNA evaluation	Can be used with the organic carbon soil-water partition coefficient, K_{oc}, to determine contaminant partitioning coefficient.
Acid Volatile Sulfides (AVS)/ Simultaneously Extracted Metals (SEM)	II, III, IV	Can be used to assess metal and metalloid partitioning to the sulfide fraction of soils and sediments, and to estimate potential metal toxicity in aquatic sediments.	Initial site characterization and MNA evaluation	Outside the source area samples are generally taken from the saturated zone to determine potential reaction between dissolved contaminants and mineral solids.
Sequential Extraction Procedures (SEP)	II, III, IV	Can be used to obtain a relative assessment of contaminant environmental availability. Site samples are subjected to successively harsher extracting solutions; contaminants released earlier are presumed to be relatively more available.	Initial MNA evaluation; thereafter at intervals based on groundwater flow velocity	Can provide quantitative information on the capacity of a material to attenuate inorganic contaminants. Measurements done over time can provide data on changes in available contaminant mass sorbed to or precipitated in the soil matrix. Assumes components released in earlier extractions are more environmentally mobile.

Notes:

1. Recommended frequency of analysis may need to be adjusted to meet site-specific data needs.

APPENDIX C

RECOMMENDED ANALYTICAL METHODS AND DATA QUALITY REQUIREMENTS FOR GROUNDWATER ANALYSES

Appendix C. Recommended Analytical Methods and Data Quality Requirements for Groundwater Analyses (EPA [2007a, 2007b])

Analysis	Method Reference and/or Description (most recent revision or date)	Sample Volume, Sample Container, Sample Preservation	Minimum Required Limit of Quantitation or Resolution	Comments
Total Metals/ Inorganic	SW 6010C (Revision 3, February 2007)/6020A (Revision 1, February 2007): *As, Cr, Cu, Pb, Ni, Se* EPA 200.8 (Revision 5.4)/SW 6020A (Revision 1, February 2007): *Cd* SW 6850 (Revision 0, January 2007/6860 (Revision 0, January 2007): ClO_4 EPA 2007a	250 mL, polycarbonate bottle, nitric acid (pH<2), cool to 4° C	1 µg/L	If aquifer is anaerobic, exposure of samples to air should be prevented or samples should be preserved to prevent sample oxidation and potential co-precipitation with iron oxides.
Radionuclides	*Standard Analytical Methods for Environmental Restoration Following Homeland Security Events v. 5.0* (EPA 2009); *Inventory of Radiological Methodologies* (EPA 2006c); *Multi-Agency Radiological Laboratory Analytical Protocols Vol. II* (EPA 2004a)	250 mL, polycarbonate bottle, cool to 4°C; also see method-specific recommendations		Analytical data should be adjusted to account for decay losses during the interval between sample collection and analysis for radionuclides with short half-lives. Use of either activity- or mass-based analytical methods may be appropriate depending on data needs.

Notes:

1. Most recent version of listed method is assumed.
2. "SW" refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods*, SW-846, EPA, most recent edition.
3. "SM" refers to *Standard Methods for the Examination of Water and Wastewater*, most recent edition.
4. "EPA" refers to *Methods for Chemical Analysis of Water and Wastes*, EPA, most recent edition.

Analysis	Method Reference and/or Description (most recent revision or date)	Sample Volume, Sample Container, Sample Preservation	Minimum Required Limit of Quantitation or Resolution	Comments
pH	EPA 150.2 (Revision 0, December 1982) or field probe with direct reading meter	Measure in field following procedures in the EPA 150.2 or per manufacturer instructions	0.2 units	Improperly calibrated electrodes could impair results; should measure immediately to prevent equilibration of groundwater with atmosphere.
Major Anions	EPA 300.1/SW 9056 A (Revision 1, February 2007)	250 mL, Polycarbonate bottle, cool to 4°C	100 µg/L	
Major Cations	SW 6010C C (Revision 3, February 2007)/7000B (Revision 2, February 2007)	250 mL, polycarbonate bottle, Nitric acid (pH<2), cool to 4°C	100 µg/L	
Ferrous Iron, Sulfide	EPA 2002a	25 mL, glass bottle, unpreserved	1 mg/L	Measured in field using colorimetric method. Analysis should be done quickly as the analytes are sensitive to exposure to atmospheric oxygen.
Temperature	Field temperature probe with direct reading meter	Measure in the field using a flow-through cell or an overflow cell filled from the bottom	0.5°C	
Oxidation-Reduction Potential (ORP)	SM 2580B (1997) EPA 2002a	Measure in the field using a flow-through cell or an overflow cell filled from the bottom	+/- 100 mV	Field measurement should be in situ or in flow-through cell to prevent introduction of atmospheric oxygen. Improperly calibrated electrodes or introduction of atmospheric oxygen during sampling could impair results.

Notes:

1. Most recent version of listed method is assumed.
2. "SW" refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods*, SW-846, EPA, most recent edition.
3. "SM" refers to *Standard Methods for the Examination of Water and Wastewater*, most recent edition.
4. "EPA" refers to *Methods for Chemical Analysis of Water and Wastes*, EPA, most recent edition.

Analysis	Method Reference and/or Description (most recent revision or date)	Sample Volume, Sample Container, Sample Preservation	Minimum Required Limit of Quantitation or Resolution	Comments
Dissolved Oxygen (DO)	Dissolved oxygen meter calibrated between each well according to the supplier's specifications	Measure in the field using a flow-through cell or an overflow cell filled from the bottom	0.2 mg/L	Field measurement should be in situ or in flow-through cell to prevent introduction of atmospheric oxygen.
Dissolved Organic Carbon (DOC)	EPA 415.3 (Revision 1.0, June 2003)	250 mL, polycarbonate bottle, 0.45 µm field filtered and H_2SO_4 (pH<2), cool to 4°C		
Total Inorganic Carbon (TIC)	SM 2320 (1997)	250 mL, zero headspace glass bottle, cool to 4° C		Quickly collect sample to prevent equilibration of groundwater with atmosphere; Hach alkalinity test kit model AL AP MG-L could be considered as an alternative method.
Conductivity	EPA 120.1 (1982), SW 9050A (Revision 1, December 1996), or direct reading meter	250 mL plastic or glass bottle, cool to 4°C; or measure in the field	50 $\mu S/cm^2$	

Notes:

1. Most recent version of listed method is assumed.
2. "SW" refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods*, SW-846, EPA, most recent edition.
3. "SM" refers to *Standard Methods for the Examination of Water and Wastewater*, most recent edition.
4. "EPA" refers to *Methods for Chemical Analysis of Water and Wastes*, EPA, most recent edition.

