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REPORT ON

CORRECTIVE MEASURES ASSESSMENT
AES PUERTO RICO – AGREMAX™ STAGING AREA
GUAYAMA, PUERTO RICO

by
Haley & Aldrich, Inc.
Cleveland, Ohio

for
AES Puerto Rico LP
Guayama, Puerto Rico

File No. 133136-004
September 2019
AMENDED 8 November 2019

Winston R. Esteves
Environmental Consultant

CMA REPORT CERTIFICATION STATEMENT

I, Winston R. Esteves, am a professional engineer and licensed in the commonwealth of Puerto Rico. I have reviewed this Corrective Measures Assessment (CMA) report for the AES Puerto Rico AGREMAX™ Staging Area located in Guayama, Puerto Rico. I hereby certify that this report has been prepared in general conformance with the requirements of the U. S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (Apr. 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (July 30, 2018) (amending 40 CFR §257.61) (CCR Rule).

Winston R. Esteves, PE

September 13, 2019
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HALEY ALDRICH

CMA REPORT CERTIFICATION STATEMENT

I, Steven F. Putrich am a professional engineer and licensed in the state of Indiana. I have reviewed the Corrective Measures Assessment (CMA) report for the AES Puerto Rico AGREMAX™ Staging Area located in Guayama, Puerto Rico dated September 13, 2019. By affixing my professional seal and signature I hereby acknowledge that this report has been prepared in conformance with the requirements of the USEPA CCR Rule[1].

For the purposes of satisfying the requirements of the USEPA CCR Rule, Winston R. Esteves of WRE [WRE, PO Box 195597, San Juan, PR 00919-5597, esteves_w@yahoo.com], a professional engineer licensed in the Commonwealth of Puerto Rico has reviewed and sealed and signed the same subject report dated September 13, 2019 for the purpose of certifying conformance with the USEPA CCR Rule, and that same certification is included in the published version of the subject report.

Steven F. Putrich, PE (Indiana)

STEVEN F. PUTRICH
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September 2019

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[1] U.S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities (USEPA CCR Rule)*. 80 Fed. Reg. 21302 (Apr. 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (July 30, 2018) (amending 40 CFR §257.61).

Overview

Counsel retained Haley & Aldrich, Inc. (Haley & Aldrich) on behalf of AES Puerto Rico LP (AES-PR) to prepare this Corrective Measures Assessment (CMA) for the AGREMAX™ temporary staging area (Staging Area) located at the AES Puerto Rico generation facility in Guayama, Puerto Rico (the Site). The Staging Area is being evaluated under the requirements applicable to a coal combustion residuals (CCR) landfill in the U. S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (Apr. 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (July 30, 2018) (amending 40 CFR §257.61) (CCR Rule). AES-PR monitors groundwater at the Staging Area and has conducted detailed geologic and hydrogeologic investigations following USEPA CCR Rule requirements.

AES-PR implemented groundwater monitoring following the CCR Rule requirements through a phased approach to allow for a graduated response and evaluation of steps to address groundwater quality. Detection monitoring indicated statistically significant increases (SSI) for some Appendix III constituents. Assessment monitoring completed in 2018 evaluated the presence and concentration of Appendix IV constituents in groundwater specified in the CCR Rule. Of the 15 CCR Appendix IV parameters evaluated, only three – molybdenum, lithium, and selenium – were detected at statistically significant levels (SSL) above the Groundwater Protection Standards (GWPS) established for the Staging Area.

In performing this CMA, Haley & Aldrich considered the following: presence and distribution of CCR-derived constituents in groundwater, the configuration of the Staging Area, hydrogeologic setting, and the results of a detailed risk evaluation. The alluvial aquifer beneath the Staging Area is approximately 15 feet in thickness transitioning to marsh deposits near the southern portion of the Site. Groundwater flow beneath the Staging Area is generally from north to south, towards Las Mareas Harbor.

To provide a comprehensive CMA, the evaluation described herein includes activities and groundwater remediation alternatives that were combined to constitute comprehensive groundwater remedies designed to achieve the GWPS, including:

- Alternative 1: Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ Monitored Natural Attenuation (MNA)
- Alternative 2: Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment
- Alternative 3: Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation
- Alternative 4: Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment
- Alternative 5: Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation

These five alternatives were evaluated based on the threshold criteria provided in the CCR rule (§257.97 (b)) and then compared to three of the four balancing criteria stated in the CCR Rule (§257.97 (c)). These criteria are introduced below and included in their entirety in **Section 1**:

> § 257.97 Selection of remedy
> (b) Remedies must [Threshold Criteria]:

(1) Be protective of human health and the environment;
(2) Attain the groundwater protection standard as specified pursuant to § 257.95(h);
(3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment;
(4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;
(5) Comply with standards for management of wastes as specified in § 257.98(d).

(c) In selecting a remedy that meets the standards of paragraph (b) of this section, the owner or operator of the CCR unit shall consider the following evaluation factors [Balancing Criteria]:

(1) The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful
(2) The effectiveness of the remedy in controlling the source to reduce further releases
(3) The ease or difficulty of implementing a potential remedy(s)
(4) The degree to which community concerns are addressed by a potential remedy(s).

All of the remedies proposed to achieve the GWPS must meet the five threshold criteria, above, to be considered for inclusion as a remedial alternative. Development of these remedial alternatives and their conformance with the threshold criteria are presented in **Section 4**.

Section 5 evaluates the five remedial alternatives with respect to the balancing criteria listed above. Note that balancing criteria (4), which considers community concerns, will be evaluated following a public information session to be held at least 30 days prior to remedy selection.

The following provides a summary of the remedial alternatives for the Staging Area, as described more fully in this report:

- **Remedial Alternatives:** One remedial alternative to achieve GWPS involves prevention of AGREMAX™ contact with the ground via installation of a synthetic liner in the Staging Area for future management of AGREMAX™. Vertical infiltration via precipitation would be virtually eliminated following installation of the Staging Area liner system. Appendix IV constituents in groundwater above GWPS would be addressed by natural attenuation. The remaining four remedial alternatives do not include a Staging Area liner system and address constituents present in groundwater above GWPS via active groundwater pumping.

- **Groundwater Risk Evaluation:** The CCR Rule groundwater investigation demonstrates that the impacts of the Staging Area are limited. To evaluate extent, nature & extent temporary groundwater monitoring wells were located at the property boundary – located less than 200 feet downgradient from the CCR Rule wells, which are located directly adjacent to the Staging Area. The analytical results demonstrate that there are no concentrations of the SSL constituents above GWPS in these wells. In other words, concentrations of lithium, molybdenum and selenium are not elevated beyond the Site property boundary.

  There is no impact on drinking water and there is no evidence of impact to human health or the environment. There are no downgradient users of groundwater as drinking water – thus, there is no impact on drinking water. Las Mareas Harbor was sampled and does not show impacts.

There is no exposure to CCR-derived constituents detected in groundwater at the Site – either via groundwater use or surface water. Even for the very few results that may be above screening values for some of the sampling events, there is no complete drinking water exposure pathway to groundwater. Where there is no exposure, there is no risk.

Therefore, because no adverse risk currently exists, any of the remedies considered herein are all protective of human health and the environment, and implementation of any of the remedial alternatives will not result in a meaningful reduction in risk to groundwater-related exposures or risk.

- **Remedy Timeframe and Approach:** The timeframes to achieve the GWPS associated with Staging Area lining and natural attenuation, and the active hydraulic containment alternatives are comparable, and the period for installation of the Staging Area liner is brief. For the remaining alternatives groundwater would be addressed by long-term pumping with either direct discharge to an existing surface water impoundment or routing of the water to the on-site water treatment system.

In accordance with §257.98, AES-PR will implement a groundwater monitoring program to document the effectiveness of the selected remedial alternative. Corrective measures are considered complete when monitoring reflects that the SSL constituent concentrations in groundwater downgradient of the Staging Area are not present above the Appendix IV GWPS for three consecutive years.

USEPA is in the process of modifying certain CCR Rule requirements and, depending upon the nature of such changes, assessments made herein could be modified or supplemented to reflect such future regulatory revisions. See *Federal Register (March 15, 2018; 83 FR 11584*).

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List of Acronyms and Abbreviations

Abbreviation	**Definition**
AES-PR	AES Puerto Rico LP
bgs	Below Ground Surface
CCR	Coal Combustion Residual
CPCPRC	Chevron Phillips Chemical Puerto Rico Core, LLC
CMA	Corrective Measures Assessment
CSM	Conceptual Site Model
DNA	DNA-Environment, LLC
GMP	Groundwater Monitoring Plan
GWPS	Groundwater Protection Standards
Haley & Aldrich	Haley & Aldrich, Inc.
HC	Hydraulic Containment
MCL	Maximum Contaminant Level
MNA	Monitored Natural Attenuation
N&E	Nature and Extent
O&M	Operation & Maintenance
RO	Reverse Osmosis
Site	AES Puerto Rico Generating Facility
SSI	Statically Significant Increase
SSL	Statistically Significant Level
Staging Area	AGREMAX™ Temporary Staging Area
SW-DAF	Surface Water Dilution and Attenuation Factor
ug/L	Microgram per Liter
USEPA	United States Environment Protection Agency

1. Introduction

Counsel retained Haley & Aldrich, Inc. (Haley & Aldrich) on behalf of AES Puerto Rico LP (AES-PR) to prepare this Corrective Measures Assessment (CMA) for the AGREMAX™ temporary staging area (Staging Area) located at the AES-PR generation facility (the Site) in Guayama, Puerto Rico. The Staging Area is being evaluated under the requirements applicable to a coal combustion residuals (CCR) landfill in the U. S. Environmental Protection Agency's (USEPA) rule entitled *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities*. 80 Fed. Reg. 21302 (Apr. 17, 2015) (promulgating 40 CFR §257.61); 83 Fed. Reg. 36435 (July 30, 2018) (amending 40 CFR §257.61) (CCR Rule). AES-PR monitors groundwater at the Staging Area and has conducted detailed geologic and hydrogeologic investigations following USEPA CCR Rule requirements.

This CMA includes a summary of the groundwater monitoring results for the CCR Rule Appendix III and Appendix IV constituents, an evaluation of the Appendix III constituents for statistically significant increases (SSI) compared to background, and a comparison of the Appendix IV constituents detected in assessment monitoring to the Groundwater Protection Standards (GWPS). These evaluations identified statistically significant levels (SSL) above GWPS for lithium, molybdenum and selenium in groundwater at two monitoring well locations downgradient of the Staging Area. This report evaluates potential corrective measures to remediate groundwater for the constituents present in groundwater at SSLs above the GWPS.

1.1 FACILITY DESCRIPTION/BACKGROUND

AES-PR operates a 454-megawatt coal-fired power plant in Guayama, Puerto Rico, located on the southern shore of the island (**Figure 1-1**). The Site is bordered by a former pharmaceutical plant to the north, a former chemical plant to the east, a marsh and Las Mareas Harbor to the south, and a solar energy farm to the west.

AES-PR uses CCR generated at the plant to produce AGREMAX™, a manufactured aggregate, which has been used beneficially for landfill daily cover, roadway construction, and other applications. Prior to beneficial use or off-site disposal, AES-PR's inventory of AGREMAX™ is placed in the on-site Staging Area, an approximately seven-acre area located to the south of the generating station (**Figure 1-2**). AES-PR has used the Staging Area to manage AGREMAX™ product since beginning operations in 2002.

The AES-PR generating plant is considered a zero-discharge facility that utilizes reclaimed water obtained from the Guayama wastewater treatment plant operated by Puerto Rico Aqueduct and Sewer Authority, located approximately 0.5 mile east of the power plant. The reclaimed water is stored in a Lagoon in the northern portion of the Site.

Site stormwater is generally directed to and collected in either the 2-million-gallon stormwater retention pond or the larger coal pile runoff pond which stores water for use in the cooling tower, where much of the water is evaporated. A water treatment system, centrally located on-site adjacent to the plant, treats water from the 2-million-gallon stormwater retention pond intended for use for non-process water needs at the Site. The treatment system includes a two-stage side stream Reverse Osmosis (RO) system. According to AES-PR personnel, the secondary system is active, but the primary RO system is currently not in use.

1.2 GROUNDWATER MONITORING

Groundwater monitoring under the CCR Rule occurs through a phased approach to allow for a graduated response (i.e., baseline, detection, and assessment monitoring as applicable) and evaluation of steps to address groundwater quality. DNA-Environment, LLC (DNA) prepared a Groundwater Monitoring Plan (GMP) as required by the CCR Rule [identified as "*AES Puerto Rico Groundwater Monitoring System*" available at http://aespuertorico.com/ccr/]. The GMP presents the design of the groundwater monitoring system, groundwater sampling and analysis procedures, and groundwater statistical analysis methods.

In July 2017, five groundwater-monitoring wells were installed by DNA, on behalf of AES-PR which meet the CCR Rule requirements in 40 CFR Part 257.91, Groundwater Monitoring Systems. Monitoring well locations are shown in **Figure 1-3**. Three of these wells (MW-3, MW-4 and MW-5) were installed hydraulically downgradient of the Staging Area, whereas monitoring wells MW-1 and MW-2 were placed at hydraulically upgradient locations from the Staging Area. The monitoring wells range in depth from 20 to 25 feet below ground surface (bgs).

Detection monitoring sampling events occurred in 2017 and 2018. The results of the sampling events were then compared to background, or natural groundwater values, using statistical methods to determine if CCR Rule Appendix III constituents at the down-gradient edge of the Staging Area are present at concentrations above background; this condition is referred to as a Statistically Significant Increase (SSI). The results of this analysis indicated SSIs necessitating the establishment of an Assessment Monitoring Program and respective notification.

During the Assessment Monitoring phase, CCR groundwater monitoring well samples were collected during June and October 2018 and subsequently analyzed for CCR Rule Appendix IV constituents. Evaluation of these data identified statistically significant levels (SSL) above GWPS for lithium, molybdenum and selenium in groundwater at two monitoring well locations downgradient of the Staging Area. Appendix IV analytical results for the baseline and Assessment Monitoring events are summarized in **Table I**.

1.3 CORRECTIVE MEASURES ASSESSMENT PROCESS

The CMA process involves assessment of groundwater remediation technologies. These remedies must meet the following threshold criteria as stated in the CCR Rule:

> §257.97 Selection of remedy [Threshold Criteria]
> (b) Remedies must:
> > (1) Be protective of human health and the environment;
> > (2) Attain the groundwater protection standard as specified pursuant to §257.95(h);
> > (3) Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in appendix IV to this part into the environment;
> > (4) Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems;
> > (5) Comply with standards for management of wastes as specified in §257.98(d).

Once these technologies are demonstrated to meet these threshold criteria, they are then compared to one another with respect to the following balancing criteria as stated in the CCR Rule:

> §257.97 Selection of remedy [Balancing Criteria]
> (c) In selecting a remedy that meets the standards of paragraph (b) of this section, the owner or operator of the CCR unit shall consider the following evaluation factors:
>
> (1) The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful based on consideration of the following:
>
> (i) Magnitude of reduction of existing risks;
> (ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;
> (iii) The type and degree of long-term management required, including monitoring, operation, and maintenance;
> (iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and redisposal of contaminant;
> (v) Time until full protection is achieved;
> (vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;
> (vii) Long-term reliability of the engineering and institutional controls; and
> (viii) Potential need for replacement of the remedy.
>
> (2) The effectiveness of the remedy in controlling the source to reduce further releases based on consideration of the following factors:
>
> (i) The extent to which containment practices will reduce further releases; and
> (ii) The extent to which treatment technologies may be used.
>
> (3) The ease or difficulty of implementing a potential remedy(s) based on consideration of the following types of factors:
>
> (i) Degree of difficulty associated with constructing the technology;
> (ii) Expected operational reliability of the technologies;
> (iii) Need to coordinate with and obtain necessary approvals and permits from other agencies;
> (iv) Availability of necessary equipment and specialists; and
> (v) Available capacity and location of needed treatment, storage, and disposal services.
>
> (4) The degree to which community concerns are addressed by a potential remedy(s).

The fourth balancing criterion involves input from the community regarding the proposed remedial alternatives. This criterion will be addressed by presenting the alternatives at a public meeting and soliciting comments. That meeting will be held at least 30 days prior to remedy selection by AES.

1.4 RISK REDUCTION AND REMEDY

As presented above, the CCR Rule (§257.97(b)(1) – Selection of Remedy) requires that remedies must be protective of human health and the environment. Further, §257.97(c) of the CCR Rule requires that in selecting a remedy, the owner or operator of the CCR unit must consider specific evaluation factors, including the risk reduction achieved by each of the proposed corrective measures. Each of the balancing criteria listed here from §257.97 and discussed in **Section 5** are those that consider risk to human health or the environment including:

- (c)(1)(i) Magnitude of reduction of existing risks;
- (c)(1)(ii) Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy;
- (c)(1)(iv) Short-term risks that might be posed to the community or the environment during implementation of such a remedy, including potential threats to human health and the environment associated with excavation, transportation, and re-disposal of contaminant;
- (c)(1)(vi) Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment;

The following are additional factors related to risk that are factored into the schedule for implementing and completing remedial activities once a remedy is selected (§257.97(d)):

- (d)(4) Potential risks to human health and the environment from exposure to contamination prior to completion of the remedy[1];
- (d)(5)(i) Current and future uses of the aquifer;
- d)(5)(ii) Proximity and withdrawal rate of users; and
- (d)(5)(iv) The potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to CCR constituents.

