Ohio Environmental Protection Agency

John R. Kasich, Governor
Mary Taylor, Lt. Governor
Craig W. Butler, Director

November 16, 2016

ALCOA, Inc.
fka Aluminum Company of America, Inc.
1600 Harvard Ave
Cuyahoga Heights, OH 44105

Re: ALCOA Inc
Director's Final Findings and Orders (DFFO)
DFFO
Industrial Solid Waste Landfills
Cuyahoga County
ISWL019352

Subject: Final Findings and Orders of the Director

Dear Sir or Madam:

Transmitted herewith are the Final Findings and Orders of the Director concerning the matter indicated for ALCOA, INC.

If you have any questions, please contact Troy Harter at (614) 644-3037.

Sincerely,

Greg Nichols, Administrative Processing Unit
Division of Materials & Waste Management

Enclosure

ec: Kelly Jeter, DMWM, CO
Bruce McCoy, DMWM, CO
Bill Lutz, DMWM, NEDO
Jarnal Singh, DMWM, NEDO
Mark Kronke, DDAGW, NEDO
Troy Harter, Legal
Teri Frinfrock, Legal

BEFORE THE

OHIO ENVIRONMENTAL PROTECTION AGENCY

In the Matter of:

Alcoa Inc. fka Aluminum Company of America, Inc. 1600 Harvard Avenue Cuyahoga Heights, Ohio 44105	:	Director's Final Findings and Orders
Respondent	:	
Facility:	:	
Alcoa Inc. Cleveland Works Industrial Waste Landfill Facility 1600 Harvard Avenue Cuyahoga Heights, Ohio 44105	:	

PREAMBLE

It is hereby agreed by and among the parties hereto as follows:

I. JURISDICTION

These Director's Final Findings and Orders ("Orders") are hereby issued to Alcoa Inc., formerly known as Aluminum Company of America, Inc. ("Alcoa" or "Respondent") pursuant to the authority vested in the Director of the Ohio Environmental Protection Agency ("Ohio EPA") under Ohio Revised Code ("ORC") Sections 3734.13 and 3745.01.

II. PARTIES BOUND

These Orders shall apply to and be binding upon the Respondent, its assigns, and successors in interest. No changes in ownership relating to the closed Alcoa Cleveland Works industrial waste landfill will in any way alter the Respondent's responsibilities under these Orders. Respondent shall provide a copy of these Orders to all contractors, subcontractors, laboratories and consultants retained as appropriate.

III. DEFINITIONS

Unless otherwise expressly stated herein, all terms in these Orders have the same meaning as used in ORC Chapter 3734 and the rules promulgated thereunder.

IV. FINDINGS OF FACT

The Director of Ohio EPA has determined the following findings:

1. Respondent is the owner and operator of the Alcoa Cleveland Works industrial waste landfill ("Facility") as those terms are defined in Ohio Administrative Code ("OAC") Rule 3745-27-01(O)(7) and 01(O)(5) respectively, and OAC Rule 3745-29-01. The approximately 14.8853 acre Facility is located at 1600 Harvard Ave., Village of Cuyahoga Heights, Cuyahoga County, Ohio 44105.

2. Respondent is a "person" as that term is defined in ORC Section 3734.01(G).

3. The Facility is an "industrial waste landfill facility" as that term is defined in OAC Rule 3745-29-01(B) and was authorized to accept "industrial waste" as that term is defined in OAC Rule 3745-29-01(A). A legal description of the Facility is attached as Exhibit 1 hereto and incorporated herein. A map showing the boundary of the Facility is attached as Exhibit 2 hereto and incorporated herein.

4. The Facility began accepting waste for disposal in the 1940s and continued to operate until March 29, 1996. Respondent submitted a closure plan for the Facility dated July 1995 in accordance with OAC Chapter 3745-29 requirements (effective June 1, 1994). Ohio EPA approved the closure/post-closure plan on January 29, 1996.

5. Respondent conducted closure activities including constructed synthetic cap, installation of a passive gas extraction system, grading, soil placement and seeding at the Facility. Closure activities for the Facility were completed by Respondent in October 1996 and a closure certification report for the Facility was submitted by the Respondent to Ohio EPA on December 31, 1996 with amended plan drawings submitted on April 23, 1999 ("closure certification report").

6. Ohio EPA reviewed the closure certification report and identified that the Facility had exceeded the elevations for waste placement approved in the closure/post-closure plan. In letters dated August 18, 2000, and January 9, 2001, Ohio EPA cited Respondent in violation of OAC 3745-29-19(C) for failure to construct the landfill in strict compliance with the applicable authorizing documents. Ohio EPA determined that a portion of the Facility was over height and out-of-bounds based upon the topographic maps submitted in the closure certification report.

7. In response to Ohio EPA's violation letters, Respondent investigated the final elevations against the preapproved closure plan drawings. Respondent determined that there was an error in the initial surveying as reflected on the closure plan drawings for the Facility that ultimately led to an apparent counter-clockwise rotation and offset of the landfill disposal area between the actual final elevation points and the final elevation points that were preapproved in the Facility's closure plan.

8. With respect to the over height condition at the Facility, Respondent asserts that the total volume of the landfill as approved in the closure/post-closure plan was not exceeded. At the time of closure, Respondent tried to delineate the waste disposal boundary in accordance with the historic operating permits. However, once construction of the trenches and drainage around the perimeter of the landfill disposal area began,

Respondent discovered that some historic waste existed outside of the delineated boundaries of the Facility.

9. Respondent reclaimed the historic waste discovered outside the delineated boundary to within the footprint of the Facility which resulted in a slightly modified configuration at the toe of the landfill from that approved in the closure plan. However, Respondent did not stop the cap construction to seek an alteration request to the closure plan as the equipment had been mobilized to meet the 180 day deadline for completion of the landfill closure by November 1, 1996.

10. Respondent submitted the final closure certification report for the Facility and requested that Ohio EPA concur with Respondent's final closure certification report for the cap construction and final closure of the Facility in accordance with the approved final closure/post-closure plan and OAC Rule 3745-29-11. On August 18, 2000 and January 9, 2001, Ohio EPA issued a Notice of Violation to Respondent for failure to construct the landfill in strict compliance of OAC Rule 3745-29-19(C).

11. Respondent acknowledges that the final cap construction on the Facility was not completed in strict compliance with OAC Rule 3745-29-19(C)(2) and the approved closure plan due to construction adjustments that were made in the field and the surveying error that was included in the Facility's previously approved closure/post-closure plan. Respondent further acknowledges that the cap construction work proceeded at the Facility without seeking a modification of the approved closure/post-closure plan and prior to the completion and certification of the construction of the cap in violation of OAC Rule 3745-29-19(C)(2)(b).

12. Respondent has demonstrated to Ohio EPA that there was no net gain or increase in disposal area at the Facility as a result of the final cap construction and that the resulting increase in the final grades of the Facility were the result of an inaccurate historical waste boundary and a surveying error that was included in the original closure/post-closure plan approved by Ohio EPA.

13. Respondent has requested that the Director declare the Respondent completed final closure activities and that the Facility is closed as of April 23, 1999.

14. Respondent has also requested that Ohio EPA release Respondent from any further obligation to maintain closure financial assurance in accordance with OAC Rules 3745-27-15 and 3745-27-17. Respondent will continue to maintain post-closure care financial assurance in accordance with OAC Rules 3745-27-16 and 3745-27-17 for the remaining post-closure care period for the facility, which would run at least until April 23, 2029.

15. In accordance with OAC Rule 3745-29-10 and OAC Rule 3745-30-08, ground water monitoring was performed at the Facility as part of the post-closure activities to evaluate whether chemicals of concern may be leaching from the waste materials placed in the Facility and migrating to the groundwater. Initially ground water monitoring was conducted in accordance with the 1995 approved closure plan. In 1997, Alcoa identified deficiencies in the ground water monitoring system and proposed modification in July 1997. In May 2001 Alcoa received a notice of violation regarding the ground water monitoring program at the Facility. Additional investigations were conducted and additional wells were installed. A ground water monitoring plan was submitted by Alcoa in June 2003 for the

Facility. New ground water regulations under OAC 3745-30-08 became effective as of August 15, 2003 and were applicable to the Facility. Alcoa made revisions to the ground water monitoring plan in November 2003 pursuant to OAC 3745-30-08. The November 2003 revised ground water monitoring plan submitted in response to additional NOVs for ground water violations was further revised and updated in response to comments from Ohio EPA. The final revised ground water monitoring plan for the Alcoa Landfill was dated February 22, 2005.

16. Based on the results of the detection monitoring activities conducted by Respondent, Ohio EPA determined that in accordance with OAC Rule 3745-30-08(E) assessment monitoring would be required at the Facility to determine rate, concentration and extent of ground water contamination, and that additional investigation was needed to confirm the ground water flow direction and adequacy of the current monitoring network. The ground water assessment plan was prepared pursuant to OAC 3745-30-08(E)(1) and dated December 7, 2004.

17. Following four rounds of semi-annual assessment monitoring, an assessment determination was submitted by Respondent to Ohio EPA in the Ground Water Quality Assessment Determination Report dated March 2006 (GWQADR 2006). This report identified several chemicals of concern that were present in the ground water at parameter levels above background at down gradient ground water well locations. The chemicals of concern were identified as waste-derived constituents in the ground water.

18. During previous sampling events, Respondent did not follow the sampling and analysis methods documented in the 2005 Revised Ground Water Monitoring Plan for purging and sampling the ground water monitoring wells at the site. In particular, Respondent sampled downgradient wells AL-21, AL-24, and AL-28 in the incorrect order. The Plan specifically states that downgradient wells will be sampled in order from the least contaminated well to the most contaminated well. Failure to follow specifications of the Plan presents a threat of cross contamination and is a violation of OAC Rule 3745-30-08(C)(1).

19. During previous sampling events, Respondent did not sample the monitoring wells following the low-flow sampling methodology contained in the 2005 Revised Ground Water Monitoring Plan. Ohio EPA review of the December 2012 and May 2013 field data sheets revealed that nearly all the wells were actually sampled following a procedure more akin to volumetric sampling. This is not considered a low-flow sampling rate. Failure to follow specifications of the Plan presents a threat of cross contamination and is a violation of OAC Rule 3745-30-08(C)(1).

20. Because Respondent did not follow the sampling and analysis methods documented in the 2005 Revised Ground Water Monitoring Plan for purging and sampling the ground water monitoring wells at the site, it is not clear if the sample results provide an accurate representation of ground water quality. Results for VOC concentrations during the previous sampling events may have been lower than what was actually present in the groundwater.

21. Respondent has proposed to implement a Compliance Monitoring Program dated September 2015 (CMP-2015) to continue semiannual ground water monitoring and reporting to Ohio EPA in accordance with OAC Rule 3745-30-08(E)(7). The CMP-2015 uses site-specific concentrations as the identified trigger levels for implementing a

corrective measures study in accordance with OAC Rule 3745-30-08(F). The CMP-2015 is attached as Exhibit 3 hereto and incorporated herein. Modifications to the CMP-2015 are addressed in Article VIII.

22. The CMP-2015 includes the requirement to record an Environmental Covenant with activity and use limitations that prohibit the use of the Facility and adjacent property, or any portion thereof, from being used in a manner that would adversely affect the integrity of any engineered components at the Facility that constitute the constructed cap, ground water monitoring network and passive gas extraction system, prevent the extraction and use of ground water on the Facility for any purpose except sampling or remediation of the ground water, or dewatering during construction or subsurface utility repair, and prohibit the construction of occupied structures on the Property without prior authorization from Ohio EPA.

23. The Environmental Covenant for the Facility and adjacent property is drafted in accordance with ORC Sections 5301.80 through 5301.92 in order to impose activity and use limitations on the Facility and adjacent property, and must be recorded with the Cuyahoga County Recorder's Office. A copy of the Environmental Covenant including exhibits is attached as Exhibit 4 hereto and incorporated herein.

24. The Director finds that Respondent's construction of the cap and passive gas extraction system is substantially in compliance with the approved Facility closure plan, and there was no apparent gain or increase in disposal area at the Facility as a result of the deviations from the approved closure plan.

25. Based on the foregoing facts, the Director concludes that the Facility was closed in substantial compliance with OAC Rules 3745-29-11 and 3745-29-19 as of April 23, 1999.

26. The Director finds that the execution and recording of the activity and use limitations set forth in Exhibit 4 to be appropriate to protect the engineered components of the cap system constructed on the Facility, and to limit the future use of the Facility and adjacent property, and to limit the future use of ground water below the Facility and adjacent property containing waste-derived constituents at levels exceeding concentrations that permit unrestricted use in accordance with ORC Sections 5301.80 through 5301.92.

V. ORDERS

The Director hereby issues the following Orders:

1. Pursuant to OAC Rule 3745-29-19(C)(2)(b)(ii), Respondent has demonstrated in the construction certification report and supplemental information submitted to Ohio EPA that the alterations performed in the construction of the final cap and related closure activities at the Facility are at least equivalent to the requirements in the approved closure plan and OAC Rules 3745-29-11 and 3745-29-19 and the Facility is deemed to be closed as of April 23, 1999.

2. Pursuant to OAC Rule 3745-27-15(O), Respondent is hereby released from its closure financial assurance obligations as set forth in OAC Rule 3745-27-15.

3. Respondent shall continue to provide financial assurance for post-closure care of the Facility in accordance with OAC Rules 3745-27-16 and 3745-27-17 until Respondent's obligations for post closure care are released in accordance with OAC Rules 3745-27-14 and 3745-27-16

4. Respondent shall demonstrate/certify that the VOC ground water sampling results from the previous sampling events are truly representative of ground water quality and were not adversely impacted by the alternate sampling method that was employed.

5. Respondent shall implement the Compliance Monitoring Program dated September 2015 (CMP-2015) and attached as Exhibit 3 hereto and incorporated herein as if fully rewritten and shall comply with the requirements of OAC Rule 3745-30-08.

6. Respondent shall execute and record the Environmental Covenant attached as Exhibit 4 hereto and incorporated herein as if fully rewritten. The parties agree that the Environmental Covenant was prepared in accordance with ORC Sections 5301.80 through 5301.92 as an equitable servitude on the land to impose activity and use limitations on the Facility and adjacent property owned by Respondent and its successor(s) in interest as described in the Environmental Covenant.

7. No later than thirty (30) days after the execution of the Environmental Covenant by the Respondent and the Director, and journalizing of these Orders in the Director's Journal, Respondent shall record with the Cuyahoga County Recorder's Office the Environmental Covenant including exhibits in the same manner as a deed to the property in accordance with 5301.88. No later than thirty (30) days after recording the Environmental Covenant, Respondent shall submit to Ohio EPA a copy of the recorded Environmental Covenant including exhibits that shows the filing date stamp of the Cuyahoga County Recorder's Office.

VI. OTHER CLAIMS

Nothing in this Order shall constitute or be construed as a release from any claim, cause of action or demand in law or equity against any person, firm, partnership or corporation, not a party to this Order, for any liability arising from, or related to, Respondent or the Facility unless specifically identified herein.

VII. OTHER APPLICABLE LAWS

All actions required to be taken pursuant to this Order shall be taken in accordance with the requirements of all applicable federal, state and local laws and regulations. Nothing in this Order shall be construed as waiving or compromising in any way the applicability and enforcement of any other statutes or regulations applicable to Respondent's activities and/or the Facility.

VIII. MODIFICATIONS AND ALTERATIONS

This Order may be modified by agreement of the parties hereto. Modifications to this Order shall be by agreement of the parties in the form of Director's Final Findings and Orders, and shall be effective on the date entered in the journal of the Director of Ohio EPA. Any proposed modification to the approved CMP-2015 attached hereto as Exhibit 3 to these Orders shall be submitted in

writing by Alcoa, and shall not be effective until approved in writing by the Ohio EPA and will not require a modification to the Order.

IX. NOTICE

All documents required to be submitted by Respondent pursuant to this Order shall be addressed to:

Ohio Environmental Protection Agency
Northeast District Office
Division of Materials and Waste Management
2110 East Aurora Road
Twinsburg, Ohio 44087

or to such persons and addresses as may hereafter be otherwise specified in writing by Ohio EPA.

All documents required to be issued by Ohio EPA, pursuant to this Order, shall be addressed to:

Alcoa Inc. - Cleveland Works
1600 Harvard Avenue
Village of Cuyahoga Heights, OH 44105
Attn.: Environmental Compliance

X. TERMINATION

Respondent's obligations under this Order shall terminate when Respondent certifies in writing and demonstrates to the satisfaction of Ohio EPA that Respondent has performed all obligations under this Order and the Chief of Ohio EPA's Division of Materials and Waste Management acknowledges, in writing, the termination of this Order. If Ohio EPA does not agree that all the obligations have been performed, then Ohio EPA will notify Respondent of the obligations that have not been performed, in which case Respondent shall have an opportunity to address any such deficiencies and seek termination as described above.

The certification shall contain the following attestation: "I certify that the information contained in or accompanying this certification is true, accurate, and complete."

This certification shall be submitted by Respondent to Ohio EPA and shall be signed by a responsible official of Respondent. For purposes of these Orders, a responsible official is a principal executive officer of at least the level of vice president or his duly authorized representative, if such a representative is responsible for the continuing care of the Facility.

XI. RESERVATION OF RIGHTS

Nothing contained herein shall be construed to prevent Ohio EPA from seeking legal or equitable relief to enforce the terms of this Order or from taking other administrative, legal or equitable

action as deemed appropriate and necessary, including seeking penalties against Respondent for noncompliance with this Order. Nothing contained herein shall be construed to prevent Ohio EPA from exercising its lawful authority to require Respondent to perform additional activities pursuant to ORC Chapter 3734. or any other applicable law in the future. Nothing herein shall restrict the right of Respondent to raise any administrative, legal or equitable claim or defense with respect to such further actions which Ohio EPA may seek to require of Respondent. Nothing in this Order shall be construed to limit the authority of Ohio EPA to seek relief for violations not addressed in this Order.

XII. WAIVER

In order to resolve disputed claims, without admission of fact, violation or liability, and in lieu of further enforcement action by Ohio EPA for only the violations specifically cited in this Order, Respondent hereby consents to the issuance of this Order and agrees to comply with this Order. Compliance with this Order shall be a full accord and satisfaction for Respondent's liability for the violations specifically cited herein.

Respondent hereby waives the right to appeal the issuance, terms and conditions, and service of this Order. Respondent hereby waives any and all rights Respondent may have to seek administrative or judicial review of this Order either in law or equity.

Notwithstanding the preceding, Ohio EPA and Respondent agree that if this Order is appealed by any other party to the Environmental Review Appeals Commission, or any court, Respondent retains the right to intervene and participate in such appeal. In such an event, Respondent shall continue to comply with this Order notwithstanding such appeal and intervention unless this Order is stayed, vacated, or modified.

XIII. EFFECTIVE DATE

The effective date of this Order is the date this Order is entered into the Ohio EPA Director's Journal.

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XIV. SIGNATORY AUTHORITY

Each undersigned representative of a party to this Order certifies that he or she is fully authorized to enter into this Order and to legally bind such party to this Order.

IT IS SO AGREED:

Alcoa Inc.

Signature

Jeffrey R. Allee
Printed or Typed Name

Director of Operations
Title Alcoa Cleveland Works

10/3/16
Date

NOTARY PUBLIC STATE OF OHIO

GLENDORIA D. BURRIS
Notary Public, State of Ohio
My Comm. Expires Feb. 28, 2018

IT IS SO ORDERED AND AGREED:

Ohio Environmental Protection Agency

Craig W. Butler, Director

Exhibit 1

Legal Description of the Facility

The Mannik & Smith Group, Inc.
4630 Richmond Road, Ste. 180 Warrensville Hts., OH 44128 Tel 216 378 1490 Fax 216 378 1497
www.manniksmithgroup.com

LEGAL DESCRIPTION for AREA OF CLOSED LANDFILL
14.8853 Acres

Situated in the Village of Cuyahoga Heights, County of Cuyahoga, State of Ohio and being part of Orginal Lot numbers 271, 272, 273 & 291, and being more fully described as follows;

Beginning at an iron monument found on the centerline of Harvard Avenue (60 feet wide) at the intersection with the westerly line of said Orginal Lot 291;

Thence North 88°54'10" East along the centerline of said Harvard Avenue, a distance of 248.36 feet to the Northeasterly corner of land conveyed to the United States Aluminum Company by deed dated May 2, 1929 and recorded in Volume 3926, Page 325 of the Cuyahoga County Deed Records to a point;

Thence southeasterly along said United States Aluminum Company parcel along a curve deflecting to the left having a length of 577.86 feet, a radius of 1533.69 feet, a delta of 21°35'16", a chord distance of 574.45 feet with a bearing of South 22° 52'02" East to a point;

Thence South 01°02'03" East along the easterly line of said United States Aluminum Company a distance of 955.27 to a point located at the northwest corner of land conveyed to the Aluminum Company of America by deed recorded in Volume 8087, Page 285 of the Cuyahoga County Deed Records;

Thence South 85°11'04" West a distance of 358.39 feet to a point, being the principal place of beginning;

Course 2a: Thence South 16°51'58" East a distance of 796.08 feet to a point;

Course 3a: Thence South 51°44'19" West a distance of 198.67 feet to a point;

Course 4a: Thence North 75°59'32" West a distance of 185.19 feet to a point;

Course 5a: Thence North 49°17'54" West a distance of 343.56 feet to a point;

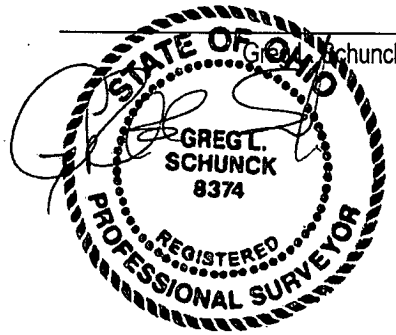
Course 6a: Thence North 28°27'03" West a distance of 503.85 feet to a point on the easterly line of an easement to the Standard Oil Company as recorded in Volume 8237, Page 417 of the Cuyahoga County Records;

Course 7a: Thence North 01°11'26" West along the easterly line of said easement a distance of 417.72 feet to a point;

Course 8a: Thence North 16°01'57" East a distance of 159.25 feet to a point;

Course 9a: Thence South 67°30'12" East a distance of 556.17 feet to a point;

Course 10a: Thence South 16°51'58" East a distance of 193.19 feet to a the principal place of beginning and containing 14.8853 acres of land be the same more or less but subject to all legal highways and easements of record. As assembled by record information, August 2010 by Greg Schunck of Mannik & Smith Group, Inc.
Bearings are to an assumed meridian and are used to denote angles only.

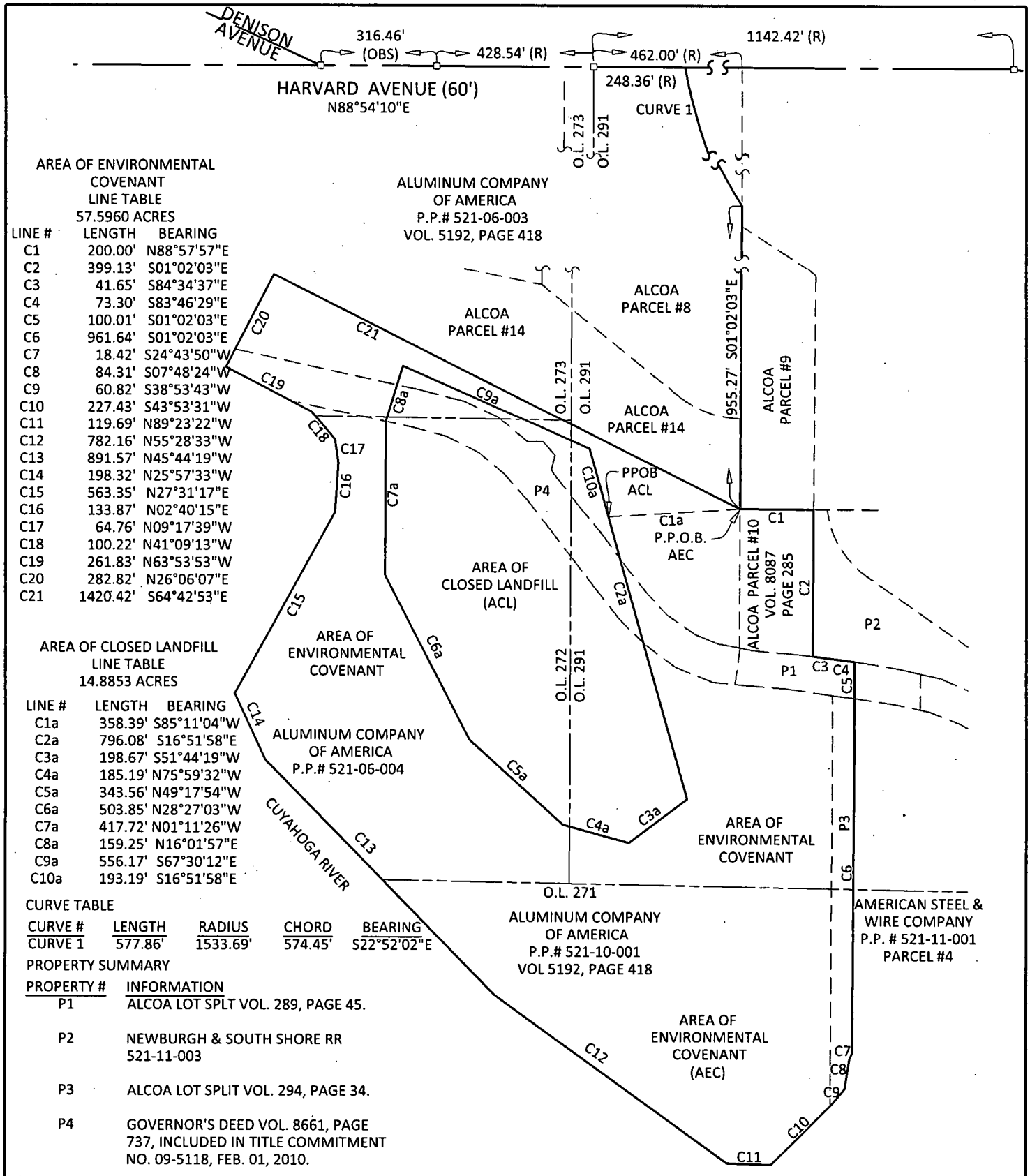


Greg L. Schunck Professional Surveyor No. 8374

LANDFILL AREA DESCRIPTION.doc

Exhibit 2

Boundary Map of the Facility



AREA OF ENVIRONMENTAL COVENANT
LINE TABLE
57.5960 ACRES

LINE #	LENGTH	BEARING
C1	200.00'	N88°57'57"E
C2	399.13'	S01°02'03"E
C3	41.65'	S84°34'37"E
C4	73.30'	S83°46'29"E
C5	100.01'	S01°02'03"E
C6	961.64'	S01°02'03"E
C7	18.42'	S24°43'50"W
C8	84.31'	S07°48'24"W
C9	60.82'	S38°53'43"W
C10	227.43'	S43°53'31"W
C11	119.69'	N89°23'22"W
C12	782.16'	N55°28'33"W
C13	891.57'	N45°44'19"W
C14	198.32'	N25°57'33"W
C15	563.35'	N27°31'17"E
C16	133.87'	N02°40'15"E
C17	64.76'	N09°17'39"W
C18	100.22'	N41°09'13"W
C19	261.83'	N63°53'53"W
C20	282.82'	N26°06'07"E
C21	1420.42'	S64°42'53"E

AREA OF CLOSED LANDFILL
LINE TABLE
14.8853 ACRES

LINE #	LENGTH	BEARING
C1a	358.39'	S85°11'04"W
C2a	796.08'	S16°51'58"E
C3a	198.67'	S51°44'19"W
C4a	185.19'	N75°59'32"W
C5a	343.56'	N49°17'54"W
C6a	503.85'	N28°27'03"W
C7a	417.72'	N01°11'26"W
C8a	159.25'	N16°01'57"E
C9a	556.17'	S67°30'12"E
C10a	193.19'	S16°51'58"E

CURVE TABLE

CURVE #	LENGTH	RADIUS	CHORD	BEARING
CURVE 1	577.86'	1533.69'	574.45'	S22°52'02"E

PROPERTY SUMMARY

PROPERTY #	INFORMATION
P1	ALCOA LOT SPLT VOL. 289, PAGE 45.
P2	NEWBURGH & SOUTH SHORE RR 521-11-003
P3	ALCOA LOT SPLIT VOL. 294, PAGE 34.
P4	GOVERNOR'S DEED VOL. 8661, PAGE 737, INCLUDED IN TITLE COMMITMENT NO. 09-5118, FEB. 01, 2010.

The Mannik & Smith Group, Inc.
4630 Richmond Road, Suite 180
Warrensville Heights, Ohio 44128
Tel (216) 378-1490
Fax (216) 378-1497
Civil Engineering, Surveying and Environmental Consulting

ALUMINUM COMPANY OF AMERICA

PROJECT LOCATION

SCALE: 1" = 350'

10/07/10

A2000007

SHEET 01/02

Exhibit 3

Compliance Monitoring Program

TETRA TECH

GROUND WATER COMPLIANCE MONITORING PROGRAM ALCOA CLOSED INDUSTRIAL LANDFILL

ALCOA CLEVELAND WORKS

September 2015

complex world CLEAR SOLUTIONS™

GROUND WATER COMPLIANCE MONITORING PROGRAM
ALCOA CLOSED INDUSTRIAL LANDFILL

ALCOA CLEVELAND WORKS
CLEVELAND, OHIO

September 2015

Prepared for:

ALCOA
1600 Harvard Ave.
Cleveland, OH 44105

Prepared by:

TETRA TECH
661 Anderson Drive
Foster Plaza 7
Pittsburgh, PA 15220

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APPENDICES

1.0 INTRODUCTION

On behalf of Alcoa, Tetra Tech has prepared this revised Ground Water Compliance Monitoring Program dated 2015 (CMP-2015) for the Alcoa Landfill located at the Alcoa Cleveland Works in Cleveland, Ohio. The site is located at 1600 Harvard Avenue, Cleveland Ohio. A location map is included as Figure 1-1. This CMP-2015 supersedes the ground water monitoring component of the 1995 Ohio Environmental Protection Agency (EPA)-approved Closure Plan (G&M, 1995) and the MFG revised Ground Water Monitoring Plan, Feb. 22, 2005. All other components of the 1995 Closure Plan for the Alcoa Landfill remain in effect unless specifically revised and authorized by the Director.