APPENDIX D

RECOMMENDED ANALYTICAL METHODS AND DATA QUALITY REQUIREMENTS FOR SOIL ANALYSES

Appendix D. Recommended Analytical Methods and Data Quality Requirements for Soil Analyses (EPA [2007a, 2007b])

Analysis	Method Reference and/or Description (most recent revision or date)	Sample Volume, Sample Container, Sample Preservation	Minimum Required Limit of Quantitation or Resolution	Comments
Total Metals	SW 6010C (Revision 3, February 2007)/7000B (Revision 2, February 2007) *To be updated as necessary*	8 oz. wide-mouth glass jar, cool to 4 C	0.01 mg/kg	Sample prep methods to be chosen from SW 3050, 3051, or 3052; or from U.S. Geological Survey (USGS) Open File Report 02-223-I. Heterogeneity of metals concentrations in soils can be significant at the field scale. Should include reporting of Fe, Mn, Na, K, Ca, Mg and Al at a minimum.
Radionuclides	*Standard Analytical Methods for Environmental Restoration Following Homeland Security Events v. 5.0* (EPA 2009); *Inventory of Radiological Methodologies* (EPA 2006c); *Multi-Agency Radiological Laboratory Analytical Protocols Vol. II* (EPA 2004a)	8 oz. wide-mouth glass jar, cool to 4°C; also see method-specific recommendations		It is critical that analytical data be adjusted to account for decay losses during the interval between sample collection and analysis for radionuclides with short half-lives. Use of either activity- or mass-based analytical methods may be appropriate depending on data needs.
Mineralogy	X-ray fluorescence and X-ray diffraction	8 oz. wide-mouth glass jar, cool to 4 C	N/A	Petrographic analysis may also be appropriate.
Cation Exchange Capacity (CEC)	SW 9081 (Revision 0, September 1986)	8 oz. wide-mouth glass jar, cool to 4 C		Perform under various pH conditions to determine pH dependence of exchange capacity.

Notes:

1. Most recent version of listed method is assumed.
2. “SW” refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods*, SW-846, EPA, most recent edition.

Analysis	Method Reference and/or Description (most recent revision or date)	Sample Volume, Sample Container, Sample Preservation	Minimum Required Limit of Quantitation or Resolution	Comments
Total Organic Carbon (TOC)	Modified SW 9060A (Revision 1, November 2004)	8 oz. wide-mouth glass jar, cool to 4 C		Method not standard between labs. Can also consider organic matter loss on ignition with subsequent calculation of TOC.
Acid Volatile Sulfide (AVS)/ Simultaneously Extracted Metals (SEM)	EPA 821-R-91-100	8 oz. wide-mouth glass jar, cool to 4 C		
Sequential Extraction Procedures (SEP)	Tessier *and others*. (1979)	8 oz. wide-mouth glass jar, cool to 4 C		

Notes:

1. Most recent version of listed method is assumed.
2. "SW" refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods*, SW-846, EPA, most recent edition.

ATTACHMENT 5

2016 ANALYTICAL RESULTS (JANUARY - MARCH)
ROXBORO STEAM ELECTRIC PLANT
DUKE ENERGY PROGRESS, LLC, SEMORA, NC

Field Parameters

Sample ID	Sample Collection Date	pH	Water Level	Temperature	Specific Conductance	Dissolved oxygen	Oxidation Reduction Potential	Eh	Turbidity	Ferrous Iron
Reporting Units		S.U.	ft	Deg C	umhos/cm	mg/l	mV	mV	NTUs	mg/l
NC2L Standard		6.5-8.5	NE	NE	NE	NE	NE	NE	NE	NE
Ash Pore Water										
ABMW-01	01/06/2016	**10.1**	6.59	8	539	0.59	-37	168	4.52	0
ABMW-01	01/07/2016	**9.6**	6.48	13	533	0.46	-196	9	1.7	NM
ABMW-02	01/05/2016	**9.2**	8.74	11	422	0.57	59	264	4.66	0
ABMW-04	01/06/2016	6.9	29.81	13	3712	0.3	-137	68	3.87	3.5
ABMW-05	01/06/2016	7.7	11.29	13	2459	0.4	-155	50	0.5	1.5
Transition Zone										
ABMW-05D	01/06/2016	7.4	45.35	12	442	0.5	-189	16	19.4	2
BG-01	01/05/2016	**6.4**	38.65	15	528	3.49	170	375	8.46	0
CW-04	01/05/2016	7.1	28.67	12	521	2.11	36	241	3.67	0
MW-05D	01/05/2016	7.1	8.06	6	1130	2.2	84	289	1	0
MW-15D	01/05/2016	**6.4**	6.63	10	617	1.18	151	356	3.29	0
MW-18D	01/05/2016	7.2	47.07	16	1055	1.23	-24	181	1.25	NM
Bedrock										
ABMW-01BR	01/06/2016	7.1	7.43	12	523	0.7	-98	107	3.11	2
ABMW-01BR	01/07/2016	7.0	7.23	14	527	0.45	-71	134	1.99	NM
ABMW-02BR	01/06/2016	**11.4**	8.60	13	1001	3.35	-31	174	9.89	0
ABMW-04BR	01/07/2016	6.9	29.90	11	433	0.49	18	223	2.96	1.5
ABMW-06BR	01/06/2016	6.8	11.56	14	538	0.31	10	215	2.94	0.5
ABMW-06BR	01/07/2016	6.6	11.49	12	541	0.59	162	367	3.36	NM
ABMW-07BR	01/07/2016	6.7	13.92	12	654	0.7	-61	144	0.89	0.5
BG-01BR	01/05/2016	6.8	39.96	14	469	0.35	66	271	7.91	0
CW-01	01/06/2016	6.5	21.64	8	575	1.6	-71	134	5.6	1.5
DG-03BR	03/15/2016	7.5	0.00	17	319	0.5	-73	132	0.27	NM
MW-01BR	01/06/2016	6.8	28.71	5	837	1.4	66	271	2.8	0
MW-02BR	01/06/2016	**6.2**	12.13	13	841	0.49	31	236	2.91	5
MW-03BR	01/06/2016	6.8	22.42	1	2659	0.9	7	212	3	0
MW-04BR	01/05/2016	8.2	46.15	3	355	0.8	1	206	8.94	0
MW-05BR	01/05/2016	7.9	26.91	5	664	0.6	-130	76	2.1	0.5
MW-09BR	01/07/2016	6.5	30.57	13	305	0.26	80	285	5.97	0
MW-09BR DUP	01/07/2016	6.5	30.57	13	305	0.26	80	285	5.97	0
MW-10BR	01/06/2016	6.8	23.31	12	567	0.48	24	229	0.61	0
MW-13BR	01/06/2016	**6.2**	39.95	10	590	0.57	-56	149	2.15	2.5
MW-13BR DUP	01/06/2016	**6.2**	39.95	10	590	0.57	-56	149	2.15	2.5
MW-14BR	01/06/2016	7.0	49.95	7	618	0.88	70	275	6.18	0.5
MW-15BR	01/05/2016	7.6	7.74	10	429	0.49	50	255	2.26	0
MW-16BR	01/06/2016	6.7	30.73	13	484	0.59	105	310	2.8	0
MW-17BR	01/06/2016	7.2	37.74	14	591	0.28	16	221	5.13	0.75
MW-18BR	01/05/2016	7.6	47.05	14	757	0.22	-127	78	5.56	1
Within Toe of Ash Dam										
MW-01	01/05/2016	6.5	10.90	5	612	1.3	189	394	1.3	0
MW-02	01/05/2016	**6.1**	12.36	4	541	0.9	201	406	0.2	0