Section 3 presents a summary of the groundwater risk evaluation that provides the basis for evaluating these risk-based balancing criteria in **Section 5**.

[1] Factors (d)(4) and (d)(5) are not part of the CMA evaluation process as described in §257.97(d)(4), §257.97(d)(5)(i)(ii)(iv); rather they are factors the owner or operator must consider as part of the schedule for remedy implementation.

2. Groundwater Conceptual Site Model

The Staging Area geology and hydrogeology were initially described in the *Groundwater Monitoring System & Sampling and Analysis Program* prepared by DNA in August 2017 to support the development of a hydrogeologic Conceptual Site Model (CSM) [available at http://aespuertorico.com/wp-content/uploads/2017/10/AESPuerto-Rico_Groundwater_Monitoring_System.pdf]. The CSM has been further enhanced with ongoing CCR groundwater monitoring and supplemental subsurface investigation activities performed by DNA. Findings from these extensive geologic and hydrogeologic investigations have produced a robust CSM that supports the CMA activities discussed in this report.

2.1 SITE SETTING

The Site is located near the marine shoreline on the southern side of the island of Puerto Rico. Based on reports prepared by DNA, the Site geology consists of alluvial deposits which transition to marine marsh and beach deposits in the far southern portion of the Site. The Site is bordered by a former pharmaceutical plant to the north, a former chemical plant to the east, a marsh and Las Mareas Harbor to the south, and a solar energy farm to the west.

2.2 GEOLOGY AND HYDROGEOLOGY

Based on reports prepared by DNA, the Site geology consists of alluvial deposits which transition to marine marsh and beach deposits in the far southern portion of the Site. The Site is underlain by fill material to a depth of approximately 10 feet bgs and an upper water bearing unit consisting of sandy clay and clayey sand to a depth of approximately 25 feet bgs. The upper water bearing unit is bounded/underlain vertically by a stiff clay layer. Slug tests performed in the upper water bearing unit indicate that the hydraulic conductivity ranges from 0.035 to 0.67 feet/day (1.2×10^{-5} to 2.4×10^{-4} centimeters/second).

Groundwater flow beneath the Staging Area is generally from north to south (see **Figure 1-2**). The groundwater hydraulic gradient beneath the Staging Area is approximately 0.005 to 0.011 (ft/ft). Groundwater elevations measured in the three downgradient monitoring wells (MW-3, MW-4, and MW-5) as well as nine temporary monitoring wells (TW-101 through TW-109) (nature and extent (N&E) wells) –installed to address the nature and extent of Appendix IV constituents at SSLs above the GWPS in groundwater) suggest that the groundwater elevations are equalized immediately adjacent to the southern property boundary. The ditch located south of the N&E wells and south property boundary represents a more permeable flow path, resulting in more consistent head values as observed in the N&E wells installed along the property boundary. The N&E wells along the property boundary do not show constituents above GWPS and therefore the ditch would not be impacted by the Staging Area.

Due to the close proximity of the Site to the ocean shoreline, fresh groundwater would be expected to transition to saline (brackish) groundwater near the estuarine or marine margin. While the groundwater collected from monitoring wells MW-3 through MW-5 is freshwater, chemical parameters in the groundwater (boron, chloride) suggest some localized mixing of saline water.

HALEY ALDRICH

2.3 ADJACENT PROPERTY ENVIRONMENTAL CONDITIONS

The former Chevron Phillips Chemical Puerto Rico Core, LLC (CPCPRC) facility on the eastern border of the Site is in Corrective Action overseen by USEPA. Based on a review of available documents, a groundwater plume of benzene and sulfolane is present beneath the former CPCPRC facility and the plume extends onto the AES-PR site, specifically in the vicinity of the Staging Area. Data from reports on file[2] indicate that the footprint of benzene and sulfolane from the former CPCPRC facility onto the AES-PR property is generally limited to monitoring wells along or near the eastern property boundary of the Site.

As described in the *"Statement of Basis Final Remedy Decision"*[3] the remedial alternative selected to address groundwater at the former CPCPRC facility is In-situ Chemical Oxidation using Catalyzed Hydrogen Peroxide that will be injected into the shallow and deep aquifers beneath the Chevron facility. A groundwater monitoring program will be implemented to evaluate the overall remedial program efficiency in reducing the concentrations of the contaminant of concerns in the deep and shallow aquifers.

At this time, the impacts and detailed assessment of nature and extent of this organic plume have not been vetted in this CMA. The specifics of the implementation of the chemical oxidation remedy at the former CPCPRC facility and the potential impact of the CPCPRC remediation system on groundwater at the AES-PR facility is not known at this time. The design of the final corrective measure for the AES-PR Staging Area will take into account the CPCPRC remedial activities. Impacts to Site RO system for treatment of groundwater collected as part of any of the remedial options considered would be part of a future corrective measures work element.

2.4 GROUNDWATER PROTECTION STANDARDS

The GWPS are defined in the CCR Rule at §257.95 Assessment monitoring program:

> (h) The owner or operator of the CCR unit must establish a groundwater protection standard for each constituent in appendix IV to this part detected in the groundwater. The groundwater protection standard shall be:
>
> > (1) For constituents for which a maximum contaminant level (MCL) has been established under §§141.62 and 141.66 of this title, the MCL for that constituent;
> > (2) For constituents for which an MCL has not been established, the background concentration for the constituent established from wells in accordance with §257.91; or
> > (3) For constituents for which the background level is higher than the MCL identified under paragraph (h)(1) of this section, the background concentration.

USEPA published Amendments to the National Minimum Criteria Finalized in 2018 (Phase One, Part One) in the Federal Register on July 30, 2018 (USEPA, 2018b). This included revising the groundwater protection standard for constituents that do not have an established drinking water standard (or MCL) at §257.95 Assessment monitoring program (h) (2):

- Cobalt – 6 ug/L (micrograms per liter)

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[2] Corrective Measures Study Report Chevron Phillips Chemical Puerto Rico Core, LLC Guayama, Puerto Rico (PEI April 2016).

[3] Statement of Basis Final Remedy Decision Chevron Phillips Chemical (USEPA, June 2017).

- Lead – 15 ug/L
- Lithium – 40 ug/L
- Molybdenum – 100 ug/l

Because the GWPS is the higher of the drinking water concentration and the background concentration, and background concentrations are specific to each ash management area, the GWPS are considered to be site-specific.

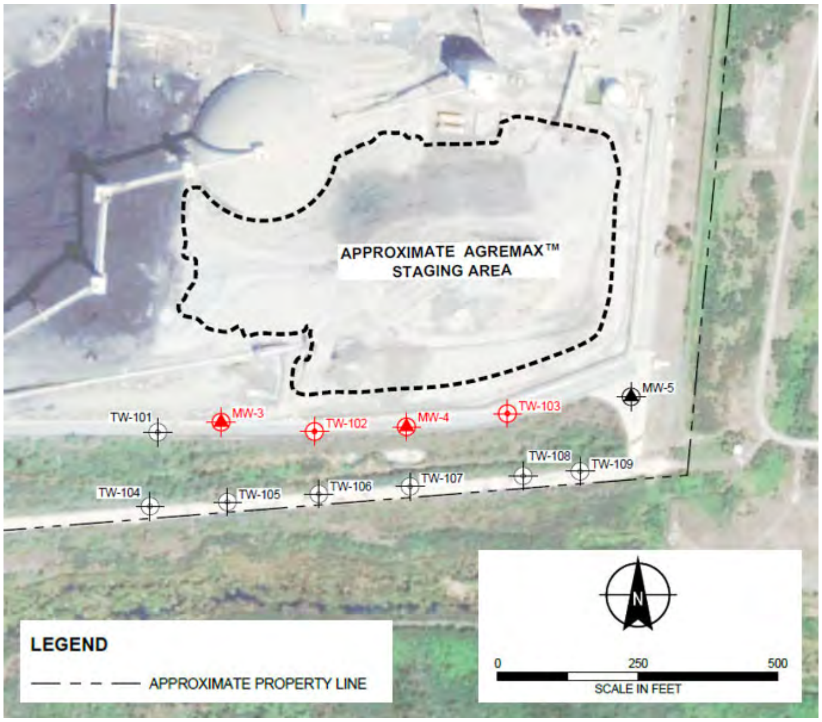
DNA completed a statistical evaluation of groundwater samples using the methods and procedures outlined in the *Groundwater Monitoring System & Sampling and Analysis Program* (DNA August 2017) [available at http://aespuertorico.com/wp-content/uploads/2017/10/AESPuerto-Rico_Groundwater_Monitoring_System.pdf] to develop the background concentrations and then the site-specific GWPS for each Appendix IV constituent.

Groundwater results were compared statistically to the site-specific GWPS. SSLs above the GWPS are limited to three constituents at two monitoring wells: lithium (MW-4), molybdenum (MW-3 and MW-4), and selenium (MW-3) as shown on **Figure 2-1**. A sample-by-sample comparison of the groundwater analytical results to GWPS is provided in **Table I**. These three Appendix IV constituents (lithium, molybdenum, and selenium), their respective concentrations compared to the GWPS and associated details of the CSM are used to assemble the viable list of remedial alternatives considered in this CMA.

2.5 NATURE AND EXTENT OF GROUNDWATER IMPACTS

AES-PR initiated a nature and extent (N&E) investigation as required by the CCR Rule in May 2019 by contracting DNA to install two (2) temporary piezometers immediately north and east of the Staging Area and nine (9) temporary monitoring wells (N&E wells) with three (TW-101, TW-102 & TW-103) in line with the three downgradient monitoring wells at the Staging Area boundary and six further downgradient along the southern Site property line. The N&E wells are screened to directly above a stiff, highly plastic Clay, that is the confining layer for the uppermost aquifer, screened in the same zone as the Staging Area monitoring wells. Wells include 10 feet of screen length with total depths ranging from approximately 14 to 25 feet bgs. Depth to water measurements collected at the piezometers and monitoring wells as part of the N&E investigation confirmed the general southerly groundwater flow direction across the Site. The N&E investigation report entitled "Groundwater Characterization Report" is included as **Appendix A**. Locations of temporary piezometers, temporary and permanent monitoring well locations are shown on **Figure 1-3**.

Analytical results from the N&E wells (**Table I**) indicate that lithium, molybdenum and selenium concentrations are limited in their extent. While analytical results from monitoring wells directly adjacent to the Staging Area indicated concentrations of lithium, molybdenum, and selenium above GWPS in two of the three N&E wells, concentrations of lithium, molybdenum, and selenium in N&E wells located less than 200 feet down gradient and along the southern property boundary, are well below the GWPS and in most cases are even below the laboratory reporting limits. In other words, concentrations of lithium, molybdenum and selenium are not elevated beyond AES-PR's property boundary.



Pictured here and shown on **Figure 2-1** wells with concentrations above GWPS are marked in red and those below GWPS are marked in black and white. Analytical results from the N&E wells were used to determine and assess corrective measures alternatives.

3. Risk Assessment and Exposure Evaluation

A "*Groundwater Risk Evaluation*" report has been prepared by Haley & Aldrich, as a companion to this CMA document, and is presented in **Appendix B**. A summary of this report is also available on the AES-PR CCR Rule website [http://aespuertorico.com/ccr/] – titled *Summary Haley & Aldrich Groundwater Risk Evaluation*. The purpose of the risk evaluation report is to provide the information needed to interpret and meaningfully understand the groundwater monitoring data collected and published for the Staging Area under the CCR Rule. In addition, AES-PR proactively took an additional step of evaluating potential groundwater-to-surface water transport and exposure pathways in the risk evaluation.

The risk evaluation report was completed by developing a CSM to identify the potential for human or ecological exposure to constituents that may have been released to the environment. The Staging Area is located at the ground surface and does not extend into the subsurface or the water table. Constituents present in the AGREMAX™ can be dissolved into infiltrating water (from precipitation and wetting for dust control) and those constituents may move through the subsurface and could then be present in shallow groundwater. Constituents could move with groundwater as it flows, usually in a downgradient/downhill direction. The general direction of groundwater flow at the Site is south/southwest toward Las Mareas Harbor.

Groundwater moves slowly through the rock and soils beneath the ground. Like surface water, it also moves from areas of high elevation to areas of low elevation and can move into adjacent surface water. Any potential release of constituents to groundwater from either the adjacent industrial sites or AES-PR will be limited in extent by the direction of groundwater flow and will not impact areas further inland.

There are no on-site users of shallow groundwater adjacent to AES-PR. As discussed in **Section 2.3** above, the CPCPRC is in Corrective Action overseen by USEPA. CPCPRC conducted a private well investigation as part of a sitewide risk characterization (CPCPRC, 2007) of the property immediately to the east of the AES-PR facility. As documented in the 2007 *CPCPRC Risk Characterization Report*, there are some census-designated communities and smaller villages near the CPCPRC and AES-PR facilities (Guayama, Quebrada, Corazon, Jobos and Puerto Jobos, and Barrancas), however none of these communities is considered downgradient (i.e., south of AES-PR and CPCPRC) and, therefore, would not be impacted by groundwater from either facility. Las Mareas is the only community downgradient of CPCPRC and potentially AES-PR, and according to the 2007 *CPCPRC Risk Characterization Report*, houses in Las Mareas obtain water from a public potable water pipeline and no existing private wells were found in the area. The 2007 CPCPRC Report also did not find any domestic wells constructed near the CPCPRC facility.

Thus, with respect to shallow groundwater, there are no users of the groundwater near the AES-PR facility. Depth to groundwater in this area is approximately 10 feet, thus, contact with groundwater during a short-term construction/excavation event is unlikely.

Analytical data from samples collected from groundwater monitoring wells and Las Mareas Harbor have been included in the risk evaluation. The samples have been analyzed for constituents that are commonly associated with CCR. However, it is recognized by the USEPA that all of these constituents can also be naturally occurring and can be found in rocks, soils, water and sediments; thus, the it is necessary to understand what the naturally occurring background levels are for these constituents. The CCR Rule requires sampling and analysis of upgradient and/or background groundwater just for this reason. Groundwater samples have also been analyzed for volatile and semi-volatile organic compounds to evaluate groundwater impacts at AES-PR from the adjoining CPCPRC property to the east, as discussed above.

To answer the question, "Are the constituent concentrations high enough to potentially exert a toxic effect?" health risk-based screening levels were used for comparison to the data. Of the groundwater data collected, the majority – 94% – are below GWPS, i.e., below drinking water standards. There is no direct exposure to groundwater by human or ecological receptors.

The groundwater results from the CCR Rule monitoring wells were also compared to ecological screening levels for surface water. All results are below the ecological screening levels with the exception of the results for selenium for MW-3, which is located immediately downgradient of the Storage Area (see **Table 8** in **Appendix B**). Two important observations can be made for the comparison of the analytical results from the N&E investigation (data reported at the end of **Table I**). Only two of the wells (TW-102 and TW-103) have a concentration of selenium above the ecological screening level, and both of these wells are also immediately downgradient of the Staging Area (see **Figure 2-1**). All constituent concentrations in the additional N&E wells located less than 200 ft downgradient of the Staging Area, at the property boundary, are below the ecological screening levels.

There is a narrow marshy area between the Staging Area and the downgradient property boundary. While groundwater may have some flow component into the marshy area, the ecological screening level for selenium is based on fish reproduction, and that type of exposure is not applicable to a marshy area. The N&E well results indicate that constituents in groundwater are not moving off of the Site property at concentrations above GWPS or above the ecological screening levels. The nearest downgradient surface water body is Las Mareas Harbor.

The Las Mareas Harbor sample was compared to risk-based human recreational screening levels, to ecological screening levels, and to seawater results available from the scientific literature. There are no analytical results for the Las Mareas Harbor sample that are above marine ecological screening levels, and with the exception of arsenic no analytical results above human health recreational screening levels; however, the arsenic concentrations are comparable to seawater concentrations worldwide (in fact, arsenic concentrations I seawater worldwide are above the human health recreational screening level). Thus, the Las Mareas Harbor sample results do not show evidence of impact of constituents derived from AES-PR. This is important in that the absence of concentrations above risk-based screening levels means that there is not a significant pathway of exposure.

In addition, a surface water dilution and attenuation factor (SW-DAF) was derived for groundwater that may flow to the Caribbean Sea at Las Mareas Harbor; the conservatively calculated SW-DAF is 1,300 (a unitless value). When the SW-DAF is applied to the lowest conservative risk-based screening level for marine surface water, the results indicate that groundwater concentrations at the Staging Area could be an order or more magnitude higher before an adverse impact on Las Mareas Harbor could occur.