1.1. SITE BACKGROUND AND REGULATORY HISTORY

The Alcoa Landfill was placed over alluvial deposits of the Cuyahoga River valley along the southern property boundary of the Alcoa Cleveland Works facility in Cuyahoga County. The Alcoa Landfill is approximately 14.8853 acres in size and the disposed waste consists of historical industrial wastes and construction debris generated from the Alcoa Cleveland Works facility. The Alcoa Landfill accepted waste material from approximately 1940 until approximately the mid 1990's.

The Alcoa Landfill was initially constructed prior to the current solid waste management rules. The Alcoa Landfill was formally closed in October 1996 in accordance with Ohio Administrative Code (OAC) Chapter 3745-29 requirements (effective June 1, 1994), and the EPA approved July 1995 Closure Plan. Post closure ground water monitoring was initially conducted in accordance with the approved 1995 Closure Plan. Thereafter, Alcoa determined there were deficiencies in the existing ground water monitoring system and modifications were proposed in July, 1997. Alcoa received a Notice of Violation (NOV) letter on May 21, 2001 regarding the ground water monitoring program at the Alcoa Landfill. Additional investigations were conducted and additional wells were installed. Although the Alcoa Landfill was initially closed under OAC Chapter 3745-29 requirements, in accordance with OAC 3745-29-10, ground water monitoring at the Site has been regulated under the residual solid waste rules pursuant to OAC 3745-30-08 since August 15, 2003.

A revised ground water detection monitoring plan was initially proposed by Alcoa in June 2003 for the Alcoa Landfill and as required under 3745-30-08(D), additional revisions were made to the revised ground water monitoring plan in November 2003. Reported statistical exceedances of detection monitoring indicator parameters were identified in down gradient wells from the Alcoa Landfill, and as a result, a ground water quality assessment plan was prepared and submitted to Ohio EPA on behalf of

Alcoa on December 7, 2004 in accordance with OAC 3745-30-08(E)(1) (2004 Assessment Plan). The purpose of the 2004 Assessment Plan was to determine ground water flow direction, the concentration, rate and extent of waste derived constituents (WDCs) that may be emanating from the Alcoa Landfill, and the adequacy of the current monitoring network.

Ground water detection monitoring continued to be performed at the Alcoa Landfill as part of the post-closure activities to evaluate the level of WDCs leaching to ground water. The November 2003 revised ground water monitoring plan submitted in response to additional NOVs for ground water violations was further revised and updated in response to comments from Ohio EPA. The final revised ground water monitoring plan for the Alcoa Landfill was dated February 22, 2005 (GWMP MFG 2005). Ground water monitoring at the Alcoa Landfill continued in accordance with the 2004 Assessment Plan, the GWMP MFG 2005, and OAC 3745-30-08(E).

As allowed under OAC 3745-30-08(E)(7), Alcoa has requested that the Ohio EPA Director approve a compliance monitoring program for the Alcoa Landfill. To that end, Alcoa developed this CMP-2015, which also requires the implementation of an environmental covenant with land use and ground water activity and use limitations. In accordance with the environmental covenant, the extraction or use of ground water on or under the Alcoa Landfill property will be prohibited for potable or non-potable purposes except for investigation, sampling, and remediation of the ground water, or incidental extraction for dewatering during construction or sub-surface installation or maintenance of utilities. The environmental covenant complies with the requirements of Ohio Revised Code (ORC) Sections 5301.80 to 5301.92. The environmental covenant will be recorded in the Cuyahoga County Fiscal Officer's Office in accordance with ORC Section 5301.88.

The Environmental Covenant approves and imposes land use and ground water use restrictions on the described Alcoa Landfill property, or any portion of the Alcoa Landfill property, for the current owner, and holders and any future transferees. The activity and use limitations and the on-going requirements of OAC 3745-27-13 will prevent uncontrolled intrusive activities within the Alcoa Landfill that could potentially increase constituent releases. Additionally, ongoing post-closure activities will continue to be performed in accordance with the Closure Plan (G&M, 1995) with proper maintenance of the Alcoa Landfill cap and ground water monitoring system to minimize the potential for any surface water infiltration that could contribute to the WDCs leaching to ground water.

1.2. REPORT ORGANIZATION

Section 2 discusses the Alcoa Landfill site hydrogeology. Section 3 identifies WDCs and describes the Compliance Monitoring Program for the Alcoa Landfill. Section 4 provides the cited references.

2.0 SITE HYDROGEOLOGY

This section provides a summary of the hydrogeologic setting in the vicinity of the Alcoa landfill. A more detailed description can be found in the 2004 Assessment Plan and in the Newfields Ground Water Quality Assessment Determination Report dated March 2006 (Newfields Report 2006) and prepared pursuant to OAC 3745-30-08(E)(2).

Figure 2-1 is a site plan of the Alcoa Landfill area depicting the ground water monitoring well locations. Ground water in the vicinity of the landfill occurs within two identified water bearing zones: a significant zone of saturation (SZS) which occurs within the backfilled Former Ohio-Erie canal, and the upper aquifer system (UAS), which occurs within the alluvial sand and gravel deposit within the Cuyahoga river valley. The UAS occurs beneath the Alcoa Landfill area and terraces to the south. The SZS is a unique water-bearing zone of limited areal extent. The SZS occurs within the approximate limits of the former canal (Figure 2-1). This feature underlies the northern edge of the Alcoa Landfill and extends east and west following the channel of the former canal zone.

2.1. FORMER CANAL ZONE (SZS)

Ground water flow in the backfilled canal is confined laterally by the walls of the former structure and, in some areas, the fill materials occurring directly outside of the canal channel. Underlying the former canal is a low permeability layer of silty clay which retards vertical migration of ground water occurring within this feature. There is a ground water divide in the SZS near well AL-27. East of well AL-27, ground water flow is to the east towards a small pond which is the last remnant of the Ohio-Erie Canal exposed at the surface near the Alcoa Landfill and is interpreted as a ground water discharge point for the SZS. To the west of AL-27, ground water flow within the approximate former canal boundaries is to the west.

2.2. SAND AND GRAVEL AQUIFER (UAS)

The alluvial sand and gravel unit underlying the silty clay layer beneath the Alcoa Landfill represents the primary saturated zone monitored downgradient of the facility. Ground water flow in the UAS is primarily toward the Cuyahoga river to the south and west from the Alcoa Landfill area. In the vicinity of wells AL-25 and AL-8, the gradient is significantly flattened and may represent localized ground water mounding due to surface water recharge. The vertical extent of this water-bearing zone is limited by the underlying low permeability clay layer and Devonian shale unit. The lateral extent is limited by the natural floodplain area. Test borings drilled within and near the manufacturing facility located on the bluff for geotechnical purposes and for the investigation of the upslope landfill area indicate that the

alluvial aquifer pinches out along the historical floodplain slope. In this area, the alluvial aquifer is replaced by glacial lacustrine fine-grained deposits occurring within the adjacent buried glacial valley.

3.0 COMPLIANCE MONITORING PROGRAM

The following describes the components of the Alcoa Landfill Ground Water Compliance Monitoring Program (CMP-2015).

3.1. WASTE-DERIVED CONSTITUENTS

The OAC 3745-30-08 regulations require that waste-derived constituents (WDCs) being released by the Alcoa Landfill be identified and accounted for in the CMP-2015. The WDCs for the UAS and SZS were selected based on ground water monitoring data for each zone from 11 monitoring events, and are listed in Table 3-1. Some of the WDCs such as ammonia, chloride, potassium, and sodium are water quality indicator parameters which provide a reliable indication of inorganic releases from the Alcoa Landfill facility to the ground water.

3.2. MONITORING LOCATIONS, FREQUENCY AND PARAMETERS

As indicated in Table 3-1, the ground water compliance monitoring program wells to be monitored include AL-9, AL-20, AL-21, AL-25 and MW-1 for the UAS; and AL-24 and AL-28 for the SZS. Background wells to be monitored include AL-22 and AL-23D for the UAS, and AL-23S and AL-27 for the SZS.

Monitored constituents include the WDCs for the UAS and SZS as set forth in Table 3-1. The compliance monitoring program wells will be sampled semiannually for WDCs during the second and fourth quarters and annually for the OAC 3745-30-08 Appendix III (H) constituents during the second quarter. The background wells will be sampled annually for WDCs and Appendix III (H) constituents during the second quarter. Ground water samples from each of the wells will also be field tested for general water quality parameters (i.e., pH, temperature, conductivity, turbidity, dissolved oxygen [DO] and oxidation reduction potential [ORP]) to ensure that representative samples are collected.

Additionally, ground water elevation measurements will be collected at each of the wells listed in Table 3-1. The ground water elevation measurements will also be collected at each of the following piezometers and wells for evaluating the potentiometric surface of the two zones: piezometers PZ-2, PZ-14 and PZ-15 and monitoring wells AL-6, AL-7, and AL-8 for the UAS; and monitoring well AL-3 for the SZS.

Piezometers 6A, 7, 8, 9, 11, 12, and 13 are no longer part of the network of ground water monitoring wells under this compliance monitoring program and will be properly abandoned in accordance with the

requirements of OAC 3745-9-07 and OAC 3745-9-10. Well abandonment will be completed within sixty (60) days of the approval of this CMP-2015. Well abandonment reports will be submitted to ODNR after the well abandonment is completed. Copies of the complete well abandonments reports prepared pursuant to ORC Section 1521.05 will also be sent to Ohio EPA-Northeast District Office, Division of Materials and Waste Management.

3.3. GROUND WATER SAMPLING AND ANALYSIS

Ground water sampling and analysis procedures under the CMP-2015 will be conducted consistent with the procedures required under OAC 3745-30-08(C)(1). The methodology to be used for collecting and analyzing ground water samples is discussed in detail in Appendix A and includes procedures for: measuring ground water elevations; detecting immiscible layers; collecting samples; performing field analysis; analyzing samples; decontaminating equipment; and documenting chain-of-custody forms.

Any water generated during well development, purging, or sampling activities will be containerized, and depending on the analytical results, will be managed as follows:

A. If the water generated is determined to be a non-hazardous liquid, it may be:

   1. Disposed via sewer drain (with permission of local authority);

   2. Containerized and transported to the nearest Public Owned Treatment Works (POTW) with capabilities of handling the level of WDCs in the generated water. If there is no POTW available in the area, the generated water will be containerized and transported to another POTW that could handle the load.

B. If the water generated is determined to be a hazardous liquid, it will be containerized for transportation to an off-site permitted hazardous waste treatment, storage and disposal facility.

Analytical testing of the containerized water will not be needed if none of the constituent concentrations in the individual well samples from the monitoring event exceed hazardous waste criteria.

3.4. ROUTINE REPORTING

Alcoa shall submit all ground water sampling data to the Ohio EPA no later than 75 days after sampling the well in accordance with the CMP-2015 and OAC 3745-30-08(C)(8). A semi-annual monitoring report will be submitted to Ohio EPA within 109 days of each semi-annual sampling event. The semi-annual monitoring reports are to contain the following:

1. A complete copy of the laboratory data, including chain of custody documentation;

2. A comparison of the results against the re-evaluation limits (RELs) provided in Section 3.5.1 and in Table 3-1;

3. Concentration maps depicting WDC concentrations measured during the monitoring event;

4. Charts depicting concentration trends of WDCs in ground water;

5. Ground water flow maps and a summary of all ground water elevations measured at the wells and piezometers included in this plan;

6. A narrative discussion concerning background information, sampling procedures, and results/trends, etc.; and

7. A copy of all the field information forms used to record the information collected at each monitoring well during the sampling event.

The semi-annual sampling report that includes the annual Appendix III (H) sampling data shall also include the identification and evaluation of any new WDCs using the procedures included in Appendix B. All new WDCs identified shall be added to Table 3-1 including the RELs and ground water trigger levels for the new WDCs. The REL and ground water trigger levels for the new WDCs shall be calculated per the procedures described in Appendices B and C.

3.5. COMPLIANCE ASSESSMENT

Concentrations of the WDCs in compliance monitoring program wells will be assessed semi-annually against the re-evaluation limits provided in Table 3-1. Depending on the results, follow-up actions may be required.

3.5.1. Re-Evaluation Limits and Ground Water Trigger Levels

Re-evaluation limits for the WDCs are in Table 3-1. If a re-evaluation limit is exceeded in a ground water compliance monitoring program well, the procedure for evaluating this exceedance is set forth in Section 3.5.2. below. The re-evaluation limits are based on ground water monitoring results that were reported by Alcoa to Ohio EPA from 11 different sampling events. In general, the limits were set to a value just above two times the maximum detected concentration of a constituent as reported over the 11 sampling events. In some cases the limits are well-specific, while in other cases the limits are shared (global) across multiple wells. For example, as indicated in Table 3-1, wells MW-1, AL-21 and AL-25 each have

their own unique re-evaluation limit for each of the UAS WDCs; while AL-9 and AL-20 share global re-evaluation limits for the UAS WDCs. Likewise, wells AL-24 and AL-28 share global re-evaluation limits for the SZS WDCs.

The re-evaluation limits will be used to identify when the concentrations of WDCs identified in the respective ground water compliance monitoring program wells will need to be evaluated per Section 3.5.2 of the CMP-2015. The term "re-evaluation limits" in this CMP-2015 is distinguished from the phrase "ground water trigger level" such as that term is used in OAC 3745-30-08(E)(7)(b) and 08(E)(7)(g) to identify the level of a WDC in ground water that requires the automatic submittal of a Corrective Measures Plan meeting the requirements of OAC 3745-30-08(F). The ground water trigger levels for WDCs included in CMP-2015 are set forth in Table 3-1. The method used to determine the ground water trigger levels in Table 3-1 is set forth in Appendix C.

3.5.2. Data Assessment and Follow-Up Actions

The procedures described in this section and illustrated on Figure 3-1 will be used to evaluate the semiannual sampling results obtained from the compliance monitoring program.

1. If the concentration of any WDC is greater than its corresponding re-evaluation limit (see Table 3-1) at any ground water monitoring well sampled in that zone as part of the compliance monitoring program, Alcoa will re-sample the subject well or wells (i.e., the well or wells that had the exceedances,) to confirm that the concentration of the WDC is greater than its re-evaluation limit. If the resample does not confirm that the concentration of the WDC is greater than its re-evaluation limit, Alcoa will resume routine monitoring according to the CMP-2015, and will include the resample data in the next semi-annual monitoring report. If however, the resample data confirms that the concentration of the WDC is greater than its re-evaluation limit, then Alcoa will take additional steps as discussed below.

2. Alcoa will notify the Ohio EPA, Northeast District Office (NEDO) of the re-evaluation limit exceedance, no later than 109 days after collecting the initial sample for analysis from the subject well or wells.

3. Alcoa will sample the subject well for all OAC 3745-27-10 Appendix II constituents within 30 days of notifying the Ohio EPA, NEDO of the exceedance per Step 2. Alcoa will then review the results of the Appendix II sampling data to identify previously undetected Appendix II constituent(s) in the subject ground water monitoring well or wells. If such Appendix II

constituent(s) are not identified in the subject ground water monitoring well or wells, Alcoa will proceed to Step 5.

4. If previously undetected Appendix II constituent(s) are identified in the subject ground water monitoring well or wells, then within 60 days of performing Step 3, Alcoa will sample the remaining compliance monitoring program wells plus the background wells in the relevant zone for the identified Appendix II constituents to determine if the concentrations exceed ground water background concentrations.

5. Alcoa will determine the rate and extent of migration and the concentration (REC) for: a) any current WDC with a confirmed re-evaluation limit exceedance in a ground water compliance monitoring program well; or b) any Appendix II constituent(s) detected above background in a ground water compliance monitoring program well. Alcoa will provide a report of the determination to the Ohio EPA within 180 days of receiving the analytical results from the Appendix II sampling per Step 3. The report will include an evaluation of all source controls that are both reasonable and practical if the results of the REC determination indicate a significant change to the previous REC determination [e.g., large confirmed increases exceeding the re-evaluation limits of known WDCs, or detections of new Appendix II constituent(s) above background].

6. Alcoa may propose to modify this approved CMP-2015 for the Alcoa Landfill, and submit a new revised CMP for Director's approval within 270 days of receiving analytical results from the Appendix II sampling per Step 3. The proposed modified Compliance Monitoring Program will reflect the updated data, and trends from the semi-annual ground water monitoring reports including the changed conditions of the site. The proposed modified Compliance Monitoring Program will include one or more of following:

    a. Additional source control measures to be implemented by Alcoa to reduce or eliminate, to the extent practicable, further releases of WDCs into the environment pursuant to OAC 3745-30-08(E)(7)(h).

    b. If the ground water trigger levels identified in Table 3-1 are not close to being exceeded and the concentrations above the re-evaluation limits of the known WDC(s) appear to be small; have leveled off; are decreasing; or are increasing so slowly as to not be an immediate threat to approach or exceed the ground water trigger levels, then Alcoa may propose new re-evaluation limit(s) for those WDCs.

c. If the results of the REC determination identify the presence of new WDCs from Appendix II sampling that were not previously known to be impacting ground water, the new WDCs will be evaluated with regard to the risk they pose at the site to human health, safety and the environment. Based on this evaluation, Alcoa will propose new re-evaluation limits and ground water trigger levels following the procedures in Appendices B and C.

7. Unless Alcoa submits a new proposed Compliance Monitoring Program pursuant to Step 6, Alcoa must submit a Corrective Measures Study in accordance with OAC Rule 3745-30-08(F) if a ground water trigger level established in Table 3-1 is exceeded, or is close to being exceeded. If triggered, the Corrective Measures Study must be submitted for Director's approval within 270 days of receiving analytical results from the Appendix II sampling per Step 3. The Corrective Measures Study will include an evaluation of all potential active remediation measures so that the most effective measure can be selected for implementation. The Corrective Measures Study will provide the detailed procedures and timeframes for implementing the selected active remediation measure.

4.0 REFERENCES

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TABLES

Table 3-1

Compliance Monitoring Wells, WDCs, and Limits

Alcoa Cleveland Closed Industrial Landfill

	Well	All Wells	AL-9	AL-20	AL-9 & AL-20	MW-1	MW-1	AL-21	AL-21	AL-25	AL-25	All UAS Wells
Upper Aquifer System	Waste-Derived Constituent	MCL, SMCL, or HHA	2x Max Detect	2x Max Detect	Global REL	2x Max Detect	Well Specific REL	2x Max Detect	Well Specific REL	2x Max Detect	Well Specific REL	GWTL[1]
	cis-1,2-Dichloroethene	0.07	ND	ND	0.002	ND	0.002	0.022	0.022	ND	0.002	9.7
	Vinyl chloride	0.002	ND	ND	0.002	ND	0.002	0.0124	0.013	ND	0.002	1.3
	Manganese	0.05	1.6	0.92	2	5.2	6	7.3	8	8.5	9	1,800
	Ammonia	30	0.8	0.6	2	3.8	4	18	18	22	22	NA
	Potassium	None	3.4	23.4	24	38.2	39	38.2	39	90.4	91	NA

	Well	All Wells	AL-24	AL-28	AL-24 & AL-28	All SZS Wells
Significant Zone of Saturation	Waste-Derived Constituent	MCL, SMCL, or HHA	2x Max Detect	2x Max Detect	Global REL	GWTL[1]
	1,1,1-Trichloroethane	0.2	0.012	0.0028	0.013	3,000
	1,1-Dichloroethane	None	0.036	0.06	0.06	239
	1,2-Dichloroethene (cis)	0.07	0.005	0.0142	0.015	9.7
	1,2-Dichloroethene (trans)	0.1	0.002	0.0048	0.005	64
	Benzene	0.005	0.002	0.0022	0.003	2.0
	Chloroform	0.08	0.005	0.0088	0.009	44
	Trichloroethene	0.005	0.009	0.0026	0.01	0.16
	Vinyl chloride	0.002	0.002	0.0108	0.011	1.3
	Nitrate	10	10.8	0.2	11	120,000
	Chloride	250	1,394	1,680	1,700	NA
	Sodium	None	530	620	650	NA

[1]GWTL = Groundwater Trigger Level (Lowest normalized RBC)

NA = Not Applicable (Water Quality Indicator Parameter)

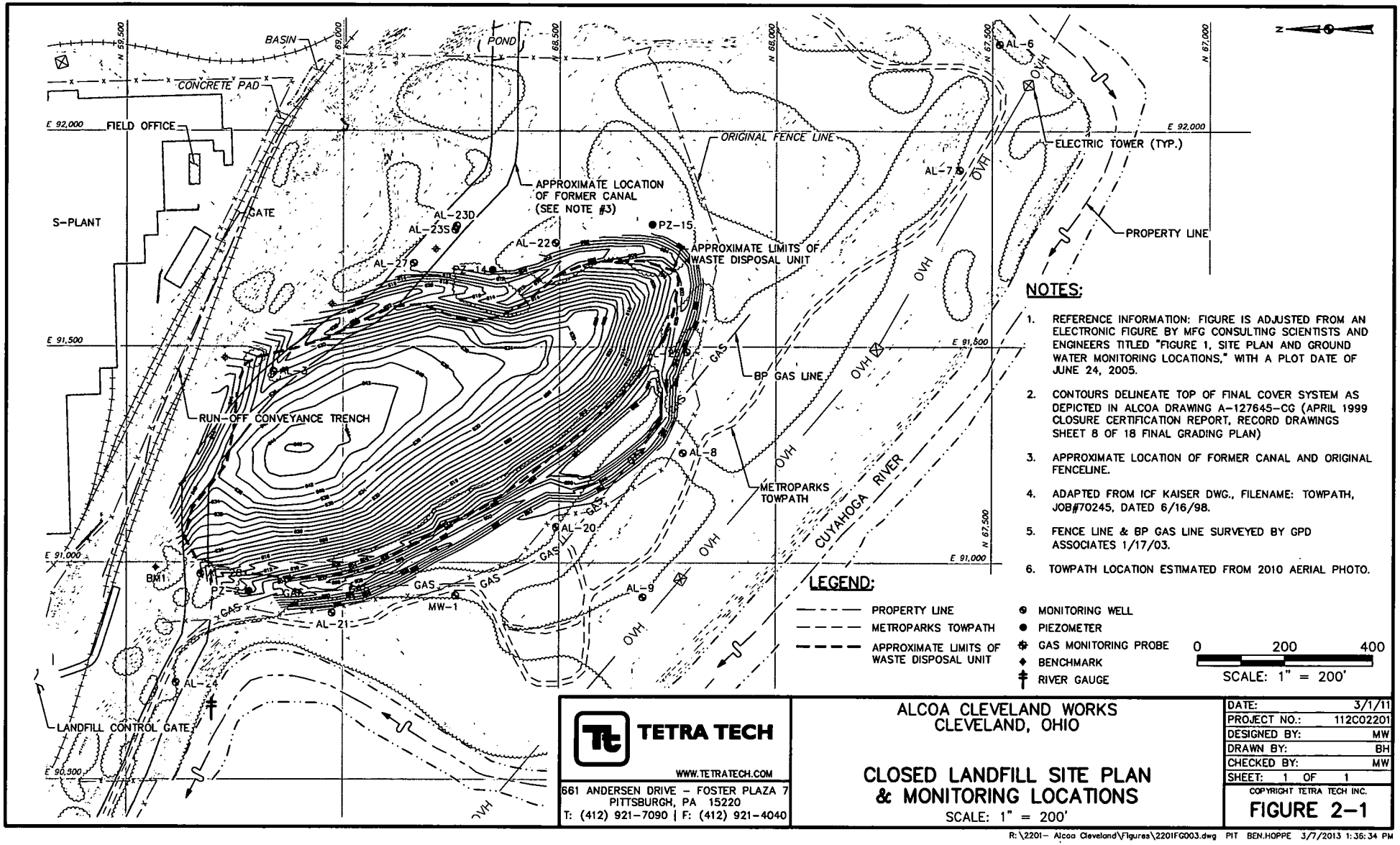
ND = Non-detect

REL = Re-Evaluation Limit

All concentrations are presented in milligrams per liter (mg/L)

FIGURES

Figure 1-1
Site Location Map



NOTES:

1. REFERENCE INFORMATION: FIGURE IS ADJUSTED FROM AN ELECTRONIC FIGURE BY MFG CONSULTING SCIENTISTS AND ENGINEERS TITLED "FIGURE 1, SITE PLAN AND GROUND WATER MONITORING LOCATIONS," WITH A PLOT DATE OF JUNE 24, 2005.
2. CONTOURS DELINEATE TOP OF FINAL COVER SYSTEM AS DEPICTED IN ALCOA DRAWING A-127645-CG (APRIL 1999 CLOSURE CERTIFICATION REPORT, RECORD DRAWINGS SHEET 8 OF 18 FINAL GRADING PLAN)
3. APPROXIMATE LOCATION OF FORMER CANAL AND ORIGINAL FENCELINE.
4. ADAPTED FROM ICF KAISER DWG., FILENAME: TOWPATH, JOB#70245, DATED 6/16/98.
5. FENCE LINE & BP GAS LINE SURVEYED BY GPD ASSOCIATES 1/17/03.
6. TOWPATH LOCATION ESTIMATED FROM 2010 AERIAL PHOTO.

LEGEND:

- PROPERTY LINE
- METROPARKS TOWPATH
- APPROXIMATE LIMITS OF WASTE DISPOSAL UNIT
- MONITORING WELL
- PIEZOMETER
- GAS MONITORING PROBE
- BENCHMARK
- RIVER GAUGE

0 200 400

SCALE: 1" = 200'

TETRA TECH
WWW.TETRATECH.COM
661 ANDERSEN DRIVE - FOSTER PLAZA 7
PITTSBURGH, PA 15220
T: (412) 921-7090 | F: (412) 921-4040

ALCOA CLEVELAND WORKS
CLEVELAND, OHIO

CLOSED LANDFILL SITE PLAN & MONITORING LOCATIONS

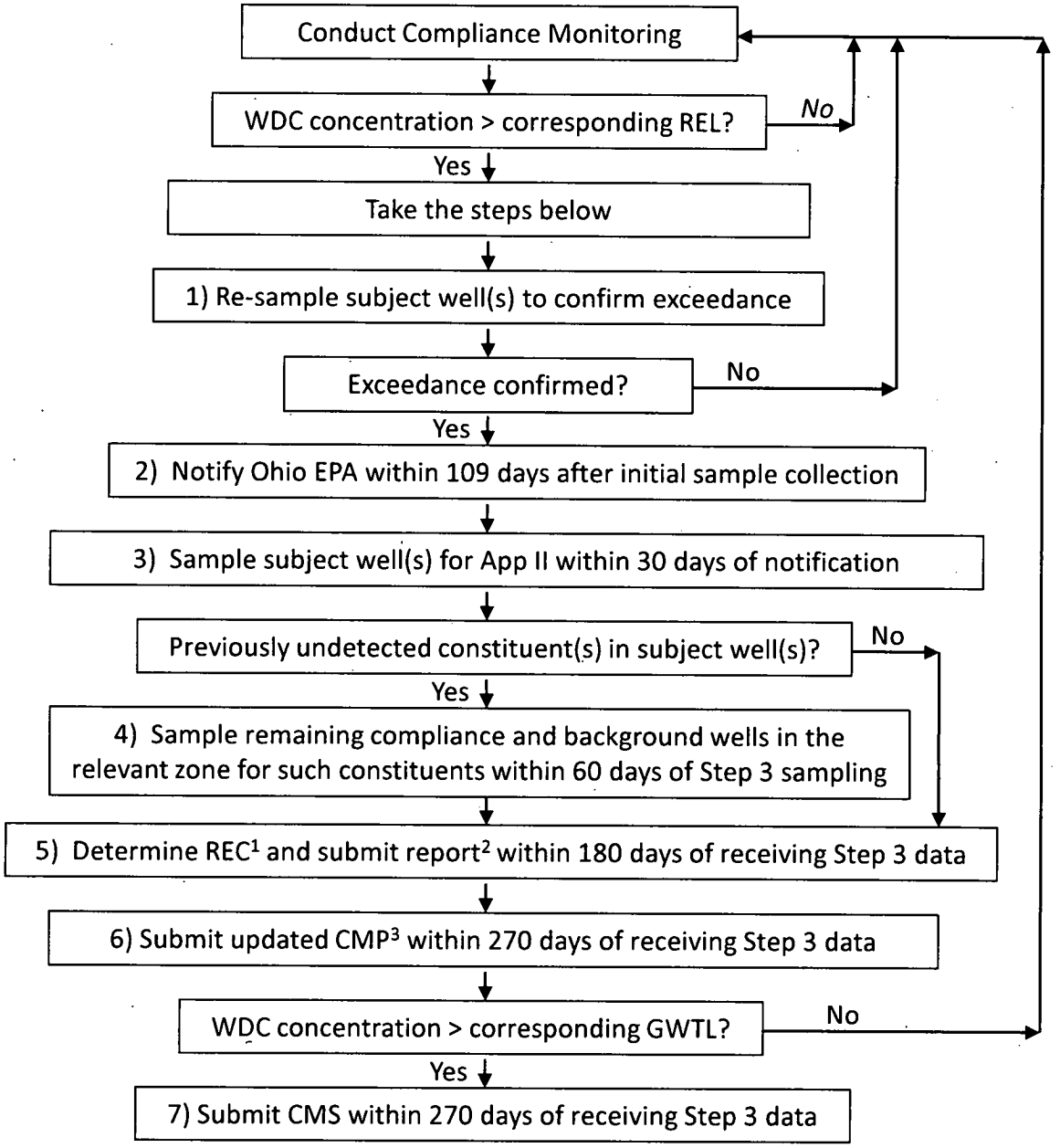
SCALE: 1" = 200'

DATE:	3/1/11
PROJECT NO.:	112C02201
DESIGNED BY:	MW
DRAWN BY:	BH
CHECKED BY:	MW
SHEET:	1 OF 1

FIGURE 2-1

R:\2201- Alcoa Cleveland\Figures\2201FG003.dwg PIT BEN.HOPPE 3/7/2013 1:36:34 PM

Figure 3-1
Compliance Monitoring Data Assessment Decision Chart*
Alcoa Cleveland Works - Closed Landfill



[1]REC determination required for a) confirmed REL exceedance; b) Appendix II constituent(s) detected above background in a compliance well; and c) new WDC identified through annual Appendix III (H) sampling.
[2]Include evaluation of source controls if REC determination indicates a significant change.
[3]Include source controls, updated RELs (if WDCs are not close to GWTL), and RELs and GWTL for any new WDC.