Analytical Results

Sample ID	Sample Collection Date	Alkalinity	Aluminum DIS	Aluminum TOT	Antimony DIS	Antimony TOT	Arsenic DIS	Arsenic TOT	Barium DIS	Barium TOT	Beryllium DIS	Beryllium TOT	Bicarbonate Alkalinity	Boron DIS	Boron TOT	Cadmium DIS	Cadmium TOT	Calcium TOT	Carbonate Alkalinity	Chloride	Chromium (Hexavalent)
Reporting Units		mg/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	mg/l	mg/l	mg/l	ug/l
NC2L Standard		NE	NE	NE	NE	1	NE	10	NE	700	NE	4	NE	NE	700	NE	2	NE	NE	250	NE
Ash Pore Water																					
ABMW-01	01/06/2016	NA	2920	2940	4.5	**4.65**	699	**658**	186	192	<1	<1	NA	11400	**11400**	<1	<1	93.4	NA	11	0.19
ABMW-01	01/07/2016	96.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	5.3	NA	NA	NA	NA	NA	91.2	NA	NA
ABMW-02	01/05/2016	83.7	1620	2410	3.15	**3.91**	524	**525**	250	224	<1	<1	83.7	7520	**7950**	<1	<1	59.8	<5	8.3	<0.03
ABMW-04	01/06/2016	538	52	102	<1	<1	928	**1160**	41	43	<1	<1	538	39500	**38600**	<1	<1	502	<5	76	<0.03
ABMW-05	01/06/2016	260	<5	46	<1	<1	231	**214**	63	71	<1	<1	260	19800	**19900**	<1	<1	321	<5	58	<0.03
Transition Zone																					
ABMW-05D	01/06/2016	175	26	122	<1	**1.24**	2.36	2.69	127	147	<1	<1	175	2160	**2160**	<1	<1	37.4	<5	11	<0.03
BG-01	01/05/2016	231	<5	434	<1	<1	<1	<1	85	91	<1	<1	231	<50	<50	<1	<1	43.4	<5	18	4.5
CW-04	01/05/2016	236	<5	33	<1	<1	<1	<1	127	131	<1	<1	236	<50	<50	<1	<1	42.9	<5	26	0.29
MW-05D	01/05/2016	104	<5	7	<1	<1	<1	<1	39	41	<1	<1	104	945	**950**	<1	<1	84.9	<5	14	0.15
MW-15D	01/05/2016	233	<5	201	<1	<1	<1	<1	7	8	<1	<1	233	<50	<50	<1	<1	60.4	<5	40	1.5 M6
MW-18D	01/05/2016	237	<5	31	<1	<1	<1	<1	16	19	<1	<1	237	<50	<50	<1	<1	85.3	<5	170	0.78
Bedrock																					
ABMW-01BR	01/06/2016	246 M1	<5	39	<1	<1	<1	<1	29	32	<1	<1	246	286	255	<1	<1	60.7	<5	14	<0.03
ABMW-01BR	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-02BR	01/06/2016	145	59	222	<1	<1	<1	<1	210	280	<1	<1	145	<50	<50	<1	<1	97.2	<5	31	<0.03
ABMW-04BR	01/07/2016	207	36	130	<1	<1	<1	<1	147	146	<1	<1	207	<50	<50	<1	<1	38.8	<5	8.2	<0.03
ABMW-06BR	01/06/2016	231	<5	20	<1	<1	<1	<1	155	61	<1	<1	231	<50	<50	<1	<1	67.1	<5	9.8	<0.03
ABMW-06BR	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-07BR	01/07/2016	223	<5	14	<1	<1	<1	<1	17	17	<1	<1	223	951	**902**	<1	<1	83.9	<5	14	<0.03
BG-01BR	01/05/2016	227	<5	118	<1	<1	<1	<1	27	33	<1	<1	227	<50	<50	<1	<1	58.2	<5	12	<0.03
CW-01	01/06/2016	93.2	5	61	<1	<1	<1	<1	71	82	<1	<1	93.2	<50	<50	<1	<1	27.6	<5	10	<0.03
DG-03BR	03/15/2016	154	<5	8	<1	<1	<1	<1	<5	<5	<1	<1	154	<50	<50	<1	<1	40.2	<5	6.3	<0.03
MW-01BR	01/06/2016	380	<5	108	<1	<1	<1	<1	529	543	<1	<1	380	732	589	<1	<1	75.4	<5	40	<0.03
MW-02BR	01/06/2016	220	19	45	<1	<1	2.31	2.32	1160	**1180**	<1	<1	220	<50	<50	<1	<1	68.2	<5	120	<0.03
MW-03BR	01/06/2016	269	<5	125	<1	<1	<1	<1	37	41	<1	<1	269	2760	**2680**	<1	<1	374	<5	76	0.26
MW-04BR	01/05/2016	123	8	85	1.63	**1.1**	1.27	1.15	36	44	<1	<1	123	<50	<50	<1	<1	23.6	<5	19	0.43
MW-05BR	01/05/2016	186	7	23	<1	<1	<1	<1	16	18	<1	<1	186	<50	<50	<1	<1	84	<5	14	<0.03
MW-09BR	01/07/2016	127	<5	175	<1	<1	<1	<1	26	26	<1	<1	127	<50	<50	<1	<1	24.4	<5	11	<0.03
MW-09BR DUP	01/07/2016	125	<5	183	<1	<1	<1	<1	24	26	<1	<1	125	<50	<50	<1	<1	24.1	<5	11	<0.03
MW-10BR	01/06/2016	250	<5	8	<1	<1	<1	<1	108	120	<1	<1	250	<50	<50	<1	<1	57.7	<5	18	<0.03
MW-13BR	01/06/2016	140	7	41	<1	<1	<1	1.06	354	349	<1	<1	140	<50	<50	<1	<1	54.4	<5	93	<0.03
MW-13BR DUP	01/06/2016	140	7	44	<1	<1	<1	1.12	350	349	<1	<1	140	<50	<50	<1	<1	47.6	<5	92	<0.03
MW-14BR	01/06/2016	269	<5	57	<1	<1	<1	<1	35	38	<1	<1	269	<50	<50	<1	<1	67.6	<5	43	<0.03
MW-15BR	01/05/2016	145	9	164	<1	<1	<1	<1	15	16	<1	<1	145	<50	<50	<1	<1	38	<5	34	<0.03
MW-16BR	01/06/2016	238	<5	93	<1	<1	<1	<1	66	75	<1	<1	238	<50	<50	<1	<1	53.3	<5	13	0.099
MW-17BR	01/06/2016	277	<5	81	<1	<1	<1	<1	95	100	<1	<1	277	<50	<50	<1	<1	85.8	<5	15	<0.03
MW-18BR	01/05/2016	195	<5	71	<1	<1	<1	<1	56	62	<1	<1	195	<50	<50	<1	<1	94.5	<5	120	<0.03
Within Toe of Ash Dam																					
MW-01	01/05/2016	120	<5	29	<1	<1	<1	<1	116	124	<1	<1	120	<50	<50	<1	<1	53.8	<5	47	0.081
MW-02	01/05/2016	91.1	<5	7	<1	<1	<1	<1	212	197	<1	<1	91.1	182	105	<1	<1	46.8	<5	90	0.072