More importantly, the analytical results from the N&E groundwater monitoring wells located at the property boundary – less than 200 feet downgradient from the CCR Rule wells, which are located directly adjacent to the Staging Area – demonstrate that there are no concentrations of the SSL constituents above GWPS in these wells. In other words, concentrations of lithium, molybdenum and selenium are not elevated beyond AES-PR's property boundary.

This evaluation demonstrates that the impacts of the Staging Area are limited and do not extend beyond the AES-PR property boundary. There is no impact on drinking water and there is no evidence of impact to human health or the environment. There are no downgradient users of groundwater as drinking water – thus, there is no impact on drinking water. Las Mareas Harbor does not show impacts. There is no exposure to CCR-derived constituents detected in groundwater at the AES-PR facility – either via groundwater use or surface water. Even for the very few results that may be above screening values for some of the groundwater sampling events, there is no complete drinking water exposure pathway to groundwater. Where there is no exposure, there is no risk.

Therefore, because no adverse risk currently exists, any of the remedies considered in this CMA are all protective of human health and the environment, and implementation of any of the remedial alternatives will not result in a meaningful reduction in risk to groundwater-related exposures or risk.

4. Corrective Measures Alternatives

4.1 CORRECTIVE MEASURES ASSESSMENT GOALS

As noted in §257.96(a), within 90 days of detecting Appendix IV SSLs, "the owner or operator must initiate an assessment of corrective measures to prevent further releases, to remediate any releases and to restore affected area to original conditions". The corrective measures evaluation that is discussed below and in subsequent sections provides an analysis of the effectiveness of five potential corrective measures in meeting the requirements and objectives of remedies as described under §257.97 (also shown on **Table II**). Additional remedial alternatives were considered but were determined to not be viable for remediating groundwater at the Staging Area. By meeting these requirements, this assessment also meets the requirements promulgated in §257.96 for the balancing criteria (provided in more detail in **Section 1.3**) which includes an evaluation of:

- The performance, reliability, ease of implementation, and potential impacts of appropriate potential remedies, including safety impacts, cross-media impacts, and control of exposure to residual contamination;
- The time required to complete the remedy; and
- The institutional requirements, such as state or local permit requirements or other environmental or public health requirements that may substantially affect implementation of the remedy.

The criteria listed above are included in the balancing criteria considered during the corrective measures evaluation, described in **Section 5**.

4.2 GROUNDWATER FATE AND TRANSPORT MODELING

Groundwater at the Site was modeled utilizing Groundwater Vista Version 7 for flow and solute transport. The model was constructed, calibrated, and subsequent simulations run to evaluate remedy alternatives for Appendix IV constituents above the GWPS. Site-specific parameters (i.e., groundwater elevations and hydraulic conductivity) were utilized for model preparation. MODFLOW 2005, a finite difference three-dimensional solver, was utilized for groundwater flow estimation. Modeled groundwater elevations were compared to observed values from the on-site well network to achieve a calibration of less than 10% scaled root mean squared of measured water levels. Once groundwater flow was calibrated in the model, solute transport was completed using MT3DMS, a three-dimensional solute transport modeling program. Parameters affecting transport such as advection, diffusion, dispersion, and adsorption are utilized within the MT3DMS package to estimate solute transport within the model domain.

The calibrated flow models were used to simulate the different remediation alternatives and the effects they have on groundwater quality through time. These simulations are incorporated into the discussion on remediation alternatives provided below.

4.3 CORRECTIVE MEASURES ALTERNATIVES

Corrective measures are considered complete when constituent concentrations in groundwater impacted by the Staging Area are no longer above the Appendix IV GWPS for three consecutive years of groundwater monitoring. In accordance with §257.97, the groundwater corrective measures being considered must meet, at a minimum, the following threshold criteria (provided in more detail in **Section 1.3**):

1. Be protective of human health and the environment;
2. Attain the GWPS as specified pursuant to §257.95(h);
3. Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituents in Appendix IV to this part into the environment;
4. Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
5. Comply with standards (regulations) for management of waste as specified in §257.98(d).

Each of the remedial alternatives assembled in this CMA meet the requirements of the threshold criteria listed above.

Each of the five remedial alternatives assume continued operation of the Staging Area.

4.3.1 Alternative 1: Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ Monitored Natural Attenuation (MNA)

This alternative involves the prevention of AGREMAX™ contact with the ground via installation of a synthetic liner in the Staging Area. Passive treatment of groundwater would occur via natural geochemical processes which will reduce concentrations of CCR-derived constituents in groundwater, referred to as monitored natural attenuation, or MNA. This liner alternative would prevent the future potential release of CCR constituents during continued use of the Staging Area.

As stated, lining the Staging Area would reduce infiltration of surface water to groundwater thereby isolating source material. The volume of AGREMAX™ would be reduced to allow for installation of the liner in two phases. All AGREMAX™ contact with the ground would be eliminated as no AGREMAX™ would remain in contact with ground following installation of the liner. Liner installation can be completed safely, in compliance with applicable federal and state regulations, and be protective of public health and the environment. The liner would be a composite/synthetic system consisting of (from bottom to top) a geosynthetic clay liner overlaid with geomembrane, a geocomposite drainage layer, a protective layer, and lastly a dye layer[4]. Liner installation is expected to be completed in two phases. Phase 1 would involve lining one half of the Staging Area and would necessitate removal of all AGREMAX™ from that half of the area while product would remain on the Phase 2 area. During Phase 2 liner installation, the remaining AGREMAX™ would be moved to the completed/lined Phase 1 area. The liner would be installed within the current footprint of the Staging Area. Following liner installation, AGREMAX™ could be managed anywhere within the lined Staging Area.
MNA is a viable remedial technology recognized by both state and federal regulators that is applicable to inorganic compounds in groundwater. The USEPA defines MNA as “the reliance on natural attenuation processes to achieve site-specific remediation objectives within a time frame that is reasonable compared to that offered by other more active methods.” The “natural attenuation processes” that are at work in such a remediation approach include a variety of physical, chemical, or

[4] The dye layer is used to alert workers in the area that movement of material or excavation should not occur below the dye layer to maintain the integrity of the liner system.

biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume, or concentration of contaminants in soil or groundwater. These in-situ processes may include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants depending on the constituent (USEPA, 2015). When combined with the prevention of the AGREMAX™ contact with the ground and installation of a synthetic liner to address the source by limiting the infiltration of precipitation into and through the CCR, MNA can reduce concentrations of lithium, molybdenum, and selenium in groundwater at the Staging Area.

4.3.2 Alternative 2 – Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment

This alternative involves long-term downgradient pumping of groundwater to hydraulically control downgradient migration of Appendix IV constituents in groundwater, with treatment of pumping system effluent in the existing plant wastewater treatment system and MNA for groundwater downgradient of the Staging Area. This alternative would rely strictly on groundwater pumping wells to control the downgradient migration of Appendix IV constituents in groundwater. The groundwater pumped to maintain hydraulic control would be piped to the existing plant RO treatment system. Based on review of system specifications provided by AES-PR and the report from AES-PR personnel, the primary RO system is currently not in use and could provide treatment capacity with some limited plumbing and limited system modifications.

Implementation of a hydraulic containment (HC) system would require a detailed design effort with bench scale testing to verify groundwater treatment by the existing treatment facility. Pilot testing, such as pumping tests and additional groundwater modeling, would be needed to verify the hydraulic capture zone.

Following the installation of the groundwater pumping well network and connection to the existing RO treatment system, AES-PR would implement activities that include operation and maintenance (O&M) of the HC system, long-term groundwater sampling to monitor HC system and MNA performance, and water treatment system performance monitoring.

4.3.3 Alternative 3 – Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation

This alternative involves long-term downgradient pumping of groundwater to hydraulically control downgradient migration of Appendix IV constituents in groundwater, with direct discharge of pumping system effluent to the coal pile runoff pond and MNA for groundwater downgradient of the Staging Area. The groundwater pumped to maintain hydraulic control would be conveyed to the coal pile runoff pond or used for AGREMAX™ dust suppression (no additional treatment is planned for this alternative).

Implementation of a HC system would require a detailed design effort with pilot testing, such as pumping tests and additional groundwater modeling, to verify the hydraulic capture zone. Following the installation of the groundwater pumping well network and associated pipework, AES-PR would implement activities that include O&M of the HC system, long-term groundwater sampling to monitor HC system and MNA performance, and long-term groundwater elevation monitoring to confirm HC system performance.

4.3.4 Alternative 4 – Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment

This alternative involves low-permeability barrier wall installation and long-term pumping of groundwater to hydraulically control downgradient migration of Appendix IV constituents in groundwater, with treatment of pumping system effluent in the existing plant treatment system, and MNA for groundwater downgradient of the Staging Area. This alternative would rely on a combination of a partial barrier wall, keyed into the underlying clay unit, and groundwater pumping wells upgradient of the barrier wall to control the downgradient migration of Appendix IV constituents in groundwater. Groundwater pumped to maintain hydraulic control would be piped to the existing RO treatment system.

Implementation of a HC system would require a detailed design effort with bench scale testing to verify groundwater treatment by the existing treatment facility. Pilot testing, such as pumping tests and additional groundwater modeling, would be needed to verify the hydraulic capture zone. A detailed design would also be required for the barrier wall.

Following the installation of the groundwater pumping well network, connection to the existing RO treatment system, and barrier wall installation, AES-PR would implement activities that include O&M of the HC system, long-term groundwater sampling to monitor HC system performance and MNA performance, and water treatment system performance monitoring.

4.3.5 Alternative 5 – Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation

This alternative involves low-permeability barrier wall installation and long-term pumping of groundwater to hydraulically control downgradient migration of Appendix IV constituents in groundwater, and MNA for groundwater downgradient of the Staging Area. This alternative would rely on a combination of a partial barrier wall, keyed into the underlying clay unit, and groundwater pumping wells upgradient of the barrier wall to control the downgradient migration of Appendix IV constituents in groundwater. The groundwater pumped to maintain hydraulic control would be conveyed to the coal pile runoff pond or used for AGREMAX™ dust suppression (similar to Alternative 3, no additional treatment is planned).

Implementation of a HC system would require a detailed design effort with pilot testing, such as pumping tests and additional groundwater modeling, to verify the hydraulic capture zone. A detailed design would also be required for the barrier wall. Following the installation of the groundwater pumping well network and associated pipework, and barrier wall, AES-PR would implement activities that include O&M of the HC system and long-term groundwater elevation monitoring to confirm HC system performance.

5. Comparison of Corrective Measures Alternatives

The purpose of this section is to evaluate, compare, and rank the five corrective measures alternatives using the balancing criteria described in §257.97.

5.1 EVALUATION/BALANCING CRITERIA

In accordance with §257.97, remedial alternatives that satisfy the threshold criteria are then compared to four balancing (evaluation) criteria. The balancing criteria allow a comparative analysis for each corrective measure, thereby informing the final corrective measure selection. The four balancing criteria include the following (provided in more detail in **Section 1.3**):

1. The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
2. The effectiveness of the remedy in controlling the source to reduce further releases;
3. The ease or difficulty of implementing a potential remedy; and
4. The degree to which community concerns are addressed by a potential remedy.

The degree to which community concerns are addressed by the potential remedies will be considered following a public information session to discuss the results of the corrective measures assessment with interested and affected parties and will be held at least 30 days prior to remedy selection in accordance with 257.96(e).

5.2 COMPARISON OF ALTERNATIVES

This section compares the alternatives to each other based on evaluation of the balancing criteria listed above. Each of the balancing criteria consists of several sub criteria listed in the CCR Rule (provided in more detail in **Section 1.3**), which have been considered in this assessment. The goal of this analysis is to evaluate the alternatives based on whether each is technologically feasible, relevant and readily implementable, provides adequate protection to human health and the environment, and minimizes impacts to the community as compared to the other alternatives. A summary of remedial alternatives is provided in **Table III**.

A graphic is provided within each subsection below to provide a visual snapshot of the favorability of each alternative, where green represents “most favorable”, yellow represents “less favorable”, and red represents “least favorable.”

Each of the five remedial alternatives evaluated here assume continued operation of the Staging Area. Moreover, the analytical results from the N&E wells (**Table I**) indicate that lithium, molybdenum, and selenium concentrations are limited in their extent, and in fact do not extend to the nearby southern property boundary.

5.2.1 Balancing Criteria 1 - The Long- and Short-Term Effectiveness and Protectiveness of the Potential Remedy, along with the Degree of Certainty that the Remedy Will Prove Successful

This balancing criterion takes into consideration the following sub criteria relative to the long-term and short-term effectiveness of the remedy, along with the anticipated success of the remedy.

5.2.1.1 *Magnitude of reduction of existing risks*

As summarized in **Section 3** and further confirmed by the results of the N&E evaluation the Staging Area does not pose a risk to human health and the environment. Therefore, the remedial alternatives considered are not necessary to reduce an assumed risk posed by Appendix IV constituents in groundwater because no such adverse risk exists. However, other types of impacts and risks (i.e., the risk of implementing the remedies sometimes referred to as "risk of remedy") can be posed by implementation of the remedial alternatives considered here.

Each of the five remedial alternatives assume continued operation of the Staging Area. The activities associated with Alternative 1 (prevention of AGREMAX™ ground contact, subsequent lining of the Staging Area for placement of material in the future, combined with MNA) are routine, and consistent with current practices. Therefore, relative to risk of remedy, the alternatives are considered equivalent.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria i) Magnitude of reduction of risks					

5.2.1.2 *Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy*

Alternative 1 (Lining with MNA) has the lowest long-term residual risk in that prevention of AGREMAX™ ground contact eliminates the source and lining of the Staging Area with a synthetic liner system reduces the likelihood of future releases to groundwater. Therefore, Alternative 1 is considered the most favorable. For Alternatives 2 and 3 (HC with and without ex-situ treatment, respectively), dissolved phase Appendix IV constituents in groundwater are addressed through hydraulic containment and MNA, while Alternatives 4 and 5 (HC with a barrier wall, with and without ex-situ treatment, respectively and MNA) incorporate the use of a subsurface barrier wall to further impede downgradient migration of groundwater and avoid salt water intrusion. Since Alternatives 2 through 5 do not remove the source and do not include the use of a low-permeability liner to isolate the Staging Area in the future, a slightly greater residual risk of further release exists, and these four alternatives are considered less favorable than Alternative 1.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria ii) Magnitude of residual risk in terms of likelihood of further release					

5.2.1.3 The type and degree of long-term management required, including monitoring, operation, and maintenance

Alternative 1 (Lining with MNA) is the most favorable alternative with respect to this criterion because it requires the least amount of long-term management and involves no mechanical systems as part of the remedy. Alternatives 2 through 5, which all include active hydraulic containment, are less favorable since they require mechanical systems (well pumps and/or treatment system) long-term until the GWPS is attained.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria iii) Type and degree of long-term management required					

5.2.1.4 Short-term risks that might be posed to the community or the environment during implementation of such a remedy

Each of the five remedial alternatives assume continued operation of the AGREMAX™ Staging Area. Therefore, relative to short-term risks to the community or environment, each alternative is considered equivalent.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria iv) Short term risk to community or environment during implementation					

5.2.1.5 Time until full protection is achieved

There is no complete drinking water exposure pathway to groundwater. Where there is no exposure, there is no risk. Therefore, protection is already achieved. Alternatives 2 through 5 all include hydraulic containment and are anticipated to take a similar period of time until natural attenuation and active pumping reduce Appendix IV constituents to GWPS concentrations. These four alternatives are considered equally favorable due to the similar timeframes. Alternative 1 (Lining with MNA) is considered less favorable since the time period to achieve the GWPS is predicted to be slightly longer than Alternatives 2 through 5.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria v) Time until full protection is achieved					

5.2.1.6 Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment

Alternatives 1 (Lining with MNA), 3 (HC with no treatment), and 5 (HC with no treatment, with barrier wall) all have similar, minimal potential for exposure to humans and environmental receptors during monitoring well system installation; and installation of the barrier wall and/or HC system, respectively. No groundwater treatment is used for Alternatives 3 and 5, therefore a concentrated waste stream and spent treatment media are not produced. These three alternatives are considered most favorable relative to potential exposure to humans and environmental receptors.

Alternatives 2 (HC with treatment) and 4 (HC with treatment and barrier wall) are considered less favorable since a concentrated waste stream will be generated and spent treatment/filtration media may need to be transported off-site for disposal, which creates a potential for exposure during the operation period.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria vi) Potential for exposure of humans and environmental receptors to remaining wastes					

5.2.1.7 Long-term reliability of the engineering and institutional controls

Alternative 1 (Lining with MNA) includes Staging Area lining and long-term monitoring which are common methods for long-term waste management. Hydraulic containment (Alternatives 2 through 5) is considered proven technology and would have high long-term reliability but relies on mechanical systems to attain GWPS. Alternative 1 (Lining with MNA) is considered the most favorable because no additional ongoing operations and maintenance (O&M) would be needed, other than periodic groundwater sampling and verification of decreasing concentrations since the liner system is a reliable technology.