WDC = Waste-Derived Constituents; CMP = Compliance Monitoring Plan; CMS = Corrective Measures Study; RELs = Re-Evaluation Limits; GWTL = Ground Water Trigger Level; App II = 3745-27-10 Appendix II Constituents

*Refer to Section 3.5.2 of CMP for details. General guidance only; the requirements of rule OAC 3745-30-08 prevail under any and all circumstances

APPENDIX A

FIELD SAMPLING AND LABORATORY PROCEDURES

This appendix to the Compliance Monitoring Program (CMP-2015) for the Alcoa Cleveland Closed Landfill provides a detailed description of the field sampling and laboratory analytical procedures. Included are procedures for: measuring ground water elevations; detecting immiscible layers; collecting samples; performing field analysis; decontaminating equipment; and documenting chain-of-custody forms. Laboratory methods are also provided.

Prior to performing any work at an individual well, the condition of the well will be checked to see if it is closed and locked, and if the cement seal around the well is in good condition. The well number will also be verified. The well condition will be documented on the field data sheets (see Attachment 1). The Alcoa environmental department will be immediately notified if the sampling team identifies any unsecured monitoring wells, damaged wells or casings, or cracked surface seals. These issues may lead to compromised ground water sample integrity and will be corrected as soon as possible, but no later than the next semiannual sampling event.

Field data sheets (see Attachment 1) will be completed to document field activities performed and record the resulting field data. In addition to the field data, the general information such as project, location, time, date, weather, and names of sampling personnel will also be included on the field data sheets.

Calibration of field instruments will be completed in accordance with manufacturer's specifications. Field instruments will be calibrated at the start of each day, and periodically checked throughout the day and adjusted as necessary. The calibration information will be documented on the field data sheets or a separate form. Field samplers will wear disposable, powder-free gloves that will be changed between the purging and sampling of each well.

A.1 Well and River Gauging

A complete round of static water level data will be measured with an electronic water level meter from the wells/piezometers listed in Table A-1 prior to sampling. The water-level measurements will be precise to 0.01 foot in elevation and shall be conducted within a single 24 hour period. Because the top of well casings are rarely level, all water level measurements will be made to the survey mark located on each casing. This will ensure consistent and accurate static water level elevation measurements are collected every sampling event. Any oil on the tape, unusual smells, and other relevant observations will be noted, and if needed based on the observations, an oil/water interface probe will be used to detect/measure both light non-aqueous phase liquids (LNAPL) and dense non-aqueous phase liquids (DNAPL) at the water table and at the bottom of the well, respectively.

Total depth measurements will be collected whenever a dedicated pump is removed from a well for servicing. If total well depth measurements indicate that more than 20% of the well screen length is blocked by sediment, the well will be redeveloped before the next semiannual monitoring event.

If excessive sample turbidity (>50 NTUs) is documented during sampling at any monitoring well, the subject well will be re-developed prior to the next semiannual monitoring event. If water levels are relatively low during dry periods, turbidity may not stabilize to acceptable levels and this could cause sample results (for parameters such as metals) to be unrepresentative of the aquifer. In such cases, field filtering will help to interpret dissolved aquifer concentrations. However, the affected well(s) will be re-

developed first in an attempt to remove sediment from the well and reduce turbidity to levels (<10-20 NTUs) that result in the collection of representative ground water samples.

In addition, surface water level data will be recorded for one location on the Cuyahoga River. This measurement will be taken from a metal spike on the concrete structure associated with Alcoa's discharge outfall near monitoring well AL-24. The river water level will be measured using a standard ground water elevation meter with the metal spike being the reference point with a measuring point elevation of 584.55 ft above mean sea level (amsl).

A.2 Well Purging

Wells identified for sampling in the CMP-2015 will be fitted with dedicated pumps suitable for low flow sampling. Dedicated polyethylene tubing will be used for each well that will be purged and sampled. The tubing will be attached to the pump and used as the discharge hose. For each well, the pump will be set at approximately the middle of the well screen depending on the water column (see Table A-1 for well information). Prior to and after pump installation, water level measurements will be recorded.

Low-flow purging and sampling will be conducted in accordance with USEPA Region I document "Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Sample from Monitoring Wells, dated January 19, 2010 (Attachment 2).

Purge water will be managed as discussed in Section 3.3 of the CMP-2015.

A.3 Ground Water Sampling and Analysis

Table A-2 provides the requirements for sample bottles and preservatives, as well as holding times. Prior to sampling, field personnel will check the sample containers supplied by the laboratory to ensure that the appropriate containers and preservatives were supplied. Sample labels will be attached to each container indicating the sample number, the name or initials of the sampler, the date and time of collection, analytical parameters, and the preservative type. If the sample containers supplied by the laboratory were not pre-preserved, the field personnel should add the appropriate amount and type of preservative, to each sample container. The field parameter readings obtained prior to sampling will be recorded for each well on the field data sheet.

Ground water samples will be collected immediately after purging using the dedicated equipment.

Sample bottles for VOC analysis will be filled first, followed by the bottles for metals. All volatile organic analysis (VOA) vials should be filled with minimal turbulence by allowing the water to flow gently down the inside of the container. When filling the VOA vials, a meniscus must be formed over the mouth of the vial to eliminate the formation of air bubbles and head space prior to capping. Ensure VOA vials have no head space by inverting and tapping the vial after capping. If any bubbles are present, the container should not be opened and topped-off to fill the additional head space. Instead, the vial should be discarded and a new sample taken.

All samples for metals analysis will be filtered in the field using 0.45-micron high capacity filters attached in-line to the end of the discharge tubing. Approximately 50 ml of ground water will be passed through the filter before sample collection.

After the samples are properly collected, each will be placed into coolers with ice to provide thermal preservation. The sample coolers will be sealed with tape, secured with chain-of-custody seals, and shipped with the chain-of-custody (COC) forms via overnight courier to the laboratory. A blank COC is provided at the end of this appendix (see Attachment 3). The sampling team will be responsible for the custody and care of collected samples until the containers are transferred to the custody of the laboratory. Sample bottles will remain within the possession of the sampling team, or will be kept in a secured area until transferred to the analytical laboratory.

A chain-of-custody form will accompany the sample containers throughout the sampling event with signatures required for each possession. The chain-of-custody records will indicate the sample number, matrix, bottle type, preservative, number of bottles for each sample set, and time and date of sample collection. The chain-of-custody records will also show the time and date that custody of the samples was transferred from the sampler to the laboratory or other responsible persons.

Upon receipt at the laboratory, the coolers will be inspected to ensure sample temperature meets the method requirements. The laboratory will document the temperature on a cooler inspection form (see Attachment 4).

A.4 Decontamination

The electric water level tape and interface probe will be liberally rinsed after each use with deionized water and wiped with clean paper towels. All field meters will be rinsed with deionized water after each well is sampled. All disposable equipment (e.g. gloves, paper towels, etc.) will be properly discarded after use at each well.

A.5 Field QA/QC

For quality control purposes, one duplicate sample will be collected during each monitoring event and submitted to the analytical laboratory. In addition, one trip blank will accompany each shipment of samples that are to be analyzed for VOCs.

Duplicate samples are defined as ground water samples collected simultaneously with the primary samples and submitted to the laboratory for analysis of the same parameters as the primary sample. Duplicate samples support an evaluation of the accuracy and reproducibility of results, and may provide insight into the quality control of field and laboratory procedures. The laboratory will be not notified from which well the duplicate was collected.

Trip blank samples are containers filled at the laboratory with contaminant-free water, and sealed prior to sample bottle pick-up by the field crew. The containers, once filled and sealed are never opened in the field. Trip blanks are carried into the field along with the sample bottles associated with the collection of VOCs. Trip blank samples are handled along with the collected samples, thereby acting as a control

sample to determine potential contamination from the containers themselves, shipping and handling procedures, the atmosphere during transport, and/or laboratory equipment during the analysis.

A.6 Analytical Procedures

Only standard EPA-approved analytical methodologies will be used to analyze ground water samples at the laboratory under this CMP-2015. Table A-3 identifies the methods that will be used for the various parameter groups included in the analyses to be performed. Because this CMP is anticipated to be performed for an extended period of time, it is possible that the standard methods may be updated to account for technological changes. The most current approved EPA method will be used and only a laboratory capable of performing the most current approved EPA method with all appropriate quality assurance and quality control methods will be used. In addition, if a new method is used, the new method and the new practical quantitation limits (PQLs) will be submitted with the data.

The QA/QC procedures of the analytical laboratory used for testing samples collected under this CMP will meet or exceed the QA/QC requirements of the standard method.

Field parameters (e.g., turbidity, pH, conductivity, DO, ORP, and temperature) will be measured according to specific instrument manufacturer's instructions.

Table A-1
Monitoring Well Elevations and Coordinates
Alcoa Cleveland CMP-2015

Well or Piezometer	Ohio State Plane Coordinates		Cleveland Survey Coordinates		Ground Surface Elevation ft-msl	TOC Elevation ft-msl	Screened Interval (ft bgs)
	Northing	Easting	Northing	Easting			
PZ-2	648546	2225787	NA	NA	610.49	613.36	38.0 - 48.0
PZ-14	647982	2226527	NA	NA	605.80	607.86	45.0 - 55.0
PZ-15	647613	2226633	NA	NA	596.60	598.48	25.0 - 35.0
AL-3	648491	2226296	NA	NA	630.83	633.70	48.8 - 58.8
AL-6	646817	2227062	67484	92198	587.93	589.35	11.0 - 21.0
AL-7	646906	2226773	67576	91909	586.89	588.70	12.4 - 22.4
AL-8	647539	2226112	NA	NA	589.80	591.81	13.0 - 23.0
AL-9	647628	2225777	68307	90920	589.63	590.90	14.4 - 24.4
AL-20	647831	2225938	68507	91082	592.19	594.10	18.0 - 23.0
AL-21	648347	2225734	69025	90881	588.54	590.81	18.0 - 23.0
AL-22	647838	2226596	NA	NA	603.90	606.47	18.0 - 23.0
AL-23D	648066	2226635	NA	NA	607.20	610.08	42.6 - 47.6
AL-23S	648070	2226624	68740	99771	606.84	609.45	15.0 - 20.0
AL-24	648705	2225570	69385	90722	608.17	610.88	40.5 - 45.5
AL-25	647534	2226347	NA	NA	592.70	594.59	20.0 - 30.0
AL-27	648164	2226547	68835	91695	609.82	612.54	15.0 - 20.0
AL-28	648657	2225828	NA	NA	622.50	624.92	32.0 - 37.0
MW-1	648062	2225777	68740	90923	589.77	592.13	18.0 - 23.0

Notes:
NA - not available.

Table A-2
Sample Containers, Holding Times, and Preservatives
Alcoa Cleveland CMP-2015

Analytical Parameter	Method[1]	Sample Container	Holding Time	Preservative
VOCs	8260B	(3) 40 mL glass VOA vials	14 days	hydrochloric acid; pH<2
VOCs (EDB, DBCP)	8011	(3) 40 mL glass VOA vials	14 days	Sodium Thiosulfate, Cool to 4°C +/- 2°C
Metals	6010B, 6020	250 mL plastic	6 months	nitric acid; pH<2
Ammonia	350.3	1L HDPE	28 days	H2SO4 to pH <2, Cool to 4°C +/- 2°C
Chemical oxygen demand	410.4	250 mL HDPE	28 days	H2SO4 to pH <2, Cool to 4°C +/- 2°C
Chloride	300	250 mL HDPE	28 days	Cool to 4°C +/- 2°C
Nitrate-nitrite	353.2	250 mL HDPE	28 days	Cool to 4°C +/- 2°C
Sulfate	300	250 mL HDPE	28 days	Cool to 4°C +/- 2°C
Total alkalinity	310.1	250 mL HDPE	14 days	Cool to 4°C +/- 2°C
Total dissolved solids	160.1	250 mL HDPE	7 days	Cool to 4°C +/- 2°C

[1]USEPA SW-846 (VOCs and metals) and USEPA MCAWW (Wet Chemistry Parameters)

Table A-3
Analytical Methods and Quantitation Limits
Alcoa Cleveland CMP-2015

Parameter[1]	Analytical Method[2]	Quantitation Limit
VOCs		
1,1,1,2-Tetrachloroethane	8260B	1
1,1,1-Trichloroethane	8260B	1
1,1,2,2-tetrachloroethane	8260B	1
1,1,2-Trichloroethane	8260B	1
1,1-Dichloroethane	8260B	1
1,1-Dichloroethene	8260B	1
1,2,3-Trichloropropane	8260B	1
1,2-Dibromo-3-chloropropane	8011	0.02
1,2-Dibromoethane	8011	0.02
1,2-Dichlorobenzene	8260B	1
1,2-Dichloroethane	8260B	1
1,2-Dichloropropane	8260B	1
1,4-Dichlorobenzene	8260B	1
2-Butanone	8260B	10
2-Hexanone	8260B	10
4-Methyl-2-pentanone	8260B	10
Acetone	8260B	10
Acrylonitrile	8260B	20
Benzene	8260B	1
Bromochloromethane	8260B	1
Bromodichloromethane	8260B	1
Bromoform	8260B	1
Bromomethane	8260B	1
Carbon disulfide	8260B	1
Carbon tetrachloride	8260B	1
Chlorobenzene	8260B	1
Chloroethane	8260B	1
Chloroform	8260B	1
Chloromethane	8260B	1
cis-1,2-dichloroethene	8260B	1
cis-1,3-Dichloropropene	8260B	1
Dibromochloromethane	8260B	1
Dibromomethane	8260B	1
Ethylbenzene	8260B	1
Iodomethane	8260B	1
Methylene Chloride	8260B	1
Styrene	8260B	1
Tetrachloroethene	8260B	1
Toluene	8260B	1
trans-1,2-Dichloroethene	8260B	1
trans-1,3-Dichloropropene	8260B	1
trans-1,4-dichloro-2-butene	8260B	1
Trichloroethene	8260B	1
Trichlorofluoromethane	8260B	1
Vinyl acetate	8260B	2
Vinyl chloride	8260B	1
Xylene (total)	8260B	2

Table A-3
Analytical Methods and Quantitation Limits
Alcoa Cleveland CMP-2015

Parameter[1]	Analytical Method[2]	Quantitation Limit
Metals		
Antimony	6020	2
Arsenic	6020	5
Barium	6010B	200
Beryllium	6010B	5
Cadmium	6010B	2
Chromium	6010B	5
Cobalt	6010B	7
Copper	6010B	25
Lead	6010B	3
Nickel	6010B	40
Selenium	6010B	5
Silver	6010B	5
Thallium	6020	2
Vanadium	6010B	7
Zinc	6010B	50
Major Cations		
Calcium	6010B	5,000
Iron	6010B	100
Magnesium	6010B	5,000
Manganese	6010B	15
Potassium	6010B	5,000
Sodium	6010B	5,000
Wet Chemistry Parameters		
Ammonia	350.3	1,000
Chemical Oxygen Demand (COD)	410.4	20,000
Chloride	300	10,000
Nitrate-nitrite	353.2	1,000
Sulfate	300	10,000
Total alkalinity	310.1	5,000
Total Dissolved Solids (TDS)	160.1	20,000
Field Parameters		
Temperature	Field Instrument	0.1 C
pH	Field Instrument	0.01 S.U.
Specific Conductance	Field Instrument	1 umhos/cm
Turbidity	Field Instrument	1 NTU

[1]OAC 3745-30-08 Appendix III (H)

[2]USEPA SW-846 (VOCs and metals) and USEPA MCAWW (Wet Chemistry Parameters)

Values are in ug/L, except as noted.

Attachment 1

Ground Water Monitoring - Well Sampling Field Data Sheet

Client: ALCOA (Cleveland Works)

WELL ID:

Weather:

Date: _____

Casing Size: _____

Total Depth: _____ ft.

Purge Rate: _____ gpm

Depth to Water: _____ ft.

Gallons Removed: _____

Measured using: _____

Purge Start: _____

Purged / Sampled using: _____

Purge End: _____

Water Quality Meter(s) used: _____

Field Measurements							
Temp. (deg.C)	pH (S.U.)	ORP (mV)	Turbidity (NTUs)	Conductivity (uS)	Dissolved Oxygen (mg/L)	Purge Time (mins)	Water Level (feet)
						5	
						10	
						15	
						20	
						25	
						30	
						35	
						40	
						45	
						50	
						55	
						60	
						65	
						70	
						75	
						80	
						85	
						90	
						95	
						100	

Analysis Required: _____

_____

_____

Sample time/date: _____

Physical Properties:

Odor: _____

Color: _____

Water Levels (Pump Installed):

Initial (Pump Off): _____

Stable (Pump On): _____

Pump Dial Settings:

Discharge: _____

Optimal (Final): _____

Comments: _____

_____

_____

Sampler: _____ **Signature:** _____

Attachment 2

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUNDWATER SAMPLES FROM MONITORING WELLS

Quality Assurance Unit
U.S. Environmental Protection Agency – Region 1
11 Technology Drive
North Chelmsford, MA 01863

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Prepared by: Charles Porfert 1/19/10
(Charles Porfert, Quality Assurance Unit) Date

Approved by: Gerard Sotolongo 1-19-10
(Gerard Sotolongo, Quality Assurance Unit) Date

Revision Page

Date	Rev #	Summary of changes	Sections
7/30/96	2	Finalized	
01/19/10	3	Updated	All sections

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USE OF TERMS

Equipment blank: The equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank needs only to include the pump in subsequent sampling rounds. If the pump and tubing are dedicated to the well, the equipment blank is collected prior to its placement in the well. If the pump and tubing will be used to sample multiple wells, the equipment blank is normally collected after sampling from contaminated wells and not after background wells.

Field duplicates: Field duplicates are collected to determine precision of the sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

Indicator field parameters: This SOP uses field measurements of turbidity, dissolved oxygen, specific conductance, temperature, pH, and oxidation/reduction potential (ORP) as indicators of when purging operations are sufficient and sample collection may begin.

Matrix Spike/Matrix Spike Duplicates: Used by the laboratory in its quality assurance program. Consult the laboratory for the sample volume to be collected.

Poteniometric Surface: The level to which water rises in a tightly cased well constructed in a confined aquifer. In an unconfined aquifer, the potentiometric surface is the water table.

QAPP: Quality Assurance Project Plan

SAP: Sampling and Analysis Plan

SOP: Standard operating procedure

Stabilization: A condition that is achieved when all indicator field parameter measurements are sufficiently stable (as described in the "Monitoring Indicator Field Parameters" section) to allow sample collection to begin.

Temperature blank: A temperature blank is added to each sample cooler. The blank is measured upon receipt at the laboratory to assess whether the samples were properly cooled during transit.

Trip blank (VOCs): Trip blank is a sample of analyte-free water taken to the sampling site and returned to the laboratory. The trip blanks (one pair) are added to each sample cooler that contains VOC samples.

SCOPE & APPLICATION

The goal of this groundwater sampling procedure is to collect water samples that reflect the total mobile organic and inorganic loads (dissolved and colloidal sized fractions) transported through the subsurface under ambient flow conditions, with minimal physical and chemical alterations from sampling operations. This standard operating procedure (SOP) for collecting groundwater samples will help ensure that the project's data quality objectives (DQOs) are met under certain low-flow conditions.

The SOP emphasizes the need to minimize hydraulic stress at the well-aquifer interface by maintaining low water-level drawdowns, and by using low pumping rates during purging and sampling operations. Indicator field parameters (e.g., dissolved oxygen, pH, etc.) are monitored during purging in order to determine when sample collection may begin. Samples properly collected using this SOP are suitable for analysis of groundwater contaminants (volatile and semi-volatile organic analytes, dissolved gases, pesticides, PCBs, metals and other inorganics), or naturally occurring analytes. This SOP is based on Puls, and Barcelona (1996).

This procedure is designed for monitoring wells with an inside diameter (1.5-inches or greater) that can accommodate a positive lift pump with a screen length or open interval ten feet or less and with a water level above the top of the screen or open interval (Hereafter, the "screen or open interval" will be referred to only as "screen interval"). This SOP is not applicable to other well-sampling conditions.

While the use of dedicated sampling equipment is not mandatory, dedicated pumps and tubing can reduce sampling costs significantly by streamlining sampling activities and thereby reducing the overall field costs.

The goal of this procedure is to emphasize the need for consistency in deploying and operating equipment while purging and sampling monitoring wells during each sampling event. This will help to minimize sampling variability.

This procedure describes a general framework for groundwater sampling. Other site specific information (hydrogeological context, conceptual site model (CSM), DQOs, etc.) coupled with systematic planning must be added to the procedure in order to develop an appropriate site specific SAP/QAPP. In addition, the site specific SAP/QAPP must identify the specific equipment that will be used to collect the groundwater samples.

This procedure does not address the collection of water or free product samples from wells containing free phase LNAPLs and/or DNAPLs (light or dense non-aqueous phase

liquids). For this type of situation, the reader may wish to check: Cohen, and Mercer (1993) or other pertinent documents.

This SOP is to be used when collecting groundwater samples from monitoring wells at all Superfund, Federal Facility and RCRA sites in Region 1 under the conditions described herein. Request for modification of this SOP, in order to better address specific situations at individual wells, must include adequate technical justification for proposed changes. All changes and modifications must be approved and included in a revised SAP/QAPP before implementation in field.

BACKGROUND FOR IMPLEMENTATION

It is expected that the monitoring well screen has been properly located (both laterally and vertically) to intercept existing contaminant plume(s) or along flow paths of potential contaminant migration. Problems with inappropriate monitoring well placement or faulty/improper well installation cannot be overcome by even the best water sampling procedures. This SOP presumes that the analytes of interest are moving (or will potentially move) primarily through the more permeable zones intercepted by the screen interval.

Proper well construction, development, and operation and maintenance cannot be overemphasized. The use of installation techniques that are appropriate to the hydrogeologic setting of the site often prevent "problem well" situations from occurring. During well development, or redevelopment, tests should be conducted to determine the hydraulic characteristics of the monitoring well. The data can then be used to set the purging/sampling rate, and provide a baseline for evaluating changes in well performance and the potential need for well rehabilitation. Note: if this installation data or well history (construction and sampling) is not available or discoverable, for all wells to be sampled, efforts to build a sampling history should commence with the next sampling event.

The pump intake should be located within the screen interval and at a depth that will remain under water at all times. It is recommended that the intake depth and pumping rate remain the same for all sampling events. The mid-point or the lowest historical midpoint of the saturated screen length is often used as the location of the pump intake. For new wells, or for wells without pump intake depth information, the site's SAP/QAPP must provide clear reasons and instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected. If the depths to top and bottom of the well screen are not known, the SAP/QAPP will need to describe how the sampling depth will be determined and how the data can be used.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU, and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection

may still take place provided the indicator field parameter criteria in this procedure are met. If after 2 hours of purging indicator field parameters have not stabilized, one of three optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization), c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may reflect a sampling bias and therefore, the data may not meet the data quality objectives of the sampling event).

It is recommended that low-flow sampling be conducted when the air temperature is above 32°F (0°C). If the procedure is used below 32°F, special precautions will need to be taken to prevent the groundwater from freezing in the equipment. Because sampling during freezing temperatures may adversely impact the data quality objectives, the need for water sample collection during months when these conditions are likely to occur should be evaluated during site planning and special sampling measures may need to be developed. Ice formation in the flow-through-cell will cause the monitoring probes to act erratically. A transparent flow-through-cell needs to be used to observe if ice is forming in the cell. If ice starts to form on the other pieces of the sampling equipment, additional problems may occur.

HEALTH & SAFETY

When working on-site, comply with all applicable OSHA requirements and the site's health/safety procedures. All proper personal protection clothing and equipment are to be worn. Some samples may contain biological and chemical hazards. These samples should be handled with suitable protection to skin, eyes, etc.

CAUTIONS

The following cautions need to be considered when planning to collect groundwater samples when the below conditions occur.

If the groundwater degasses during purging of the monitoring well, dissolved gases and VOCs will be lost. When this happens, the groundwater data for dissolved gases (e.g., methane, ethene, ethane, dissolved oxygen, etc.) and VOCs will need to be qualified. Some conditions that can promote degassing are the use of a vacuum pump (e.g., peristaltic pumps), changes in aperture along the sampling tubing, and squeezing/pinching the pump's tubing which results in a pressure change.

When collecting the samples for dissolved gases and VOCs analyses, avoid aerating the groundwater in the pump's tubing. This can cause loss of the dissolved gases and VOCs in

the groundwater. Having the pump's tubing completely filled prior to sampling will avoid this problem when using a centrifugal pump or peristaltic pump.

Direct sun light and hot ambient air temperatures may cause the groundwater in the tubing and flow-through-cell to heat up. This may cause the groundwater to degas which will result in loss of VOCs and dissolved gases. When sampling under these conditions, the sampler will need to shade the equipment from the sunlight (e.g., umbrella, tent, etc.). If possible, sampling on hot days, or during the hottest time of the day, should be avoided. The tubing exiting the monitoring well should be kept as short as possible to avoid the sun light or ambient air from heating up the groundwater.

Thermal currents in the monitoring well may cause vertical mixing of water in the well bore. When the air temperature is colder than the groundwater temperature, it can cool the top of the water column. Colder water which is denser than warm water sinks to the bottom of the well and the warmer water at the bottom of the well rises, setting up a convention cell. "During low-flow sampling, the pumped water may be a mixture of convecting water from within the well casing and aquifer water moving inward through the screen. This mixing of water during low-flow sampling can substantially increase equilibration times, can cause false stabilization of indicator parameters, can give false indication of redox state, and can provide biological data that are not representative of the aquifer conditions" (Vroblesky 2007).

Failure to calibrate or perform proper maintenance on the sampling equipment and measurement instruments (e.g., dissolved oxygen meter, etc.) can result in faulty data being collected.

Interferences may result from using contaminated equipment, cleaning materials, sample containers, or uncontrolled ambient/surrounding air conditions (e.g., truck/vehicle exhaust nearby).

Cross contamination problems can be eliminated or minimized through the use of dedicated sampling equipment and/or proper planning to avoid ambient air interferences. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

Clean and decontaminate all sampling equipment prior to use. All sampling equipment needs to be routinely checked to be free from contaminants and equipment blanks collected to ensure that the equipment is free of contaminants. Check the previous equipment blank data for the site (if they exist) to determine if the previous cleaning procedure removed the contaminants. If contaminants were detected and they are a concern, then a more vigorous cleaning procedure will be needed.

PERSONNEL QUALIFICATIONS

All field samplers working at sites containing hazardous waste must meet the requirements of the OSHA regulations. OSHA regulations may require the sampler to take the 40 hour OSHA health and safety training course and a refresher course prior to engaging in any field activities, depending upon the site and field conditions.

The field samplers must be trained prior to the use of the sampling equipment, field instruments, and procedures. Training is to be conducted by an experienced sampler before initiating any sampling procedure.

The entire sampling team needs to read, and be familiar with, the site Health and Safety Plan, all relevant SOPs, and SAP/QAPP (and the most recent amendments) before going onsite for the sampling event. It is recommended that the field sampling leader attest to the understanding of these site documents and that it is recorded.

EQUIPMENT AND SUPPLIES

A. Informational materials for sampling event

A copy of the current Health and Safety Plan, SAP/QAPP, monitoring well construction data, location map(s), field data from last sampling event, manuals for sampling, and the monitoring instruments' operation, maintenance, and calibration manuals should be brought to the site.

B. Well keys.

C. Extraction device

Adjustable rate, submersible pumps (e.g., centrifugal, bladder, etc.) which are constructed of stainless steel or Teflon are preferred. Note: if extraction devices constructed of other materials are to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

If bladder pumps are selected for the collection of VOCs and dissolved gases, the pump setting should be set so that one pulse will deliver a water volume that is sufficient to fill a 40 mL VOC vial. This is not mandatory, but is considered a "best practice". For the proper operation, the bladder pump will need a minimum amount of water above the pump; consult the manufacturer for the recommended submergence. The pump's recommended submergence value should be determined during the planning stage, since it may influence well construction and placement of dedicated pumps where water-level fluctuations are significant.

Adjustable rate, peristaltic pumps (suction) are to be used with caution when collecting samples for VOCs and dissolved gases (e.g., methane, carbon dioxide, etc.) analyses. Additional information on the use of peristaltic pumps can be found in Appendix A. If peristaltic pumps are used, the inside diameter of the rotor head tubing needs to match the inside diameter of the tubing installed in the monitoring well.

Inertial pumping devices (motor driven or manual) are not recommended. These devices frequently cause greater disturbance during purging and sampling, and are less easily controlled than submersible pumps (potentially increasing turbidity and sampling variability, etc.). This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

D. Tubing

Teflon or Teflon-lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics. Note: if tubing constructed of other materials is to be used, adequate information must be provided to show that the substituted materials do not leach contaminants nor cause interferences to the analytical procedures to be used. Acceptance of these materials must be obtained before the sampling event.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for metal and other inorganics analyses.

The use of 1/4 inch or 3/8 inch (inside diameter) tubing is recommended. This will help ensure that the tubing remains liquid filled when operating at very low pumping rates when using centrifugal and peristaltic pumps.

Silastic tubing should be used for the section around the rotor head of a peristaltic pump. It should be less than a foot in length. The inside diameter of the tubing used at the pump rotor head must be the same as the inside diameter of tubing placed in the well. A tubing connector is used to connect the pump rotor head tubing to the well tubing. Alternatively, the two pieces of tubing can be connected to each other by placing the one end of the tubing inside the end of the other tubing. The tubing must not be reused.

E. The water level measuring device

Electronic "tape", pressure transducer, water level sounder/level indicator, etc. should be capable of measuring to 0.01 foot accuracy. Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use must include check measurements with a water level "tape" at the start and end of each sampling event.

F. Flow measurement supplies

Graduated cylinder (size according to flow rate) and stopwatch usually will suffice.