Sample ID	Sample Collection Date	Chromium DIS	Chromium TOT	Cobalt DIS	Cobalt TOT	Copper DIS	Copper TOT	Iron DIS	Iron TOT	Lead DIS	Lead TOT	Magnesium TOT	Manganese DIS	Manganese TOT	Mercury DIS	Mercury TOT	Methane
Reporting Units		ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	mg/l	ug/l	ug/l	ug/l	ug/l	ug/l
NC2L Standard		NE	10	NE	1	NE	1000	NE	300	NE	15	NE	NE	50	NE	1	NE
Ash Pore Water																	
ABMW-01	01/06/2016	<1	<1	<1	<1	<1	<1	<10	39	<1	<1	0.441	<5	<5	<0.05	<0.05	1900
ABMW-01	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-02	01/05/2016	<1	<1	<1	<1	<1	<1	940	**374**	<1	<1	6.41	261	**106**	<0.05	<0.05	10800
ABMW-04	01/06/2016	<1	<1	2.42	**2.23**	<1	<1	44600	**51700**	<1	<1	199	6800	**7270**	<0.05	<0.05	570
ABMW-05	01/06/2016	<1	<1	1.05	**1.08**	<1	<1	1670	**1620**	<1	<1	78	970	**1110**	<0.05	<0.05	168
Transition Zone																	
ABMW-05D	01/06/2016	<1	1.03	<1	<1	<1	<1	25200	**30000**	<1	<1	12.3	5380	**5690**	<0.05	<0.05	7280
BG-01	01/05/2016	4.88	9.02	<1	<1	<1	2.49	<10	**484**	<1	<1	20.6	8	17	<0.05	<0.05	<10
CW-04	01/05/2016	<1	<1	<1	<1	<1	<1	<10	29	<1	<1	27.4	<5	<5	<0.05	<0.05	<10
MW-05D	01/05/2016	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1	20.7	63	**57**	<0.05	<0.05	<10
MW-15D	01/05/2016	1.43	1.77	<1	<1	<1	<1	<10	240	<1	<1	24.3	48	48	<0.05	<0.05	<10
MW-18D	01/05/2016	1.58	2	<1	<1	<1	<1	262	**334**	<1	<1	42.3	955	**978**	<0.05	<0.05	<10
Bedrock																	
ABMW-01BR	01/06/2016	<1	<1	1.56	**1.12**	<1	<1	1580	**1740**	<1	<1	16.3	943	**944**	<0.05	<0.05	22.6
ABMW-01BR	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-02BR	01/06/2016	<1	1.41	<1	<1	<1	<1	74	262	<1	<1	7.73	1180	**868**	<0.05	<0.05	13.9
ABMW-04BR	01/07/2016	<1	<1	<1	<1	<1	<1	17600	**18600**	<1	<1	14.1	3040	**3010**	<0.05	<0.05	288
ABMW-06BR	01/06/2016	<1	<1	1.17	<1	<1	<1	323	167	<1	<1	19.9	2690	**1710**	<0.05	<0.05	<10
ABMW-06BR	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-07BR	01/07/2016	<1	<1	<1	<1	<1	<1	274	**307**	<1	<1	30.2	451	**432**	<0.05	<0.05	74.8
BG-01BR	01/05/2016	<1	1.96	<1	<1	<1	<1	73	**375**	<1	<1	13.5	402	**445**	<0.05	<0.05	<10
CW-01	01/06/2016	<1	<1	1.12	**1.29**	<1	1.62	1200	**1400**	<1	<1	12.3	137	**153**	<0.05	<0.05	75.2
DG-03BR	03/15/2016	<1	<1	<1	<1	<1	<1	<10	**352**	<1	<1	5.59	285	**295**	<0.05	<0.05	<10
MW-01BR	01/06/2016	<1	<1	2.45	**3.37**	<1	<1	41	234	<1	<1	40.2	1060	**1820**	<0.05	<0.05	<10
MW-02BR	01/06/2016	<1	<1	4.85	**5.27**	<1	<1	15300	**16000**	<1	<1	33.4	998	**967**	<0.05	<0.05	<10
MW-03BR	01/06/2016	<1	<1	2.02	**2.44**	11.2	11.2	10	140	<1	<1	173	37	44	<0.05	<0.05	144
MW-04BR	01/05/2016	1.4	1.75	<1	<1	<1	<1	<10	78	<1	<1	10.1	11	17	<0.05	<0.05	<10
MW-05BR	01/05/2016	<1	<1	4.95	**4.42**	<1	<1	348	**594**	<1	<1	20.8	194	**196**	<0.05	<0.05	<10
MW-09BR	01/07/2016	<1	<1	1.77	**1.97**	<1	<1	62	275	<1	<1	14.6	247	**250**	<0.05	<0.05	<10
MW-09BR DUP	01/07/2016	<1	<1	1.78	**1.96**	<1	<1	62	283	<1	<1	14.4	247	**249**	<0.05	<0.05	<10
MW-10BR	01/06/2016	<1	<1	6.18	**6.38**	<1	<1	64	87	<1	<1	19.8	676	**752**	<0.05	<0.05	<10
MW-13BR	01/06/2016	<1	<1	5.44	**5.31**	<1	<1	4960	**6080**	<1	<1	23.3	879	**1200**	<0.05	<0.05	40.6
MW-13BR DUP	01/06/2016	<1	<1	5.4	**5.5**	<1	<1	4810	**6140**	<1	<1	20.9	874	**1220**	<0.05	<0.05	41.2
MW-14BR	01/06/2016	<1	1.98	1.47	**1.25**	<1	2.16	1200	**1780**	<1	<1	27.2	279	**291**	<0.05	<0.05	25.8
MW-15BR	01/05/2016	<1	<1	<1	<1	<1	<1	11	262	<1	<1	7.76	8	10	<0.05	<0.05	<10
MW-16BR	01/06/2016	<1	<1	<1	<1	<1	1.28	14	116	<1	<1	23.5	125	**138**	<0.05	<0.05	<10
MW-17BR	01/06/2016	<1	<1	<1	<1	<1	<1	574	**756**	<1	<1	20.1	358	**359**	<0.05	<0.05	<10
MW-18BR	01/05/2016	<1	4.24	<1	**1.63**	<1	<1	1060	**1260**	<1	<1	21.7	875	**874**	<0.05	<0.05	11.7
Within Toe of Ash Dam																	
MW-01	01/05/2016	<1	<1	<1	<1	<1	<1	<10	35	<1	<1	20.8	73	**100**	<0.05	<0.05	<10
MW-02	01/05/2016	<1	<1	<1	<1	<1	<1	<10	<10	<1	<1	19.1	27	22	<0.05	0.09	<10