Alternatives 4 (HC with treatment and barrier wall) and 5 (HC with no treatment, with barrier wall) are considered reliable, but less favorable when compared to Alternative 1 since they both rely on mechanical systems such as pumps, pipework, etc. Alternatives 2 (HC with treatment) and 3 (HC with no treatment) are considered the least favorable since they both rely on mechanical systems to operate, and uncertainty is introduced since a barrier wall is not included to improve pumping efficiency and avoid saltwater intrusion at the pumping wells. Saltwater intrusion at the pumping wells would not only create corrosion issues but would reduce the reliability/operability of the treatment system (Alternative 2) or ability to directly discharge the pumping effluent (Alternative 3) to the coal pile runoff pond.

For all alternatives, institutional controls, such as recording of an environmental covenant restricting the use of groundwater can easily be implemented because the AGREMAX™ Staging Area is located on property owned by AES.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria vii) Long-term reliability of engineering and institutional controls					

5.2.1.8 Potential need for replacement of the remedy

Prevention of AGREMAX™ ground contact by installation of a synthetic liner at the Staging Area (Alternative 1) is considered permanent and is expected to be effective. Also lining the Staging Area will isolate AGREMAX™ from groundwater in the future, Alternative 1 is considered the most favorable.

Since Alternatives 2 and 3 (HC with and without treatment, respectively) rely on groundwater pumping to achieve the GWPS, and the pumping wells may be susceptible to saltwater intrusion, these alternatives are considered the least favorable. Alternatives 4 and 5 (HC with and without treatment, respectively, plus a barrier wall) include a secondary remedial technology to contain groundwater and reduce the likelihood of saltwater intrusion, these alternatives are considered more favorable than Alternatives 2 and 3, but less favorable than Alternative 1 (Lining with MNA).

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 1 - Subcriteria viii) Potential need for replacement of the remedy					

5.2.1.9 Long- and short-term effectiveness and protectiveness criterion summary

The following graphic provides a summary of the long- and short-term effectiveness and protectiveness of the potential remedy, along with the degree of certainty that the remedy will prove successful. Alternative 1 (Lining with MNA) is the most favorable. There is a similar timeframe for all alternatives to meet the GWPS, with the timeline for Alternative 1 being slightly longer than Alternatives 2 through 5 which include active pumping. Alternative 1 (Lining with MNA) does not include additional treatment technology aside from MNA and, therefore, long-term management requirements are minimal. Alternative 1 (Lining with MNA) does not rely on mechanical systems aside from low permeability lining. Alternatives 2 (HC with treatment) and 4 (HC with treatment and barrier) provide groundwater treatment but require additional long-term operation and maintenance and will generate a secondary waste stream. Alternatives 2 (HC with treatment) and 3 (HC with no treatment) are considered the least favorable since the long-term reliability is uncertain due to the absence of a barrier wall and have the greatest potential for needing replacement.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
CATEGORY 1 Long- and Short Term Effectiveness, Protectiveness, and Certainty of Success					

5.2.2 Balancing Criteria 2 - The Effectiveness of the Remedy in Controlling the Source to Reduce Further Releases

This balancing criterion takes into consideration the ability of the remedy to control a future release, and the extensiveness of treatment technologies that will be required.

5.2.2.1 The extent to which containment practices will reduce further releases

For remedial Alternative 1, installation of the liner system will minimize infiltration of precipitation and decrease/prevent the flux of Appendix IV constituents to groundwater by creating a physical barrier in the future. The construction period to place the liner is expected to be short-term. Alternatives 4 and 5 (HC with treatment and no treatment, respectively, and barrier wall) are expected to effectively control the down-gradient migration of groundwater through groundwater pumping and the subsurface low-permeability barrier wall. These three alternatives (Alternatives 1, 4, and 5) are considered most favorable for reducing further releases.

Alternatives 2 and 3 (HC with treatment and no treatment, respectively) are considered less favorable since these two alternatives rely on groundwater pumping only. Without a barrier wall, the ability to control the down-gradient migration of groundwater, and to avoid saltwater intrusion, is less certain.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 2 - Subcriteria i) Extent to which containment practices will reduce further releases					

5.2.2.2 The extent to which treatment technologies may be used

No groundwater treatment technologies, other than natural attenuation, will be used for Alternative 1 (Lining with MNA). There would be no ongoing operation and maintenance of a treatment technology, other than periodic groundwater monitoring. Alternative 3 (HC with no treatment) relies only on groundwater pumping with no treatment. Therefore, Alternatives 1 and 3 are considered the most favorable since the remedial approaches are the least complex.

Alternatives 2 (HC with treatment), 4, (HC with treatment and barrier wall), and 5 (HC with no treatment and barrier wall) use additional technologies, which increases complexity and reliance on engineering controls. Therefore, these three Alternatives are considered less favorable when compared to Alternatives 1 and 3.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 2 - Subcriteria ii) Extent to which treatment technologies may be used					

5.2.2.3 Effectiveness of the remedy in controlling the source to reduce further releases summary

The graphic below provides a summary of the effectiveness of the remedial alternatives to control the source to reduce further releases. Alternative 1 (Lining with MNA) is considered the most favorable since prevention of ground contact and isolation of the AGREMAX™ is expected to be effective at controlling future releases and does not rely on active containment or treatment technology. Alternatives 2 through 5 are all expected to be effective at controlling the source to reduce a further release, but all four alternatives rely on mechanical systems and are considered less favorable when compared to Alternative 1.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
CATEGORY 2 Effectiveness in controlling the source to reduce further releases					

5.2.3 Balancing Criteria 3 - The Ease or Difficulty of Implementing a Potential Remedy

This balancing criterion takes into consideration technical and logistical challenges required to implement a remedy, including practical considerations such as equipment availability and disposal facility capacity.

5.2.3.1 Degree of difficulty associated with constructing the technology

Installation of the hydraulic containment system considered under Alternatives 2 (HC with treatment) and 3 (HC with no treatment) is considered straightforward and readily constructible. Alternative 2 (HC with treatment) will utilize the existing treatment system, therefore, no additional difficulty is anticipated. Due to the ease of construction, Alternatives 2 (HC with treatment) and 3 (HC with no treatment) are considered the most favorable.

Installation of the hydraulic containment system considered under Alternatives 4 (HC with treatment and barrier wall) and 5 (HC with no treatment, with barrier wall) are also considered straightforward, however these two alternatives also include the installation of a low-permeability subsurface barrier wall. Relative to Alternatives 2 and 3, Alternatives 4 and 5 are considered less favorable due to the additional complexity of installing the barrier wall.

While the Alternative 1 is considered readily constructible, it is considered less favorable than Alternatives 2 and 3.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 3 - Subcriteria i) Degree of difficulty associated with constructing the technology					

5.2.3.2 *Expected operational reliability of the technologies*

Alternative 1 (Lining with MNA) includes Staging Area lining and long-term monitoring which are common methods for long-term waste management. Hydraulic containment (Alternatives 2 through 5) are considered proven technologies and would have high long-term reliability but rely on mechanical systems to attain GWPS. Alternative 1 (Lining with MNA) is considered the most favorable because no additional ongoing O&M would be needed, other than periodic groundwater sampling and verification of decreasing concentrations.

Alternatives 4 (HC with treatment and barrier wall) and 5 (HC with no treatment and barrier wall) are considered reliable, but less favorable when compared to Alternative 1 since they both rely on mechanical systems such as pumps, pipework, etc. Alternatives 2 (HC with treatment) and 3 (HC with no treatment) are considered the least favorable since they both rely on mechanical systems to operate, and uncertainty is introduced since a barrier wall is not included to improve pumping efficiency and avoid salt water intrusion at the pumping wells. Saltwater intrusion at the pumping wells would not only create corrosion issues but would reduce the reliability/operability of the treatment system (Alternative 2) or ability to directly discharge the pumping effluent (Alternative 3).

For all alternatives, institutional controls, such as recording of an environmental covenant restricting the use of groundwater, can easily be implemented because the AGREMAX™ Staging Area is located on property owned by AES.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 3 - Subcriteria ii) Expected operational reliability of the technologies					

5.2.3.3 *Need to coordinate with and obtain necessary approvals and permits from other agencies*

Alternatives 4 (HC with treatment and barrier wall) and 5 (HC with no treatment, with barrier wall) are considered the most favorable since inclusion of the barrier wall is expected to reduce the groundwater pumping rate to maintain hydraulic control. While permitting will be required, including permitting for barrier wall construction, the groundwater withdrawal will be minimized to the extent practicable. Relative to Alternatives 4 and 5, Alternatives 2 (HC with treatment) and 3 (HC with no treatment) are considered less favorable due to the higher pumping rate that will be needed to maintain hydraulic control.

Alternative 1 (Lining with MNA) may require permits for liner system construction. Therefore, relative to Alternatives 4 and 5, Alternative 1 is also considered less favorable.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 3 - Subcriteria iii) Need to coordinate with and obtain necessary approvals and permits from other agencies					

5.2.3.4 *Availability of necessary equipment and specialists*

For all alternatives, construction equipment is readily available, and specialists are not anticipated. Therefore, the alternatives are considered equally favorable.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 3 - Subcriteria iv) Availability of necessary equipment and specialists					

5.2.3.5 *Available capacity and location of needed treatment, storage, and disposal services*

Alternatives 2 through 5, which include hydraulic containment, are considered the most favorable since the AGREMAX™ Staging Area continues to operate without modification or interruption. Pumping well effluent will either be discharged to the coal pile runoff pond (Alternatives 3 and 5) or treated on-site using the existing RO system (Alternatives 2 and 4). Alternative 1 (Lining with MNA) is considered less favorable since it will require additional management of AGREMAX™ during the phase liner system construction.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
Category 3 - Subcriteria v) Available capacity and location of needed treatment, storage, and disposal services					

5.2.3.6 *Ease or difficulty of implementation summary*

The color ribbon below provides a summary of the ease or difficulty that will be needed to implement each alternative. Alternatives 4 (HC with treatment and barrier wall) and 5 (HC with no treatment, with barrier wall) are the most favorable, while Alternatives 1 (Lining with MNA), 2 (HC with treatment) and 3 (HC with no treatment) are less favorable for various degrees of difficulty in implementing the remedy.

	Alternative 1 Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ MNA	**Alternative 2** Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	**Alternative 3** Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	**Alternative 4** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	**Alternative 5** Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation
CATEGORY 3 Ease of implementation					

6. Summary

This Corrective Measures Assessment has evaluated the following alternatives:

- Alternative 1: Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ Monitored Natural Attenuation (MNA)
- Alternative 2: Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment
- Alternative 3: Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation
- Alternative 4: Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment
- Alternative 5: Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation

In accordance with §257.97, each of these alternatives has been confirmed to meet the following threshold criteria:

- Be protective of human health and the environment;
- Attain the GWPS;
- Control the source(s) of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of constituent of concerns to the environment;
- Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, considering factors such as avoiding inappropriate disturbance of sensitive ecosystems; and
- Comply with standards (regulations) for waste management.

In addition, in accordance with §257.96, each of the alternatives has been evaluated in the context of the following balancing criteria:

- The long- and short-term effectiveness and protectiveness of the potential remedy(s), along with the degree of certainty that the remedy will prove successful;
- The effectiveness of the remedy in controlling the source to reduce further releases;
- The ease or difficulty of implementing a potential remedy; and
- The degree to which community concerns are addressed by a potential remedy.

This Corrective Measures Assessment, and the input received during the public comment period, will be used to identify and select a final corrective measure for implementation at the AES-PR Staging Area.

References

1. USEPA. 2015a. Final Rule: Disposal of Coal Combustion Residuals (CCRs) for Electric Utilities. 80 FR 21301-21501. U.S. Environmental Protection Agency, Washington, D.C. Available at: https://www.govinfo.gov/content/pkg/FR-2015-04-17/pdf/2015-00257.pdf

2. USEPA. 2015b. Use of Monitored Natural Attenuation for Inorganic Contaminants in Groundwater at Superfund Sites.

3. USEPA. 2018a. USEPA Regional Screening Levels. November 2018, values for tapwater. U.S. Environmental Protection Agency. Available at: https://www.epa.gov/risk/regional-screening-levels-rsls-generic-tables

4. PEI. 2016. Corrective Measures Study Report, Chevron Phillips Chemical, Puerto Rico Core, LLC Guayama, Puerto Rico.

5. USEPA. 2017. Statement of Basis Final Remedy Decision, Chevron Phillips Chemical, Puerto Rico Core, LLC Guayama, Puerto Rico. EPA ID Number: PRD991291972.

Revision Log

Date	Page No.	Section	Description	September 2019 Text	Revised Text
11/1/2019	7	2.5	Correction	While analytical results from monitoring wells directly adjacent to the Staging Area indicated concentrations of lithium, molybdenum, and selenium above GWPS in two of the three N&E wells, concentrations of lithium, molybdenum, and selenium in N&E wells located **only 100** feet down gradient and along the southern property boundary, are well below the GWPS and in most cases are even below the laboratory reporting limits.	While analytical results from monitoring wells directly adjacent to the Staging Area indicated concentrations of lithium, molybdenum, and selenium above GWPS in two of the three N&E wells, concentrations of lithium, molybdenum, and selenium in N&E wells located **less than 200** feet down gradient and along the southern property boundary, are well below the GWPS and in most cases are even below the laboratory reporting limits.
11/8/2019	Appendix A		Updated Appendix A with Amended Version	See description in Amended Appendix A – Groundwater Characterization Report. No additional revisions to CMA required.	

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TABLES

TABLE I
GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
AES PUERTO RICO - AGREMAX STAGING AREA
GUAYAMA, PUERTO RICO