Large graduated bucket used to record total water purged from the well.

G. Interface probe

To be used to check on the presence of free phase liquids (LNAPL, or DNAPL) before purging begins (as needed).

H. Power source (generator, nitrogen tank, battery, etc.)

When a gasoline generator is used, locate it downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate samples.

I. Indicator field parameter monitoring instruments

Use of a multi-parameter instrument capable of measuring pH, oxidation/reduction potential (ORP), dissolved oxygen (DO), specific conductance, temperature, and coupled with a flow-through-cell is required when measuring all indicator field parameters, except turbidity. Turbidity is collected using a separate instrument. Record equipment/instrument identification (manufacturer, and model number).

Transparent, small volume flow-through-cells (e.g., 250 mLs or less) are preferred. This allows observation of air bubbles and sediment buildup in the cell, which can interfere with the operation of the monitoring instrument probes, to be easily detected. A small volume cell facilitates rapid turnover of water in the cell between measurements of the indicator field parameters.

It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.

Turbidity samples are collected before the flow-through-cell. A "T" connector coupled with a valve is connected between the pump's tubing and flow-through-cell. When a turbidity measurement is required, the valve is opened to allow the groundwater to flow into a container. The valve is closed and the container sample is then placed in the turbidimeter.

Standards are necessary to perform field calibration of instruments. A minimum of two standards are needed to bracket the instrument measurement range for all parameters except ORP which use a Zobell solution as a standard. For dissolved oxygen, a wet sponge used for the 100% saturation and a zero dissolved oxygen solution are used for the calibration.

Barometer (used in the calibration of the Dissolved Oxygen probe) and the conversion formula to convert the barometric pressure into the units of measure used by the Dissolved Oxygen meter are needed.

J. Decontamination supplies

Includes (for example) non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.

K. Record keeping supplies

Logbook(s), well purging forms, chain-of-custody forms, field instrument calibration forms, etc.

L. Sample bottles

M. Sample preservation supplies (as required by the analytical methods)

N. Sample tags or labels

O. PID or FID instrument

If appropriate, to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

P. Miscellaneous Equipment

Equipment to keep the sampling apparatus shaded in the summer (e.g., umbrella) and from freezing in the winter. If the pump's tubing is allowed to heat up in the warm weather, the cold groundwater may degas as it is warmed in the tubing.

EQUIPMENT/INSTRUMENT CALIBRATION

Prior to the sampling event, perform maintenance checks on the equipment and instruments according to the manufacturer's manual and/or applicable SOP. This will ensure that the equipment/instruments are working properly before they are used in the field.

Prior to sampling, the monitoring instruments must be calibrated and the calibration documented. The instruments are calibrated using U.S Environmental Protection Agency Region 1 *Calibration of Field Instruments (temperature, pH, dissolved oxygen, conductivity/specific conductance, oxidation/reduction [ORP], and turbidity),* January 19, 2010, or latest version or from one of the methods listed in 40CFR136, 40CFR141 and SW-846.

The instruments shall be calibrated at the beginning of each day. If the field measurement falls outside the calibration range, the instrument must be re-calibrated so that all measurements fall within the calibration range. At the end of each day, a calibration check is performed to verify that instruments remained in calibration throughout the day. This check is performed while the instrument is in measurement mode, not calibration mode. If the field instruments are being used to monitor the natural attenuation parameters, then a calibration check at mid-day is highly recommended to ensure that the instruments did not drift out of calibration. Note: during the day if the instrument reads zero or a negative number for dissolved oxygen, pH, specific conductance, or turbidity (negative value only), this indicates that the instrument drifted out of calibration or the instrument is malfunctioning. If this situation occurs the data from this instrument will need to be qualified or rejected.

PRELIMINARY SITE ACTIVITIES (as applicable)

Check the well for security (damage, evidence of tampering, missing lock, etc.) and record pertinent observations (include photograph as warranted).

If needed lay out sheet of clean polyethylene for monitoring and sampling equipment, unless equipment is elevated above the ground (e.g., on a table, etc.).

Remove well cap and if appropriate measure VOCs at the rim of the well with a PID or FID instrument and record reading in field logbook or on the well purge form.

If the well casing does not have an established reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook (consider a photographic record as well). All water level measurements must be recorded relative to this reference point (and the altitude of this point should be determined using techniques that are appropriate to site's DQOs.

If water-table or potentiometric surface map(s) are to be constructed for the sampling event, perform synoptic water level measurement round (in the shortest possible time) before any purging and sampling activities begin. If possible, measure water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) the day before sampling begins, in order to allow for re-settlement of any particulates in the water column. This is especially important for those wells that have not been recently sampled because sediment buildup in the well may require the well to be redeveloped. If measurement of total well depth is not made the day before, it should be measured after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe may not be necessary unless analytical data or field analysis signal a worsening situation. This SOP cannot be used in the presence of LNAPLs or DNAPLs. If NAPLs are present, the project team must decide upon an alternate sampling method. All project modifications must be approved and documented prior to implementation.

If available check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). If changes are made in the intake depth or extraction rate(s) used during previous sampling event(s), for either portable or dedicated extraction devices, record new values, and explain reasons for the changes in the field logbook.

PURGING AND SAMPLING PROCEDURE

Purging and sampling wells in order of increasing chemical concentrations (known or anticipated) are preferred.

The use of dedicated pumps is recommended to minimize artificial mobilization and entrainment of particulates each time the well is sampled. Note that the use of dedicated sampling equipment can also significantly reduce the time needed to complete each

sampling event, will promote consistency in the sampling, and may reduce sampling bias by having the pump's intake at a constant depth.

A. Initial Water Level

Measure the water level in the well before installing the pump if a non-dedicated pump is being used. The initial water level is recorded on the purge form or in the field logbook.

B. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the appropriate depth (may not be the mid-point of the screen/open interval). The Sampling and Analysis Plan/Quality Assurance Project Plan should specify the sampling depth (used previously), or provide criteria for selection of intake depth for each new well. If possible keep the pump intake at least two feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well.

Pump tubing lengths, above the top of well casing should be kept as short as possible to minimize heating the groundwater in the tubing by exposure to sun light and ambient air temperatures. Heating may cause the groundwater to degas, which is unacceptable for the collection of samples for VOC and dissolved gases analyses.

C. Measure Water Level

Before starting pump, measure water level. Install recording pressure transducer, if used to track drawdowns, to initialize starting condition.

D. Purge Well

From the time the pump starts purging and until the time the samples are collected, the purged water is discharged into a graduated bucket to determine the total volume of groundwater purged. This information is recorded on the purge form or in the field logbook.

Start the pump at low speed and slowly increase the speed until discharge occurs. Check water level. Check equipment for water leaks and if present fix or replace the affected equipment. Try to match pumping rate used during previous sampling event(s). Otherwise, adjust pump speed until there is little or no water level drawdown. If the minimal drawdown that can be achieved exceeds 0.3 feet, but remains stable, continue purging.

Monitor and record the water level and pumping rate every five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump to ensure stabilization of the water level. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" somewhat as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. If the initial water level is above the top of the screen do not allow the water level to fall into the well screen. The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

Avoid the use of constriction devices on the tubing to decrease the flow rate because the constrictor will cause a pressure difference in the water column. This will cause the groundwater to degas and result in a loss of VOCs and dissolved gasses in the groundwater samples.

Note: the flow rate used to achieve a stable pumping level should remain constant while monitoring the indicator parameters for stabilization and while collecting the samples.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (e.g., bladder, peristaltic), and/or the use of dedicated equipment. For new monitoring wells, or wells where the following situation has not occurred before, if the recovery rate to the well is less than 50 mL/min., or the well is being essentially dewatered during purging, the well should be sampled as soon as the water level has recovered sufficiently to collect the volume needed for all anticipated samples. The project manager or field team leader will need to make the decision when samples should be collected, how the sample is to be collected, and the reasons recorded on the purge form or in the field logbook. A water level measurement needs to be performed and recorded before samples are collected. If the project manager decides to collect the samples using the pump, it is best during this recovery period that the pump intake tubing not be removed, since this will aggravate any turbidity problems. Samples in this specific situation may be collected without stabilization of indicator field parameters. Note that field conditions and efforts to overcome problematic situations must be recorded in order to support field decisions to deviate from normal procedures described in this SOP. If this type of problematic situation persists in a well, then water sample collection should be changed to a passive or no-purge method, if consistent with the site's DQOs, or have a new well installed.

E. Monitor Indicator Field Parameters

After the water level has stabilized, connect the "T" connector with a valve and the flow-through-cell to monitor the indicator field parameters. If excessive turbidity is anticipated or encountered with the pump startup, the well may be purged for a while without connecting up the flow-through-cell, in order to minimize particulate buildup in the cell (This is a judgment call made by the sampler). Water level drawdown measurements should be made as usual. If possible, the pump may be installed the day before purging to allow particulates that were disturbed during pump insertion to settle.

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, ORP, DO) at a frequency of five minute intervals or greater. The pump's flow rate must be able to "turn over" at least one flow-through-cell volume between measurements (for a 250 mL flow-through-cell with a flow rate of 50 mLs/min., the monitoring frequency would be every five minutes; for a 500 mL flow-through-cell it would be every ten minutes). If the cell volume cannot be replaced in the five minute interval, then the time between measurements must be increased accordingly. Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments followed by stabilization of indicator parameters. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings are within the following limits:

Turbidity (10% for values greater than 5 NTU; if three Turbidity values are less than 5 NTU, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Samples for turbidity measurements are obtained before water enters the flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities. Record start and stop times and give a brief description of cleaning activities.

The flow-through-cell must be designed in a way that prevents gas bubble entrapment in the cell. Placing the flow-through-cell at a 45 degree angle with the port facing upward can help remove bubbles from the flow-through-cell (see Appendix B Low-Flow Setup Diagram). All during the measurement process, the flow-through-cell must remain free of any gas bubbles. Otherwise, the monitoring probes may act erratically. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must remain submerged in water at all times.

F. Collect Water Samples

When samples are collected for laboratory analyses, the pump's tubing is disconnected from the "T" connector with a valve and the flow-through-cell. The samples are collected directly from the pump's tubing. Samples must not be collected from the flow-through-cell or from the "T" connector with a valve.

VOC samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

If the pump's flow rate is too high to collect the VOC/dissolved gases samples, collect the other samples first. Lower the pump's flow rate to a reasonable rate and collect the VOC/dissolved gases samples and record the new flow rate.

During purging and sampling, the centrifugal/peristaltic pump tubing must remain filled with water to avoid aeration of the groundwater. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use the following procedure to collect samples: collect non-VOC/dissolved gases samples first, then increase flow rate slightly until the water completely fills the tubing, collect the VOC/dissolved gases samples, and record new drawdown depth and flow rate.

For bladder pumps that will be used to collect VOC or dissolved gas samples, it is recommended that the pump be set to deliver long pulses of water so that one pulse will fill a 40 mL VOC vial.

Use pre-preserved sample containers or add preservative, as required by analytical methods, to the samples immediately after they are collected. Check the analytical methods (e.g. EPA SW-846, 40 CFR 136, water supply, etc.) for additional information on preservation.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter (transparent housing preferred) is required, and the filter size (0.45 μm is commonly used) should be based on the sampling objective. Pre-rinse the filter with groundwater prior to sample collection. Make sure the filter is free of air bubbles before samples are collected. Preserve the filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in groundwater for human health or ecological risk calculations.

Label each sample as collected. Samples requiring cooling will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

G. Post Sampling Activities

If a recording pressure transducer is used to track drawdown, re-measure water level with tape.

After collection of samples, the pump tubing may be dedicated to the well for re-sampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth annually is usually sufficient after the initial low stress sampling event. However, a greater frequency may be needed if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and then following sampling of each well. Pumps should not be removed between purging and sampling operations. The pump, tubing, support cable and electrical wires which were in contact with the well should be decontaminated by one of the procedures listed below.

The use of dedicated pumps and tubing will reduce the amount of time spent on decontamination of the equipment. If dedicated pumps and tubing are used, only the initial sampling event will require decontamination of the pump and tubing.

Note if the previous equipment blank data showed that contaminant(s) were present after using the below procedure or the one described in the SAP/QAPP, a more vigorous procedure may be needed.

Procedure 1

Decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump and tubing. The pump may be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Optional - flush with isopropyl alcohol (pesticide grade; must be free of ketones {e.g., acetone}) or with methanol. This step may be required if the well is highly contaminated or if the equipment blank data from the previous sampling event show that the level of contaminants is significant.

Flush with distilled/deionized water. This step must remove all traces of alcohol (if used) from the equipment. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the groundwater samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. Quality control samples include field duplicates, equipment blanks, matrix spike/matrix spike duplicates, trip blanks (VOCs), and temperature blanks.

FIELD LOGBOOK

A field log shall be kept to document all groundwater field monitoring activities (see Appendix C, example table), and record the following for each well:

Site name, municipality, state.

Well identifier, latitude-longitude or state grid coordinates.

Measuring point description (e.g., north side of PVC pipe).

Well depth, and measurement technique.

Well screen length.

Pump depth.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, calculated or measured total volume pumped, and clock time of each set of measurements.

Type of tubing used and its length.

Type of pump used.

Clock time of start and end of purging and sampling activity.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analyses.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions, including approximate ambient air temperature.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling/monitoring equipment used, including trade names, model number, instrument identification number, diameters, material composition, etc.

DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, field indicator parameters measured during purging, field instrument calibration information, and whatever other field logbook information is needed to allow for a full evaluation of data usability.

Note: the use of trade, product, or firm names in this sampling procedure is for descriptive purposes only and does not constitute endorsement by the U.S. EPA.

REFERENCES

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Robert W. Puls and Michael J. Barcelona, *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*, April 1996 (EPA/540/S-95/504).

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U.S Environmental Protection Agency, EPA SW-846.

U.S Environmental Protection Agency, 40 CFR 136.

U.S Environmental Protection Agency, 40 CFR 141.

Vroblesky, Don A., Clifton C. Casey, and Mark A. Lowery, Summer 2007, Influence of Dissolved Oxygen Convection on Well Sampling, *Ground Water Monitoring & Remediation* 27, no. 3: 49-58.

APPENDIX A
PERISTALTIC PUMPS

Before selecting a peristaltic pump to collect groundwater samples for VOCs and/or dissolved gases (e.g., methane, carbon dioxide, etc.) consideration should be given to the following:

- The decision of whether or not to use a peristaltic pump is dependent on the intended use of the data.
- If the additional sampling error that may be introduced by this device is NOT of concern for the VOC/dissolved gases data's intended use, then this device may be acceptable.
- If minor differences in the groundwater concentrations could effect the decision, such as to continue or terminate groundwater cleanup or whether the cleanup goals have been reached, then this device should NOT be used for VOC/dissolved gases sampling. In these cases, centrifugal or bladder pumps are a better choice for more accurate results.

EPA and USGS have documented their concerns with the use of the peristaltic pumps to collect water sample in the below documents.

- "Suction Pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" *A Compendium of Superfund Field Operations Methods*, EPA/540/P-87/001, December 1987.
- "The agency does not recommend the use of peristaltic pumps to sample ground water particularly for volatile organic analytes" *RCRA Ground-Water Monitoring Draft Technical Guidance*, EPA Office of Solid Waste, November 1992.
- "The peristaltic pump is limited to shallow applications and can cause degassing resulting in alteration of pH, alkalinity, and volatiles loss", *Low-flow (Minimal drawdown) Ground-Water Sampling Procedures*, by Robert Puls & Michael Barcelona, April 1996, EPA/540/S-95/504.
- "Suction-lift pumps, such as peristaltic pumps, can operate at a very low pumping rate; however, using negative pressure to lift the sample can result in the loss of volatile analytes", USGS Book 9 Techniques of Water-Resources Investigation, Chapter A4. (Version 2.0, 9/2006).

APPENDIX B

SUMMARY OF SAMPLING INSTRUCTIONS

These instructions are for using an adjustable rate, submersible pump or a peristaltic pump with the pump's intake placed at the midpoint of a 10 foot or less well screen or an open interval. The water level in the monitoring well is above the top of the well screen or open interval, the ambient temperature is above 32°F, and the equipment is not dedicated. Field instruments are already calibrated. The equipment is setup according to the diagram at the end of these instructions.

1. Review well installation information. Record well depth, length of screen or open interval, and depth to top of the well screen. Determine the pump's intake depth (e.g., mid-point of screen/open interval).

2. On the day of sampling, check security of the well casing, perform any safety checks needed for the site, lay out a sheet of polyethylene around the well (if necessary), and setup the equipment. If necessary a canopy or an equivalent item can be setup to shade the pump's tubing and flow-through-cell from the sun light to prevent the sun light from heating the groundwater.

3. Check well casing for a reference mark. If missing, make a reference mark. Measure the water level (initial) to 0.01 ft. and record this information.

4. Install the pump's intake to the appropriate depth (e.g., midpoint) of the well screen or open interval. Do not turn-on the pump at this time.

5. Measure water level and record this information.

6. Turn-on the pump and discharge the groundwater into a graduated waste bucket. Slowly increase the flow rate until the water level starts to drop. Reduce the flow rate slightly so the water level stabilizes. Record the pump's settings. Calculate the flow rate using a graduated container and a stop watch. Record the flow rate. Do not let the water level drop below the top of the well screen.

If the groundwater is highly turbid or colored, continue to discharge the water into the bucket until the water clears (visual observation); this usually takes a few minutes. The turbid or colored water is usually from the well being disturbed during the pump installation. If the water does not clear, then you need to make a choice whether to continue purging the well (hoping that it will clear after a reasonable time) or continue to

the next step. Note, it is sometimes helpful to install the pump the day before the sampling event so that the disturbed materials in the well can settle out.

If the water level drops to the top of the well screen during the purging of the well, stop purging the well, and do the following:

> Wait for the well to recharge to a sufficient volume so samples can be collected. This may take awhile (pump maybe removed from well, if turbidity is not a problem). The project manager will need to make the decision when samples should be collected and the reasons recorded in the site's log book. A water level measurement needs to be performed and recorded before samples are collected. When samples are being collected, the water level must not drop below the top of the screen or open interval. Collect the samples from the pump's tubing. Always collect the VOCs and dissolved gases samples first. Normally, the samples requiring a small volume are collected before the large volume samples are collected just in case there is not sufficient water in the well to fill all the sample containers. All samples must be collected, preserved, and stored according to the analytical method. Remove the pump from the well and decontaminate the sampling equipment.

If the water level has dropped 0.3 feet or less from the initial water level (water level measure before the pump was installed); proceed to Step 7. If the water level has dropped more than 0.3 feet, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are be collected.

7. Attach the pump's tubing to the "T" connector with a valve (or a three-way stop cock). The pump's tubing from the well casing to the "T" connector must be as short as possible to prevent the groundwater in the tubing from heating up from the sun light or from the ambient air. Attach a short piece of tubing to the other end of the end of the "T" connector to serve as a sampling port for the turbidity samples. Attach the remaining end of the "T" connector to a short piece of tubing and connect the tubing to the flow-through-cell bottom port. To the top port, attach a small piece of tubing to direct the water into a calibrated waste bucket. Fill the cell with the groundwater and remove all gas bubbles from the cell. Position the flow-through-cell in such a way that if gas bubbles enter the cell they can easily exit the cell. If the ports are on the same side of the cell and the cell is cylindrical shape, the cell can be placed at a 45-degree angle with the ports facing upwards; this position should keep any gas bubbles entering the cell away from the monitoring probes and allow the gas bubbles to exit the cell easily (see Low-Flow Setup Diagram). Note,

make sure there are no gas bubbles caught in the probes' protective guard; you may need to shake the cell to remove these bubbles.

8. Turn-on the monitoring probes and turbidity meter.

9. Record the temperature, pH, dissolved oxygen, specific conductance, and oxidation/reduction potential measurements. Open the valve on the "T" connector to collect a sample for the turbidity measurement, close the valve, do the measurement, and record this measurement. Calculate the pump's flow rate from the water exiting the flow-through-cell using a graduated container and a stop watch, and record the measurement. Measure and record the water level. Check flow-through-cell for gas bubbles and sediment; if present, remove them.

10. Repeat Step 9 every 5 minutes or as appropriate until monitoring parameters stabilized. Note at least one flow-through-cell volume must be exchanged between readings. If not, the time interval between readings will need to be increased. Stabilization is achieved when three consecutive measurements are within the following limits:

Turbidity (10% for values greater than 5 NTUs; if three Turbidity values are less than 5 NTUs, consider the values as stabilized),
Dissolved Oxygen (10% for values greater than 0.5 mg/L, if three Dissolved Oxygen values are less than 0.5 mg/L, consider the values as stabilized),
Specific Conductance (3%),
Temperature (3%),
pH (± 0.1 unit),
Oxidation/Reduction Potential (±10 millivolts).

If these stabilization requirements do not stabilize in a reasonable time, the probes may have been coated from the materials in the groundwater, from a buildup of sediment in the flow-through-cell, or a gas bubble is lodged in the probe. The cell and the probes will need to be cleaned. Turn-off the probes (not the pump), disconnect the cell from the "T" connector and continue to purge the well. Disassemble the cell, remove the sediment, and clean the probes according to the manufacturer's instructions. Reassemble the cell and connect the cell to the "T" connector. Remove all gas bubbles from the cell, turn-on the probes, and continue the measurements. Record that the time the cell was cleaned.

11. When it is time to collect the groundwater samples, turn-off the monitoring probes, and disconnect the pump's tubing from the "T" connector. If you are using a centrifugal or peristaltic pump check the pump's tubing to determine if the tubing is completely filled with water (no air space).

All samples must be collected and preserved according to the analytical method. VOCs and dissolved gases samples are normally collected first and directly into pre-preserved sample containers. However, this may not be the case for all sampling locations; the SAP/QAPP should list the order in which the samples are to be collected based on the project's objective(s). Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

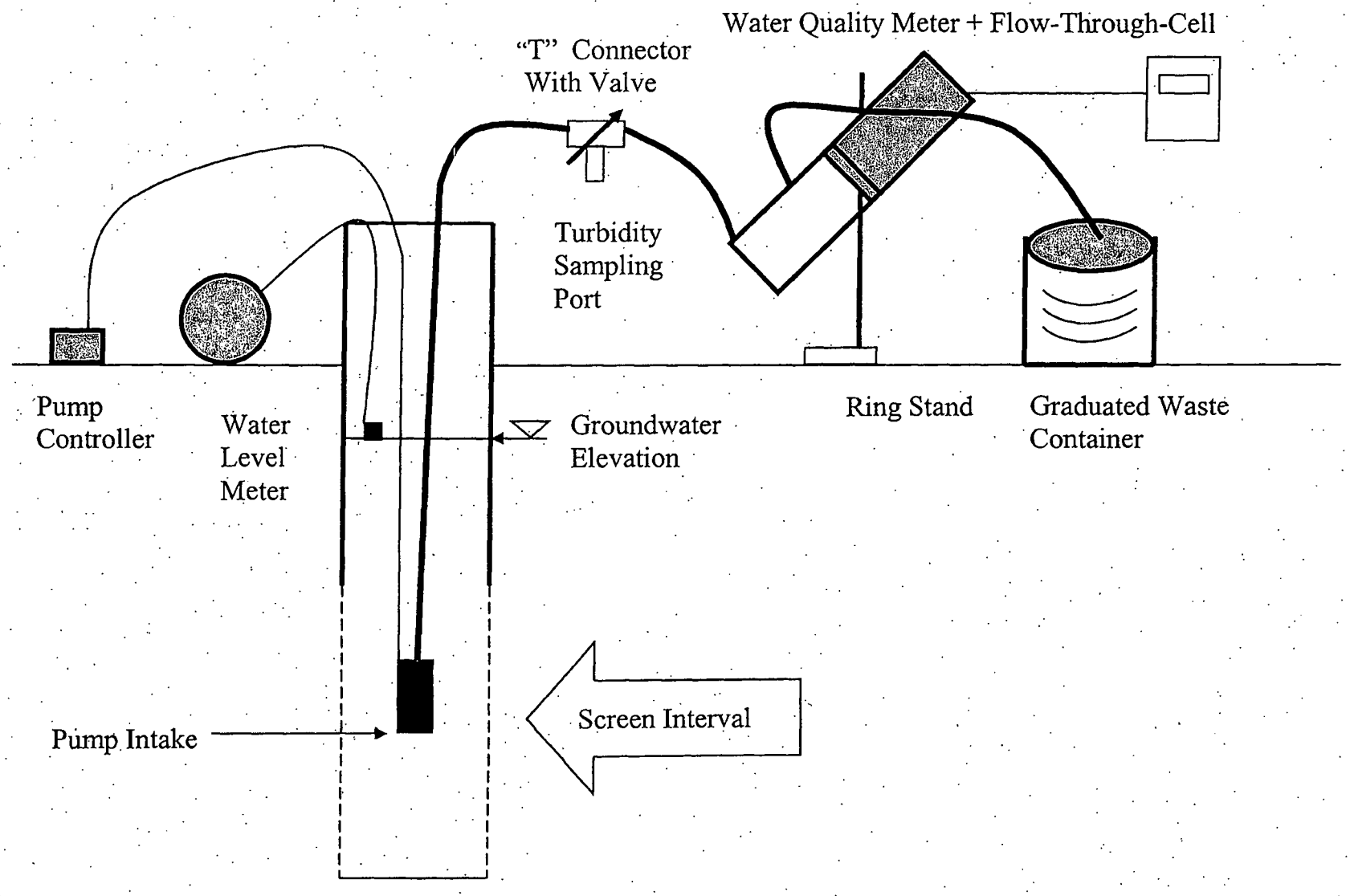
If the pump's tubing is not completely filled with water and the samples are being collected for VOCs and/or dissolved gases analyses using a centrifugal or peristaltic pump, do the following:

> All samples must be collected and preserved according to the analytical method. The VOCs and the dissolved gases (e.g., methane, ethane, ethene, and carbon dioxide) samples are collected last. When it becomes time to collect these samples increase the pump's flow rate until the tubing is completely filled. Collect the samples and record the new flow rate.

12. Store the samples according to the analytical method.

13. Record the total purged volume (graduated waste bucket). Remove the pump from the well and decontaminate the sampling equipment.

Low-Flow Setup Diagram



APPENDIX C
EXAMPLE (Minimum Requirements)
WELL PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name)_____ Depth to _____/_____ of screen
Well Number_____ Date_____ (below MP) top bottom
Field Personnel_____ Pump Intake at (ft. below MP)_____
Sampling Organization_____ Purging Device; (pump type)_____
Identify MP_____ Total Volume Purged _____

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] µS/cm	pH	ORP[3] mv	DO mg/L	Turb-idity NTU	Comments
Stabilization Criteria					3%	3%	±0.1	± 10 mv	10%	10%	

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. µSiemens per cm(same as µmhos/cm)at 25°C.
3. Oxidation reduction potential (ORP)

Chain of Custody Record

Temperature on Receipt _____

Drinking Water? Yes☐ No☐

TestAmerica

THE LEADER IN ENVIRONMENTAL TESTING

Attachment 3

TAL-4124 (1007)

Client	Project Manager	Date	Chain of Custody Number 185944
Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page _____ of _____
City / State / Zip Code	Site Contact	Lab Contact	Analysis (Attach list if more space is needed)
Project Name and Location (State)	Carrier/Waybill Number		
Contract/Purchase Order/Quote No.	Matrix / Containers & Preservatives		Special Instructions/ Conditions of Receipt

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH	

Possible Hazard Identification

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal

☐ Return To Client ☐ Disposal By Lab ☐ Archive For _____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required

☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other_____

QC Requirements (Specify)

1. Relinquished By	Date	Time	1. Received By	Date	Time
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

Attachment 4

TestAmerica Cooler Receipt Form/Narrative **Lot Number:**_____
North Canton Facility

Client _____ Project _____ By:_____
Cooler Received on _____ Opened on_____ (Signature)
FedEx ☐ UPS ☐ DHL ☐ FAS ☐ Stetson ☐ Client Drop Off ☐ TestAmerica Courier ☐ Other_____
TestAmerica Cooler # _____ Multiple Coolers ☐ Foam Box ☐ Client Cooler ☐ Other _____

1. Were custody seals on the outside of the cooler(s)? Yes ☐ No ☐ Intact? Yes ☐ No ☐ NA ☐
   If YES, Quantity_____ Quantity Unsalvageable_____
   Were custody seals on the outside of cooler(s) signed and dated? Yes ☐ No ☐ NA ☐
   Were custody seals on the bottle(s)? Yes ☐ No ☐
   If YES, are there any exceptions? _____
2. Shippers' packing slip attached to the cooler(s)? Yes ☐ No ☐
3. Did custody papers accompany the sample(s)? Yes ☐ No ☐ Relinquished by client? Yes ☐ No ☐
4. Were the custody papers signed in the appropriate place? Yes ☐ No ☐
5. Packing material used: Bubble Wrap ☐ Foam ☐ None ☐ Other _____
6. Cooler temperature upon receipt _____ °C See back of form for multiple coolers/temps ☐
   METHOD: IR ☐ Other ☐ _____
   COOLANT: Wet Ice ☐ Blue Ice ☐ Dry Ice ☐ Water ☐ None ☐
7. Did all bottles arrive in good condition (Unbroken)? Yes ☐ No ☐
8. Could all bottle labels be reconciled with the COC? Yes ☐ No ☐
9. Were sample(s) at the correct pH upon receipt? Yes ☐ No ☐ NA ☐
10. Were correct bottle(s) used for the test(s) indicated? Yes ☐ No ☐
11. Were air bubbles >6 mm in any VOA vials? Yes ☐ No ☐ NA ☐
12. Sufficient quantity received to perform indicated analyses? Yes ☐ No ☐
13. Was a trip blank present in the cooler(s)? Yes ☐ No ☐ Were VOAs on the COC? Yes ☐ No ☐

Contacted PM _____ Date _____ by _____ via Verbal ☐ Voice Mail ☐ Other ☐
Concerning _____

14. CHAIN OF CUSTODY

The following discrepancies occurred:

_____

_____

_____

_____

_____

_____

15. SAMPLE CONDITION

Sample(s)_____ were received after the recommended holding time had expired.
Sample(s)_____ were received in a broken container.
Sample(s)_____ were received with bubble >6 mm in diameter. (Notify PM)

16. SAMPLE PRESERVATION

Sample(s) _____ were further preserved in Sample Receiving to meet recommended pH level(s). *Nitric Acid Lot#* 100110-HNO_3; *Sulfuric Acid Lot#* 110410-H_2SO_4; *Sodium Hydroxide Lot#* 100108 -*NaOH; Hydrochloric Acid Lot#* 092006-*HCl; Sodium Hydroxide and Zinc Acetate Lot#* 100108-$(CH_3COO)_2ZN$/*NaOH*. What time was preservative added to sample(s)? _____

Client ID	pH	Date	Initials

TestAmerica Cooler Receipt Form/Narrative
North Canton Facility

Client ID	pH	Date	Initials

Cooler #	Temp. °C	Method	Coolant

Discrepancies Cont'd:

APPENDIX B

PROCEDURES TO IDENTIFY AND EVALUATE NEW WASTE DERIVED CONSTITUENTS

Prior to the implementation of the CMP-2015, assessment monitoring was performed according to OAC 3745-30-08 (E). The assessment monitoring program included semiannual sampling for the indicator parameters listed in OAC 3745-30-08 Appendix III (H) and those constituents determined to be released, as well as annual sampling for all the parameters listed in Appendix III (H). During development of the CMP-2015, Ohio EPA selected the initial waste-derived constituents (WDCs) based on their review of data from 11 assessment monitoring events.