Sample ID	Sample Collection Date	Molybdenum DIS	Molybdenum TOT	Nickel DIS	Nickel TOT	Nitrate (as N)	Potassium TOT	Selenium DIS	Selenium TOT	Sodium TOT	Strontium DIS	Strontium TOT	Sulfate	Sulfide	Thallium DIS	Thallium TOT	Total Dissolved Solids
Reporting Units		ug/l	ug/l	ug/l	ug/l	mg-N/L	mg/l	ug/l	ug/l	mg/l	ug/l	ug/l	mg/l	mg/l	ug/l	ug/l	mg/l
NC2L Standard		NE	NE	NE	100	10	NE	NE	20	NE	NE	NE	250	NE	NE	0.2	500
Ash Pore Water																	
ABMW-01	01/06/2016	2340	2230	3.23	3.28	<0.01	12.7	7.53	7.99	11.1	2120	2160	190	1.5	<0.2	<0.2	420
ABMW-01	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-02	01/05/2016	625	792	1.65	2.21	<0.01	12	3.32	3.39	3.66	1920	2040	130	<0.1	<0.2	<0.2	310
ABMW-04	01/06/2016	495	466	1.45	1.18	0.015	127	<1	<1	205	9340	9300	**2100**	<0.1	<0.2	<0.2	**3300**
ABMW-05	01/06/2016	1080	1200	1.39	1.41	<0.01	83.2	<1	<1	96.8	4220	4360	**1200**	<0.1	<0.2	<0.2	**2000**
Transition Zone																	
ABMW-05D	01/06/2016	16.9	15.8	1.96	2.06	0.014	9.67	<1	<1	12.5	420	464	<0.1	<0.1	<0.2	<0.2	220
BG-01	01/05/2016	<1	<1	1.51	2.96	2.6	1.87	<1	1.01	31.6	436	445	23	<0.1	<0.2	<0.2	350
CW-04	01/05/2016	5.76	5.98	<1	<1	0.438	3.98	<1	<1	46	185	189	36	<0.1	<0.2	<0.2	360
MW-05D	01/05/2016	19.4	20.2	1.88	1.76	0.838	2.18	<1	<1	87.8	439	440	**470**	<0.1	<0.2	<0.2	**900**
MW-15D	01/05/2016	<1	<1	14.9	15.2	3	<1	<1	<1	26.3	230	231	24	<0.1 M1	<0.2	<0.2	430
MW-18D	01/05/2016	6.21	6.08	<1	<1	0.198	2.96	1.75	1.64	21.9	616	629	39	<0.1	<0.2	<0.2	**610**
Bedrock																	
ABMW-01BR	01/06/2016	3.46	4.16	<1	<1	<0.01	5.78	<1	<1	17.7	171	176	20	<0.1	<0.2	<0.2	350
ABMW-01BR	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-02BR	01/06/2016	20.6	18.5	<1	<1	0.048	8.55	<1	<1	27	823	958	90	<0.1	<0.2	<0.2	340
ABMW-04BR	01/07/2016	10.8	12.4	<1	<1	0.022	3.58	<1	<1	22.5	178	182	1.4	<0.1	<0.2	<0.2	230
ABMW-06BR	01/06/2016	5.29	3.18	2.91	3.33	0.925	6.08	<1	<1	19.4	210	208	58	<0.1	<0.2	<0.2	400
ABMW-06BR	01/07/2016	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
ABMW-07BR	01/07/2016	<1	<1	<1	<1	<0.01	4.12	<1	<1	17	237	246	150	<0.1	<0.2	<0.2	480
BG-01BR	01/05/2016	14.8	9.26	1.43	2.1	0.295	5.09	<1	<1	21.9	166	163	21	<0.1	<0.2	<0.2	330
CW-01	01/06/2016	<1	<1	<1	<1	0.023	2.76	<1	<1	71.8	284	303	170	0.26	<0.2	<0.2	430
DG-03BR	03/15/2016	1.65	1.33	<1	<1	<0.01	3.03	<1	<1	13.8	149	155	7.5	<0.1	<0.2	<0.2	210
MW-01BR	01/06/2016	1.14	<1	5.5	9.72	0.045	9.49	1.8	1.03	54	479	487	47	<0.1	<0.2	<0.2	**580**
MW-02BR	01/06/2016	2.07	2.26	1.4	1.47	0.048	5.01	<1	<1	45	550	556	32	<0.1	<0.2	<0.2	500
MW-03BR	01/06/2016	<1	<1	1.12	1.19	0.081	3.31	5.31	5.03	56.3	1410	1470	**1400**	<0.1	<0.2	<0.2	**2300**
MW-04BR	01/05/2016	8.1	8.53	<1	<1	0.156	11	<1	<1	35	225	246	39	<0.1	<0.2	<0.2	220
MW-05BR	01/05/2016	4.39	4.64	<1	<1	0.026	4.66	<1	<1	16.1	287	290	160	<0.1	<0.2	<0.2	470
MW-09BR	01/07/2016	2.6	2.34	<1	<1	0.047	2.38	<1	<1	18.3	173	178	22	<0.1	<0.2	<0.2	210
MW-09BR DUP	01/07/2016	2.53	2.3	<1	<1	0.019	2.34	<1	<1	18	173	177	22	<0.1	<0.2	<0.2	220
MW-10BR	01/06/2016	21.1	22.7	<1	<1	0.049	9.21	<1	<1	36.7	184	196	42	<0.1	<0.2	<0.2	370
MW-13BR	01/06/2016	1.01	1.09	1.59	1.07	0.017	5.6	<1	<1	39.8	411	416	29	<0.1	<0.2	<0.2	420
MW-13BR DUP	01/06/2016	<1	1.19	1.47	1.13	0.018	4.97	<1	<1	34.9	408	417	29	<0.1	<0.2	<0.2	410
MW-14BR	01/06/2016	1.36	1.44	1.28	1.8	0.014	7.19	<1	<1	22.1	165	175	12	<0.1	<0.2	<0.2	390
MW-15BR	01/05/2016	12.3	13.8	<1	<1	0.01	7.58	<1	<1	35.3	90	92	22	<0.1	<0.2	<0.2	280
MW-16BR	01/06/2016	<1	<1	1.14	1.22	0.078	3.89	<1	<1	18.5	160	171	26	<0.1	<0.2	<0.2	310
MW-17BR	01/06/2016	2.08	2.75	<1	<1	0.011	4.6	<1	<1	18.5	891	917	39	<0.1	<0.2	<0.2	380
MW-18BR	01/05/2016	3.73	4.92	<1	2.11	<0.01	4.52	<1	<1	18.8	221	232	5	<0.1	<0.2	<0.2	**530**
Within Toe of Ash Dam																	
MW-01	01/05/2016	<1	<1	<1	<1	<0.01	1.47	<1	<1	30.2	494	509	120	<0.1	<0.2	<0.2	450
MW-02	01/05/2016	<1	<1	<1	<1	0.109	1.64	<1	<1	28.3	614	497	63	<0.1	<0.2	<0.2	440

Analyte concentration exceeds the standard for:

[highlighted] NC2L Standard

2016 ANALYTICAL RESULTS (JANUARY - MARCH)
ROXBORO STEAM ELECTRIC PLANT
DUKE ENERGY PROGRESS, LLC, SEMORA, NC

Total Organic Carbon	Total Suspended Solids	Vanadium	Vanadium	Zinc	Zinc	Radium-226	Radium-228	Uranium-233	Uranium-234	Uranium-236	Uranium-238
		DIS	TOT	DIS	TOT						
mg/l	mg/l	ug/l	ug/l	ug/l	ug/l	pCi/l	pCi/l	ug/mL	ug/mL	ug/mL	ug/mL
NE	NE	NE	0.3	NE	1000	NE	NE	NE	NE	NE	NE
9.3	<5	5.68	**6.93**	<5	<5	NA	NA	NA	NA	NA	NA
NA	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6.9	6	2.76	**9.19**	<5	<5	NA	NA	NA	NA	NA	NA
1.3	100	0.94	**1.07**	<5	<5	NA	NA	NA	NA	NA	NA
0.641	5	<0.3	**0.371**	<5	<5	NA	NA	NA	NA	NA	NA
6.9	70	<0.3	**0.556**	<5	<5	NA	NA	NA	NA	NA	NA
0.579	8	15.4	**17.5**	<5	<5	NA	NA	NA	NA	NA	NA
0.788	<5	1.86	**2.07**	7	<5	NA	NA	NA	NA	NA	NA
1.2	<5	9.14	**9.23**	<5	<5	NA	NA	NA	NA	NA	NA
0.935	<5	7.37	**8.03**	<5	<5	NA	NA	NA	NA	NA	NA
2.4	<5	0.9	**1.1**	7	8	NA	NA	NA	NA	NA	NA
0.377	7	<0.3	**0.346**	28	<5	NA	NA	NA	NA	NA	NA
NA	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1.7	73	0.35	**1.44**	<5	<5	NA	NA	NA	NA	NA	NA
1.4	37	<0.3	<0.3	25	12	NA	NA	NA	NA	NA	NA
0.684	<5	<0.3	**0.308**	<5	<5	NA	NA	NA	NA	NA	NA
NA	<5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
0.827	<5	<0.3	<0.3	<5	<5	NA	NA	NA	NA	NA	NA
0.693	<5	1.03	**1.25**	58	51	NA	NA	NA	NA	NA	NA
3	<5	13.3	**14.8**	<5	<5	NA	NA	NA	NA	NA	NA
0.203	<5	<0.3	<0.3	<5	<5	<1	<3	<0.00005	<0.00005	<0.00005	0.000108 j
1.8	<5	15.3	**8.41**	<5	6	NA	NA	NA	NA	NA	NA
2.5	22	<0.3	**0.357**	15	<5	NA	NA	NA	NA	NA	NA
1.4	<5	13.9	**14**	<5	<5	NA	NA	NA	NA	NA	NA
1	<5	2.44	**1.85**	<5	8	NA	NA	NA	NA	NA	NA
1.2	<5	<0.3	<0.3	<5	<5	NA	NA	NA	NA	NA	NA
0.785	<5	1.44	**1.27**	22	25	NA	NA	NA	NA	NA	NA
0.694	<5	1.5	**1.3**	21	24	NA	NA	NA	NA	NA	NA
0.902	<5	1.31	**1.28**	5	<5	NA	NA	NA	NA	NA	NA
3.8	<5	<0.3	**0.398**	7	32	NA	NA	NA	NA	NA	NA
3.8	<5	0.348	**0.386**	7	31	NA	NA	NA	NA	NA	NA
0.943	5	0.319	**0.362**	51	45	NA	NA	NA	NA	NA	NA
0.694	<5	<0.3	<0.3	<5	<5	NA	NA	NA	NA	NA	NA
0.454	<5	2.74	**3.08**	<5	<5	NA	NA	NA	NA	NA	NA
0.783	<5	<0.3	**0.454**	<5	15	NA	NA	NA	NA	NA	NA
3	8	<0.3	<0.3	<5	7	NA	NA	NA	NA	NA	NA
1.6	<5	6.09	**6.3**	6	6	NA	NA	NA	NA	NA	NA
0.737	<5	5.62	**6.18**	<5	<5	NA	NA	NA	NA	NA	NA

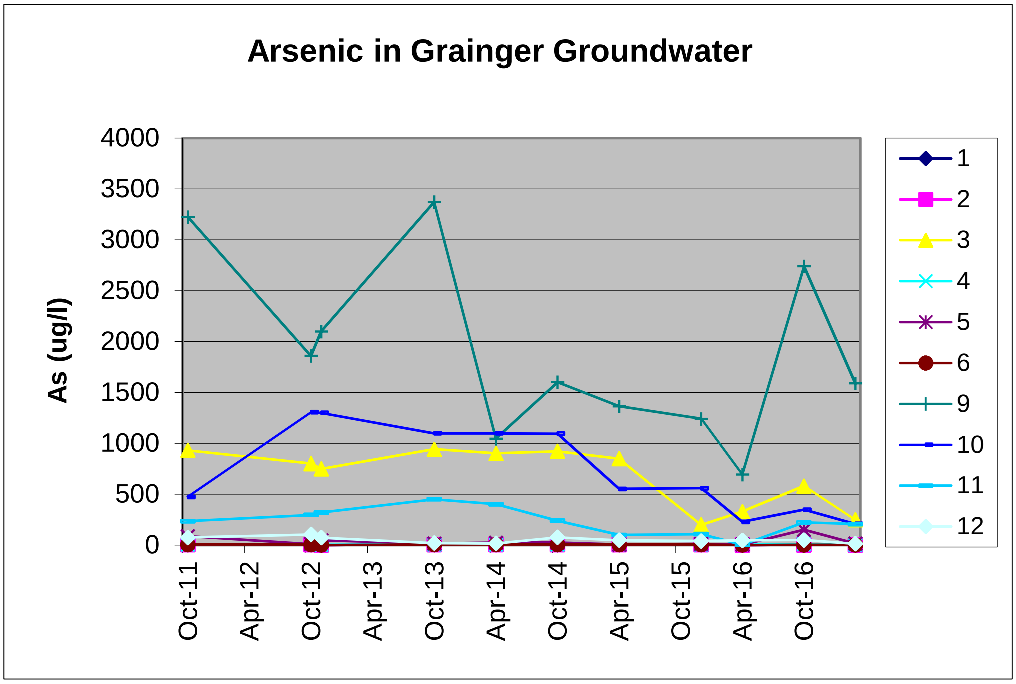
Electronic Filing: Received, Clerk's Office 09/24/2020