WELL ID	Event	GWPS	0.006	0.010	2	0.004	0.005	0.1	0.006	4	0.015	0.040	0.002	0.100	0.05	0.002	5
		Sampling Date	Antimony mg/l	Arsenic mg/l	Barium mg/l	Beryllium mg/l	Cadmium mg/l	Chromium mg/l	Cobalt mg/l	Fluoride mg/l	Lead mg/l	Lithium mg/l	Mercury mg/l	Molybdenum mg/l	Selenium mg/l	Thallium mg/l	Radium 226/228 pCi/L
MW-1	1	8/8/17	0.0010 U	0.00046 U	0.050	0.00034 U	0.00034 U	0.0011 U	0.00058 J	0.47	0.00035 U	0.0032 U	0.000070 U	0.0022 J	0.0073	0.000085 U	0.0899 U
MW-2	1	8/8/17	0.0010 U	0.00046 U	0.10	0.00034 U	0.00034 U	0.0011 U	0.00040 U	0.36	0.00035 U	0.0032 U	0.000070 U	0.00085 U	0.00035 J	0.000085 U	0.129 U
MW-3	1	8/8/17	0.0010 U	0.0038	0.33	0.00034 U	0.00034 U	0.0011 U	0.0018 J	2.0	0.00035 U	0.0068	0.000070 U	0.096	0.052	0.000085 U	0.272 U
MW-4	1	8/8/17	0.0010 U	0.0036	0.057	0.00034 U	0.00036 J	0.0011 U	0.0018 J	0.63	0.00035 U	1.0	0.000070 U	0.44	0.011	0.000085 U	0.527
MW-4	1	8/8/17	0.0014 J	0.0031	0.057	0.00034 U	0.00034 U	0.0011 U	0.0017 J	0.61	0.00035 U	1.0	0.000070 U	0.45	0.011	0.000085 U	0.381
MW-5	1	8/9/17	0.0010 U	0.0032	0.041	0.00034 U	0.00034 U	0.0011 U	0.0034	0.42	0.00035 U	0.0032 U	0.000070 U	0.0022 J	0.010	0.000085 U	0.473
MW-1	2	8/15/17	0.0010 U	0.00055 J	0.056	0.00034 U	0.00034 U	0.0011 U	0.00055 J	0.53	0.00035 U	0.0032 U	0.000070 U	0.00085 U	0.0062	0.000085 U	0.349 U
MW-2	2	8/15/17	0.0010 U	0.00047 J	0.11	0.00034 U	0.00034 U	0.0011 U	0.00040 U	0.40	0.00035 U	0.0032 U	0.000070 U	0.00085 U	0.00024 U	0.000085 U	0.614
MW-3	2	8/15/17	0.0010 U	0.0034	0.29	0.00034 U	0.00034 U	0.0011 U	0.0019	2.1	0.00035 U	0.0077	0.000070 U	0.16	0.098	0.000085 U	0.417
MW-4	2	8/16/17	0.0010 U	0.0037	0.060	0.00034 U	0.00034 U	0.0011 U	0.0017	0.63	0.00035 U	1.1	0.000070 U	0.40	0.0048	0.000085 U	0.367 U
MW-4	2	8/16/17	0.0010 U	0.0033	0.060	0.00034 U	0.00034 U	0.0011 U	0.0016	0.61	0.00035 U	1.1	0.000070 U	0.38	0.0061	0.000085 U	0.600
MW-5	2	8/16/17	0.0010 U	0.0024	0.043	0.00034 U	0.00034 U	0.0011 U	0.0035	0.45	0.00035 U	0.0047 J	0.000070 U	0.0086 J	0.013	0.000085 U	0.576
MW-1	3	8/22/17	0.0010 U	0.00046 U	0.058	0.00034 U	0.00034 U	0.0011 U	0.00068 J	0.55	0.00035 U	0.0032 U	0.000070 U	0.0023 J	0.0065	0.000085 U	0.533
MW-2	3	8/22/17	0.0010 U	0.00046 U	0.11	0.00034 U	0.00034 U	0.0011 U	0.00040 U	0.40	0.00035 U	0.0032 U	0.000070 U	0.0010 J	0.00061 J	0.000085 U	-0.0403 U
MW-3	3	8/22/17	0.0010 U	0.0021	0.37	0.00034 U	0.00034 U	0.0011 U	0.0023 J	2.2	0.00035 U	0.0075	0.000070 U	0.2	0.13	0.000085 U	0.231 U
MW-4	3	8/23/17	0.0010 U	0.0026	0.057	0.00034 U	0.00034 U	0.0011 U	0.0017 J	0.65	0.00035 U	0.88	0.000070 U	0.44	0.0060	0.000085 U	0.0815 U
MW-4	3	8/23/17	0.0010 U	0.0025	0.058	0.00034 U	0.00034 U	0.0011 U	0.0017 J	0.65	0.00035 U	1.1	0.000070 U	0.38	0.0065	0.000085 U	0.441
MW-5	3	8/22/17	0.0010 U	0.0018	0.039	0.00034 U	0.00034 U	0.0011 U	0.0036	0.46	0.00035 U	0.0044 J	0.000070 U	0.0080 J	0.014	0.000085 U	0.391 U
MW-1	4	8/29/17	0.0010 U	0.00046 U	0.055	0.00034 U	0.00034 U	0.0011 U	0.00062 J	0.58	0.00035 U	0.0032 U	0.000070 U	0.00085 U	0.0057	0.000085 U	0.620
MW-2	4	8/29/17	0.0010 U	0.00046 U	0.11	0.00034 U	0.00034 U	0.0011 U	0.00040 U	0.42	0.00035 U	0.0032 U	0.000070 U	0.00085 U	0.00044 J	0.000085 U	0.181 U
MW-3	4	8/29/17	0.0010 U	0.0024	0.25	0.00034 U	0.00034 U	0.0011 U	0.0022 J	2.30	0.00035 U	0.0075	0.000070 U	0.22	0.14	0.000085 U	0.374
MW-4	4	8/30/17	0.0010 U	0.0027	0.055	0.00034 U	0.00034 U	0.0011 U	0.0017 J	0.68	0.00035 U	0.90	0.000070 U	0.40	0.0058	0.000085 U	0.457
MW-4	4	8/30/17	0.0010 U	0.0024	0.054	0.00034 U	0.00034 U	0.0011 U	0.0016 J	0.66	0.00035 U	0.98	0.000070 U	0.42	0.0054	0.000085 U	0.146 U
MW-5	4	8/29/17	0.0010 U	0.0021	0.036	0.00034 U	0.00034 U	0.0011 U	0.0033	0.48	0.00035 U	0.0039 J	0.000070 U	0.0057 J	0.0099	0.000085 U	0.601
MW-1	5	9/12/17	0.0010 U	0.00046 J	0.057	0.00034 U	0.00034 U	0.0011 U	0.00075 J	0.47	0.00035 U	0.0032 U	0.000070 U	0.0018 J	0.0057	0.000085 U	0.333 U
MW-2	5	9/12/17	0.0010 U	0.00046 U	0.11	0.00034 U	0.00034 U	0.0011 U	0.00040 U	0.35	0.00035 U	0.0032 U	0.000070 U	0.00094 J	0.00046 J	0.000085 U	0.196 U
MW-3	5	9/12/17	0.0012 J	0.0029	0.23	0.00034 U	0.00034 U	0.0011 U	0.0025	1.9	0.00035 U	0.0056	0.000070 U	0.28	0.18	0.000085 U	0.462
MW-4	5	9/13/17	0.0010 U	0.0035	0.056	0.00034 U	0.00034 U	0.0011 U	0.0017	0.53	0.00035 U	0.75	0.000070 U	0.41	0.013	0.000085 U	0.361
MW-4	5	9/13/17	0.0010 U	0.0038	0.056	0.00034 U	0.00034 U	0.0011 U	0.0017	0.63	0.00035 U	0.86	0.000070 U	0.42	0.014	0.000085 U	0.656
MW-5	5	9/12/17	0.0010 U	0.0041	0.0038	0.00034 U	0.00034 U	0.0011 U	0.0033	0.29	0.00035 U	0.0032 U	0.000070 U	0.0048 J	0.0053	0.000085 U	0.227 U
MW-1	6	10/3/17	0.0010 U	0.00087 J	0.056	0.00034 U	0.00034 U	0.0011 U	0.00087 J	0.61	0.00035 U	0.0032 U	0.000070 U	0.0027 J	0.0055	0.000085 U	0.230 U
MW-2	6	10/3/17	0.0010 U	0.00046 J	0.093	0.00034 U	0.00034 U	0.0011 U	0.00040 U	0.43	0.00035 U	0.0032 U	0.000070 U	0.0013 J	0.0012 J	0.000085 U	0.675
MW-3	6	10/3/17	0.0017 J	0.0036	0.19	0.00034 U	0.00063 J	0.031	0.0040	1.8	0.00035 U	0.034	0.000070 U	0.53	0.57	0.000085 U	1.07
MW-4	6	10/4/17	0.0019 J	0.0059	0.059	0.00034 U	0.00034 U	0.0011 U	0.0018 J	0.64	0.00035 U	0.77	0.000070 U	0.44	0.011	0.000085 U	0.699
MW-4	6	10/4/17	0.0010 U	0.0056	0.065	0.00034 U	0.00034 U	0.0011 U	0.0017 J	0.63	0.00035 U	0.82	0.000070 U	0.46	0.0095	0.000085 U	0.528
MW-5	6	10/3/17	0.0010 U	0.0060	0.034	0.00034 U	0.00034 U	0.0011 U	0.0030	0.52	0.00035 U	0.0061	0.000070 U	0.0053 J	0.0034	0.000085 U	0.445

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CORRECTIVE MEASURES ASSESSMENT
AES PUERTO RICO - AGREMAX STAGING AREA
GUAYAMA, PUERTO RICO

WELL ID	Event	GWPS	0.006	0.010	2	0.004	0.005	0.1	0.006	4	0.015	0.040	0.002	0.100	0.05	0.002	5
		Sampling Date	Antimony mg/l	Arsenic mg/l	Barium mg/l	Beryllium mg/l	Cadmium mg/l	Chromium mg/l	Cobalt mg/l	Fluoride mg/l	Lead mg/l	Lithium mg/l	Mercury mg/l	Molybdenum mg/l	Selenium mg/l	Thallium mg/l	Radium 226/228 pCi/L
MW-1	7	10/11/17	0.0010 U	**0.00047 J**	**0.063**	0.00034 U	0.00034 U	**0.0023 J**	**0.0011 J**	**0.58**	0.00035 U	0.0032 U	0.000070 U	**0.0028 J**	**0.0044**	0.000085 U	0.362 U
MW-2	7	10/11/17	0.0010 U	**0.00094 J**	**0.10**	0.00034 U	0.00034 U	0.0011 U	0.00040 U	**0.41**	0.00035 U	0.0032 U	0.000070 U	**0.0013 J**	**0.0011 J**	0.000085 U	0.313 U
MW-3	7	10/11/17	**0.0017 J**	**0.0031**	**0.22**	0.00034 U	**0.00054 J**	0.0011 U	**0.0032**	**1.9**	0.00035 U	**0.012**	0.000070 U	**0.40**	**0.38**	0.000085 U	**0.429**
MW-4	7	10/12/17	**0.0022 J**	**0.0033**	**0.047**	0.00034 U	0.00034 U	**0.0035**	**0.0017 J**	**0.67**	0.00047 J	**0.74**	0.000070 U	**0.44**	**0.0067**	0.000085 U	0.251 U
MW-4	7	10/12/17	**0.0026**	**0.0038**	**0.052**	0.00034 U	0.00034 U	**0.0033**	**0.0017 J**	**0.65**	0.00047 J	**0.73**	0.000070 U	**0.51**	**0.0073**	0.000085 U	0.236 U
MW-5	7	10/11/17	0.0010 U	**0.0065**	**0.034**	0.00034 U	0.00034 U	0.0011 U	**0.0032**	**0.49**	0.00035 U	**0.0043 J**	0.000070 U	**0.0054 J**	**0.0038**	0.000085 U	0.300 U
MW-1	8	10/17/17	0.0010 U	**0.00069 J**	**0.06**	0.00034 U	0.00034 U	0.0011 U	**0.00097 J**	**0.55**	0.00035 U	0.0032 U	0.000070 U	**0.0020 J**	**0.0074**	0.000085 U	0.319 U
MW-2	8	10/17/17	0.0010 U	**0.0014**	**0.089**	0.00034 U	0.00034 U	**0.0039**	0.00040 U	**0.36**	0.00035 U	0.0032 U	0.000070 U	**0.0023 J**	**0.0034**	0.000085 U	0.439 U
MW-3	8	10/17/17	0.0010 U	**0.0032**	**0.21**	0.00034 U	0.00034 U	**0.0024 J**	**0.0028**	**1.8**	0.00035 U	**0.010**	0.000070 U	**0.37**	**0.33**	0.000085 U	**0.537**
MW-4	8	10/17/17	**0.0012 J**	**0.0055**	**0.04**	0.00034 U	0.00034 U	**0.0012 J**	**0.0018 J**	**0.65**	0.00036 J	**0.69**	0.000070 U	**0.53**	**0.010**	0.000085 U	0.231 U
MW-4	8	10/17/17	0.0010 U	**0.0062**	**0.04**	0.00034 U	**0.00037 J**	**0.0012 J**	**0.0018 J**	**0.64**	0.00035 J	**0.74**	0.000070 U	**0.54**	**0.0092**	0.000085 U	0.366 U
MW-5	8	10/17/17	**0.0049**	**0.0060**	**0.030**	0.00034 U	0.00034 U	0.0011 U	**0.0029**	**0.47**	0.00035 U	**0.0067**	0.000070 U	**0.0076 J**	**0.0049**	0.000085 U	0.282 U
MW-1	9	6/25/18	0.0010 U	0.00046 U	**0.039**	0.00034 U	0.00034 U	0.0011 U	0.00040 U	**0.61**	0.00077 J	0.0011 U	0.000070 U	0.00085 U	**0.025**	0.000085 U	NA
MW-2	9	6/25/18	0.0010 U	0.00046 U	**0.15**	0.00034 U	0.00034 U	0.0011 U	**0.00067 J**	**0.52**	0.00035 U	0.0011 U	0.000070 U	0.00085 U	**0.00040 J**	0.000085 U	NA
MW-3	9	6/25/18	0.0010 U	**0.0018**	**0.24**	0.00034 U	**0.00042 J**	0.0011 U	**0.0031**	**1.6**	0.00035 U	**0.0073**	0.000070 U	**0.22**	**0.21**	0.000085 U	NA
MW-4	9	6/25/18	**0.0023 J**	**0.0024**	**0.044**	0.00034 U	**0.00034 J**	0.0011 U	**0.0016 J**	**0.76**	0.00035 U	**0.54**	0.000070 U	**0.55**	**0.0064**	0.000085 U	NA
MW-4	9	6/25/18	**0.0019 J**	**0.0021**	**0.046**	0.00034 U	0.00034 U	0.0011 U	**0.0016 J**	**0.76**	0.00035 U	**0.57**	0.000070 U	**0.58**	**0.0055**	0.000085 U	NA
MW-5	9	6/25/18	0.0010 U	**0.0071**	**0.036**	0.00034 U	0.00034 U	0.0011 U	**0.0030**	**0.49**	0.00035 U	**0.0038**	0.000070 U	**0.0042 J**	0.00024 U	0.000085 U	NA
MW-1	10	10/1/18	0.0010 U	0.00046 U	**0.032**	NA	0.00034 U	NA	**0.00050 J**	**0.69**	NA	0.0011 U	NA	0.00085 U	**0.015**	NA	**0.495**
MW-2	10	10/1/18	0.0010 U	0.00046 U	**0.13**	NA	0.00034 U	NA	**0.00058 J**	**0.67**	NA	**0.0014 J**	NA	0.00085 U	0.00024 U	NA	0.321 U
MW-3	10	10/1/18	0.0010 U	**0.0024**	**0.19**	NA	0.00034 U	NA	**0.0031**	**1.6**	NA	**0.021**	NA	**0.22**	**0.23**	NA	**0.511**
MW-4	10	10/2/18	0.0010 U	**0.0031**	**0.035**	NA	**0.00057 J**	NA	**0.0016 J**	**1.00**	NA	**0.38**	NA	**0.74**	**0.0043**	NA	0.0708 U
MW-4	10	10/2/18	0.0010 U	**0.0027**	**0.036**	NA	**0.00051 J**	NA	**0.0016 J**	**1.00**	NA	**0.34**	NA	**0.76**	**0.0048**	NA	0.168 U
MW-5	10	10/2/18	0.0010 U	**0.0088**	**0.032**	NA	0.00034 U	NA	**0.0030**	**0.50**	NA	**0.0038 J**	NA	**0.0053 J**	**0.00046 J**	NA	**-0.0397**

TABLE I
GROUNDWATER ANALYTICAL RESULTS - APPENDIX IV CONSTITUENTS
CORRECTIVE MEASURES ASSESSMENT
AES PUERTO RICO - AGREMAX STAGING AREA
GUAYAMA, PUERTO RICO

WELL ID	Event	GWPS	0.006	0.010	2	0.004	0.005	0.1	0.006	4	0.015	0.040	0.002	0.100	0.05	0.002	5
		Sampling Date	Antimony mg/l	Arsenic mg/l	Barium mg/l	Beryllium mg/l	Cadmium mg/l	Chromium mg/l	Cobalt mg/l	Fluoride mg/l	Lead mg/l	Lithium mg/l	Mercury mg/l	Molybdenum mg/l	Selenium mg/l	Thallium mg/l	Radium 226/228 pCi/L
TW-101	11	6/3/19	NA	NA	NA	NA	NA	NA	NA	**0.96**	NA	**0.0048 J**	NA	**0.0067**	0.0049 U	NA	NA
MW-3	11	6/3/19	NA	NA	NA	NA	NA	NA	NA	**1.6**	NA	**0.0035 J**	NA	**0.17**	**0.11**	NA	NA
TW-102	11	6/3/19	NA	NA	NA	NA	NA	NA	NA	**0.74**	NA	**1.1**	NA	**1.4**	**0.98**	NA	NA
MW-4	11	6/3/19	NA	NA	NA	NA	NA	NA	NA	**0.78**	NA	**0.38**	NA	**0.51**	0.0049 U	NA	NA
MW-4	11	6/3/19	NA	NA	NA	NA	NA	NA	NA	**0.79**	NA	**0.37**	NA	**0.51**	0.0049 U	NA	NA
TW-103	11	6/3/19	NA	NA	NA	NA	NA	NA	NA	**0.74**	NA	**0.60**	NA	**1.4**	**0.70**	NA	NA
MW-5	11	6/3/19	NA	NA	NA	NA	NA	NA	NA	**0.42**	NA	**0.0043 J**	NA	**0.0035 J**	0.0049 U	NA	NA
TW-104	11	6/4/19	NA	NA	NA	NA	NA	NA	NA	**0.78**	NA	**0.0027 J**	NA	0.012 U	0.0049 U	NA	NA
TW-105	11	6/4/19	NA	NA	NA	NA	NA	NA	NA	**1.2**	NA	**0.0026 J**	NA	0.012 U	0.0049 U	NA	NA
TW-106	11	6/4/19	NA	NA	NA	NA	NA	NA	NA	**0.98**	NA	**0.0048 J**	NA	0.013 U	0.0049 U	NA	NA
TW-107	11	6/4/19	NA	NA	NA	NA	NA	NA	NA	**0.61**	NA	**0.016**	NA	0.012 U	0.0049 U	NA	NA
TW-108	11	6/4/19	NA	NA	NA	NA	NA	NA	NA	**0.71**	NA	**0.0041 J**	NA	0.012 U	0.0049 U	NA	NA
TW-109	11	6/4/19	NA	NA	NA	NA	NA	NA	NA	**0.66**	NA	**0.0041 J**	NA	0.012 U	0.0049 U	NA	NA

Notes:
1. mg/L - milligrams per Liter.
2. pCi/L - picoCurie per liter.
3. U - Constituent was not detected, value is the reporting limit.
4. J - Result is less than the Reporting Limit but greater than or equal to the MDL; concentration is an approximate value.
5. Detected values are shown in **bold**.
6. NA - not available.
7. GWPS - Groundwater Protection Standards.