In addition to the semi-annual sampling for the identified WDCs, the CMP-2015 monitoring includes the annual sampling of Appendix III (H) constituents at both compliance wells and background wells which is consistent with the previous assessment monitoring program. If Appendix III (H) analytical results from a CMP-2015 monitoring event show new constituents are present above background levels in downgradient ground water beyond the limits waste placement, it will be necessary to:

a. Determine whether the new constituents are WDCs not previously identified as being released above background concentrations beyond the limits of waste placement;

b. Calculate a re-evaluation limit and a ground water trigger level for each new WDC and update Table 3-1 of CMP-2015 accordingly; and

c. Determine the concentration and extent above background concentrations of any new WDCs beyond the limits of waste placement as well as the rate of migration of the WDCs away from the limits of waste placement.

B.1 Appendix III (H) Data Evaluation

Per the OAC 3745-30-08 regulations, constituents being released by the landfill will be identified and accounted for in the CMP-2015. Therefore, the Appendix III (H) data will be evaluated annually to update the list of WDCs [i.e., determine whether a statistically significant increase above background has occurred].

Figure B-1 illustrates the process that will be used to evaluate constituents detected above reporting limits to determine if they are new WDCs. There are several constituents that have been detected in upgradient and downgradient ground water during assessment monitoring but were not identified as WDCs in the CMP-2015 (e.g., barium, chloroethane) so the evaluation will start by first categorizing the detection with regards to the constituent's history by determining whether the constituent has been previously detected.

As a screening step when evaluating data from a monitoring event, a previously detected constituent with a current downgradient concentration that has increased to at least two times greater than the upgradient concentration will be carried through the statistical evaluation described below unless the detection is determined to be a false positive as discussed near the end of this section. The purpose of screening step is to simply determine if the concentration of a constituent that was ruled out as WDCs in the past has since increased to the point where further evaluation is needed to determine if a release has occurred.

A parameter which has not been detected historically but is observed in downgradient ground water at a concentration greater than that in upgradient ground water will automatically be identified as a new WDC unless the detection is determined to be a false positive.

Parameters that are not screened out will be statistically evaluated to identify new WDCs. This will be done by comparing the maximum concentration of each detected constituent at each downgradient ground water monitoring well to the background upper tolerance limit (UTL) of that constituent according to the appropriate statistical procedures specified in OAC 3745-30-08 (C)(5 and 6). If it becomes necessary to calculate the background UTL of a constituent, data from the previous 11 Appendix III (H) sample results, which may include data collected during the assessment monitoring program, will be used in the statistical evaluation.

With regards to the statistical method to be used, OAC 3745-30-08 (C)(5)(a) states that "*A tolerance or prediction interval procedure in which an interval for each parameter is established from the distribution of the background data, and the level of each parameter in each monitoring well is compared to the upper tolerance or prediction limit.*" As such, UTLs will be determined by following the procedures provided in the 2009 Unified Guidance (EPA, 2009); however, if during the post closure monitoring period EPA revises the guidance or issues a new relevant guidance, then other more up-to-date statistical methods may be used as appropriate.

Before a background UTL can be calculated, the distribution of the data set will be determined using the Shapiro-Wilk Method (see Section 10.5.1 of the Unified Guidance) with a significance level (α) = 0.05, and the data will be tested for outliers using the Dixons Test (see Section 12.3 of the Unified Guidance).

The presence of non-detects in any well data set can influence the tested distribution. If the data set contains no more than 10 to 15% non-detected results, a concentration equal to one-half of the reporting limit will be used for each non-detected sample result in statistical calculations. If the data set contains more than 15% non-detected results, the Kaplan-Meier method or the Robust Regression on Order

Statistics (ROS) method found in Sections 15.3 and 15.4 of the Unified Guidance, respectively will be used to attempt to fit the data to a known distribution (e.g., normal, lognormal) and then to estimate the mean and standard deviation of this distribution which can be input into parametric UTL equations.

Depending on the distribution of the data, either a parametric 95% UTL with 95% coverage or a nonparametric 95% UTL will be generated for each constituent detected in background ground water. The calculation of these UTLs will follow the equations provided in the 2009 Unified Guidance. Equation 17.16 will be used if the data follow a normal distribution whereas Equation 17.17 will be used if the data follow a lognormal distribution. If the log transformation does not normalize the data, a non-parametric UTL will be determined instead following Section 17.2.2 of the Guidance.

Within a particular zone (i.e., SZS or UAS), if the same parameter is present in more than one background well, the highest UTL will be selected for comparison with downgradient data to identify the WDCs.

If it is demonstrated to Ohio EPA's satisfaction that a source other than the landfill facility is the cause of the contamination or that the statistically significant increase results from natural variation in ground water quality or an error in the sampling, analysis, or statistical evaluation, then parameters being evaluated will not be considered WDCs. Re-sampling may be performed if needed to make the demonstration.

If a new WDC is identified at any downgradient ground water monitoring well, Alcoa will provide notice to Ohio EPA in the semi-annual monitoring report.

B.2 New WDC REL and GWTL

For each new WDC identified under the CMP-2015, a re-evaluation limit and a ground water trigger level will be calculated, and Table 3-1 of CMP-2015 will be updated accordingly.

The re-evaluation limits will be calculated in the same manner as done by Ohio EPA for the initial WDCs in the CMP-2015. These limits will be no greater than two times the greatest concentration detected (rounded up to the nearest whole number) and will be set as either a global re-evaluation limit that applies to more than one well (e.g AL-24 and AL-28 in the SZS, or AL-9 and AL-20 in the UAS) or a well-specific re-evaluation limit (e.g AL-21 in the UAS) as has been laid out in Table 3-1.

The ground water trigger level will be calculated using the same risk-based methodology presented in Appendix C of CMP-2015.

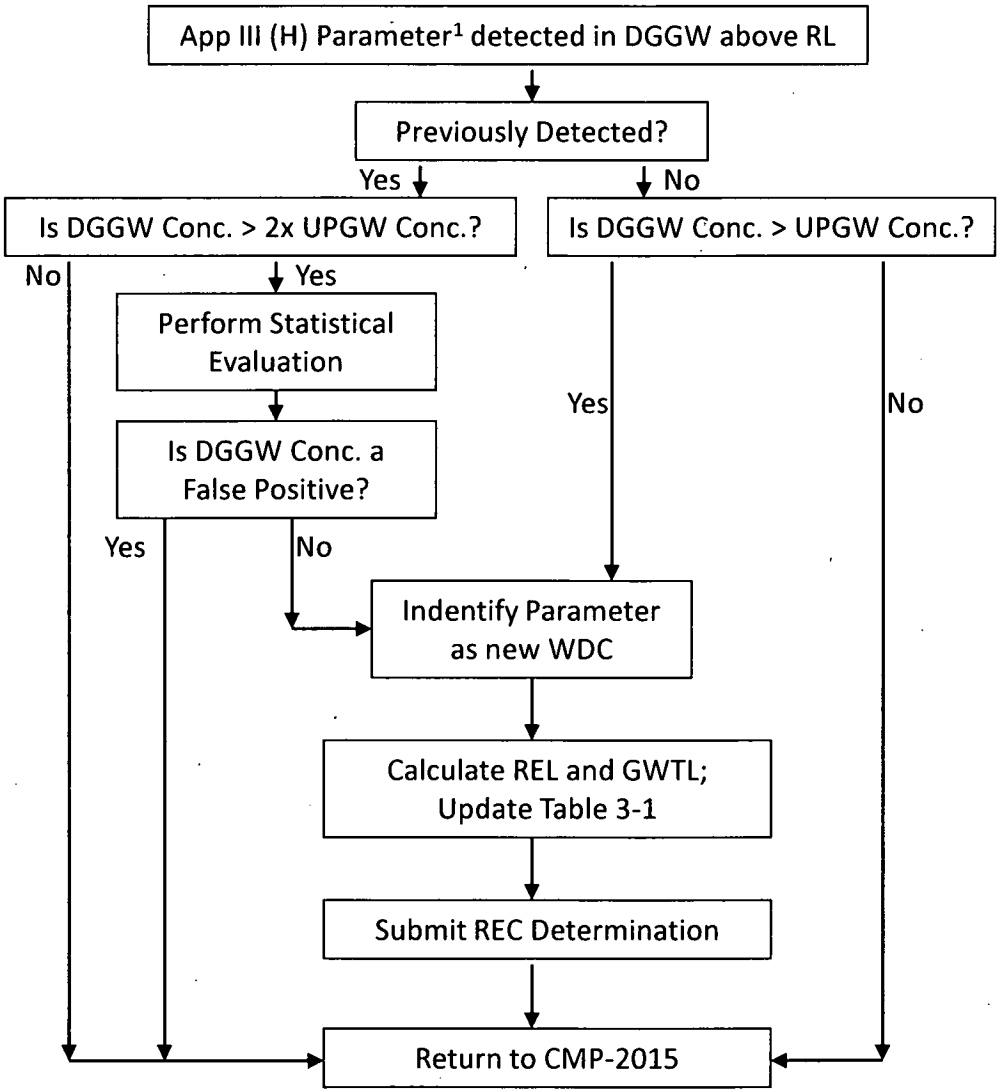
B.3 New WDC Evaluation

As discussed in Section 1.1 of CMP-2015, statistical exceedances of detection monitoring indicator parameters were identified in downgradient wells from the Alcoa Landfill, and as a result, a ground water quality assessment plan (2004 Assessment Plan) was prepared to determine ground water flow direction, the rate and extent of migration and the concentration (REC) of WDCs emanating from the Alcoa Landfill, and the adequacy of the current monitoring network. The assessment results were documented in the Newfields Ground Water Quality Assessment Determination Report (Newfields Report 2006) submitted pursuant to OAC 3745-30-08(E)(2).

If a new WDC is identified under the CMP-2015, the REC of the WDC in the ground water at the landfill facility will be assessed similarly and will use applicable site information from the 2004 Assessment Plan and the Newfields Report 2006. Alcoa will determine the REC for any new WDC and will provide a report of the determination to the Ohio EPA within 180 days of receiving the analytical results from the annual Appendix III (H) sampling. The report will include an evaluation of all source controls that are both reasonable and practical if the results of the REC determination indicate a significant change to the previous REC determination.

After incorporating new WDCs into Table 3-1 of CMP-2015, Alcoa will resume monitoring according to the CMP-2015.

Figure B-1 New WDC Identification
Alcoa Cleveland Works - Closed Landfill



App III (H) = 3745-27-10 Appendix III (H) Constituents

Conc. = Concentration

DGGW = Downgradient Ground Water

GWTL = Ground Water Trigger Level

CMP = Compliance Monitoring Plan

REC = Rate, Extent and Concentration

RELs = Re-Evaluation Limits

RL = Reporting Limit

UGGW = Upgradient Ground Water

WDC = Waste-Derived Constituent

[1]Does not include existing WDCs.

APPENDIX C

GROUND WATER TRIGGER LEVEL DEVELOPMENT

APPENDIX C - GROUND WATER TRIGGER LEVEL DEVELOPMENT

The CMP-2015 uses ground water trigger levels, which is a term in the rules that automatically pushes a site into corrective measures once an exceedance is verified. The ground water trigger levels are risk-based concentrations (RBCs) that were originally developed for the UAS and SZS as part of the site-specific risk assessment presented to Ohio EPA in the Ground water Quality Assessment Determination Report (Newfields Report 2006). The RBCs were developed according to the "USEPA's Risk Assessment Guidance for Superfund, Part B – Development of Preliminary Remediation Goals" (USEPA, 1991). Upon review of the Newfields Report 2006, Ohio EPA indicated that although the risk assessment was acceptable, because it was based on restricted use of the property, the RBCs needed to be coupled with an appropriate environmental covenant including deed restrictions. As such, the covenant was made part of a Findings and Order issued by the state.

Ohio EPA identified the WDCs for the CMP-2015. Some of these (chloroform and nitrate) are constituents that were not evaluated in the Newfields Report 2006. As such, ground water trigger levels were needed for these additional WDCs and are calculated in this appendix. In calculating these standards, it was noted that toxicity criteria for several WDCs (nearly all of the VOCs) have changed since the Newfields Report 2006 was submitted. Therefore, to ensure consistency, it was considered appropriate to recalculate the ground water trigger levels for all of the WDCs based on the current toxicity data. The same methodology and exposure factors used in the Newfields Report 2006 that was previously reviewed by Ohio EPA were used in these calculations although, as indicated below, child receptors were included in certain exposure scenarios as requested by Ohio EPA.

For completeness and to maintain consistency with previously reviewed Newfields Report 2006, the subsections below describe the Conceptual Site Model, Exposure Assessment, Toxicity Assessment, Risk Characterization and RBC Generation, and Uncertainty Analysis with respect to the human health pathway-specific evaluation.

C.1 CONCEPTUAL SITE MODEL (CSM)

A site conceptual model based on known conditions is provided as Figure C-1, and has been developed to identify migration pathways and potentially complete exposure pathways for landfill constituents.

The potential source of chemicals that have been released to the environment is the material disposed of in the landfill. The surface of the landfill is covered and has met State-approved closure requirements. Therefore, there are no complete exposure pathways for direct contact with landfilled materials.

Through historical infiltration of precipitation, constituents in the landfill could have been released to shallow ground water through leaching. However, there are no complete routine exposure pathways for on-site ground water as ground water is not used for potable or production purposes within the vicinity of the Site. It is possible that if future construction activities in this area were to be conducted, such as subsurface pipeline repairs/construction, that incidental contact with subsurface ground water could occur. Additionally, it is possible that volatile constituents in shallow ground water could volatilize during invasive construction activities or through the soil column to ambient air; however, there is no current potential for vapor intrusion into building structures as there are currently no structures on the landfill surface or above the downgradient plume. Furthermore, conditions in the river valley are not ideal for future building construction because the area downgradient of the landfill to the river is within the river floodplain. The Environmental Covenant describes the engineering controls that would be required in the event Alcoa wished to build a structure on the property covered by the covenant in the future.

There are no complete exposure pathways for off-site ground water as there are no known industrial or residential wells downgradient of the site, and all residents in the general area are served by a municipal water supply. As discussed in the Newfields Report 2006, the deeper ground water unit at the site is unproductive as a water supply, and a local well survey conducted by Geraghty and Miller Engineers, Inc. (Geraghty and Miller) as part of the pre-install permit prior to the landfill closure did not reveal any potential public or private wells in the vicinity of the Site.

Constituents in ground water could migrate to the river with the ground water flow. The river is not used for drinking water (per OAC 3745-1-26), and use for recreational swimming is unlikely as this is a highly industrialized reach of water. Therefore, there are no complete exposure pathways for drinking or swimming in the river. There is the possibility of incidental contact of surface water near the river's edge by someone walking through the area.

Therefore, based on the current understanding of the site, the CSM indicates that there are three potentially complete pathways for landfill constituents in ground water. These are: 1) volatilization from ground water through the soil column to outdoor air; 2) transport to surface water with subsequent incidental contact; and 3) possible incidental contact with subsurface ground water during invasive construction activities.

Regarding the volatilization to outdoor air pathway, this is unlikely to be a significant exposure pathway for a number of reasons. Given the location of the landfill, there are no receptors that are frequently or constantly present in the vicinity. The landfill is closed and industrial worker activity in this area is

generally restricted to infrequent landfill-maintenance activities. The Metroparks Towpath runs adjacent to and downgradient extent of the closed landfill, so a recreational TowPath user passing through the area on the Metroparks Towpath is a possible receptor.

C.2 EXPOSURE ASSESSMENT

The WDCs identified by Ohio EPA are the chemicals of potential concern (COPCs) requiring further risk evaluation for human exposure. The exposure assessment estimates the extent of human contact with COPCs by characterizing potentially exposed populations, identifying actual or potential routes of exposure, and estimating the extent of human exposure.

Potential Receptors

In order to evaluate the above pathways consistent with the CSM, the following scenarios were considered:

- Infrequent Industrial Worker Scenario – Assumes plant personnel would be at the landfill performing maintenance activities with exposure to VOCs that volatilize from ground water to ambient air.

- Recreational Towpath User Scenario – Assumes a potential receptor could be walking, skating or biking along the trail with exposure to VOCs in ambient air that originated from ground water.

- Recreational River Wader Scenario – Assumes a potential receptor could be wading along the shoreline with exposure via direct contact to VOCs in surface water that originated from ground water.

- Construction Worker Scenario – Assumes a future construction worker in the vicinity of the landfill with exposure via direct contact with ground water and inhalation of VOCs in ambient air that originated from ground water.

USEPA RAGS Supplemental Guidance, (EPA, 1991) provides default exposure factors for industrial receptors that the risk assessment provided in the Newfields Report 2006. In 2013, the Ohio EPA asked that children be included in the Recreational Towpath User Scenario and the Recreational River Wader Scenario. Exposure factors for children were derived from information in the USEPA Exposure Factor Handbook (USEPA, 2011). Table C-1 presents the exposure factors used in developing the RBCs. Because the RBCs are site-specific, professional judgment, based on knowledge of the site, was used in

determining certain exposure factors such as exposure frequency and times. The assumptions behind the exposure parameters for each receptor scenario are discussed below.

Infrequent Industrial Worker

The exposure assessment conservatively assumes that inhalation of volatiles would take place on an infrequent basis during routine maintenance activities such as mowing the grass. The exposure contact time (how long they would remain in the area each time) is assumed to be 8 hours per day to represent a full work day. The exposure frequency (a conservative estimate of how often the a receptor would be exposed) is assumed to be two times per month or 24 days per year, which is a very conservative estimate given that the landfill is closed and away from the main plant area, with no active leachate or gas collection system, thus requiring minimal maintenance. The exposure duration of 25 years is USEPA's default for an upperbound estimate of employment tenure at one location. The body weight (BW) is the default for an adult of 70 kg. The averaging time factor provides a means for averaging exposure on a daily basis. That is, on a lifetime daily basis for evaluating carcinogenic effects (i.e., 365 days per year for 70 years), and on a daily basis during exposure for evaluating noncarcinogenic effects (i.e., 365 days per year for the exposure duration (ED) or 25 years).

Recreational Towpath User

The exposure assessment conservatively assumes that inhalation of volatiles would take place during the course of typical recreational activities occurring on the Towpath such as walking, jogging, biking or rollerblading. The exposure contact time is assumed to be 2 hours per day representing someone who might go on the Towpath during a lunch break. This is believed to be very conservative as the actual time spent on the Towpath in the vicinity of the Site (which constitutes approximately 1 mile in length) would likely be much less, especially during faster moving activities such as jogging or biking. For instance, even at a very slow walking pace of 30 minutes/mile the distance up and down the path (i.e., 2 miles) would only take one hour. The exposure frequency is assumed to consist of one visit per week in the spring, summer and fall for a total of 39 days per year.

The exposure duration (ED) of 30 years is based on the upper bound estimate on the time that a local resident would be expected to live in a certain area. Of the 30 yrs, the first 10 are assumed to occur during childhood (age 6 to 16). The body weight (BW) is 70 kg for an adult (Newfields Report 2006) and 47 kg for a child (average of children ages 6 to 16 from USEPA, 2011). The breathing rate (BR) is 2.5 m^3/hr for an adult (Newfields Report 2006) and 2.6 m^3/hr for a child (average of children ages 6 and 10 from USEPA, 2011). The averaging time factor provides a means for averaging exposure on a daily basis. That

is, on a lifetime daily basis for evaluating carcinogenic effects (i.e., 365 days per year for 70 years), and on a daily basis during exposure for evaluating noncarcinogenic effects (i.e., 365 days per year for the ED).

Recreational River Wader

A simple dermal exposure model was used that incorporates a chemical-specific permeability constant to estimate the rate of dermal uptake that would be expected from wading in surface water. In addition to the dermal absorption modeling, which is time dependent, other assumptions were made about the exposure frequency and exposure time. The exposure assessment conservatively assumes that contact with surface water would include the lower half of the body (feet, legs) and hands and forearms. The exposure contact time is assumed to be 1 hour to conservatively account for the time spent in contact with the surface water. There are no beaches or designed wading areas along the river in the vicinity of the Facility. The exposure frequency is assumed to be 36 days per year, assuming 2 days a week from mid-May to mid-September.

The ED of 30 years is based on the upper bound estimate on the time that a local resident would be expected to live in a certain area. Of the 30 yrs, the first 10 are assumed to occur during childhood (age 6 to 16). The exposed surface area (SA) includes the feet, legs and hands and forearms. The SA representing the combined 50th percentile surface area of males and females is 4,740 cm^2 for an adult (Newfields Report 2006) and 3,738 cm^2 for a child (average of children ages 6 and 10 from USEPA, 2011). The body weight (BW) is 70 kg for an adult (Newfields Report 2006) and 47 kg for a child (average of children ages 6 to 16 from USEPA, 2011). The averaging time factor provides a means for averaging exposure on a daily basis. That is, on a lifetime daily basis for evaluating carcinogenic effects (i.e., 365 days per year for 70 years), and on a daily basis during exposure for evaluating noncarcinogenic effects (i.e., 365 days per year for the ED).

Future Construction Worker

The exposure assessment assumes that a construction worker would come into contact with shallow ground water in the vicinity of the landfill during the course of subsurface construction activities in this area. Additionally, during these activities, the workers under this scenario would potentially be exposed to VOCs volatilizing from the ground water. This exposure scenario is not specific to either of the water bearing zones. Construction activities would be limited in duration and expected to take place only in localized areas at the Site. Note that as the lease signed by the Cleveland MetroParks prohibits subsurface

activities from being performed by MetroParks on Alcoa property, maintenance of the TowPath is not expected to include direct contact with ground water.

The exposure time is assumed to be 8 hours per day to represent a full work day. The exposure frequency is assumed to be 10 days (two work weeks) per year. The exposure duration of 2 years was selected to estimate that a construction receptor may perform these activities during two events. The exposure assessment assumes that contact with surface water would include the hands and forearms. The exposure contact time is assumed to be 2 hours per day to conservatively account for the time spent in physical contact with the water. The exposed surface area is the hands and forearms or 1693 cm^2 which represents the combined 50th percentile surface area of men and women. The body weight (BW) is the default for an adult of 70 kg. The averaging time factor provides a means for averaging exposure on a daily basis. That is, on a lifetime daily basis for evaluating carcinogenic effects (i.e., 365 days per year for 70 years), and on a daily basis during exposure for evaluating noncarcinogenic effects (i.e., 365 days per year for the ED of 2 years).

It should be understood that for a future construction worker scenario, while it is possible for incidental dermal contact with and inhalation of VOCs volatilizing from the ground water to occur, all work that is performed would be conducted (on Alcoa property) by qualified contractors that would use engineering controls and personal protective equipment (PPE) when needed to minimize or eliminate exposure to site contaminants.

C.3 TOXICITY ASSESSMENT

The toxicity assessment provides a description of the relationship between a dose of a chemical and the anticipated incidence of an adverse health effect. Toxicity values are derived from the quantitative dose response association and are correlated with the quantitative exposure assessment in the risk characterization step of risk assessment. As noted above, many of the toxicity values for the WDCs have changed since the Newfields Report 2006 was submitted. Therefore, updated toxicity values obtained from the 2012 USEPA Region IX Regional Screening Levels Table (formerly PRGs) were used in this development of site-specific RBCs. Toxicity values for the COPCs identified in this risk evaluation are presented in Table C-2, and the types of values are described below.

For risk assessment purposes, toxic constituent effects are separated into two categories of toxicity: carcinogenic effects and non-carcinogenic effects. Potential carcinogenic effects resulting from human exposure to chemicals are estimated using cancer slope factors (CSFs), and are presented in units of (mg/kg day)-1. CSFs are typically derived for "known or probable" human carcinogens. Chemicals that

are believed to be carcinogenic may also have non-cancer effects. Potential health risks for carcinogenic chemicals are evaluated for both cancer and other types of effects as described below.

Non-carcinogenic effects of chemical substances are assumed to require a threshold dose. This threshold concept of noncarcinogenic effects assumes that a range of exposures up to some defined threshold can be tolerated without appreciable risk of harm. Reference dose (RfD) values are expressed in units of daily dose (mg/kg-day) and incorporate uncertainty factors to account for limitations in the quality or quantity of available data.

C.4 RISK CHARACTERIZATION AND GENERATION OF RBCS

Risk characterization is the integration of the exposure and toxicity information to make quantitative estimates and/or qualitative statements regarding potential risk to human health. In this risk evaluation, acceptable RBCs were calculated for each COPC in ground water. The RBCs are calculated for an acceptable target risk level for carcinogenic effects, and for an acceptable hazard target for noncarcinogenic effects. For carcinogenic effects, USEPA typically considers the range of risk of 10^{-6} to 10^{-4} or below to be acceptable, which is consistent with the requirements of OAC 3745-30-8(F)(6). For noncarcinogenic effects, a hazard index (HI) of 1 is considered to be acceptable by USEPA, consistent with the requirements of OAC 3745-30-8(F)(6).

The basic equation for calculating RBCs is the inverse for calculating a risk given a known exposure concentration. General equations for calculating RBCs for carcinogenic and noncarcinogenic effects are presented in Table C-3.

In assessing risk scenarios that included children, it was necessary to modify the risk equations originally provided in the Newfields Report 2006 to account for carcinogenic COPCs that have a mutagenic mode of action per USEPA Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens (USEPA, 2005). Carcinogens acting by a mutagenic mode of action include a term called an age dependent adjustment factor (ADAF) to account for increased carcinogenic potency during early life stages. For ages up to 2 years, the ADAF is 10, indicating a ten-fold increase in carcinogenic potency during this period. For ages from 2 years to 16 years, the ADAF is 3. For ages 16 years and older, the ADAF is 1. Using ADAFs, the differences in potency are incorporated by a factor separate from the slope factor, so only one cancer slope factor is needed. Risk assessments for carcinogens that do not act by a mutagenic mode of action use the slope factor without adjustments for age. As indicated above, the Recreational Towpath User Scenario, and Recreational River Wader Scenario now include an assessment

of children ages 6 to 16), so the ADAF of 3 was applied to the slope factor for TCE and vinyl chloride as these two COPCs were identified as mutagens (USEPA, 2012).

As was done in the Newfields Report 2006, a model developed by and used by the Louisiana Department of Environmental Quality (LDEQ) under their Risk Evaluation Corrective Action Program (RECAP; LDEQ, 2003) was utilized to estimate site-specific ground water to ambient air volatilization factors so that exposure to VOCs volatilizing from ground water through the soil column and into ambient air could be evaluated. The site-specific input parameters for the model calculations provided in Tables C-4 and C-5 were taken from the Newfields Report 2006. For the construction worker scenario (Table C-5), the depth to ground water was conservatively set to 1 cm.

Note that while Tables C-6 through C-9 show RBCs for both 10^{-6} and 10^{-4} target risk levels for the four receptor scenarios, carcinogenic ground water trigger levels are based on a human health cumulative excess lifetime carcinogenic risk goal of 10^{-5}. The carcinogenic (10^{-5}) and noncarcinogenic RBCs were normalized and then the lower of the two was identified.

It is important to understand that the RBC values in Table C-8 for the Recreational River Wader scenario are not ground water concentrations but rather surface water concentrations. This is because the receptor experiences dermal exposure to VOCs while wading in the river, not in ground water. Because the contaminant concentrations in ground water would be diluted upon discharge to the river via mixing, the ground water concentration required to cause an exceedance of the RBC in surface water is higher than the surface water RBC. To estimate a ground water concentration necessary to produce a surface water concentration equal to the surface water RBC, a basic mass balance water quality equation was used as shown in Table C-10.

To establish the ground water trigger level for each WDC, the lowest normalized RBC from Tables C-6, C-7, C-9 and C-10 were evaluated as shown on Table C-11 to identify the lowest RBC overall. These were then identified as the ground water trigger levels and were carried over to Table 3-1 of the CMP-2015.

C.5 UNCERTAINTY ANALYSIS

Uncertainties are inherent in every aspect of a quantitative human health risk assessment. Uncertainties can arise from several sources including data collection and interpretation, assumptions used to characterize exposures, and toxicity values. The inclusion of site-specific factors can decrease uncertainty, although significant uncertainty persists in even the most site-specific and accurate risk

assessments. Worst case assumptions and default values, which conform to the USEPA guidance, add a level of conservatism to human health risk assessments. This conservatism is intentionally included in order to tilt the assessment toward over-prediction of risk and hence protection of human health. It is important to the risk management decision-making process that the sources of uncertainty be considered.

A careful and comprehensive analysis of the critical areas of uncertainty in a risk assessment is an important part of the risk assessment process. USEPA (1989) guidance stresses the importance of providing a complete analysis of uncertainties so that risk management decisions take these uncertainties into account when evaluating risk assessment conclusions. The uncertainty analysis provides a context for better understanding the assessment conclusions by identifying the uncertainties that have most significantly affected the assessment results. Therefore, sources of uncertainty in the exposure assessment, and toxicity assessment of the risk assessment are identified and qualitatively evaluated below.