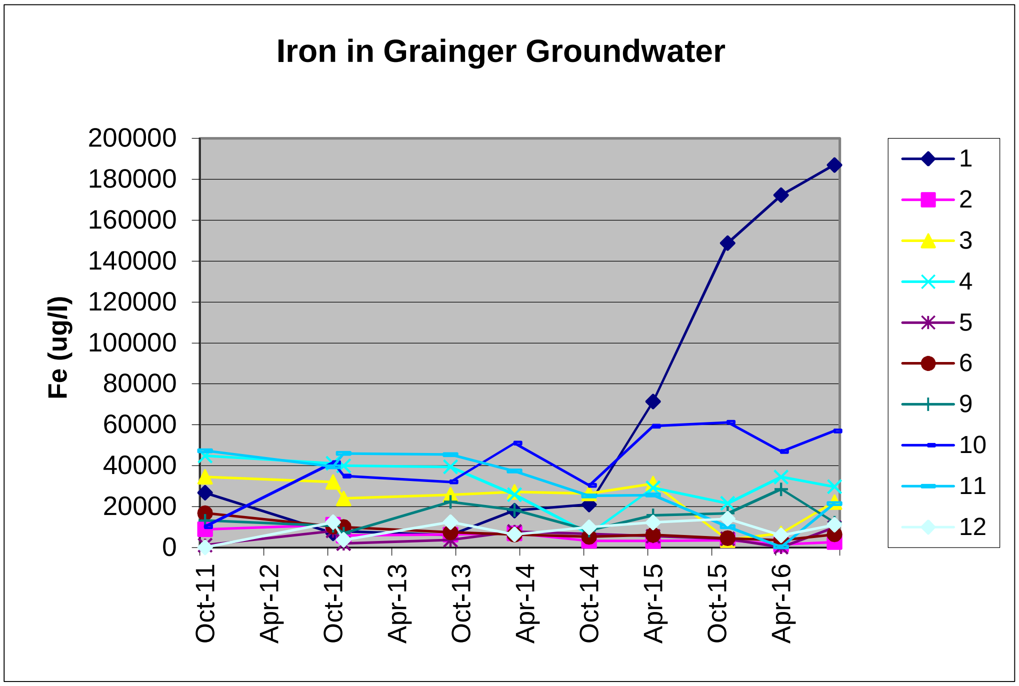
ATTACHMENT 6

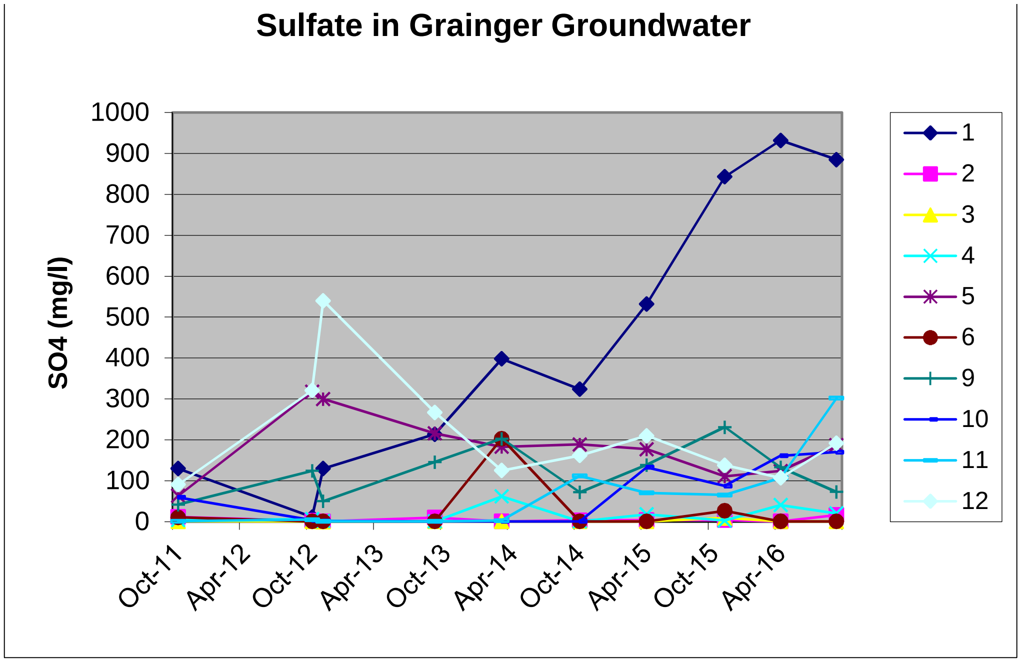
Well	Sample Date	Arsenic ug/l	Iron ug/l	Sulfate mg/l	TDS mg/l	Manganese ug/l
1	10/4/2011	5	26757.7	130	343	
1	10/2/2012	5	6969.4	11.34	270	
1	11/5/2012	0.77	7900	130	340	140
1	9/30/2013	5	6103	214	397.5	
1	3/31/2014	5	18116.6	398	665	
1	9/30/2014	5	21083.7	324	597.5	
1	4/14/2015	5	71390	532	789	
1	11/2/2015	5	148873	843	1416	
1	4/4/2016	0.53	172227.4	932	1450	
1	9/28/2016	2.5	187000	885	1277	
1	3/27/2017	2.5	163000	954	1557	
2	10/4/2011	5	8931.2	11.9	373	
2	10/2/2012	5	11137.1	2.35	384	
2	11/5/2012	0.5	5900	0.95	480	220
2	9/30/2013	5	6353.1	10.4	505	
2	3/31/2014	5	6957.9	1	402.5	
2	9/30/2014	5	3271.1	3.45	320	
2	4/14/2015	5	3244.1	3.77	168	
2	11/2/2015	5	3601.4	3.89	206	
2	4/6/2016	0.42	1475.9	1	115	
2	9/28/2016	2.5	2680	16.6	176.7	
2	3/27/2017	2.5	2210	73.5	258.3	
3	10/6/2011	932.1	34546.4	1.3	672	
3	10/2/2012	801.3	32104.8	1	673	
3	11/6/2012	750	24000	0.5	700	1200
3	10/1/2013	941.9	25861.2	1	747.5	
3	4/10/2014	901.5	27232.6	1	720	
3	10/1/2014	921.8	26466.3	1	707.5	
3	4/16/2015	849.9	31303	1	623	
3	12/18/2015	198.4	3682.4	8.85	240	
3	4/5/2016	329.7	6993.2	1	556.7	
3	10/4/2016	581	22300	1	633.3	
3	3/27/2017	250	10100	1	451.7	
3						
4	10/5/2011	5	44804.6	4.27	252	
4	10/2/2012	10.7	41190.3	6.32	237	
4	11/6/2012	3	40000	2	280	59
4	10/1/2013	5	39443.2	1	280	
4	3/31/2014	5	25867.5	61.9	260	
4	9/30/2014	5	6673	1	237.5	
4	4/14/2015	5	29193	18	201	
4	11/2/2015	5	21599.1	2.94	228	
4	4/5/2016	4.525	34482.6	40.6	258.3	
4	10/4/2016	9.1	29700	20.5	310	
4	3/27/2017	2.5	35100	1	280	
4						