TABLE II
REMEDIAL ALTERNATIVE ROADMAP
CORRECTIVE MEASURES ASSESSMENT
AES PUERTO RICO - AGREMAX™ STAGING AREA
GUAYAMA, PUERTO RICO

<table>
<tr><th rowspan="2">Alternative Number</th><th rowspan="2">Remedial Alternative Description</th><th colspan="3">Groundwater Remedy Components</th></tr>
<tr><th>A. Groundwater Remedy Approach</th><th>B. Groundwater Remedy Implementation Method</th><th>C. On-Going / Long-Term Actions</th></tr>
<tr><td>1</td><td>Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ Monitored Natural Attenuation (MNA)</td><td>Natural Attenuation with Monitoring
Mitigate downgradient migration of CCR-derived constituents present in groundwater at concentrations above Groundwater Protection Standards (GWPS) through process of natural attenuation</td><td>Passive Treatment
Natural geochemical processes will be used to reduce concentrations of CCR-derived constituents in groundwater</td><td>Monitored Natural Attenuation
Long-term groundwater monitoring will be used to confirm reduction of CCR-derived constituent concentrations</td></tr>
<tr><td>2</td><td>Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment</td><td rowspan="2">Hydraulic Containment
Mitigate downgradient migration of CCR-derived constituents present in groundwater at concentrations above GWPS using shallow extraction wells installed downgradient/side-gradient of the Staging Area</td><td>Pump & Treat
Treat extracted water using existing reverse osmosis (RO) system and discharge to the coal plie runoff pond or reuse for dust control; operate for duration of Staging Area activity</td><td rowspan="4">Pump Long-Term
Continue to operate hydraulic containment system to maintain reduction of CCR-derived constituents in groundwater</td></tr>
<tr><td>3</td><td>Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation</td><td>Pump with Recirculation
Pump water to coal pile runoff pond or re-use for dust control without treatment; operate for duration of Staging Area activity</td></tr>
<tr><td>4</td><td>Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment</td><td rowspan="2">Hydraulic Containment with Barrier Wall
Install 30-ft barrier wall downgradient from Staging Area, install extraction wells to reduce groundwater flow and mitigate downgradient migration of CCR-derived constituents present in groundwater at concentrations above GWPS</td><td>Pump & Treat
Treat extracted water using existing RO system and discharge to the coal pile runoff pond or reuse for dust control; operate for duration of Staging Area activity</td></tr>
<tr><td>5</td><td>Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation</td><td>Pump with Recirculation
Pump water to coal pile runoff pond or re-use for dust control without treatment; operate for duration of Staging Area activity</td></tr>
</table>

TABLE III

SUMMARY OF CORRECTIVE MEASURES

CORRECTIVE MEASURES ASSESSMENT

AES PUERTO RICO - AGREMAX STAGING AREA

GUAYAMA, PUERTO RICO

Alternative Number	Remedial Alternative Description	THRESHOLD CRITERIA: Be protective of human health and the environment	Attain the groundwater protective standard	Control the source of releases so as to reduce or eliminate, to the maximum extent feasible, further releases of Appendix IV constituents into the environment	Remove from the environment as much of the contaminated material that was released from the CCR unit as is feasible, taking into account factors such as avoiding inappropriate disturbance of sensitive ecosystems	Management of waste to comply with all applicable RCRA requirements
1	Prevent AGREMAX™ Contact with the Ground by Installation of a Synthetic Liner and Employ Monitored Natural Attenuation (MNA)	✓	✓	✓	✓	✓
2	Hydraulic Containment of Groundwater via Groundwater Pumping with Treatment	✓	✓	✓	✓	✓
3	Hydraulic Containment of Groundwater via Groundwater Pumping with Recirculation	✓	✓	✓	✓	✓
4	Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Treatment	✓	✓	✓	✓	✓
5	Hydraulic Containment of Groundwater via Groundwater Pumping with Barrier Wall and Recirculation	✓	✓	✓	✓	✓

BALANCING CRITERIA

Alternative Number	CATEGORY 1 Long- and Short-Term Effectiveness, Protectiveness, and Certainty of Success that the Remedy will Prove Successful	Sub-Category 1: 1 Magnitude of reduction of existing risks	2 Magnitude of residual risks in terms of likelihood of further releases due to CCR remaining following implementation of a remedy	3 Type and degree of long-term management required, including monitoring, operation and maintenance	4 Short-term risk to community or environment during implementation of remedy	5 Time until full protection is achieved	6 Potential for exposure of humans and environmental receptors to remaining wastes, considering the potential threat to human health and the environment associated with excavation, transportation, re-disposal, or containment	7 Long-term reliability of engineering and institutional controls	8 Potential need for replacement of the remedy
1	Green	Green	Green	Green	Green	Yellow	Green	Green	Green
2	Red	Green	Yellow	Yellow	Green	Green	Yellow	Red	Red
3	Red	Green	Yellow	Yellow	Green	Green	Green	Red	Red
4	Yellow	Green	Yellow	Yellow	Green	Green	Yellow	Yellow	Yellow
5	Yellow	Green	Yellow	Yellow	Green	Green	Green	Yellow	Yellow

Alternative Number	CATEGORY 2 Effectiveness in Controlling the Source to Reduce Further Releases	Sub-Cat. 2: 1 Extent to which containment practices will reduce further releases	2 Extent to which treatment technologies may be used	CATEGORY 3 The Ease or Difficulty of Implementation	Sub-Category 3: 1 Degree of difficulty associated with constructing the technology	2 Expected operational reliability of the technologies	3 Need to coordinate with and obtain necessary approvals and permits from other agencies	4 Availability of necessary equipment and specialists	5 Available capacity and location of needed treatment, storage, and disposal services
1	Green	Green	Green	Yellow	Yellow	Green	Yellow	Green	Yellow
2	Yellow	Yellow	Yellow	Yellow	Green	Red	Yellow	Green	Green
3	Yellow	Yellow	Green	Yellow	Green	Red	Yellow	Green	Green
4	Yellow	Green	Yellow	Green	Yellow	Yellow	Green	Green	Green
5	Yellow	Green	Yellow	Green	Yellow	Yellow	Green	Green	Green

COLOR LEGEND

- Green: Most favorable when compared to other alternatives
- Yellow: Less favorable when compared to other alternatives
- Red: Least favorable when compared to other alternatives

1. For context, this a relative comparison of remedial options for this site. Site conditions, weather, and site-specific considerations are made in this table. This is not a comparison to all options at all sites.
2. AGREMAX™ is a beneficial use product that has been shown to be protective of human health and the environment in transport, delivery and use.

HALEY ALDRICH

FIGURES

LEGEND

APPROXIMATE SITE BOUNDARY

AERIAL IMAGERY SOURCE: ESRI

0 600
APPROXIMATE SCALE IN FEET

HALEY ALDRICH

CORRECTIVE MEASURES ASSESSMENT
AGREMAX STAGING AREA
AES PUERTO RICO
GUAYAMA, PUERTO RICO

SITE LOCATION MAP

SCALE: AS SHOWN
SEPTEMBER 2019

FIGURE 1-1

VARI, KATALIN Printed: 9/6/2019 2:14 PM Layout: FIGURE 1
G:\133136 AES PUERTO RICO AGREMAX CORRECTIVE MEASURES ASSESSMENT\CORRECTIVE MEASURES\STAGING AREA\133136-004_FIG 1-1_SLM.DWG

LEGEND

APPROXIMATE PROPERTY LINE

APPROXIMATE AGREMAX™ STAGING AREA

GROUNDWATER FLOW DIRECTION

NOTES

1. BACKGROUND IMAGE WAS TAKEN FROM GOOGLE EARTH PRO, DATED MARCH 06, 2019.
2. COORDINATE SYSTEM: NAD83, PUERTO RICO STATE PLANE (METERS). ELEVATION REFERENCE: ORTHOMETRIC, GEOID 12B.
3. LIMITS OF EXISTING AGREMAX™ STAGING AREA AND SOIL BORING LOCATIONS OBTAINED FROM CARASQUILLO ASSOCIATES, LTD. REPORT, DATED OCTOBER 15, 2018.
4. ESTUARINE AND MARINE WETLAND BOUNDARIES OBTAINED FROM CCR GROUNDWATER MONITORING PROGRAM PRESENTATION BY DNA-ENVIRONMENT, LLC, DATED DECEMBER 14, 2017.
5. ALL BOUNDARY LOCATIONS ARE APPROXIMATE.

N

0 300 600

SCALE IN FEET

HALEY ALDRICH

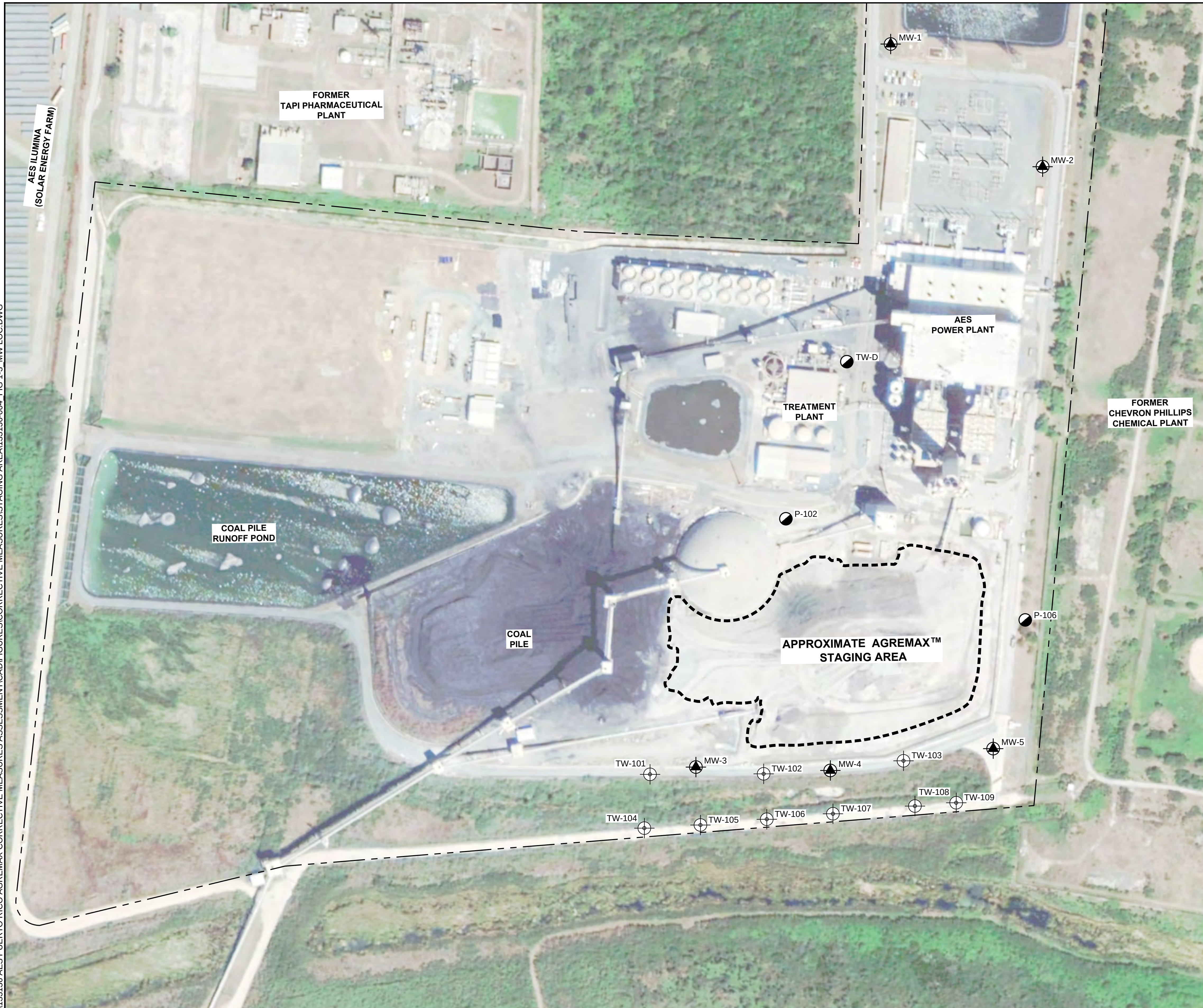
CORRECTIVE MEASURES ASSESSMENT
AGREMAX STAGING AREA
AES PUERTO RICO
GUAYAMA, PUERTO RICO

SITE FEATURES MAP

SCALE: AS SHOWN
SEPTEMBER 2019

FIGURE 1-2

Saved by: KVARI Printed: 9/13/2019 11:47 AM Sheet: FIGURE 1-2
G:\133136 AES PUERTO RICO AGREMAX CORRECTIVE MEASURES ASSESSMENT\CAD\FIGURES\CORRECTIVE MEASURES\STAGING AREA\133136-004_FIG 1-2_SITE.DWG



LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE AGREMAX™ STAGING AREA
- MW-1 — CCR MONITORING WELL LOCATION
- TW-101 — NATURE AND EXTENT MONITORING WELL LOCATION
- P-102 — PIEZOMETER LOCATION

NOTES

1. BACKGROUND IMAGE WAS TAKEN FROM GOOGLE EARTH PRO, DATED MARCH 06, 2019.
2. COORDINATE SYSTEM: NAD83, PUERTO RICO STATE PLANE (METERS). ELEVATION REFERENCE: ORTHOMETRIC, GEOID 12B.
3. LIMITS OF EXISTING AGREMAX™ STAGING AREA AND SOIL BORING LOCATIONS OBTAINED FROM CARASQUILLO ASSOCIATES, LTD. REPORT, DATED OCTOBER 15, 2018.
4. ALL BOUNDARY LOCATIONS ARE APPROXIMATE.
5. CCR = COAL COMBUSTION RESIDUALS

N

0 250 500
SCALE IN FEET

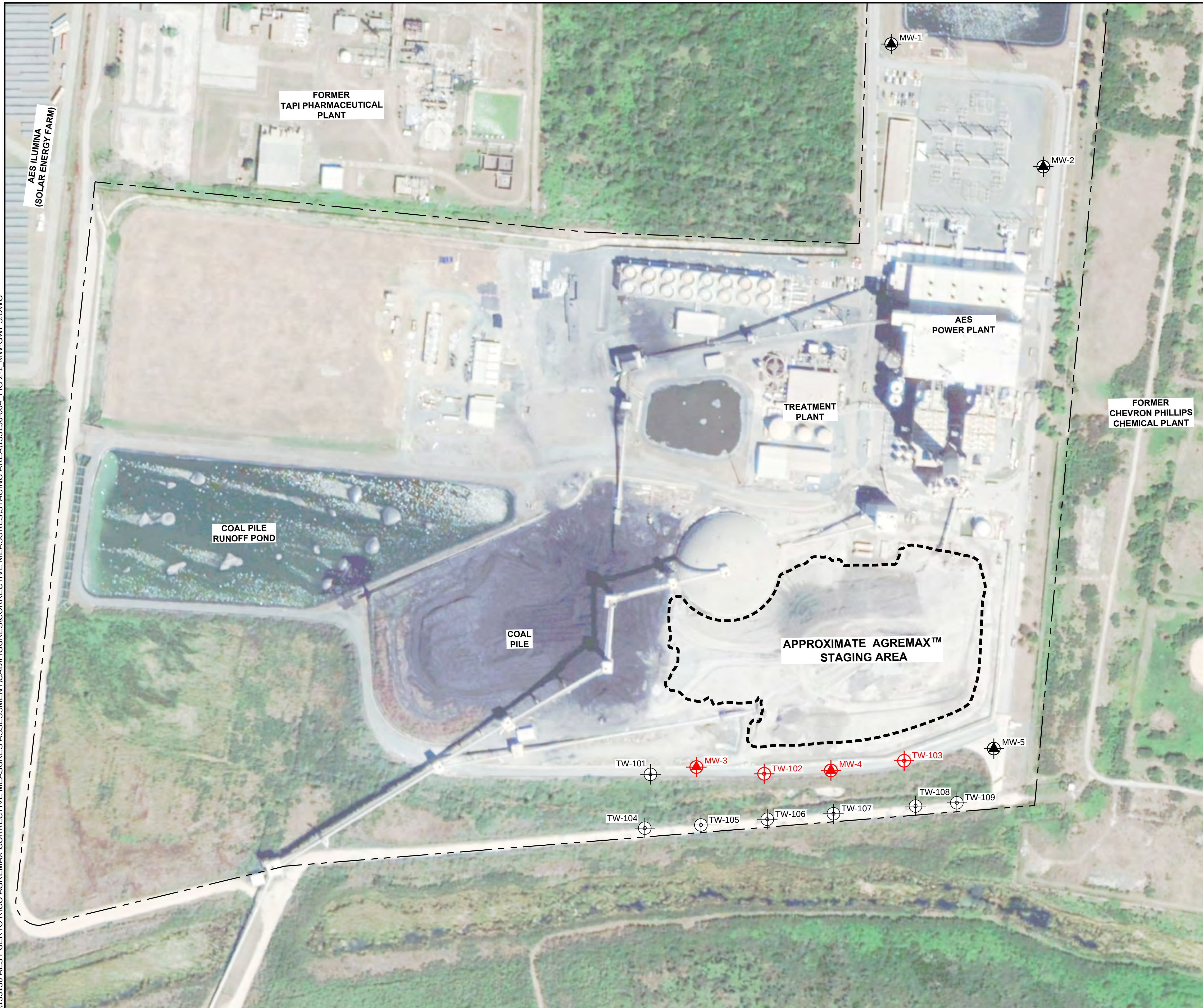
HALEY ALDRICH

CORRECTIVE MEASURES ASSESSMENT
AGREMAX STAGING AREA
AES PUERTO RICO
GUAYAMA, PUERTO RICO

MONITORING WELL LOCATIONS

SCALE: AS SHOWN
SEPTEMBER 2019

FIGURE 1-3



LEGEND

- APPROXIMATE PROPERTY LINE
- APPROXIMATE AGREMAX™ STAGING AREA
- MW-1: CCR MONITORING WELL WITH NO CONSTITUENTS ABOVE GWPS
- TW-101: NATURE AND EXTENT MONITORING WELL WITH NO CONSTITUENTS ABOVE GWPS
- MW-3: CCR MONITORING WELL WITH LITHIUM, MOLYBDENUM, OR SELENIUM CONCENTRATION ABOVE GWPS
- TW-102: NATURE AND EXTENT MONITORING WELL WITH LITHIUM, MOLYBDENUM, OR SELENIUM CONCENTRATION ABOVE GWPS