Uncertainty in Exposure Assessment

Although care has been taken to apply site and/or receptor-specific exposure factors, for those with limited data, USEPA defaults were used. For example, the USEPA default values were used for exposure duration for the industrial worker and may result in an overestimation of actual exposure and thus risks. In the exposure scenario used for the industrial worker in this risk assessment (8 hours per day, 2 days per month, 12 months per year, for 25 years) this assumes that the entire work day will be performed in an area potentially impacted by the landfill, and does not account for the fact that maintenance work could be performed by several individuals on a rotating basis. The actual time spent working exclusively in potentially impacted portions of the facility is likely to be less than the exposure time in the default assumptions. It is also unlikely that a worker would remain in the same job for the period of time or that the level of activities in the winter months would be equal to those during warm weather.

Similarly, for the future construction worker assumptions regarding the inhalation of volatiles conservatively estimate that the worker would be within the construction trench for 8 hours per day and that contact with water would occur during 2 hours per day. These values are highly conservative and do not account for the use of engineering controls or PPE to reduce exposure to constituents. Similar considerations regarding exposure assumptions were made for the recreational TowPath and Cuyahoga Wader scenarios. Therefore, the exposure factors used in calculating the RBCs tend to overestimate the potential exposure.

If the RBCs are used to assess risk based on some WDC concentration in ground water, such an assessment would assume that the exposure to the WDC(s) in ground water remains constant over time, which further assumes that the source of contamination is unlimited and that concentrations will remain steady for up to 30 years. Given that the landfill is capped and no new waste is being added, the pre-closure impacts would be expected to attenuate overtime. If this was not considered in the assessment, the potential exposure would likely be overestimated.

Uncertainty in Toxicity Assessment

Dose Response Assessment - Carcinogens.

The preferred method of the EPA Cancer Assessment Group (CAG) for determination of upperbounds on risk and the derivation of cancer slope factors (CSFs) is the linearized multistage (LMS) model. This model is considered by EPA to be valid for low risk levels, and generally leads to substantially higher values of the probability of developing cancer than other multistage models whose parameters have been estimated by the maximum likelihood method. As Holland (1993) has observed: "The upperbounds are relatively near the fitted model values at high doses, but may be several thousand times as large as the fitted model values at low doses..."

The EPA, in its guidelines for carcinogen risk assessment makes the following statement regarding uncertainty: "...(the LMS procedure) does not necessarily give a realistic prediction of the risk. The true value of risk is unknown, and may be as low as zero...depends almost entirely on the value of the highest dose tested and is almost independent of the outcomes at the lower experimental dose levels. That is, the USEPA method fails to adequately reflect the shape of the observed dose response relationship and especially the outcomes in the low dose region, the region of primary interest in risk assessment."

In addition, CSFs (themselves upperbound estimates), when summed, do not yield the 95 Percent Upper Confidence Limit of the sum of the risks, but represent a far greater percentile. The cancer risk equation for multiple substances sums all carcinogens equally, giving as much weight to Class B or C as to Class A carcinogens. In addition, slope factors derived from animal data will be given the same weight as human data. Finally, the action of two different carcinogens might not be independent (EPA, 1989a).

EPA further comments that, because 95th percentile estimates "are not strictly additive, the total cancer risk estimate might become artificially more conservative as risks from a number of different carcinogens are summed." The effect of these uncertainties is to overestimate potential risks.

In addition to the LMS obscuring any actual threshold that may exist, USEPA has made several other policy choices for determination of carcinogenicity. For example, all tumors (malignant or benign) are counted as positive evidence of carcinogenicity (Hawkins, 1992). The most sensitive gender and most sensitive species in animal testing are the primary drivers in the assignment of CSFs and weight of evidence categorization. This would overestimate potential risks.

Dose Response Assessment - Noncarcinogens.

Approaches typically utilized for designating reference doses are highly conservative. For example, the USEPA (1989) applies a factor of 10 to a no observed adverse effect level (NOAEL) for a constituent in an animal study for animal-to-human extrapolation. An additional factor of 10 is applied for inter-individual variation in the human population, and additional factors of 10 may be applied to account for limitations in data quality or incomplete studies. Frequently, reference doses are derived from animal studies that have little quantitative bearing on potential adverse effects in humans. Some of this uncertainty may be reduced if the absorption, distribution, metabolic fate, and excretion parameters of a constituent are known.

Table C-1
Receptor-Specific Exposure Factors
Alcoa Cleveland Closed Landfill

Receptor (Exposure Point)	Exposure Pathway	Exposure Factor	Value	Reference
Infrequent Industrial Worker (UAS and SZS)	Inhalation (Groundwater to Air Migration)	EF (Exposure Frequency)	24 days/year	Site-Specific
		ED (Exposure Duration)	25 year	USEPA, 1991
		Averaging time-Noncarcinogenic	9125 days	USEPA, 1989
		Averaging time-Carcinogenic	25550 days	USEPA, 1989
		BW (Body Weight)	70 kg	USEPA, 1989
		BR (Breathing Rate)	2.5 m3/day	USEPA, 1997
		ET (Exposure Time)	8 hours/day	USEPA, 1991
Recreational TowPath User (UAS and SZS)	Inhalation (Groundwater to Air Migration)	EF (Exposure Frequency)	39 days/year	Site-Specific
		Child ED (Exposure Duration)	10 year	Site-Specific
		Adult ED (Exposure Duration)	20 year	Site-Specific
		Child Averaging time-Noncarcinogenic	3650 days	USEPA, 1989
		Adult Averaging time-Noncarcinogenic	7300 days	USEPA, 1989
		Averaging time-Carcinogenic	25550 days	USEPA, 1989
		Child BW (Body Weight)	47 kg	USEPA, 2011
		Adult BW (Body Weight)	70 kg	USEPA, 1989
		Child BR (Breathing Rate)	2.6 m3/day	USEPA, 2011
		Adult BR (Breathing Rate)	2.5 m3/day	USEPA, 1997
		ET (Exposure Time)	2 hours/day	Site Specific
Recreational River Wader (Cuyahoga)	Dermal Contact (Surface Water)	EF (Exposure Frequency)	36 days/year	Site-Specific
		Child ED (Exposure Duration)	10 year	Site-Specific
		Adult ED (Exposure Duration)	20 year	Site-Specific
		Child Averaging time-Noncarcinogenic	3650 days	USEPA, 1989
		Adult Averaging time-Noncarcinogenic	7300 days	USEPA, 1989
		Child BW (Body Weight)	47 kg	USEPA, 2011
		Adult BW (Body Weight)	70 kg	USEPA, 1989
		ET (Exposure Time)	1 hour/day	Site Specific
		Child SSA (Skin Surface Area)	3738 cm2	USEPA, 2011
		Adult SSA (Skin Surface Area)	4740 cm2	USEPA, 1997
		PC (permeability coefficient)	Chemical Specific	USEPA, 1992
Construction Worker (UAS and SZS)	Dermal Contact (Groundwater)	EF (Exposure Frequency)	10 days/year	Site-Specific
		ED (Exposure Duration)	2 year	Site-Specific
		Averaging time-Noncarcinogenic	730 days	USEPA, 1989
		Averaging time-Carcinogenic	25550 days	USEPA, 1989
		BW (Body Weight)	70 kg	USEPA, 1989
		ET (Exposure Time) Inhalation	8 hour/day	USEPA, 1989
		ET (Exposure Time) Dermal Contact	2 hours/day	Site-Specific
		BR (Breathing Rate)	2.5 m3/day	USEPA, 1997
		SSA (Skin Surface Area)	1693 cm2	USEPA, 1997
		PC (permeability coefficient)	Chemical Specific	USEPA, 1992

Table C-2
Toxicity Values for RBC Calculations
Alcoa Cleveland Closed Landfill

VOCs	Dermal[2] CSFa (kg-day/mg)	Inhalation CSFi (kg-day/mg)	Dermal[2] Chronic RfDa (mg/kg-day)	Inhalation Chronic RfDi (mg/kg-day)
1,1,1-Trichloroethane	NA	NA	2.0E+00	1.4E+00
1,1-Dichloroethane	5.7E-03	5.6E-03	2.0E-01	NA
1,2-Dichloroethene (cis)	NA	NA	2.0E-03	2.0E-03
1,2-Dichloroethene (trans)	NA	NA	2.0E-02	1.7E-02
Benzene	5.5E-02	2.7E-02	4.0E-03	8.6E-03
Chloroform	3.1E-02	8.1E-02	1.0E-02	2.8E-02
Trichloroethene	4.6E-02	1.4E-02	5.0E-04	5.7E-04
Vinyl chloride	7.2E-01	1.5E-02	3.0E-03	2.9E-02
Inorganics				
Manganese	NA	NA	2.4E-02	1.4E-05
Nitrate	NA	NA	1.6E+00	NA

Source: CSF and RfD from 2012 EPA Region IX RSLs

Table C-3
Risk-Based Concentration Equations for Groundwater Exposure
Alcoa Cleveland Works Closed Industrial Landfill

ROUTE-SPECIFIC RBCs*:

Dermal:

$$(RBC_d)_{C\,or\,NC} = \frac{(TCR\ or\ THI) \times BW \times (AT_C\ or\ AT_{NC}) \times (1{,}000\,cm^3/L)}{SSA \times PC \times ET \times EF \times ED \times [CSF_a\ or\ (1/RfD_a)]}$$

Inhalation:

$$(RBC_i)_{C\,or\,NC} = \frac{(TCR\ or\ THI) \times BW \times (AT_C\ or\ AT_{NC})}{VF_w \times BR \times EF \times ET \times ED \times [CSF_i\ or (1/RfD_i)]}$$

*Notes:

- For scenarios that include children, the RBC should be based on the combined risk for a receptor as a child (age 6 to 16) and as an adult.
- For carcinogens with mutagenic mode of action, the CSF is multiplied by the ADAF
- All RBCs are normalized to account for sum of all parameters (= single compound RBC/total # compounds)

SITE-SPECIFIC RBCs:

Cancer Effects RBC:

$$RBC_C = \frac{1}{\frac{1}{(RBC_d)_C} + \frac{1}{(RBC_i)_C}}$$

Non-Cancer Effects RBC:

$$RBC_{NC} = \frac{1}{\frac{1}{(RBC_d)_{NC}} + \frac{1}{(RBC_i)_{NC}}}$$

where:

ADAF	Age-dependent adjustment factor.
AT_C	Averaging time for cancer effects (days).
AT_{NC}	Averaging time for non-cancer effects (days); ED × 365 days/year (EPA 1991a).
B	Dermal absorption parameter; relative contribution of the permeability coefficients of the chemical in the stratum corneum and the viable epidermis (unitless).
BR	Breathing rate (m^3/day).
BW	Body weight (kg).
CSF	Cancer slope factor for dermal (adjusted to an absorbed dose, CSF_a), or inhalation (CSF_i) exposure (kg-day/mg; inverse of mg/kg/day).
ED	Exposure duration (years).
EF	Exposure frequency (days/year).
ET	Exposure time (hours/day).
PC	Permeability constant (cm/hour); constituent specific.
RBC	Risk-based concentration (mg/L); minimum of the RBC_C (based on cancer effects) and the RBC_{NC} (based on non-cancer effects, which are based upon the appropriate route-specific RBCs (RBC_d for the dermal route, and RBC_i for the inhalation route).
RfD	Reference dose dermal (adjusted to an absorbed dose, RfD_a), or inhalation (RfD_i) exposure (mg/kg/day).
SSA	Exposed skin surface area (cm^2).
TCR	Target cancer risk (unitless); results presented for TCR values of 10^{-6}, 10^{-5}, and 10^{-4}.
THI	Target hazard index (unitless); results presented for THI value of 1.
VF_W	VOC Volatilization factor (derived from Louisiana DEQ RECAP Model).

Table C-4

Volatilization Factor Calculation

Groundwater to Ambient Air - Infrequent Industrial Worker and Towpath User

Alcoa Cleveland Closed Landfill

INPUTS TO GROUNDWATER TO AMBIENT AIR MODEL	Site-Specific Parameters[1]		
volumetric air content in capillary fringe	nacap =	0.09	cm3-air/cm3-soil
volumetric water content in capillary fringe	nwcap =	0.345	cm3-water/cm3-soil
total porosity of capillary fringe soil	nc =	0.435	cm3/cm3
thickness of capillary fringe	hcap =	5	cm
thickness of vadose zone	hv =	300	cm
depth to groundwater	Lgw =	305	cm
wind speed above ground surface in ambient mixing zone	Uair =	225	cm/s
width of source area parallel to wind	W =	1829	cm
ambient air mixing zone height	dair =	200	cm
total soil porosity	n =	0.43	Lpore/Lsoil
water-filled soil porosity	nw =	0.3	Lwater/Lsoil
air-filled soil porosity	na =	0.13	Lair/Lsoil

Ds = Da*na^3.33/n^2+Dw*1/(H*41)*nw^3.33/n^2

Dcap = Da*nacap^3.33/nc^2+Dw*1/(H*41)*nwcap^3.33/nc^2

Dws = (hcap+hv)/(hcap/Dcap+hv/Ds)

VFgwairi = (H*41*1000)/[1+(Uair*dair*Lgw)/(W*Dws)]

Chemical Properties				
COMPOUND	CAS #	H	Da	Dw
		atm-m3/mol	cm2/s	cm2/s
1,1,1-Trichloroethane	71-55-6	0.0172	0.078	0.0000088
1,1-Dichloroethane	75-34-3	0.00562	0.0742	0.0000105
1,2-Dichloroethene (cis)	156-59-2	0.00408	0.0736	0.0000113
1,2-Dichloroethene (trans)	156-60-5	0.00938	0.0707	0.0000119
Benzene	71-43-2	0.00555	0.088	0.0000098
Chloroethane	75-00-3	0.0088	0.271	0.0000115
Chloroform	67-66-3	0.00367	0.104	0.00001
Ethyl benzene	100-41-4	0.00788	0.075	0.0000078
Methylene chloride	75-09-2	0.00219	0.101	0.0000117
Trichloroethene	79-01-6	0.0103	0.079	0.0000091
Vinyl chloride	75-01-4	0.027	0.106	0.00000123

Results using above RECAP Equations			
Ds	Dcap	Dws	VFgwairi
(cm2/s)	(cm2/s)	(cm2/s)	(mg/m3/mg/l)
4.74E-04	1.38E-04	4.56E-04	4.28E-05
4.54E-04	1.36E-04	4.37E-04	1.34E-05
4.53E-04	1.38E-04	4.36E-04	9.73E-06
4.32E-04	1.28E-04	4.15E-04	2.13E-05
5.38E-04	1.60E-04	5.17E-04	1.57E-05
1.65E-03	4.77E-04	1.58E-03	7.61E-05
6.37E-04	1.91E-04	6.13E-04	1.23E-05
4.57E-04	1.34E-04	4.40E-04	1.89E-05
6.25E-04	1.96E-04	6.03E-04	7.22E-06
4.81E-04	1.41E-04	4.63E-04	2.60E-05
6.43E-04	1.85E-04	6.17E-04	9.11E-05

[1]Parameters obtained from 2006 GQADR for Industrial Worker and Towpath User Scenarios and used in RECAP VF Model

Table C-5
Volatilization Factor Calculation
Groundwater to Ambient Air - Construction Worker
Alcoa Cleveland Closed Landfill

INPUTS TO GROUNDWATER TO AMBIENT AIR MODEL-INDUSTRIAL	Site-Specific Parameters[1]		
volumetric air content in capillary fringe	nacap =	0.09	cm3-air/cm3-soil
volumetric water content in capillary fringe	nwcap =	0.345	cm3-water/cm3-soil
total porosity of capillary fringe soil	nc =	0.435	cm3/cm3
thickness of capillary fringe	hcap =	1	cm
thickness of vadose zone	hv =	0	cm
depth to groundwater	Lgw =	1	cm
wind speed above ground surface in ambient mixing zone	Uair =	225	cm/s
width of source area parallel to wind	W =	1829	cm
ambient air mixing zone height	dair =	200	cm
total soil porosity	n =	0.43	Lpore/Lsoil
water-filled soil porosity	nw =	0.3	Lwater/Lsoil
air-filled soil porosity	na =	0.13	Lair/Lsoil

Ds = Da*na^3.33/n^2+Dw*1/(H*41)*nw^3.33/n^2
Dcap = Da*nacap^3.33/nc^2+Dw*1/(H*41)*nwcap^3.33/nc^2
Dws = (hcap+hv)/(hcap/Dcap+hv/Ds)
VFgwairi = (H*41*1000)/[1+(Uair*dair*Lgw)/(W*Dws)]

Chemical Properties				
COMPOUND	CAS #	H	Da	Dw
		atm-m3/mol	cm2/s	cm2/s
1,1,1-Trichloroethane	71-55-6	0.0172	0.078	0.0000088
1,1-Dichloroethane	75-34-3	0.00562	0.0742	0.0000105
1,2-Dichloroethene (cis)	156-59-2	0.00408	0.0736	0.0000113
1,2-Dichloroethene (trans)	156-60-5	0.00938	0.0707	0.0000119
Benzene	71-43-2	0.00555	0.088	0.0000098
Chloroethane	75-00-3	0.0088	0.271	0.0000115
Chloroform	67-66-3	0.00367	0.104	0.00001
Ethyl benzene	100-41-4	0.00788	0.075	0.0000078
Methylene chloride	75-09-2	0.00219	0.101	0.0000117
Trichloroethene	79-01-6	0.0103	0.079	0.0000091
Vinyl chloride	75-01-4	0.027	0.106	0.00000123

Results using above RECAP Equations			
Ds	Dcap	Dws	VFgwairi
(cm2/s)	(cm2/s)	(cm2/s)	(mg/m3/mg/l)
4.74E-04	1.38E-04	1.38E-04	3.95E-03
4.54E-04	1.36E-04	1.36E-04	1.27E-03
4.53E-04	1.38E-04	1.38E-04	9.41E-04
4.32E-04	1.28E-04	1.28E-04	2.00E-03
5.38E-04	1.60E-04	1.60E-04	1.48E-03
1.65E-03	4.77E-04	4.77E-04	6.99E-03
6.37E-04	1.91E-04	1.91E-04	1.17E-03
4.57E-04	1.34E-04	1.34E-04	1.76E-03
6.25E-04	1.96E-04	1.96E-04	7.14E-04
4.81E-04	1.41E-04	1.41E-04	2.42E-03
6.43E-04	1.85E-04	1.85E-04	8.31E-03

[1]Parameters obtained from 2006 GQADR for Construction Worker Scenario and used in RECAP VF Model

Table C-6
Risk-Based Concentration Goal Calculations for Industrial Worker Exposure to Groundwater
Alcoa-Cleveland Closed Landfill

Waste-Derived Constituent	CANCER EFFECTS				NON-CANCER EFFECTS		Normalized RBCs[1]			TOXICITY VALUES[2]		
	Route-Specific RBCs	Calculated Goals			Route-Specific RBCs	Calculated Goal	10^{-5} RBC_C	THI = 1 RBC_{NC}	Lowest RBC	VFw	Inhalation CSFi (kg-day/mg)	Inhalation Chronic RfDi (mg/kg/day)
	Inhalation	RBC_C			Inhalation							
	TCR = 1E-06	TCR = 1E-06	TCR = 1E-05	TCR = 1E-04	THI = 1	THI = 1						
VOCs												
1,1,1-Trichloroethane	NA	NA	NA	NA	1.8E+06	1.8E+06	NA	2.6E+05	2.6E+05	4.28E-05	NA	1.4E+00
1,1-Dichloroethane	2.0E+03	2.0E+03	2.0E+04	2.0E+05	NA	NA	4.0E+03	NA	4.0E+03	1.34E-05	5.6E-03	NA
1,2-Dichloroethene (cis)	NA	NA	NA	NA	1.1E+04	1.1E+04	NA	1.6E+03	1.6E+03	9.73E-06	NA	2.0E-03
1,2-Dichloroethene (trans)	NA	NA	NA	NA	4.3E+04	4.3E+04	NA	6.1E+03	6.1E+03	2.13E-05	NA	1.7E-02
Benzene	3.5E+02	3.5E+02	3.5E+03	3.5E+04	2.9E+04	2.9E+04	7.0E+02	4.1E+03	7.0E+02	1.57E-05	2.7E-02	8.6E-03
Chloroform	1.5E+02	1.5E+02	1.5E+03	1.5E+04	1.2E+05	1.2E+05	3.0E+02	1.7E+04	3.0E+02	1.2E-05	8.1E-02	2.8E-02
Trichloroethene	4.0E+02	4.0E+02	4.0E+03	4.0E+04	1.2E+03	1.2E+03	8.0E+02	1.7E+02	1.7E+02	2.60E-05	1.4E-02	5.7E-04
Vinyl chloride	1.1E+02	1.1E+02	1.1E+03	1.1E+04	1.7E+04	1.7E+04	2.2E+02	2.4E+03	2.2E+02	9.11E-05	1.5E-02	2.9E-02

[1]Normalized to account for sum of all parameters (= single compound RBC/total # compounds)

[2]CSF and RfD from 2012 EPA Region 9 RSLs

All concentrations are presented in milligrams per liter (mg/L).

CSF = Cancer Slope Factor
NA = Not available; insufficient toxicity data.
NC = Not carcinogenic.
RBC = Risk-based concentration.
RfD = Reference Dose
TCR = Target cancer risk.
THI = Target hazard index.
VFw = Volatilization factor (Chem-specific)

VARIABLES	
25,550 ATc	1E-06 TCR1
9,125 ATnc	1E-04 TCR2
2.5 BR	1 THI
70 BW	1000 UC1
24 EF	
25 ED	
8 ETinh	

Table C-7
Risk-Based Concentration Goal Calculations for Recreational Towpath User Exposure to Groundwater
Alcoa-Cleveland Closed Landfill

Waste-Derived Constituent	CANCER EFFECTS						NONCANCER EFFECTS				Normalized RBCs[1]			TOXICITY VALUES[2]				
	Child	Adult	Cumulative	Calculated Goals			Child	Adult	Cumulative	Calculated Goal								
	Route-Specific RBCs	Route-Specific RBCs	Route-Specific RBCs				Route-Specific RBCs	Route-Specific RBCs	Route-Specific RBCs		10^{-5} RBC_C	THI = 1 RBC_{NC}	Lowest RBC	VFw	Inhalation CSFi (kg-day/mg)	Age-Dependent Adjustment Factor		Inhalation Chronic RfDi (mg/kg/day)
	Inhalation	Inhalation	Inhalation	RBC_C			Inhalation	Inhalation	Inhalation	RBC_{NC}						Child (Age 6-16)	Adult	
	TCR = 1E-06			TCR = 1E-06	TCR = 1E-05	TCR = 1E-04	THI = 1			THI = 1								
VOCs																		
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA	2.8E+06	4.4E+06	1.7E+06	1.7E+06	NA	2.4E+05	2.4E+05	4.28E-05	NA	NA	NA	1.4E+00
1,1-Dichloroethane	7.9E+03	6.1E+03	3.4E+03	3.4E+03	3.4E+04	3.4E+05	NA	NA	NA	NA	6.9E+03	NA	6.9E+03	1.34E-05	5.6E-03	NA	NA	NA
1,2-Dichloroethene (cis)	NA	NA	NA	NA	NA	NA	1.7E+04	2.7E+04	1.1E+04	1.1E+04	NA	1.5E+03	1.5E+03	9.73E-06	NA	NA	NA	2.0E-03
1,2-Dichloroethene (trans)	NA	NA	NA	NA	NA	NA	6.8E+04	1.1E+05	4.1E+04	4.1E+04	NA	5.9E+03	5.9E+03	2.13E-05	NA	NA	NA	1.7E-02
Benzene	1.4E+03	1.1E+03	6.0E+02	6.0E+02	6.0E+03	6.0E+04	4.6E+04	7.2E+04	2.8E+04	2.8E+04	1.2E+03	4.0E+03	1.2E+03	1.57E-05	2.7E-02	NA	NA	8.6E-03
Chloroform	6.0E+02	4.6E+02	2.6E+02	2.6E+02	2.6E+03	2.6E+04	1.9E+05	3.0E+05	1.2E+05	1.2E+05	5.2E+02	1.7E+04	5.2E+02	1.2E-05	8.1E-02	NA	NA	2.8E-02
Trichloroethene	5.3E+02	1.2E+03	3.7E+02	3.7E+02	3.7E+03	3.7E+04	1.9E+03	2.9E+03	1.1E+03	1.1E+03	7.4E+02	1.6E+02	1.6E+02	2.60E-05	1.4E-02	3	1	5.7E-04
Vinyl chloride	1.4E+02	3.3E+02	9.8E+01	9.8E+01	9.8E+02	9.8E+03	2.7E+04	4.1E+04	1.6E+04	1.6E+04	2.0E+02	2.3E+03	2.0E+02	9.11E-05	1.5E-02	3	1	2.9E-02

[1]Normalized to account for sum of all parameters (= single compound RBC/total # compounds)

[2]CSF and RfD from 2012 EPA Region 9 RSLs

All concentrations are presented in milligrams per liter (mg/L).

Variables	Child	Adult
Atc (days)	25,550	25,550
Atnc (days)	3,650	7,300
BR (m3/hr)	2.6	2.5
BW (kg)	47	70
EF (days/year)	39	39
ED (years)	10	20
ET (hours/day)	2	2
CF (cm^3/L)	1000	1000

CSF = Cancer Slope Factor
NA = Not available; insufficient toxicity data.
NC = Not carcinogenic.
RBC = Risk-based concentration.
RfD = Reference Dose
TCR = Target cancer risk.
THI = Target hazard index.
VFw = Volatilization Factor (Chem-specific)

Table C-8
Risk-Based Concentration Goal Calculations for Recreational River Wader Exposure to Surface Water
Alcoa-Cleveland Closed Landfill

Waste-Derived Constituent	CANCER EFFECTS						NONCANCER EFFECTS				Normalized RBCs[1]			TOXICITY VALUES[2]				
	Child	Adult	Cumulative	Calculated Goals			Child	Adult	Cumulative	Calculated Goal	10^{-5} RBC_C	THI = 1 RBC_{NC}	Lowest RBC	PC (cm/hour)	Dermal[3] CSFa (kg-day/mg)	Age-Dependent Adjustment Factor		Dermal[3] Chronic RfDa (mg/kg/day)
	Route-Specific RBCs	Route-Specific RBCs	Route-Specific RBCs	RBC_C			Route-Specific RBCs	Route-Specific RBCs	Route-Specific RBCs	RBC_{NC}						Child (Age 6-16)	Adult	
	Dermal	Dermal	Dermal				Dermal	Dermal	Dermal									
	TCR = 1E-06			TCR = 1E-06	TCR = 1E-05	TCR = 1E-04	THI = 1			THI = 1								
VOCs																		
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA	1.5E+04	1.8E+04	8.1E+03	8.1E+03	NA	8.1E+02	8.1E+02	1.7E-02	NA	NA	NA	2.0E+00
1,1-Dichloroethane	1.8E+01	1.0E+01	6.5E+00	6.5E+00	6.5E+01	6.5E+02	2.9E+03	3.4E+03	1.5E+03	1.5E+03	1.3E+01	1.5E+02	1.3E+01	8.9E-03	5.7E-03	NA	NA	2.0E-01
1,2-Dichloroethene (cis)	NA	NA	NA	NA	NA	NA	2.5E+01	3.0E+01	1.4E+01	1.4E+01	NA	1.4E+00	1.4E+00	1.0E-02	NA	NA	NA	2.0E-03
1,2-Dichloroethene (trans)	NA	NA	NA	NA	NA	NA	2.5E+02	3.0E+02	1.4E+02	1.4E+02	NA	1.4E+01	1.4E+01	1.0E-02	NA	NA	NA	2.0E-02
Benzene	1.5E-01	8.7E-02	5.5E-02	5.5E-02	5.5E-01	5.5E+00	4.6E+00	5.4E+00	2.5E+00	2.5E+00	1.1E-01	2.5E-01	1.1E-01	1.1E-01	5.5E-02	NA	NA	4.0E-03
Chloroform	3.2E+00	1.9E+00	1.2E+00	1.2E+00	1.2E+01	1.2E+02	1.4E+02	1.7E+02	7.7E+01	7.7E+01	2.4E+00	7.7E+00	2.4E+00	8.9E-03	3.1E-02	NA	NA	1.0E-02
Trichloroethene	2.8E-02	5.0E-02	1.8E-02	1.8E-02	1.8E-01	1.8E+00	2.8E-01	3.3E-01	1.5E-01	1.5E-01	3.6E-02	1.5E-02	1.5E-02	2.3E-01	4.6E-02	3	1	5.0E-04
Vinyl chloride	5.7E-02	1.0E-01	3.6E-02	3.6E-02	3.6E-01	3.6E+00	5.2E+01	6.2E+01	2.8E+01	2.8E+01	7.2E-02	2.8E+00	7.2E-02	7.3E-03	7.2E-01	3	1	3.0E-03
Inorganics																		
Manganese	NA	NA	NA	NA	NA	NA	3.1E+03	3.6E+03	1.7E+03	1.7E+03	NA	1.7E+02	1.7E+02	1.0E-03	NA	NA	NA	2.4E-02
Nitrate	NA	NA	NA	NA	NA	NA	2.0E+05	2.4E+05	1.1E+05	1.1E+05	NA	1.1E+04	1.1E+04	1.0E-03	NA	NA	NA	1.6E+00

[1]Normalized to account for sum of all parameters (= single compound RBC/total # compounds)

[2]CSF and RfD from 2012 EPA Region 9 RSLs

[3]Adjusted from oral toxicity values

All concentrations are presented in milligrams per liter (mg/L).

Variables	Child	Adult
Atc (days)	25,550	25,550
Atnc (days)	3,650	7,300
BW (kg)	47	70
EF (days/year)	36	36
ED (years)	10	20
ET (hours/day)	1	1
SSA (cm2)	3738	4740
CF (cm^3/L)	1000	1000

CSF = Cancer Slope Factor

NA = Not available; insufficient toxicity data.

NC = Not carcinogenic.

PC = Permeability Coefficient

RBC = Risk-based concentration.

RfD = Reference Dose

TCR = Target cancer risk.

THI = Target hazard index.