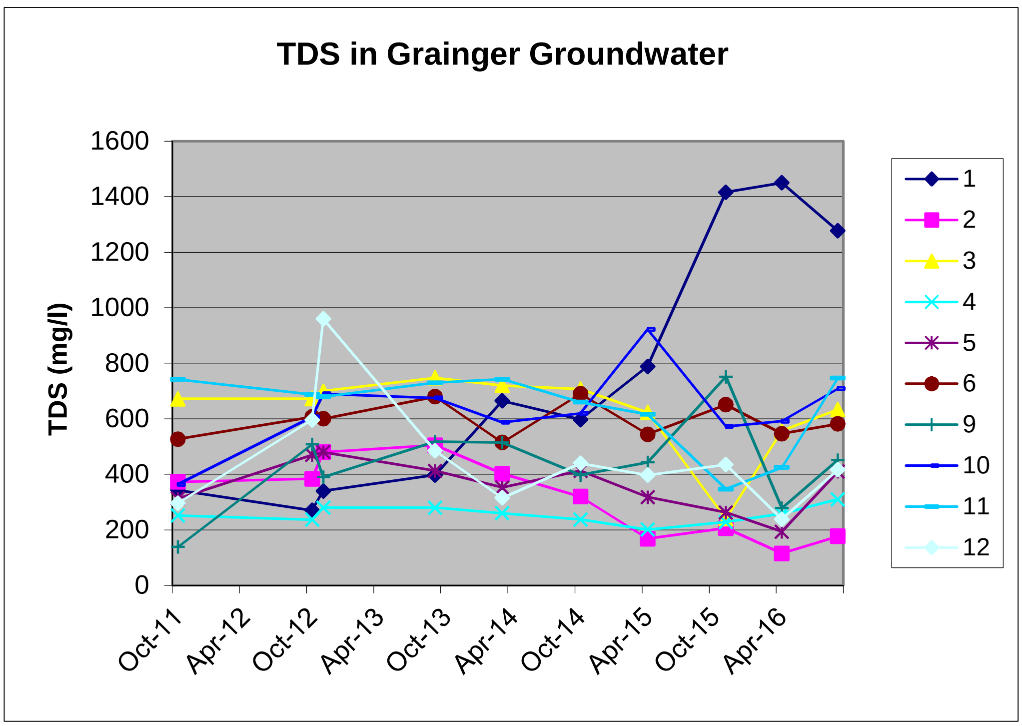
5	10/5/2011	87.5	1205.1	63.2	313	
5	10/2/2012	10.7	8147.5	317.6	470	
5	11/6/2012	47	2000	300	480	340
5	9/30/2013	14.5	3665.6	216	412.5	
5	4/1/2014	24.3	7805.7	183	352.5	
5	10/1/2014	24.6	6673	189	412.5	
5	4/14/2015	5	5554.4	177	318	
5	11/3/2015	11.9	4213.1	111	263	
5	4/5/2016	4.469	172.1	124	193.3	
5	9/28/2016	150	9820	187	410	
5	3/27/2017	14.9	322	92.2	246.7	
5						
6	10/5/2011	5	16828.1	10.7	527	
6	10/2/2012	5	10286.8	1	607	
6	11/6/2012	1.6	10000	1	600	94
6	9/30/2013	5	7412.8	0.93	680	
6	3/31/2014	5	6360.1	203	515	
6	9/30/2014	5	5219	1	690	
6	4/14/2015	5	6231	1	544	
6	11/2/2015	5	4521.7	26.8	651	
6	4/5/2016	0.827	3500	1	546.7	
6	9/28/2016	2.5	6390	1	581.7	
6	3/27/2017	2.5	4850	1	543.3	
6						
9	10/5/2011	3225.8	13235.4	41.8	139	
9	10/2/2012	1859.7	10637.5	124.43	508	
9	11/7/2012	2100	7000	50	390	180
9	10/1/2013	3371.6	22352.7	146	517.5	
9	4/1/2014	1046.4	18410.1	203	515	
9	10/1/2014	1601	8394.8	71.8	397.5	
9	4/16/2015	1363.3	15791	139	443	
9	11/2/2015	1241.3	16768.3	231	752	
9	4/6/2016	694.1	28553.3	133	278.3	
9	10/4/2016	2740	12300	72.8	451.7	
9	3/28/2017	1590	17500	79	353.3	
9						
10	10/6/2011	473.9	10252.3	59.3	364	
10	10/2/2012	1306.2	41504.9	3.63	607	
10	11/7/2012	1300	35000	1.7	690	650
10	10/1/2013	1097.9	32095.3	1	675	
10	4/10/2014	1098.2	50981.7	1	587.5	
10	10/1/2014	1095	30373.8	1	620	
10	4/16/2015	553	59406	133	922	
10	12/18/2015	558.9	61180.6	87.1	572.5	
10	4/6/2016	229.4	46942.5	161	591.7	
10	10/4/2016	349	57000	170	708.3	
10	3/28/2017	209	63400	271	653.3	
10						
11	10/6/2011	235.7	47333.2	1.322	742	
11	10/2/2012	296.5	39547.2	4.97	688	
11	11/6/2012	320	46000	1	680	890
11	9/30/2013	450	45491.5	1	730	

11	4/1/2014	401.8	37431.7	2.65	742.5	
11	10/1/2014	239.9	25313.7	112	660	
11	4/16/2015	99.2	25661	70.6	616	
11	11/3/2015	108.5	10171.5	65.2	347	
11	4/6/2016	4.367	348.6	107	425	
11	10/4/2016	223	21500	302	746.7	
11	3/28/2017	207	25400	239	725	
11						
12	10/5/2011	75	69.6	90.8	296	
12	10/2/2012	104.4	12351.1	320.56	596	
12	11/6/2012	73	3800	540	960	1900
12	9/30/2013	19.4	12436.4	267	485	
12	3/31/2014	16.1	6451.2	125	315	
12	10/1/2014	75.7	9973.7	162	440	
12	4/14/2015	48.1	12276	210	397	
12	11/3/2015	40.8	14070.7	138	435	
12	4/5/2016	47.081	5951.3	107	238.3	
12	9/28/2016	49.3	11100	192	416.7	
12	3/27/2017	14	2800	54.3	208.3	


Arsenic in Grainger Groundwater
As (ug/l)
4000
3500
3000
2500
2000
1500
1000
500
0
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Apr-16
Oct-16
1
2
3
4
5
6
9
10
11
12


Iron in Grainger Groundwater
Fe (ug/l)
200000
180000
160000
140000
120000
100000
80000
60000
40000
20000
0
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Apr-16
1
2
3
4
5
6
9
10
11
12


Sulfate in Grainger Groundwater
SO4 (mg/l)
1000
900
800
700
600
500
400
300
200
100
0
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Apr-16
1
2
3
4
5
6
9
10
11
12


TDS in Grainger Groundwater
TDS (mg/l)
1600
1400
1200
1000
800
600
400
200
0
Oct-11
Apr-12
Oct-12
Apr-13
Oct-13
Apr-14
Oct-14
Apr-15
Oct-15
Apr-16
1
2
3
4
5
6
9
10
11
12

ATTACHMENT 7

NOTES:
1. AERIAL IMAGERY IS A COMBINATION OF NC ONEMAP (2010) AND A WSP AERIAL SURVEY (2014)
2. TEN FOOT TOPOGRAPHICAL CONTOURS OBTAINED FROM 2015 WSP SURVEY DATA
2. PARCEL DATA FOR THE SITE WAS OBTAINED FROM DUKE ENERGY REAL ESTATE AND IS APPROXIMATE.
3. THE COMPLIANCE BOUNDARY IS ESTABLISHED ACCORDING TO THE DEFINITION FOUND IN 15A NCAC 02L .0107 (a).
4. WASTE BOUNDARY IS APPROXIMATE.
5. AS-BUILT CAMA ASSESSMENT AND NPDES SERIES MONITORING WELLS ARE PROVIDED BY DUKE ENERGY, WSP, AND OTHERS.
6. EPA RULE CCR WELL LOCATIONS AND CAMA H/V DELINEATION WELL LOCATIONS (BLUE LABELS) ARE APPROXIMATE AND HAVE NOT BEEN SURVEYED.
7. LIGHT GREEN LABELS INDICATE AN ADDITIONAL ASSESSMENT WELL COMPLETED POST-CSA.

0 500 1,000 1,500 Feet

HDR

SAMPLE LOCATION MAP
DUKE ENERGY CAROLINAS, LLC
BELEWS CREEK STEAM STATION

STOKES COUNTY, NORTH CAROLINA

DATE
AUGUST 2016

FIGURE
1-2