NOTES

1. BACKGROUND IMAGE WAS TAKEN FROM GOOGLE EARTH PRO, DATED MARCH 06, 2019.
2. COORDINATE SYSTEM: NAD83, PUERTO RICO STATE PLANE (METERS). ELEVATION REFERENCE: ORTHOMETRIC, GEOID 12B.
3. LIMITS OF EXISTING AGREMAX™ STAGING AREA AND SOIL BORING LOCATIONS OBTAINED FROM CARASQUILLO ASSOCIATES, LTD. REPORT, DATED OCTOBER 15, 2018.
4. ALL BOUNDARY LOCATIONS ARE APPROXIMATE.
5. CCR = COAL COMBUSTION RESIDUALS
6. GWPS = GROUNDWATER PROTECTION STANDARDS

N

0 250 500
SCALE IN FEET

HALEY ALDRICH

CORRECTIVE MEASURES ASSESSMENT
AGREMAX STAGING AREA
AES PUERTO RICO
GUAYAMA, PUERTO RICO

MONITORING WELL LOCATIONS WITH STATISTICALLY SIGNIFICANT LEVELS ABOVE GWPS

SCALE: AS SHOWN
SEPTEMBER 2019

FIGURE 2-1

Saved by: KVARI Printed: 9/12/2019 1:22 PM Sheet: FIGURE 2-1
G:\133136 AES PUERTO RICO AGREMAX CORRECTIVE MEASURES ASSESSMENT\CAD\FIGURES\CORRECTIVE MEASURES\STAGING AREA\133136-004_FIG 2-1_MW-GWPS.DWG

APPENDIX A

Groundwater Characterization Report

GROUNDWATER CHARACTERIZATION REPORT
USEPA COAL COMBUSTION RESIDUALS RULE
AES PUERTO RICO LP, GUAYAMA, PR

SEPTEMBER 2019
AMENDED NOVEMBER 2019

Prepared for:

AES Puerto Rico, LP
PO Box 1890
Guayama, Puerto Rico 00785

Prepared by:

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DNA-ENVIRONMENT, LLC

GROUNDWATER CHARACTERIZATION REPORT
USEPA COAL COMBUSTION RESIDUALS RULE
AES PUERTO RICO LP, GUAYAMA, PR

SEPTEMBER 2019
AMENDED NOVEMBER 2019

Prepared by: ______________________________

Alberto Meléndez

Principal, DNA-Environment, LLC

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Appendix A - Prepacked Screen Monitoring Well Specifications

Appendix B - Soil Boring Logs and Well Construction Diagrams

1 INTRODUCTION

1.1 Purpose and Scope

This report describes the procedures, findings and conclusions pertaining to the characterization of the nature and extent of lithium, molybdenum and selenium in the groundwater at AES Puerto Rico, LP (AES-PR) in Guayama, Puerto Rico (Facility). Field activities were conducted from 6 May to 5 June 2019. These included the installation of nine temporary monitoring wells at the southern portion of the Facility, and sampling and analysis of groundwater samples from all newly installed temporary wells and existing Monitoring Wells MW-3 to MW-5. Monitoring Wells MW-3 to MW-5 were installed in 2017 for the monitoring of groundwater in accordance with the U.S. Environmental Protection Agency's (USEPA) Coal Combustion Residuals Rule (CCR Rule).

Groundwater characterization was conducted pursuant to 40 CFR §257.95(g)(1) given that CCR groundwater monitoring events conducted from 2017 to 2018 resulted in statistical significant levels above the groundwater protection standards (GWPS) of lithium, molybdenum and selenium in groundwater samples collected from certain monitoring wells at the Facility.

1.2 Facility Information

AES-PR operates a coal-fired power plant located in the municipality of Guayama in the south coast of Puerto Rico (**Figure 1**). The Facility utilizes bituminous coal for energy production and generates coal combustion residuals (CCR). The CCR is converted to a manufactured aggregate known as Agremax that is stored in a temporary staging area located near the southern property limit (**Figure 2**).

Since 2017, AES-PR implemented a groundwater monitoring program in accordance with the CCR Rule. The Facility's monitoring network consists of five monitoring wells located either hydraulically upgradient or downgradient of the Agremax Staging Area. This network includes upgradient wells MW-1 and MW-2, and downgradient wells MW-3, MW-4 and MW-5. The locations of the CCR monitoring wells are shown in **Figure 2**. Groundwater samples collected from these wells have been analyzed for the constituents listed in Appendices III and IV to 40 CFR Part 257. Statistical evaluation completed in January 2019, per the USEPA's CCR Rule, resulted in statistical significant levels above the GWPS of selenium and molybdenum in groundwater samples collected from Monitoring Well MW-3, and of lithium and molybdenum from Monitoring Well MW-4.

2 MONITORING WELL PLACEMENT AND INSTALLATION

Prior to drilling activities, well locations were cleared of subsurface utilities using Ground Penetrating Radar (GPR), Pipe and Cable Line Locator, and Acoustic Detector.

Newly installed monitoring wells were placed hydraulically downgradient from the Agremax Staging Area (**Figure 2**). These consisted of temporary wells at the downgradient boundary of the Agremax Staging Area (Wells TW-101 to TW-103), and wells near the southern property boundary of AES-PR (Wells TW-104 to TW-109).

In addition, Temporary Piezometers P-102 and P-106 (**Figure 2)** were installed to obtain higher definition of groundwater elevation contours at the Facility.

All temporary wells and piezometers were installed in the uppermost aquifer to a depth immediately above the upper aquifer's confining clay layer. During the hydrogeologic investigation conducted at the Facility for CCR groundwater monitoring implementation, the confining clay layer was intercepted at a depth ranging from 20 to 25 feet below ground surface.

2.1 Monitoring Well Installation Procedures

Boreholes for well installation were advanced using a Geoprobe® drill rig. At each well location, continuous soil cores were collected for lithologic description. Temporary Wells TW-102 to TW-109 were installed using 4.25-inch inner diameter hollow stem augers. These wells were constructed of 2-inch diameter, schedule-40, PVC piping and consisted of screen and blank riser sections. Each well consisted of a 10-foot screen section of 0.010-inch factory slotted pipe and blank riser. The blank riser section was installed to span the length from the upper end of the well screen to an approximate height of three feet above existing grade. The wells were completed with a bentonite seal and cement grout.

Attempts to advance a borehole at location TW-101 were met with probe refusal at an approximate depth of nine feet below grade, even after offsetting the original location three times. Analysis of historical site aerial photographs revealed that this area had been underlain with boulders (gabions) during Facility construction. Because subsurface obstructions precluded the advancement of the 4.25 inner diameter hollow stem augers, Temporary Well TW-101 was installed using a 1.5-inch diameter PVC prepacked well screen after advancing a borehole with the 3.25-inch outer diameter Geoprobe® dual tube system. This well consisted of a 10-foot PVC well screen section of 0.010-inch factory slotted pipe containing metal-free prepacked well materials from ECT Manufacturing. The well was completed with a stickup PVC blank riser pipe to an approximate height of three feet above grade. Additional silica sand was added to fill any remaining annular space between the well exterior and borehole walls. The well was completed with a bentonite seal and cement grout. **Appendix A** includes the prepacked screen monitoring well specifications from the manufacturer.

Newly installed monitoring wells were allowed to set for a minimum of 24 hours after which wells were developed by purging the groundwater with an electrical submersible pump to remove bottom and suspended sediments.

Piezometers P-102 and P-106 were installed with the Geoprobe® 3.25-inch outer diameter dual tube system. The piezometers consisted of 1.5-inch diameter PVC screen and blank riser sections.

A professional land surveyor measured the geographical coordinates and top of casing well elevations of each monitoring well and piezometer. These measurements were subsequently used to determine groundwater elevation contours from depth to groundwater measurements collected at monitoring well and piezometer locations.

2.2 Equipment Decontamination

Hollow stem augers were decontaminated onsite by placing them inside an impervious containment dike and washing each auger with a hot water pressure washer. Augers were thoroughly cleansed and the contact water containerized as Investigation-Derived Waste.

2.3 Handling and Disposal of Investigation-Derived Waste

Soil cuttings, contact water from drilling equipment decontamination, and purged water from well development and sampling were containerized in drums (United Nations Certified), and labeled as investigation-derived waste (IDW) for subsequent handling and disposal in accordance with federal and state regulations.

3 SAMPLING AND ANALYTICAL METHODS

Sampling and analytical methods are described in detail in the Sampling and Analysis Plan prepared for the groundwater characterization event (DNA, March 2019). These procedures are in accordance with 40 CFR §257.93 of the CCR Rule, "Groundwater Sampling and Analysis Requirements".

3.1 Sampling Methods

One groundwater sample from each newly installed monitoring well and from each downgradient CCR monitoring wells (i.e., Wells MW-3 to MW-5) was collected with a peristaltic pump directly into the laboratory-supplied container. Groundwater samples were collected without filtration, so as to measure the total recoverable concentration of the constituent present in the particulate and dissolved fractions of the sample.

Groundwater sampling was conducted using the *Low Stress (Low Flow) Purging and Sampling Procedure* in accordance with USEPA Region 2 (USEPA, 1998). Low flow purging and sampling was conducted using a peristaltic pump and flow-through-cell attached to a handheld multi-parameter meter to monitor pH, conductivity, dissolved oxygen, oxidation-reduction (redox) potential, and temperature. Turbidity measurements were collected using a turbidimeter. The pump tubing was set at a depth corresponding to the vertical mid-section of the well screen. Purging proceeded until field parameters achieved stabilization. Instruments for field parameter measurements were calibrated following the instruments' manufacturer instructions. Instrument calibration was conducted daily prior to sampling activities. Additional calibrations or calibration checks were performed based on instrument performance, as needed.

Field quality control samples consisted of one field duplicate sample, and one matrix spike/matrix spike duplicate set per sampling event. In addition, one field blank was prepared and analyzed per each day of sampling. Equipment blanks were not collected as new sampling tubing was used in the peristaltic pump for the collection of each groundwater sample.

Each sample was placed inside a sealable plastic bag before sample container placement in the sample cooler. Samples were kept iced, inside chest coolers until samples were delivered to the analytical laboratory to ensure sample integrity. Sample coolers were packed and shipped to Eurofins TestAmerica laboratory facilities in Pensacola, Florida to be analyzed for the constituents listed in **Table 1**. Sample coolers were shipped via overnight courier following chain-of-custody protocols.

3.2 Analytical Methods

Table 1 summarizes the parameters, analytical methods, holding times and container types for the collected groundwater and quality control samples.

Besides characterizing the nature and extent of lithium, molybdenum and selenium at the Facility, groundwater samples were analyzed for the following parameters to obtain a better understanding of the groundwater chemistry:

- Alkalinity, boron, calcium, chloride, fluoride, iron, magnesium, manganese, potassium, sodium sulfate and total dissolved solids.

4 RESULTS AND DISCUSSION

4.1 Site Geology and Hydrogeology

Site geology is characteristic of an alluvial transitional zone, where alluvial deposits in the uppermost aquifer at the northern portion of the Facility transitions to swamp and beach deposits near the southern boundary of AES-PR.

Based on the soil boring logs (**Appendix B**), the area immediately south of the Agremax Staging Area (i.e., west-to-east transect from Wells TW-101 to MW-5) is underlain by fill material to an average depth of 10 feet below ground surface (bgs). The fill material consists mainly of a mixture of silty sand, sandy silt, and fine to medium sand with rock fragments. The fill stratum is underlain by the uppermost aquifer, which extends from about 10 to 24 feet bgs. This shallow aquifer is comprised of alluvial deposits consisting of layers of sandy silt, silty sand, sandy clay, clayey sand, and fine to medium sand. The lower bound of the uppermost aquifer consists of stiff clay of high plasticity that was intercepted at an average depth of 24 feet bgs. During a hydrogeologic characterization conducted in 2017 by DNA-Environment, LLC (DNA), this clay-confining layer was found to extend to the maximum drilling depth of 30 feet (lithologic data was not collected beyond this depth).

The stratigraphic sequence near the southern property boundary of the facility is similar to the above sequence (Wells TW-101 to MW-5). However, ground elevation near the southern property boundary drops some 10 feet when compared to ground elevation immediately south of the Agremax Staging Area. Fill material near the southern property boundary (i.e., west-to-east transect from Wells TW-104 to TW-109) extends to about one foot below grade. The uppermost aquifer extends from about 1 to 14 ft below ground surface at most drilled locations (and to 17 ft bgs at location TW-107). The stiff clay layer was intercepted at an average depth of 14 feet (and 17 ft at location TW-107), and was confirmed to extend to the maximum drilling depth of 20 feet (lithologic data was not collected beyond this depth).

A professional land survey was conducted in July 2019 to determine the geographical coordinates and top-of-well-casing and ground elevations at each newly and existing monitoring well. **Table 2** summarizes these data, along with the static water elevations determined from the depth to water measurements collected at each well point during the groundwater characterization sampling event of 3 – 4 June 2019. Based on these data, the general direction of groundwater flow is southward (**Figure 3**).

4.2 Groundwater Sampling Results

The groundwater analytical results are summarized in **Table 3**. The concentrations of lithium, molybdenum and selenium in groundwater samples are referenced to the sampled monitoring well locations in **Figure 4**.

Sampling results revealed the following:

- Concentrations of lithium, molybdenum and selenium in groundwater were generally detected immediately downgradient of the Agremax Staging Area along the east-west axis, but were not detected above the laboratory reporting limit (limit of quantitation) in samples collected from the monitoring wells to the west (Well TW-101) and east (Well MW-5).

- The highest groundwater concentrations of lithium, molybdenum and selenium were detected in samples collected from Temporary Wells TW-102 and TW-103, respectively. These monitoring wells are located immediately downgradient of the Agremax Staging Area.

- Molybdenum and selenium were not detected above the laboratory reporting limit in Temporary Wells TW-104 to TW-109, which are located near the Facility's southern property limit. Similarly lithium was not detected in these wells, except for Well TW-107 where the lithium concentration was 0.016 milligram per Liter (mg/L). This concentration is just above lithium's reporting limit of 0.010 mg/L, and below lithium's GWPS of 0.040 mg/L by a factor greater than two.

5 CONCLUSIONS

Based on the analytical results from the June 2019 groundwater sampling event, groundwater impacts from lithium, molybdenum and selenium, in the uppermost aquifer, are confined within AES-PR's property boundaries. The concentrations of these metal constituents were below or near their corresponding laboratory reporting limits in all samples from the monitoring wells installed near the Facility's southern property limit. Additionally, all concentrations were well below the GWPS at the southern property limit. That sampled wells are located hydraulically downgradient from the Agremax Staging Area was confirmed from the general southward groundwater flow direction as determined from depth to water measurements at each well point.

6 REFERENCES

DNA (DNA-Environment, LLC) March 2019. *Sampling and Analysis Plan, Characterization of Lithium, Molybdenum and Selenium in Groundwater, USEPA Coal Combustion Rule, AES Puerto Rico LP, Guayama, PR*

USEPA (United States Environmental Protection Agency). 1998. *Ground Water Sampling Procedure. Low Stress (Low Flow) Purging and Sampling*.

USEPA, 2015. 40 CFR Parts 257 and 261, *Hazardous and Solid Waste Management System; Disposal of Coal Combustion Residuals from Electric Utilities; Final Rule. 17* April.