Table C-9
Risk-Based Concentration Goal Calculations for Construction Worker Exposure to Groundwater
Alcoa-Cleveland Closed Landfill

Waste-Derived Constituent	CANCER EFFECTS					NON-CANCER EFFECTS			Normalized RBCs[1]			TOXICITY VALUES[2]					
	Route-Specific RBCs		Calculated Goals			Route-Specific RBCs		Calculated Goal									
	Dermal	Inhalation	RBC_C			Dermal	Inhalation	RBC_{NC}	10^{-5} RBC_C	THI = 1 RBC_{NC}	Lowest RBC	VFw	PC (cm/hour)	Dermal[3] CSFa (kg-day/mg)	Inhalation CSFi (kg-day/mg)	Dermal[3] Chronic RfDa (mg/kg/day)	Inhalation Chronic RfDi (mg/kg/day)
	TCR = 1E-06		TCR = 1E-06	TCR = 1E-05	TCR = 1E-04	THI = 1		THI = 1									
VOCs																	
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	8.9E+04	4.6E+04	3.0E+04	NA	3.0E+03	3.0E+03	3.9E-03	1.7E-02	NA	NA	2.0E+00	1.4E+00
1,1-Dichloroethane	5.2E+02	6.3E+02	2.8E+02	2.8E+03	2.8E+04	1.7E+04	NA	1.7E+04	560	1.7E+03	5.6E+02	1.3E-03	8.9E-03	5.7E-03	5.6E-03	2.0E-01	NA
1,2-Dichloroethene (cis)	NA	NA	NA	NA	NA	1.5E+02	2.7E+02	9.7E+01	NA	9.7E+00	9.7E+00	9.4E-04	1.0E-02	NA	NA	2.0E-03	2.0E-03
1,2-Dichloroethene (trans)	NA	NA	NA	NA	NA	1.5E+03	1.1E+03	6.4E+02	NA	6.4E+01	6.4E+01	2.0E-03	1.0E-02	NA	NA	2.0E-02	1.7E-02
Benzene	4.4E+00	1.1E+02	4.2E+00	4.2E+01	4.2E+02	2.7E+01	7.4E+02	2.6E+01	8.4E+00	2.6E+00	2.6E+00	1.5E-03	1.1E-01	5.5E-02	2.7E-02	4.0E-03	8.6E-03
Chloroform	9.6E+01	4.8E+01	3.2E+01	3.2E+02	3.2E+03	8.5E+02	3.1E+03	6.6E+02	6.4E+01	6.6E+01	6.4E+01	1.2E-03	8.9E-03	3.1E-02	8.1E-02	1.0E-02	2.8E-02
Trichloroethene	2.5E+00	1.3E+02	2.4E+00	2.4E+01	2.4E+02	1.6E+00	3.0E+01	1.6E+00	4.8E+00	1.6E-01	1.6E-01	2.4E-03	2.3E-01	4.6E-02	1.4E-02	5.0E-04	5.7E-04
Vinyl chloride	5.0E+00	3.5E+01	4.4E+00	4.4E+01	4.4E+02	3.1E+02	4.4E+02	1.8E+02	8.8E+00	1.8E+01	8.8E+00	8.3E-03	7.3E-03	7.2E-01	1.5E-02	3.0E-03	2.9E-02
Inorganics																	
Manganese	NA	NAP	NA	NA	NA	1.8E+04	NAP	1.8E+04	NA	1.8E+03	1.8E+03	NAP	1.0E-03	NA	NA	2.4E-02	1.4E-05
Nitrate	NA	NAP	NA	NA	NA	1.2E+06	NAP	1.2E+06	NA	1.2E+05	1.2E+05	NAP	1.0E-03	NA	NA	1.6E+00	NA

[1]Normalized to account for sum of all parameters (= single compound RBC/total # compounds)

[2]CSF and RfD from 2012 EPA Region 9 RSLs

[3]Adjusted from oral toxicity values

All concentrations are presented in milligrams per liter (mg/L)

CSF = Cancer Slope Factor

NA = Not available; insufficient toxicity data.

NC = Not carcinogenic.

PC = Permeability Coefficient

RBC = Risk-based concentration.

RfD = Reference Dose

TCR = Target cancer risk.

THI = Target hazard index.

VFw = Volatilization factor (Chem-specific)

VARIABLES	
25,550 ATc	2 ETderm
730 ATnc	1,693 SSA
2.5 BR	1E-06 TCR1
70 BW	1E-04 TCR2
10 EF	1 THI
2 ED	1000 UC1
8 ETinh	

Table C-10
Groundwater RBCs based on Surface Water Exposure
Alcoa Cleveland Closed Landfill

Basic Mass Balance Water Quality Equation

$RBC_{GW} = (RBC_{SW}Q_{SW}-Q_BC_B)/Q_{GW}$

Where:

RBC_{GW} = pollutant concentration (mg/L) in groundwater required to produce river water concentration at RBCSW.

RBC_{SW} = in-stream pollutant concentration at RBC after complete mixing occurs (mg/l); RBC = risk-based concentration for surface water exposure by a river

Q_{SW} = resultant in-stream flow (Zone of Initial Dilution) after grounwater discharge in mgd; assumes 1% of river flow .

Q_B = background stream flow in mgd above point of discharge [USGS Independence Gauging Station; typical minimum flow]

C_B = background in-stream pollutant concentration in mg/L (assumed to be zero)

Q_{GW} = groundwater discharge flow in million gallons per day (mgd) [See calculation below; does not account for contaminant retardation]

Groundwater Discharge Calculation

$Q_{GW} = V \times A$		
Groundwater Velocity (ft/day)	V	0.35
Length (ft)	L	2500
Average Depth (ft)	D	13.1
Cross-sectional area (ft^2)	A	32750
Groundwater Discharge (mgd)	Q_{GW} =	0.0857395

River Factors	
Q_B[1]	1.5
C_B[2]	0
Q_{SW}	1.6

V, L, D, A, and Q_B taken from 2006 GQADR

Groundwater RBC Calculation

$RBC_{GW} = (RBC_{SW}Q_{SW}-Q_BC_B)/Q_{GW}$		
Parameter	RBC_{SW} (mg/L)	RBC_{GW} (mg/L)
1,1,1-Trichloroethane	810	14,874
1,1-Dichloroethane	13.0	239
1,2-Dichloroethene (cis)	1.38	25
1,2-Dichloroethene (trans)	13.8	253
Benzene	0.11	2.0
Chloroform	2.39	44
Trichloroethene	0.015	0.27
Vinyl chloride	0.072	1.3
Manganese	165	3,034
Nitrate	11,017	202,284

Table C-11
RBC Evaluation
Alcoa Cleveland Closed Landfill

Receptor	Industrial Worker	TowPath User	River Wader	Construction Worker	Overall Minimum
Zone	UAS and SZS	UAS and SZS	UAS	UAS and SZS	
WDC	RBCs				
1,1,1-Trichloroethane	257,143	244,978	14,874	3,000	3,000
1,1-Dichloroethane	4,000	6,872	239	560	239
1,2-Dichloroethene (cis)	1,571	1,510	25	10	10
1,2-Dichloroethene (trans)	6,143	5,914	253	64	64
Benzene	700	1,207	2.0	3	2.0
Chloroform	300	522	44	64	44
Trichloroethene	171	161	0.27	0.16	0.16
Vinyl chloride	220	197	1.3	9	1.3
Manganese	NA	NA	3,034	1,800	1,800
Nitrate	NA	NA	202,284	120,000	120,000

All concentrations are presented in milligrams per liter (mg/L)
NA = Not applicable

Figure C-1
Conceptual Site Model
Closed Landfill – Alcoa Cleveland Works

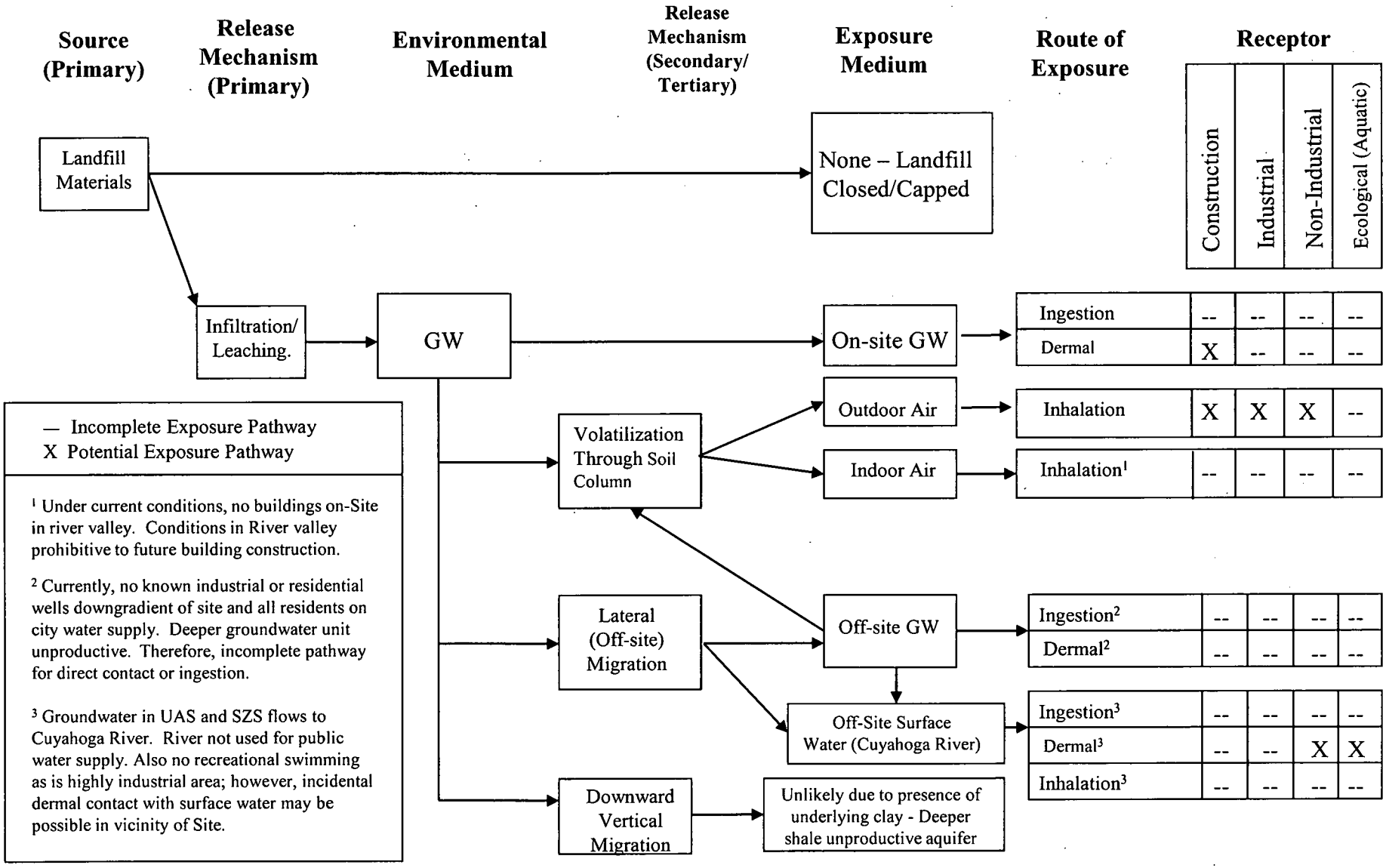


Exhibit 4

Environmental Covenant

To be recorded with Deed Records - ORC § 317.08

ENVIRONMENTAL COVENANT FOR ALCOA INC. (FKA ALUMINUM COMPANY OF AMERICA, INC.) CLEVELAND WORKS LANDFILL PROPERTY VILLAGE OF CUYAHOGA HEIGHTS, CUYAHOGA COUNTY, OHIO

This Environmental Covenant is entered into pursuant to Ohio Revised Code ("ORC") §§ 5301.80 to 5301.92 by Alcoa Inc., formerly known as Aluminum Company of America, Inc., a Pennsylvania corporation ("Alcoa" or "Owner"), having offices at 1600 Harvard Avenue, Village of Cuyahoga Heights, Ohio 44105 and the Ohio Environmental Protection Agency ("Ohio EPA") as a non-holder agency. This Environmental Covenant concerns an approximately 57.5960 acre property that includes the closed Alcoa Cleveland Works industrial landfill and adjacent property as described in the attached Exhibits. The purpose of this Environmental Covenant is to subject the Alcoa Cleveland Works industrial landfill and adjacent property to activity and use limitations as set forth herein.

Whereas, Alcoa is the current owner of the Alcoa Cleveland Works plant and surrounding properties including the closed Alcoa Cleveland Works industrial landfill located at 1600 Harvard Avenue, Village of Cuyahoga Heights, Cuyahoga County, Ohio; and

Whereas, Alcoa operated the Alcoa Cleveland Works industrial landfill on the site beginning in the 1940s and ceased disposal operations on March 29, 1996; and

Whereas, Alcoa submitted a closure/post-closure care plan for the Alcoa Cleveland Works industrial landfill to Ohio EPA dated July 1995. The closure/post-closure care plan was approved by Ohio EPA on January 29, 1996. The closure/post-closure care plan described, in part, the cap system to be constructed on the Alcoa Cleveland Works industrial landfill. Synthetic cap construction, grading, soil placement and seeding were completed by Alcoa in October 1996. Alcoa submitted a final closure certification report to Ohio EPA on April 23, 1999. Thereafter Alcoa began undertaking the post-closure care responsibilities pursuant to the closure/post-closure care plan, ORC Chapter 3734, and Ohio Administrative Code ("OAC") Chapter 3745-29, and OAC Rule 3745-30-08; and

Whereas, Alcoa has ongoing post-closure care obligations at the Alcoa Cleveland Works industrial landfill for the post-closure care period including but not limited to maintenance of the landfill cap and periodic ground water monitoring in accordance with pursuant to OAC Chapter 3745-29, OAC Rule 3745-30-08; and

Whereas, Alcoa is currently subject to the ground water monitoring requirements set forth in OAC Rule 3745-30-08 and a revised compliance monitoring program dated September 2015 (CMP-2015) for the Alcoa Cleveland Works industrial landfill; and

Whereas, volatile organic compounds (VOCs) and various metals have been identified as contaminants of concern (COCs) in the ground water underlying the Alcoa Cleveland Works industrial landfill and adjacent property; and

Whereas, some of the COCs identified on or underlying the Alcoa Cleveland Works industrial landfill have been detected at concentrations above the federal drinking water maximum contaminant levels (MCLs); and

Whereas, in accordance with the CMP-2015, Alcoa has determined to impose activity and use limitations on the Alcoa Cleveland Works industrial landfill and adjacent property as described in this Environmental Covenant to protect the engineered components of the closed landfill facility, prevent ingestion of COCs in the ground water and prevent the inhalation of VOCs that could volatize from ground water to indoor air; and

Whereas, the approximately 57.5960 acre property including the Alcoa Cleveland Works industrial landfill and adjacent property (the "Property") subject to this Environmental Covenant is described in the legal description attached as Exhibit 1 and incorporated by reference herein as if fully rewritten; and

Whereas, the approximately 14.8853 acre tract of land that constitutes the identified limits of waste placement for the closed Alcoa Cleveland Works industrial landfill located on the Property described in Exhibit 1 is further described in the legal description attached as Exhibit 2 and incorporated by reference herein as if fully rewritten; and

Whereas, the area of the Property described in Exhibit 1 has a potential risk to human health through the inhalation of VOCs intruding from the ground water to indoor air should construction of occupied structures occur on this Property without appropriate engineering controls; and

Whereas, a map that depicts the Property subject to this environmental covenant as described in Exhibit 1 and further indicates the limits of waste placement for the Cleveland Works industrial landfill located on the Property as described in Exhibit 2 is attached hereto as Exhibit 3 and incorporated herein; and

Whereas, the administrative record for the Property and the administrative consent final findings and orders relating to the Property including the closure of the Cleveland Works industrial waste landfill and the ground water compliance monitoring program can be reviewed at the Ohio EPA's Northeast District Office located at 2110 East Aurora Road, Twinsburg, Ohio 44087.

Now therefore, Alcoa and Ohio EPA (collectively referred to as "the Parties") agree to the following:

1. Intention of the Parties. This Environmental Covenant touches and concerns the described Property and is intended to limit the use of the described Property as identified in Exhibits 1 and 2 and restrict certain activities from occurring on the Property pursuant to ORC §§ 5301.80 to 5301.92. It is also the intent of the Parties that the covenants, terms, conditions and restrictions of this Environmental Covenant shall be binding upon and inure to the benefit of the Parties and continue as a servitude running in perpetuity with the Property, subject to ORC § 5301.89. It is the further intention of the Parties that the Environmental Covenant be enforceable at law pursuant to ORC § 5301.91.

2. Property. This Environmental Covenant concerns an approximately 57.5960 acre tract of land currently owned by Alcoa and located at approximately 1600 Harvard Ave., Village of Cuyahoga Heights, Cuyahoga County, Ohio, and more specifically described in Exhibit 1 attached hereto and incorporated by reference herein. The closed Cleveland Works industrial waste landfill limits of waste placement is an approximately 14.8853 acre area described in Exhibit 2 and wholly located within the boundaries of the Property described in Exhibit 1. The two separately described tracts of land identified in Exhibits 1 and 2 shall be known collectively as the "Property" for purposes of this Environmental Covenant.

3. Owner. Alcoa Inc., formerly known as Aluminum Company of America, Inc., whose address is 1600 Harvard Road, Village of Cuyahoga Heights, Cuyahoga County, Ohio is the Owner of the Property.

4. Holder. Owner, whose address is listed above, is the holder of this Environmental Covenant.

5. Activity and Use Limitations. The Property is hereby limited to commercial or industrial land use only. In accordance with ORC §§ 5301.80 through 5301.92, and to protect the engineered components of the industrial waste landfill, and to comply with Consensual Director's Final Findings and Orders, the Owner herby imposes and agrees to comply with the following activity and use limitations for the Property:

A. ***Limitation Prohibiting Ground Water Extraction and Use***. Ground water underlying the Property or any portion of the Property shall not be extracted or used for any purpose, potable or otherwise, except for the investigation, monitoring or remediation of the groundwater; or for dewatering during authorized construction or excavation activities, or during installation or maintenance of subsurface utilities. Alcoa and Ohio EPA retain the right to access the Property described in Exhibit 1 to install ground water monitoring wells and conduct sampling, assessment and remediation activities as may be determined necessary by Ohio EPA.

B. ***Limitation for Any Construction Activity.*** To protect the integrity of the Landfill facility and its engineered components including the ground water monitoring network and passive gas extraction system, no person shall engage in any filling, grading, drilling, excavating, building, drilling or mining on the Property as described in Exhibit 1 without express prior authorization from Ohio EPA in accordance with OAC Rule 3745-27-13 or other applicable authority.

C. ***Limitation for Any Occupied Structures.*** To prevent the potential inhalation of volatile organic compounds, including but not limited to, potential exposure to volatile emissions from ground water to indoor air, no person shall construct any occupied structures on the Property described in Exhibit 1 without prior authorization from Ohio EPA.

6. Running with the Land. This Environmental Covenant shall be binding upon the Owner during the time that the Owner owns the Property or any portion thereof, and upon all assigns and successors in interest, including any Transferee, and shall run with the land, pursuant to ORC § 5301.85, subject to amendment or termination as set forth herein. The term "Transferee," as used in this Environmental Covenant, shall mean any future owner of any interest in the described Property or any portion thereof, including, but not limited to, owners of an interest in fee simple, mortgagees, easement holders, and/or lessees.

7. Compliance Enforcement. Compliance with this Environmental Covenant may be enforced pursuant to ORC § 5301.91. Failure to timely enforce compliance with this Environmental Covenant or the use limitations contained herein by any party shall not bar subsequent enforcement by such party and shall not be deemed a waiver of the party's right to take action to enforce any non-compliance. Nothing in this Environmental Covenant shall restrict the Director of Ohio EPA from exercising any authority under applicable law in order to protect public health or safety or the environment.

8. Rights of Access. Owner hereby grants to Ohio EPA, its agents, representatives, employees, and contractors, the right of access to the Property in connection with the implementation or enforcement of this Environmental Covenant.

9. Compliance Reporting. In addition to any other reporting requirements imposed by law or agreement, Owner and any Transferee shall submit to Ohio EPA annual written documentation verifying that the activity and use limitations on the Property remain in place and are being complied with. Said written documentation may be a statement submitted by the Owner or Transferee under affidavit or in conjunction with any other reporting requirements imposed by law or agreement, as long as said documentation is submitted no less than annually.

10. Notice of Activity and Use Limitations upon Conveyance. Each instrument hereafter conveying any interest in the Property or any portion of the Property shall contain a notice of the activity and use limitations set forth in paragraph 5 of this Environmental Covenant, and provide the recorded location of this Environmental Covenant. The notice shall be substantially in the following form:

THE INTEREST CONVEYED HEREBY IS SUBJECT TO AN ENVIRONMENTAL COVENANT, DATED_____, 2016, RECORDED IN THE DEED OR OFFICIAL RECORDS OF THE CUYAHOGA COUNTY RECORDER ON _____, 2016, IN [DOCUMENT ____, *or* BOOK___, PAGE ____,]. THE ENVIRONMENTAL COVENANT CONTAINS THE FOLLOWING ACTIVITY AND USE LIMITATIONS:

A. Limitation Prohibiting Ground Water Extraction and Use. Ground water underlying the Property or any portion of the Property shall not be extracted or used for any purpose, potable or otherwise, except for the

investigation, monitoring or remediation of the groundwater; or for dewatering during authorized construction or excavation activities, or during installation or maintenance of subsurface utilities. Alcoa and Ohio EPA retain the right to access the Property described in Exhibit 1 to install ground water monitoring wells and conduct sampling, assessment and remediation activities as may be determined necessary by Ohio EPA.

B. Limitation for Any Construction Activity. To protect the integrity of the Landfill facility and its engineered components including the ground water monitoring network and passive gas extraction system, no person shall engage in any filling, grading, drilling, excavating, building, drilling or mining on the Property as described in Exhibit 1 without express prior authorization from Ohio EPA in accordance with OAC Rule 3745-27-13 or other applicable authority.

C. Limitation for Any Occupied Structures. To prevent the potential inhalation of volatile organic compounds, including but not limited to, potential exposure to volatile emissions from ground water to indoor air, no person shall construct any occupied structures on the Property described in Exhibit 1 without prior authorization from Ohio EPA.

Owner or Transferee, if applicable, shall notify Ohio EPA and any "Holders" other than the current Owner within thirty (30) days after each conveyance of an interest in any portion of the Property described in Exhibit 1. Owner's notice shall include the name, address, and telephone number of the Transferee, a copy of the deed or other documentation providing evidence of the conveyance, and a survey map that shows the boundaries of the restricted Property, or portion thereof, that is being transferred.

11. Representations and Warranties. Owner hereby represents and warrants to the other signatories hereto:

A. that the Owner is the sole owner of the Property;
B. that the Owner holds fee simple title to the Property which is subject to the interests or encumbrances identified in Exhibit 4;
C. that the Owner has the power and authority to enter into this Environmental Covenant, to grant the rights and interests herein provided and to carry out all obligations hereunder;
D. that the Owner has identified all other persons that have an interest in or hold an encumbrance on the Property and notified such persons of the Owner's intention to enter into this Environmental Covenant;

E. that this Environmental Covenant will not materially violate or contravene or constitute a material default under any other agreement, document or instrument to which Owner is a party or by which Owner may be bound or affected; and

F. to the extent that any other interests in or encumbrances on the Property conflict with the activity and use limitations set forth in this Environmental Covenant, the persons who own such interests or hold such encumbrances have agreed to subordinate such interests or encumbrances to the Environmental Covenant, pursuant to ORC § 5301.86 except for leases, right of ways or easements for public utilities or distribution lines above or below the surface.

12. Amendment or Termination. This Environmental Covenant may be amended or terminated only by written instrument executed by and documenting the consent of all of the following: the Owner or a Transferee; the Holders, and the Director of Ohio EPA, pursuant to ORC §§ 5301.89 or § 5301.90. The term, "Amendment," as used in this Environmental Covenant, shall mean any changes to the Environmental Covenant, including the activity and use limitations set forth herein, or the elimination of one or more activity and use limitations when there is at least one limitation remaining. The term, "Termination," as used in this Environmental Covenant, shall mean the elimination of all activity and use limitations set forth herein and all other obligations under this Environmental Covenant.

Within thirty (30) days of signature by all requisite parties on any amendment or termination of this Environmental Covenant, the Owner or Transferee shall file such instrument for recording with the Cuyahoga County Recorder's Office, and shall provide a file- and date-stamped copy of the recorded instrument to Ohio EPA and Holders.

13. Severability. If any provision of this Environmental Covenant is found to be unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions shall not in any way be affected or impaired. Owner expressly waives the ability to contest the legality and operation of this Environmental Covenant.

14. Governing Law. This Environmental Covenant shall be governed by and interpreted in accordance with the laws of the State of Ohio.

15. Recordation. Within thirty (30) days after the date of the final required signature upon this Environmental Covenant, Owner shall file this Environmental

Covenant for recording, in the same manner as a deed to the Property, with the Cuyahoga County Recorder's Office, in accordance with ORC § 5301.88.

16. Effective Date. The effective date of this Environmental Covenant shall be the date upon which the fully executed Environmental Covenant has been recorded as a deed record for the Property with the Cuyahoga County Recorder.

17. Distribution of Environmental Covenant. The Owner shall distribute a file- and date-stamped copy of the recorded Environmental Covenant to the Ohio EPA, any other signatories to the Environmental Covenant, and the city of Cleveland in accordance with ORC § 5301.83.

18. Notice. Unless otherwise notified in writing by any party hereto or Ohio EPA, any document or communication required by this Environmental Covenant shall be submitted to:

Division of Materials and Waste Management
Ohio EPA
P.O. Box 1049
Columbus, Ohio 43216-1049

And

Division of Materials and Waste Management
Ohio EPA, Northeast District Office
2110 East Aura Road
Twinsburg, Ohio 44087
Attn.: DMWM Site Inspector for Alcoa Cleveland Works

OHIO ENVIRONMENTAL PROTECTION AGENCY

Craig W. Butler, Director

Date 11/10/16

State of Ohio)
) ss:
County of Franklin)

Before me, a notary public, in and for said county and state, personally appeared Craig W. Butler, the Director of Ohio EPA, who acknowledged to me that he did execute the foregoing instrument on behalf of Ohio EPA.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this 10th day of NOVEMBER, 2016.

NOTARIAL SEAL STATE OF OHIO

Notary Public

CHARMA DIANE CASTEEL
NOTARY PUBLIC
STATE OF OHIO
MY COMMISSION EXPIRES
May 10, 2019

The undersigned representative of the Owner represents and certifies that he/she is authorized to execute this Environmental Covenant.

IT IS SO AGREED:

Alcoa Inc.

JEFFREY R. ALLEN
Signature of Owner

JEFFREY R. ALLEN
DIRECTOR OF OPERATIONS
Printed Name and Title
ALCOA CLEVELAND WORKS

10/3/16
Date

State of OHIO)
) ss:
County of CUYAHOGA)

Before me, a notary public, in and for said county and state, personally appeared JEFFREY R. ALLEN the DIRECTOR OF OPERATIONS ALCOA CLEVELAND WORKS and duly authorized representative of Alcoa Inc., who acknowledged to me that he/she did execute the foregoing instrument on behalf of Alcoa Inc.

IN TESTIMONY WHEREOF, I have subscribed my name and affixed my official seal this 3 day of October, 2016.

Glendoria D. Burrus
Notary Public

NOTARY PUBLIC STATE OF OHIO

GLENDORIA D. BURRUS
Notary Public, State of Ohio
My Comm. Expires Feb. 28, 2018

Environmental Covenant Exhibit 1

Legal Description of the Environmental Covenant Area

The Mannik & Smith Group, Inc.
4630 Richmond Road, Ste. 180 Warrensville Hts., OH 44128 Tel 216 378 1490 Fax 216 378 1497
www.manniksmithgroup.com

LEGAL DESCRIPTION of AREA OF ENVIRONMENTAL COVENANT
57.5960 Acres

Situated in the Village of Cuyahoga Heights, County of Cuyahoga, State of Ohio and being part of Orginal Lot numbers 271, 272, 273 & 291, and being more fully described as follows;

Beginning at an iron monument found on the centerline of Harvard Avenue (60 feet wide) at the intersection with the westerly line of said Orginal Lot 291;

Thence North 88°54'10" East along the centerline of said Harvard Avenue, a distance of 248.36 feet to the Northeasterly corner of land conveyed to the United States Aluminum Company by deed dated May 2, 1929 and recorded in Volume 3926, Page 325 of the Cuyahoga County Deed Records to a point;

Thence southeasterly along said United States Aluminum Company parcel along a curve deflecting to the left having a length of 577.86 feet, a radius of 1533.69 feet, a delta of 21°35'16", a chord distance of 574.45 feet with a bearing of South 22° 52'02" East to a point;

Thence South 01°02'03" East along the easterly line of said United States Aluminum Company a distance of 955.27 to a point located at the northwest corner of land conveyed to the Aluminum Company of America by deed recorded in Volume 8087, Page 285 of the Cuyahoga County Deed Records being, the principal place of beginning;

Course 1: Thence North 88°57'57" East along the northerly line of said Aluminum Company of America parcel a distance of 200.00 feet to a point located at the northeast corner of said parcel;

Course 2: Thence South 01°02'03" East along the easterly line of said Aluminum Company of America parcel a distance of 399.13 feet to a point located at the southeast corner of said parcel, said point located on the northerly line of Canal Lands conveyed to the Aluminum Company of America by deed dated May 1998 and recorded in Volume 98-2591 Page 29 of the Cuyahoga County Deed Records;

Course 3: Thence South 84°34'37" East along said northerly line a distance of 41.65 feet to a point;

Course 4: Thence South 83°46'29" East continuing along said northerly line a distance of 73.30 feet to a point;

Course 5: Thence South 01°02'03" East a distance of 100.01 feet to an iron pin found with a cap stamped '7104' located at the northeast corner of a lot split prepared for the Aluminum Company of America and transferred by deed dated May 1998 as recorded in Volume 98-2591 Page 29 of the Cuyahoga County Deed Records;

Course 6: Thence South 01°02'03" East along the easterly line of said Aluminum Company of America parcel a distance of 961.64 feet to a point on the Northerly bank of the Cuyahoga River as it existed in 2010;

Thence in a Westerly direction along the approximate northerly bank of the Cuyahoga River the following 12 courses;

Course 7: Thence South 24°43'50" West a distance of 18.42 feet to a point;

Course 8: Thence South 07°48'24" West a distance of 84.31 feet to a point;

Environmental Covenant Exhibit 2
Legal Description of the Facility

The Mannik & Smith Group, Inc.
4630 Richmond Road, Ste. 180 Warrensville Hts., OH 44128 Tel 216 378 1490 Fax 216 378 1497
www.manniksmithgroup.com

LEGAL DESCRIPTION for AREA OF CLOSED LANDFILL
14.8853 Acres

Situated in the Village of Cuyahoga Heights, County of Cuyahoga, State of Ohio and being part of Orginal Lot numbers 271, 272, 273 & 291, and being more fully described as follows;

Beginning at an iron monument found on the centerline of Harvard Avenue (60 feet wide) at the intersection with the westerly line of said Orginal Lot 291;

Thence North 88°54'10" East along the centerline of said Harvard Avenue, a distance of 248.36 feet to the Northeasterly corner of land conveyed to the United States Aluminum Company by deed dated May 2, 1929 and recorded in Volume 3926, Page 325 of the Cuyahoga County Deed Records to a point;

Thence southeasterly along said United States Aluminum Company parcel along a curve deflecting to the left having a length of 577.86 feet, a radius of 1533.69 feet, a delta of 21°35'16", a chord distance of 574.45 feet with a bearing of South 22° 52'02" East to a point;

Thence South 01°02'03" East along the easterly line of said United States Aluminum Company a distance of 955.27 to a point located at the northwest corner of land conveyed to the Aluminum Company of America by deed recorded in Volume 8087, Page 285 of the Cuyahoga County Deed Records;

Thence South 85°11'04" West a distance of 358.39 feet to a point, being the principal place of beginning;

Course 2a: Thence South 16°51'58" East a distance of 796.08 feet to a point;

Course 3a: Thence South 51°44'19" West a distance of 198.67 feet to a point;

Course 4a: Thence North 75°59'32" West a distance of 185.19 feet to a point;

Course 5a: Thence North 49°17'54" West a distance of 343.56 feet to a point;

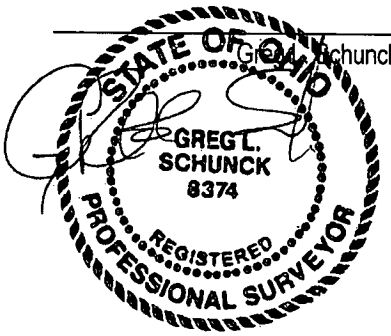
Course 6a: Thence North 28°27'03" West a distance of 503.85 feet to a point on the easterly line of an easement to the Standard Oil Company as recorded in Volume 8237, Page 417 of the Cuyahoga County Records;

Course 7a: Thence North 01°11'26" West along the easterly line of said easement a distance of 417.72 feet to a point;

Course 8a: Thence North 16°01'57" East a distance of 159.25 feet to a point;

Course 9a: Thence South 67°30'12" East a distance of 556.17 feet to a point;

Course 10a: Thence South 16°51'58" East a distance of 193.19 feet to a the principal place of beginning and containing 14.8853 acres of land be the same more or less but subject to all legal highways and easements of record. As assembled by record information, August 2010 by Greg Schunck of Mannik & Smith Group, Inc.
Bearings are to an assumed meridian and are used to denote angles only.



Greg L. Schunck Professional Surveyor No. 8374

LANDFILL AREA DESCRIPTION.doc

Course 9: Thence South 38°53'43" West a distance of 60.82 feet to a point;

Course 10: Thence South 43°53'31" West a distance of 227.43 feet to a point;

Course 11: Thence North 89°23'22" West a distance of 119.69 feet to a point;

Course 12: Thence North 55°28'33" West a distance of 782.16 feet to a point;

Course 13: Thence North 45°44'19" West a distance of 891.57 feet to a point;

Course 14: Thence North 25°57'33" West a distance of 198.32 feet to a point;

Course 15: Thence North 27°31'17" East a distance of 563.35 feet to a point;

Course 16: Thence North 02°40'15" East a distance of 133.87 feet to a point;

Course 17: Thence North 09°17'39" West a distance of 64.76 feet to a point;

Course 18: Thence North 41°09'13" West a distance of 100.22 feet to a point;

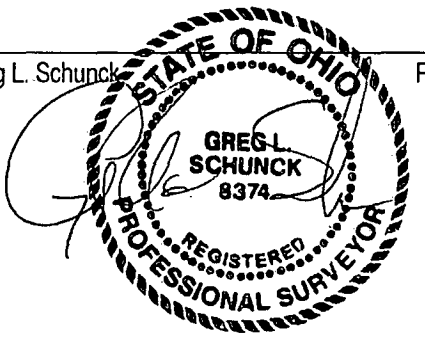
Course 19: Thence North 63°53'53" West a distance of 261.83 feet to a point;

Course 20: Thence North 26°06'07" East leaving the northerly bank of the Cuyahoga River a distance of 282.82 feet to a point;

Course 21: Thence South 64°42'53" East a distance of 1420.42 feet to a the principal place of beginning and containing 57.5960 acres of land be the same more or less but subject to all legal highways and easements of record. As assembled by record information, August 2010 by Greg Schunck of Mannik & Smith Group, Inc.

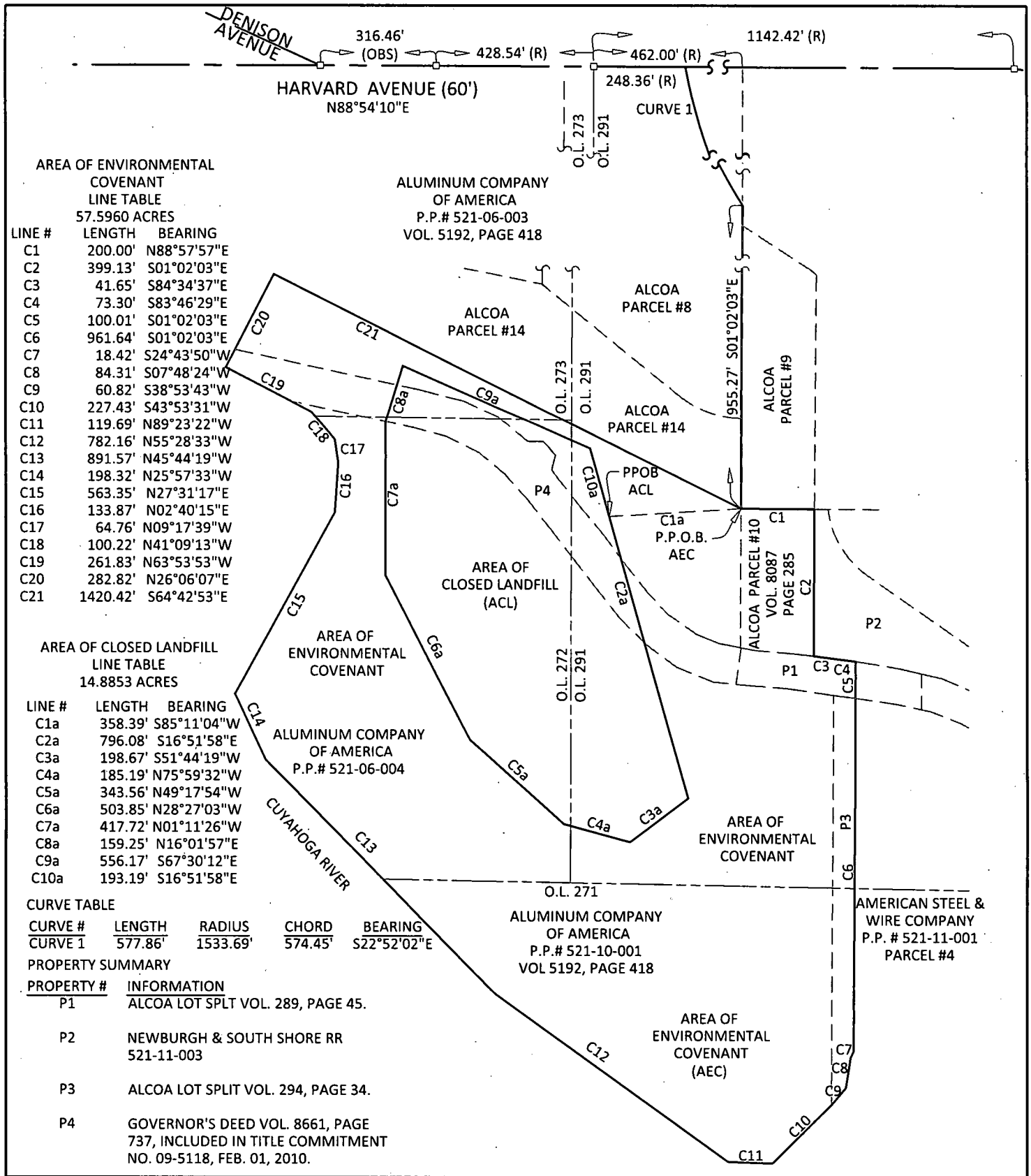
Bearings are to an assumed meridian and are used to denote angles only.

Greg L. Schunck Professional Surveyor No. 8374



Environmental Covenant Exhibit 3

Maps



AREA OF ENVIRONMENTAL COVENANT
LINE TABLE
57.5960 ACRES

LINE #	LENGTH	BEARING
C1	200.00'	N88°57'57"E
C2	399.13'	S01°02'03"E
C3	41.65'	S84°34'37"E
C4	73.30'	S83°46'29"E
C5	100.01'	S01°02'03"E
C6	961.64'	S01°02'03"E
C7	18.42'	S24°43'50"W
C8	84.31'	S07°48'24"W
C9	60.82'	S38°53'43"W
C10	227.43'	S43°53'31"W
C11	119.69'	N89°23'22"W
C12	782.16'	N55°28'33"W
C13	891.57'	N45°44'19"W
C14	198.32'	N25°57'33"W
C15	563.35'	N27°31'17"E
C16	133.87'	N02°40'15"E
C17	64.76'	N09°17'39"W
C18	100.22'	N41°09'13"W
C19	261.83'	N63°53'53"W
C20	282.82'	N26°06'07"E
C21	1420.42'	S64°42'53"E

AREA OF CLOSED LANDFILL
LINE TABLE
14.8853 ACRES

LINE #	LENGTH	BEARING
C1a	358.39'	S85°11'04"W
C2a	796.08'	S16°51'58"E
C3a	198.67'	S51°44'19"W
C4a	185.19'	N75°59'32"W
C5a	343.56'	N49°17'54"W
C6a	503.85'	N28°27'03"W
C7a	417.72'	N01°11'26"W
C8a	159.25'	N16°01'57"E
C9a	556.17'	S67°30'12"E
C10a	193.19'	S16°51'58"E

CURVE TABLE

CURVE #	LENGTH	RADIUS	CHORD	BEARING
CURVE 1	577.86'	1533.69'	574.45'	S22°52'02"E

PROPERTY SUMMARY

PROPERTY #	INFORMATION
P1	ALCOA LOT SPLT VOL. 289, PAGE 45.
P2	NEWBURGH & SOUTH SHORE RR 521-11-003
P3	ALCOA LOT SPLIT VOL. 294, PAGE 34.
P4	GOVERNOR'S DEED VOL. 8661, PAGE 737, INCLUDED IN TITLE COMMITMENT NO. 09-5118, FEB. 01, 2010.

The Mannik & Smith Group, Inc.
4630 Richmond Road, Suite 180
Warrensville Heights, Ohio 44128
Tel (216) 378-1490
Fax (216) 378-1497
Civil Engineering, Surveying and Environmental Consulting

ALUMINUM COMPANY OF AMERICA

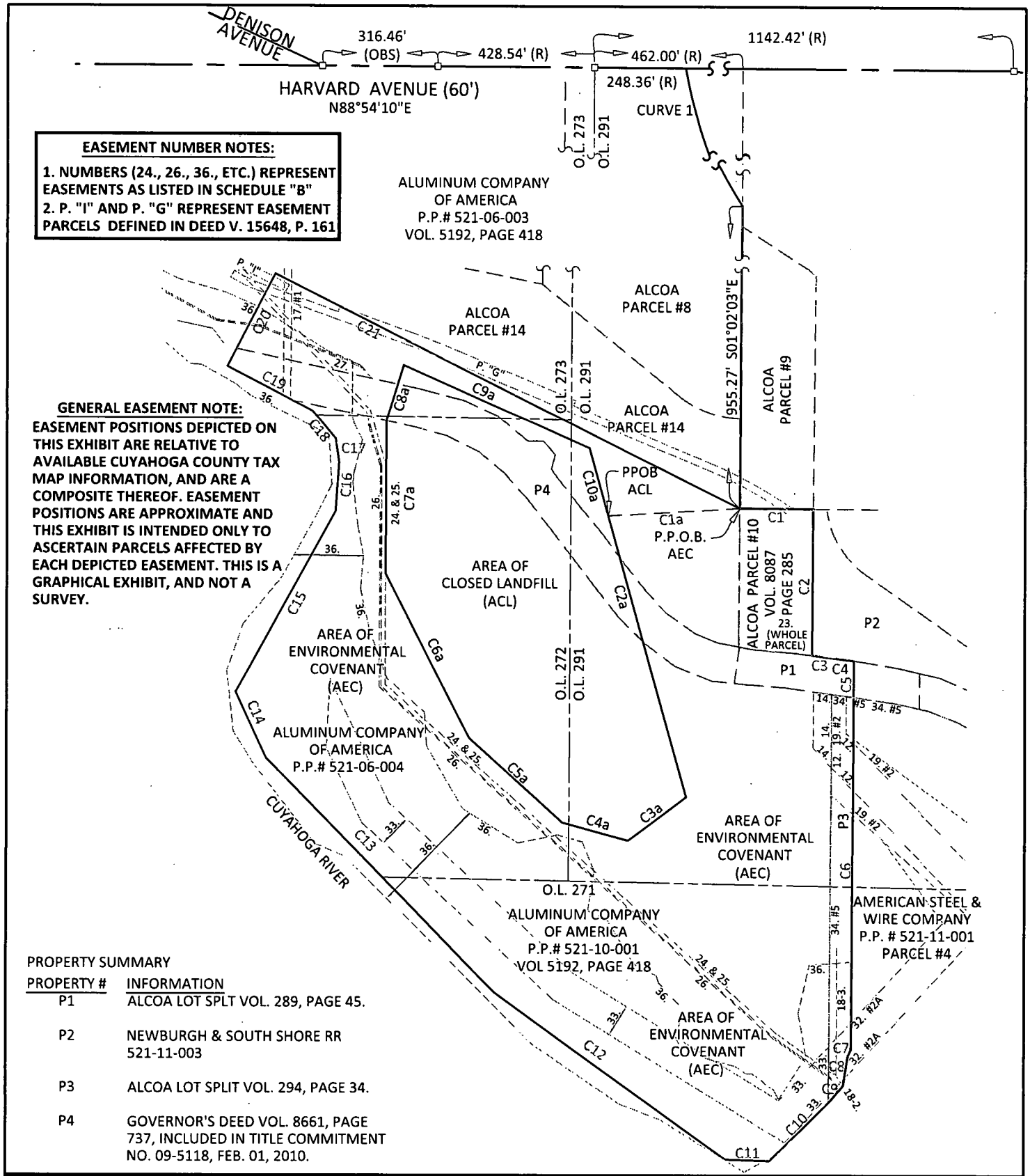
PROJECT LOCATION

SCALE: 1" = 350'

10/07/10

A2000007

SHEET 01/02



GENERAL EASEMENT NOTE:
EASEMENT POSITIONS DEPICTED ON THIS EXHIBIT ARE RELATIVE TO AVAILABLE CUYAHOGA COUNTY TAX MAP INFORMATION, AND ARE A COMPOSITE THEREOF. EASEMENT POSITIONS ARE APPROXIMATE AND THIS EXHIBIT IS INTENDED ONLY TO ASCERTAIN PARCELS AFFECTED BY EACH DEPICTED EASEMENT. THIS IS A GRAPHICAL EXHIBIT, AND NOT A SURVEY.

PROPERTY SUMMARY

PROPERTY #	INFORMATION
P1	ALCOA LOT SPLT VOL. 289, PAGE 45.
P2	NEWBURGH & SOUTH SHORE RR 521-11-003
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Civil Engineering, Surveying and Environmental Consulting

ALUMINUM COMPANY OF AMERICA

PROJECT LOCATION

SCALE: 1" = 350'

10/07/10

A2000007

SHEET 02/02

Environmental Covenant Exhibit 4
Interests and Encumbrances

NOTE:

This document represents a copy of the original Schedule B – Section II of the original Title Commitment for this property.

The intent of this document is to comment regarding whether easements, as described in the Title Commitment, and listed in paragraph numbers 9 through 37, below, appear to affect the Area of Closed Landfill (ACL) and/or the Area of Environmental Covenant (AEC).

The Area of Closed Landfill (herein referred to as ACL) and the Area of Environmental Covenant (herein referred to as AEC) along with the appropriate easements are shown on Map Exhibit Page 2 of 2, attached.

This document is not intended to replace the original Schedule B document.

COPY OF:

COMMITMENT FOR TITLE INSURANCE
SCHEDULE B – SECTION II

Commitment No: 09-5118 Effective Date: January 19, 2010

The policy or policies to be issued will contain exceptions to the following unless the same are disposed of to the satisfaction of the Company.

1. Defects, liens, encumbrances, adverse claims or other matters, if any, created, first appearing in the public records or attaching subsequent to the effective date hereof but prior to the date the Proposed Insured acquires for value of record the estate or interest or mortgage thereon covered by this Commitment.

2. Any facts, rights, interest, or claims which are not shown by the public records but which could be ascertained by an inspection of said land or by making inquiry of persons in possession thereof.

3. Any encroachment, encumbrance, violation, variation, or adverse circumstance affecting the Title that would be disclosed by an accurate and complete land survey of the Land. The term "encroachment" includes encroachments of existing improvements located on the Land onto adjoining land, and encroachments onto the Land of existing improvements located on adjoining land.

4. Any lien or right to a lien, for services, labor or material theretofore or hereafter furnished, imposed by law and not shown by the public records.

5. Rights of parties in actual possession of all or any part of the premises.

6. Special assessments and special taxes, if any and taxes not yet due and payable.

7. Easements or claims of easements, not shown by the public records.

8. This Commitment for Title Insurance is issued In contemplation of the Issuance of a policy, or policies, of title insurance and Cleveland Title Services Agency, Ltd. (hereinafter "Cleveland Title") and/or the Underwrited assigned herein shall have no obligations outside the terms of this commitment. Specifically, any title search or examination conducted by Cleveland Title as a basis for issuing this commitment shall be for the benefit of Cleveland Title and the Underwriter only, an does not inure to the benefit of any other party, including any seller, purchaser or lender. In the event any proposed Insured under this commitment falls to acquire; or elects not to acquire, a final policy prior to the expiration date of the commitment, said proposed Insured shall have no cause of action or recourse against Cleveland Title or the Underwriter and in no event shall any proposed Insured have any claim or cause of action against Cleveland Title or the Underwriter based on the title search or examination. By accepting the within commitment, the proposed insured, along with any other parties to the contemplated transaction, consents to and agrees with the foregoing.

9. Notwithstanding the reference to acreage or square footage in the description set forth in Schedule A hereof, this commitment policy does not guarantee nor insure nor guarantee the acreage or exact quantity of land set forth therein.

10. Easement from The Aluminum Castings Co. to The East Ohio Gas Co. filed December 5, 1916 and recorded in Volume 1855, Page 640 of Cuyahoga County Records. NOTE: We have made no examination of the above Item. For further conditions see record.

    Does not appear to affect either the Area of Environmental Covenant (AEC) or the Area of Closed Landfill (ACL).

11. Easement Agreement between The Newburgh and South Shore Railway Company, the Grantors, and The United States Aluminum Company, recorded in Volume 4225, Page 583 of Cuyahoga County Records. NOTE: We have made no examination of the above Item. For further conditions see record.

    Does not appear to affect either AEC or ACL.

12. Right of Way and Easement from The American Steel and Wire Company of New Jersey, to The Cleveland Electric Illuminating Company, filed May 18, 1943 and recorded in Volume 5604, Page 151 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    This Easement is for towers and overhead wires. The easement has 2 parts. Part #1 does not appear to affect either the AEC or ACL. Part #2 does appear to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

13. Right of Way and Easement from The Newburgh and South Shore Railway Company, to The Cleveland Electric Illuminating Company, filed May 28, 1943 and recorded in Volume 5606, Page 546 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

14. Easement from Henry J. Huy, aka H.J. Huy, et al. to The Cleveland Electric Illuminating Company, filed October 23, 1943 and recorded in Volume 5637, Page 613 of Cuyahoga

County Records. NOTE: We have made no examination of the above item. For further conditions see record.

The Easement is for a tower and transmission lines. It appears to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

15. Right of Way and Easement from The Aluminum Company of America to The Cleveland Electric Illuminating Company, filed January 3, 1944 and recorded In Volume 5651, Page 505 of Cuyahoga County Records. NOTE: We have made no examination of the above Item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

16. Sewer Easement from The Aluminum Company of America to the Village of Cuyahoga Heights, filed August 28, 1945 and recorded In Volume 5892, Page 263 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

17. Sewer Easement from The Aluminum Company of America to the Village of Cuyahoga Heights, filed August 28, 1945 and recorded In Volume 5892, Page 265 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Easement consists of two parts. Part #1 is for a combined storm and sanitary sewer. Part #2 is for a sanitary interceptor sewer. Part #1 appears to affect the AEC, only, and is shown on Map Exhibit Sheet 02 of 02. Part #2 does not appear to affect either the AEC or ACL.

18. Pipe Line License whereas The American Steel and Wire Company of New Jersey, the Licensor, does grant union The Standard Oil Company, the Licensee, filed May 5, 1949 and recorded In Volume 6689, Page 153 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The License is for pipe lines over, across and under the property. The License consists of 3 Parts. Part #1 does not appear to affect either the AEC or ACL. Parts #2 & #3 appear to affect the AEC, only, and are shown on Map Exhibit Sheet 02 of 02.

19. Right of Way and Easement from The American Steel and Wire Company of New Jersey to The Cleveland Electric Illuminating Company filed December 20, 1951 and recorded in Volume 7432, Page 39 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Easement is for towers and transmission lines. The Easement consists of 2 Parts. Part #1 does not appear to affect either the AEC or ACL. Part #2 appears to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

20. Right of Way and Easement from the Aluminum Company of America, to The Cleveland Electric Illuminating Company, filed February 10, 1953 and recorded in Volume 7681,

Page 686 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

Does not appear to affect either the AEC or ACL.

21. Reservation contained in the Deed to Aluminum Company of America, a Pennsylvania corporation, filed May 1, 1953 and recorded in Volume 7809, Page 680 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

22. Easement for Pipe Line Right of Way from the Secretary of the Air Force, to The Standard Oil Company, dated October 15, 1953 and recorded In Volume 8016, Page 92 of Cuyahoga County Records. NOTE: We have made no examination of the above Item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

23. Recital contained in the Deed from The Newburgh and South Shore Railway Company, to The Aluminum Company of America, filed August 31, 1954 and recorded in Volume 8087, Page 285 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Special Warranty Deed to ALCOA from The Newburgh and South Shore Railway Company. It appears to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

24. Agreement by and between Aluminum Company of America and The Standard Oil Company, filed December 28, 1954 and recorded in Volume 8232, Page 219 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Agreement is for pipe lines over, through and across the property. Does not appear to affect the ACL. It appears to affect the AEC. It is shown on Map Exhibit Sheet 02 of 02.

25. Agreement by and between Aluminum Company of America and The Standard Oil Company, filed January 12, 1955 and recorded In Volume 8237, Page 417 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Agreement is for pipe lines over, through and across the property. Does not appear to affect the ACL. It appears to affect the AEC. It is shown on Map Exhibit Sheet 02 of 02.

26. Agreement by and between Aluminum Company of America and The Standard Oil Company, filed February 13, 1956 and recorded In Volume 8494, Page 730 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

The Agreement is for pipe lines over and under the property. Does not appear to affect the ACL. It appears to affect the AEC. It is shown on Map Exhibit Sheet 02 of 02.

27. Easement between the Aluminum Company of America and Inland Corporation, filed May 23, 1958 and recorded In Volume 9083, Page 97 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Easement is for one or more pipe lines over and through the property. It appears to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

28. Appurtenant Easement between Louis Viny and the Aluminum Company of America filed July 14, 1959 and recorded in Volume 9406, Page 403 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

    Assignment of the above Easement to the United States of America, filed July 14, 1959 and recorded In Volume 9725, Page 193 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

29. Easement for the Installation and Maintenance of a Water Main from the Aluminum Company of America to the Village of Cuyahoga Heights filed March 26, 1968 and recorded in Volume 12306, Page 345 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

30. Pipe Line Right of Way from the Aluminum Company of America to The East Ohio Gas Company, filed February 5, 1969 and recorded In Volume 12393, Page 955 of Cuyahoga County Records. NOTE: We have made no 'examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

31. Reservation contained in the Deed to the Board of County Commissioners, filed February 28, 1975 and recorded in Volume 13812, Page 81 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

32. Right of Way and Easement from the United States Steel Corporation, to The Cleveland Electric Illuminating Company of Cleveland, Ohio, filed November 7, 1975 and recorded in Volume 13889, Page 901 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

The Easement is for towers and transmission lines. The Easement consists of 3 Parts (1A, 1B and 2A). Parts 1A and 1B do not appear to affect either the AEC or ACL. Part 2A appears to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

33. Grant of Transmission Line Easement by and between Aluminum Company of America and The Cleveland Electric Illuminating Company, filed October 15, 1975 and recorded in Volume 14461, Page 617 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Easement is for towers and transmission lines. It appears to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

34. Oil and Gas Lease by and between American Steel & Wire Corporation and Target Energy Corporation, filed October 30, 1989 and recorded in Volume 89-5924, Page 20 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Easement is for drilling, pipe lines, and transport of oil and gas over and through the property. The Easement has 3 Parts. Part 1 (Parcel 1) and Part 2 (Parcel 4) do not appear to affect either the AEC or ACL. Part 3 (Parcel 5) appears to affect the AEC, only. It is shown on Map Exhibit Sheet 02 of 02.

35. Easement Agreement between the Aluminum Company of America and James Ragone filed June 25, 1992 and recorded In Volume 92-5467, Page 59 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

36. Ohio & Erie Canal Reservation Lease between ALCOA, Inc, and The Board of Park Commissioners of the Cleveland Metropolitan Park District, filed January 13, 2000 and recorded in AFN 200001130254 of Cuyahoga County Records. NOTE: We have made no examination of the above item. For further conditions see record.

    The Lease is for the use of part of the property as a park. Does not appear to affect the ACL. It appears to affect the AEC. It is shown on Map Exhibit Sheet 02 of 02.

37. Easement Agreement by and between ALCOA, Inc. and 550 Harvard Ltd., filed June 13, 2002 and recorded in AFN 200206130567 of Cuyahoga County Records. NOTE: We have 1'16 made no examination of the above Item. For further conditions see record.

    Does not appear to affect either the AEC or ACL.

38. Anything to the contrary herein notwithstanding, the land described in Schedule A of this commitment and/or policy shall not be deemed to include any part thereof, resulting through the change in the course of the Ohio River and Ohio Canal occasioned by other than natural causes or by natural causes other than accretion.

39. Rights of all upper and lower Riparian owners and the public in general in and to the waters of Ohio River and Ohio Canal and to tile uninterrupted natural unpolluted flow thereof. NOTE: Riparian Rights are neither guaranteed nor insured.

40. The County Treasurer's General Tax Duplicate shows:

Taxes and assessments for the first half of 2009, listed in the name of Aluminum Company of America, Parcel No. 521-11-004 (parcel No.1), covering caption, in the amount of $79.39, are paid.

Taxes and assessments for the first half of 2009, listed in, the name of Aluminum Company of America, Parcel No. 521-11-005 (parcel No.2), covering caption, in the amount of $45.87, are paid.

Taxes and assessments for the first half of 2009, listed in the name of Aluminum Company of America, Parcel No. 521-11-006 (parcel No.3), covering caption, in the amount of $64,52, are paid.

Taxes and assessments for the first half of 2009, listed In the name of Aluminum Company of America, Parcel No. 521-10-001 (parcel No.4), covering caption, in the amount of $1,557.85, are paid.

Taxes and assessments for the first half of 2009, listed In the name of Aluminum Company of America, Parcel No. 511-06-107 (parcel No. 5), covering caption, In the amount of $7,781.92, are paid.

Taxes and assessments for the first half of 2009, listed in the name of Aluminum Company of America, Parcel No. 521-07-001 and 002 (listed together) (parcel No. 6), covering caption, in the amount of $55,131.52, are paid.

Taxes and assessments for the first half of 2009, listed in the name of Aluminum Company of America, Parcel No. 521-05-001, 002, and 003 and 521-06-001 (listed together) (parcel No.7 a, b, c, d, e, and f), covering caption, in the amount of $49,416,31, are paid.

Taxes and assessments for the first half of 2009, listed in the name of Aluminum Company of America, Parcel No. 521-06-002, 003 and 004 (listed together) (parcel No.8, 9 and 10), covering caption, In the amount of $65,991.58, are paid.

Taxes and assessments for the first half of 2009, listed in the name of Aluminum Company of America, Parcel No. 521-03-004 (parcel No. 11), covering caption, in the amount of $1,621.36, are paid.

NOTE: Board of Revision Complaint in Appeals. See Attached.

Said premises are subject to special assessments, if any.

Taxes for the last half of 2009 are a lien, but not yet due and payable.

Said premises are subject to special assessments, if any, taxes or assessments approved, levied or enacted by the State, County, Municipality, Township, or similar taxing authority, but not yet certified to the tax duplicate of the County In which the land is situated, including any retroactive increases In taxes or assessments resulting from any retroactive increase in the valuation of the land by the State, County, Municipality, Township or other taxing authority.