Revision Log		
Date	Table	Description
November 8, 2019	Table 3	Corrected value of Manganese. Revised from 8.2 mg/L to 11 mg/L for Sample ID AES-MW5-060319, collected from Monitoring Well MW-5 on June 3, 2019.

TABLES

Table 1. Analytical Methods and Testing Requirements for Groundwater and Quality Control Samples

Parameter	Testing Method	Holding Time Before Extraction	Container Type	Preservation
Characterization of Nature and Extent				
Lithium, Molybdenum and Selenium	EPA 6020	180 days	Plastic 250 mL	HNO_3 to pH < 2 [1] Cool ≤ 6 ℃ [2]
Groundwater Geochemistry				
Boron and Calcium	EPA 6020	180 days	Plastic 250 mL [4]	HNO_3 to pH < 2 Cool ≤ 6 ℃
Chloride, Total	SM [3] 4500-Cl-E	28 days	Plastic 1 L [5]	Cool ≤ 6 ℃
Fluoride, Total	SM 4500-F-C	28 days	Plastic 1 L	Cool ≤ 6 ℃
Sulfate, Total	SM 4500-SO4-E	28 days	Plastic 1 L	Cool ≤ 6 ℃
Total Dissolved Solids	SM 2540C	7 days	Plastic 1 L	Cool ≤ 6 ℃
Iron, Magnesium, Manganese, Potassium and Sodium	EPA 6020	180 days	Plastic 250 mL	HNO_3 to pH <2 Cool ≤ 6 ℃
Alkalinity (Total, Bicarbonate and Carbonate)	SM 2320B	14 days	Plastic 1 L	Cool ≤ 6 ℃

Notes:

[1] HNO_3 to pH < 2 = Nitric acid added to lower sample pH to less than two units.
[2] Cool ≤ 6 ℃ = Cool sample to six degrees Celsius or less.
[3] SM = Standard Methods for the Examination of Waters and Wastewaters.
[4] mL = milliliter
[5] L = Liter

Table 2. 2019 Monitoring Well Professional Land Survey and Groundwater Elevation Data from June 2019 Sampling Event

Well ID	Northing (Y)	Easting (X)	Latitude	Longitude	Ground Elevation (meters)*	Ground Elevation (feet)	TOC Elevation (meters)	TOC Elevation (feet)	Depth to Water (feet)	Groundwater Elevation (feet)
MW-1	212731.3196	230013.699	17.9481512	-66.1500155	6.148	20.171	6.948	22.795	12.22	10.58
MW-2	212639.2969	230127.7269	17.9473182	-66.1489405	6.193	20.318	6.998	22.959	12.57	10.39
MW-3	212188.6158	229867.5265	17.9432499	-66.1514032	4.022	13.196	4.842	15.886	13.75	2.14
MW-4	212186.082	229968.4781	17.9432256	-66.1504504	4.507	14.787	5.372	17.625	13.10	4.52
MW-5	212202.488	230090.6473	17.9433722	-66.1492969	4.141	13.586	4.953	16.250	13.65	2.60
TW-D	212492.9126	229980.8134	17.9459977	-66.1503294	5.407	17.740	6.026	19.770	10.12	9.65
TW-101	212183.1763	229833.1169	17.9432013	-66.1517281	3.962	12.999	4.869	15.974	14.13	1.84
TW-102	212183.5493	229918.3735	17.9432035	-66.1509233	4.256	13.963	5.183	17.005	15.20	1.80
TW-103	212193.3289	230023.3263	17.9432904	-66.1499325	4.563	14.970	5.479	17.976	15.18	2.80
TW-104	212142.7859	229828.8634	17.9428364	-66.1517689	4.594	15.072	1.759	5.771	4.11	1.66
TW-105	212145.2408	229870.9677	17.9428580	-66.1513714	0.972	3.189	1.931	6.335	4.65	1.69
TW-106	212149.4473	229920.7523	17.9428953	-66.1509014	1.257	4.124	2.189	7.182	5.54	1.64
TW-107	212153.5554	229970.3777	17.9429317	-66.1504329	1.349	4.426	2.254	7.395	5.69	1.71
TW-108	212159.3198	230031.9076	17.9429830	-66.1498520	1.280	4.199	2.155	7.070	5.45	1.62
TW-109	212162.1096	230060.4476	17.9430078	-66.1495826	1.255	4.117	2.179	7.149	5.45	1.70
P-102	212375.0089	229935.0988	17.9449331	-66.1507627	4.834	15.860	5.542	18.182	9.19	8.99
P-106	212299.0367	230114.7307	17.9442441	-66.1490682	4.609	15.121	4.949	16.237	10.49	5.75
	SURVEYED	SURVEYED			SURVEYED*		SURVEYED		FIELD DATA	CALCULATED

Notes:
Coordinate System: NAD 83, Puerto Rico State Plane (meters)
Elevation Reference: Orthometric, Geoid12B
Horizontal and vertical coordinates were surveyed in meters.
* Ground surface elevations at Wells MW-1 to MW-5 were determined by subtracting the aboveground thickness of the concrete pad (0.08 m) from the concrete pad's surface elevation.
Meters to feet conversion factor = 3.28084 feet per meter.
TOC - Top of Well Casing.
Groundwater Elevation was calculated by substracting the Depth to Water (Ft) from the TOC Elevation (Ft).

Table 3. Analytical Results and Monitoring Data for Groundwater Samples Collected in June 2019
AES Puerto Rico, LP in Guayama, Puerto Rico

	Well ID	TW-101	MW-3	TW-102	MW-4	MW-4	TW-103	MW-5
	Well Type and Location	N&E Downgradient[1]	CCR Downgradient[1]	N&E Downgradient	CCR Downgradient	Field Duplicate	N&E Downgradient	CCR Downgradient
	Sample ID	AES-TW101-060319	AES-MW3-060319	AES-TW102-060319	AES-MW4-060319	AES-MW4-Dup-060319	AES-TW103-060319	AES-MW5-060319
	Sampling Date	6/3/2019	6/3/2019	6/3/2019	6/3/2019	6/3/2019	6/3/2019	6/3/2019
Static Water Elevation (ft MSL)		1.84	2.14	1.80	4.52	NA	2.80	2.60
Field Parameters	Units							
pH	SU	6.81	7.00	6.93	7.16	NA	7.09	6.56
Conductivity	mS/cm	13.94	13.95	35.52	18.72	NA	30.86	12.67
Redox Potential	mV	-89.9	-76.9	-73.3	-117.8	NA	-94.6	-67.6
Dissolved Oxygen	mg/L	1.02	0.76	1.02	0.51	NA	0.51	0.76
Turbidity	NTU	7.07	2.30	4.18	15.60	NA	2.70	20.99
Temperature	°C	30.30	30.83	31.90	33.14	NA	30.90	29.26
Analytical Results								
Lithium	mg/L	0.0048 J	0.0035 J	1.1	0.38	0.37	0.60	0.0043 J
Molybdenum	mg/L	0.0067	0.17	1.4	0.51	0.51	1.4	0.0035 J
Selenium	mg/L	0.0049 U	0.11	0.98	0.0049 U	0.0049 U	0.70	0.0049 U
Boron	mg/L	0.77	1.1	2.8	1.6	1.6	2.0	0.43
Calcium	mg/L	950	310	590	280	270	590	680
Chloride	mg/L	4700	4100	9000	4400	4500	5200	3800
Fluoride	mg/L	0.96	1.6	0.74	0.78	0.79	0.74	0.42
pH, Field	SU	6.81	7.00	6.93	7.16	NA	7.09	6.56
Sulfate	mg/L	620	1900	11000	4500	4300	10000	2300
Total Dissolved Solids	mg/L	16000	8700	41000	16000	13000	32000	9900
Alkalinity, Total	mg/L	650	550	350	800	810	320	500
Iron	mg/L	45	0.83	0.23 U	13	10	1.3	10
Magnesium	mg/L	840	480	290	68	66	180	380
Manganese	mg/L	7.6	1.2	4.0	2.2	2.1	6.9	11
Potassium	mg/L	10	23	1100	900	860	1000	7.4
Sodium	mg/L	1800	2700	11000	5900	5700	11000	2600

Notes:
mg/L - milligrams per Liter
SU - Standard Units
ft MSL - Feet above Mean Sea Level
mS/cm - millisiemens per centimeter
mV - millivolt
NTU - Nephelometric Turbidity Units
°C - degrees Celsius
NS - Not Sampled.
Static water elevations listed are based on measurements collected in all wells on 4 June 2019.

[1]Wells installed immediately south (hydraulically downgradient) of the Agremax Staging Area.
N&E = Well for Nature and Extent Characterization; CCR = Well for Coal Combustion Residuals Groundwater Monitoring.
Analytical results of metal elements are "Total Recoverable".
Sampling Date format is mmddyy.
Sample ID format is: "Site Name-MW_ID-Sampling_Date".
Sample AES-MW4-DUP-060319 is the field duplicate sample of AES-MW4-060319.
U - Not detected at indicated Method Detection Limit (MDL).
J - Result is less than the Reporting Limit, but greater than or equal to the MDL and concentration is an approximate value.
NA - Not Applicable to the field duplicate sample.

Table 3 (Cont.). Analytical Results and Monitoring Data for Groundwater Samples Collected in June 2019
AES Puerto Rico, LP in Guayama, Puerto Rico

	Well ID	TW-104	TW-105	TW-106	TW-107	TW-108	TW-109
	Well Type and Location	N&E Property Boundary[2]	N&E Property Boundary	N&E Property Boundary	N&E Property Boundary	N&E Property Boundary	N&E Property Boundary
	Sample ID	AES-TW104-060419	AES-TW105-060419	AES-TW106-060419	AES-TW107-060419	AES-TW108-060419	AES-TW109-060419
	Sampling Date	6/4/2019	6/4/2019	6/4/2019	6/4/2019	6/4/2019	6/4/2019
Static Water Elevation (ft MSL)		1.66	1.69	1.64	1.71	1.62	1.70
Field Parameters	Units						
pH	SU	7.00	7.14	6.93	7.18	6.91	6.76
Conductivity	mS/cm	14.28	13.28	21.45	26.35	20.81	12.86
Redox Potential	mV	-92.7	-131.1	-98.4	-85.6	-68.4	-69.9
Dissolved Oxygen	mg/L	0.86	0.85	1.16	0.69	0.81	1.02
Turbidity	NTU	14.63	11.01	7.59	3.50	21.14	16.45
Temperature	°C	28.09	29.02	28.86	29.36	28.60	27.54
Analytical Results							
Lithium	mg/L	0.0027 J	0.0026 J	0.0048 J	0.016	0.0041 J	0.0041 J
Molybdenum	mg/L	0.012 U	0.012 U	0.013 J	0.012 U	0.012 U	0.012 U
Selenium	mg/L	0.0049 U	0.0049 U	0.0049 U	0.0049 U	0.0049 U	0.0049 U
Boron	mg/L	0.78	0.79	1.1	1.1	0.66	0.43
Calcium	mg/L	630	420	810	570	700	970
Chloride	mg/L	4800	3600	6300	7000	6300	4000
Fluoride	mg/L	0.78	1.2	0.98	0.61	0.71	0.66
pH, Field	SU	7.00	7.14	6.93	7.18	6.91	6.76
Sulfate	mg/L	1800	3000	4400	7800	4200	2300
Total Dissolved Solids	mg/L	13000	12000	50000	39000	26000	13000
Alkalinity, Total	mg/L	600	820	830	510	530	500
Iron	mg/L	1.5	1.5	6.7	4.9	5.7	13
Magnesium	mg/L	650	460	810	580	640	570
Manganese	mg/L	12	8.2	16	16	18	14
Potassium	mg/L	21	30	89	170	10	4.7
Sodium	mg/L	2600	2900	5600	8900	5200	2100 V

Notes:
mg/L - milligrams per Liter
SU - Standard Units
ft MSL - Feet above Mean Sea Level
mS/cm - millisiemens per centimeter
mV - millivolt
NTU - Nephelometric Turbidity Units
°C - degrees Celsius
NS - Not Sampled.
Static water elevations listed are based on measurements collected in all wells on 4 June 2019.

[2]Wells installed near AES-PR's southern property boundary.
N&E = Well for Nature and Extent Characterization.
Analytical results of metal elements are "Total Recoverable".
Sampling Date format is mmddyy.
Sample ID format is: "Site Name-MW_ID-Sampling_Date".
Sample AES-MW4-DUP-060319 is the field duplicate sample of AES-MW4-060319.
U - Not detected at indicated Method Detection Limit (MDL).
J - Result is less than the Reporting Limit, but greater than or equal to the MDL and concentration is an approximate value.
V - Serial Dilution exceeds the control limits.

FIGURES

Figure 1

Site Location Map

AES Puerto Rico, LP
Guayama, Puerto Rico

Legend

AES Puerto Rico Approximate Property Boundary

N

0 250 500 750 1000 1250 ft

DNA-ENVIRONMENT, LLC

Figure 2

CCR Groundwater Monitoring System and Groundwater Characterization Temporary Wells AES Puerto Rico, LP in Guayama, PR

DNA-ENVIRONMENT, LLC

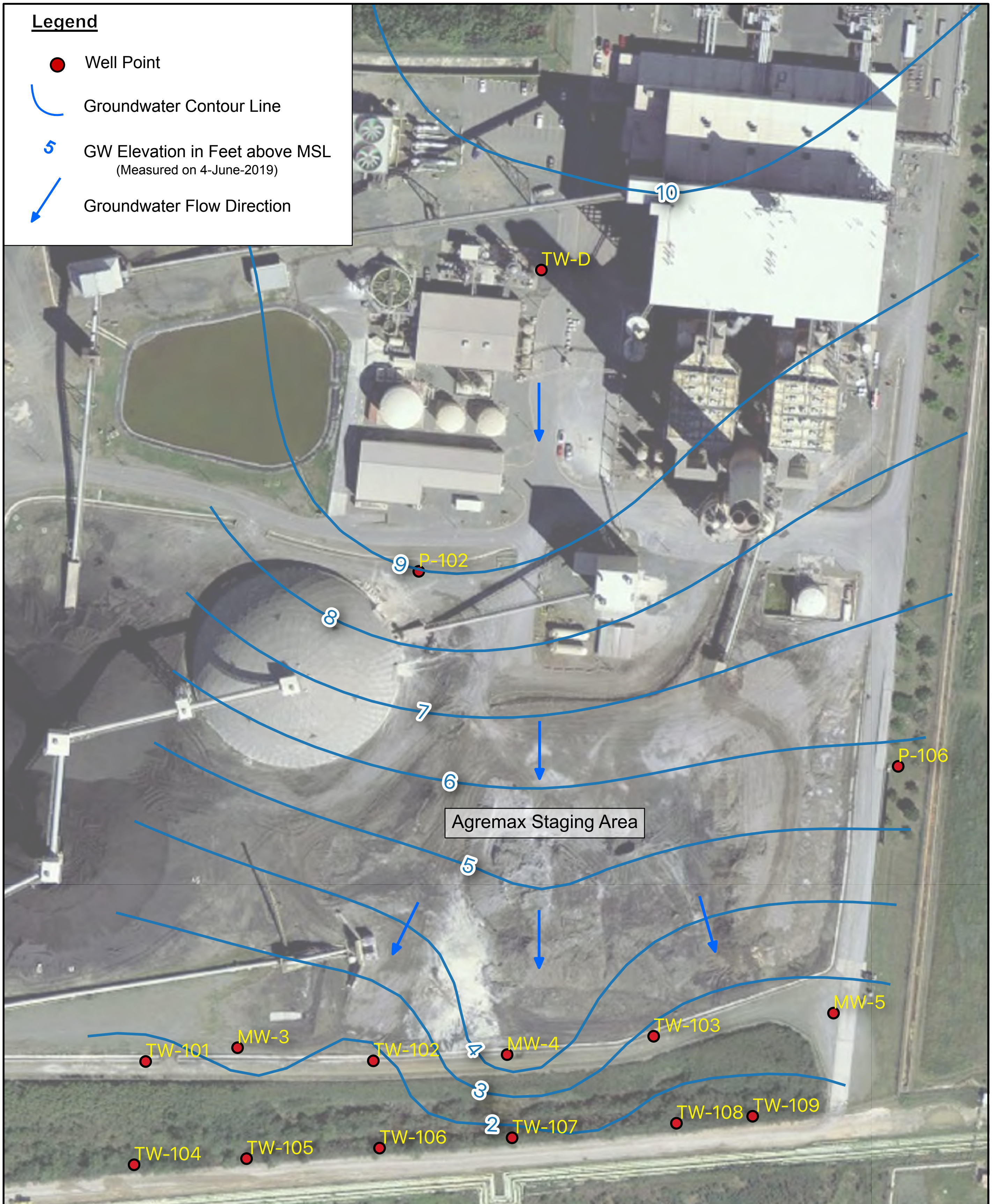


Figure 3
Groundwater Elevation Contours
AES Puerto Rico, LP
Guayama, Puerto Rico

N

0 100 200 300 ft

DNA-ENVIRONMENT, LLC

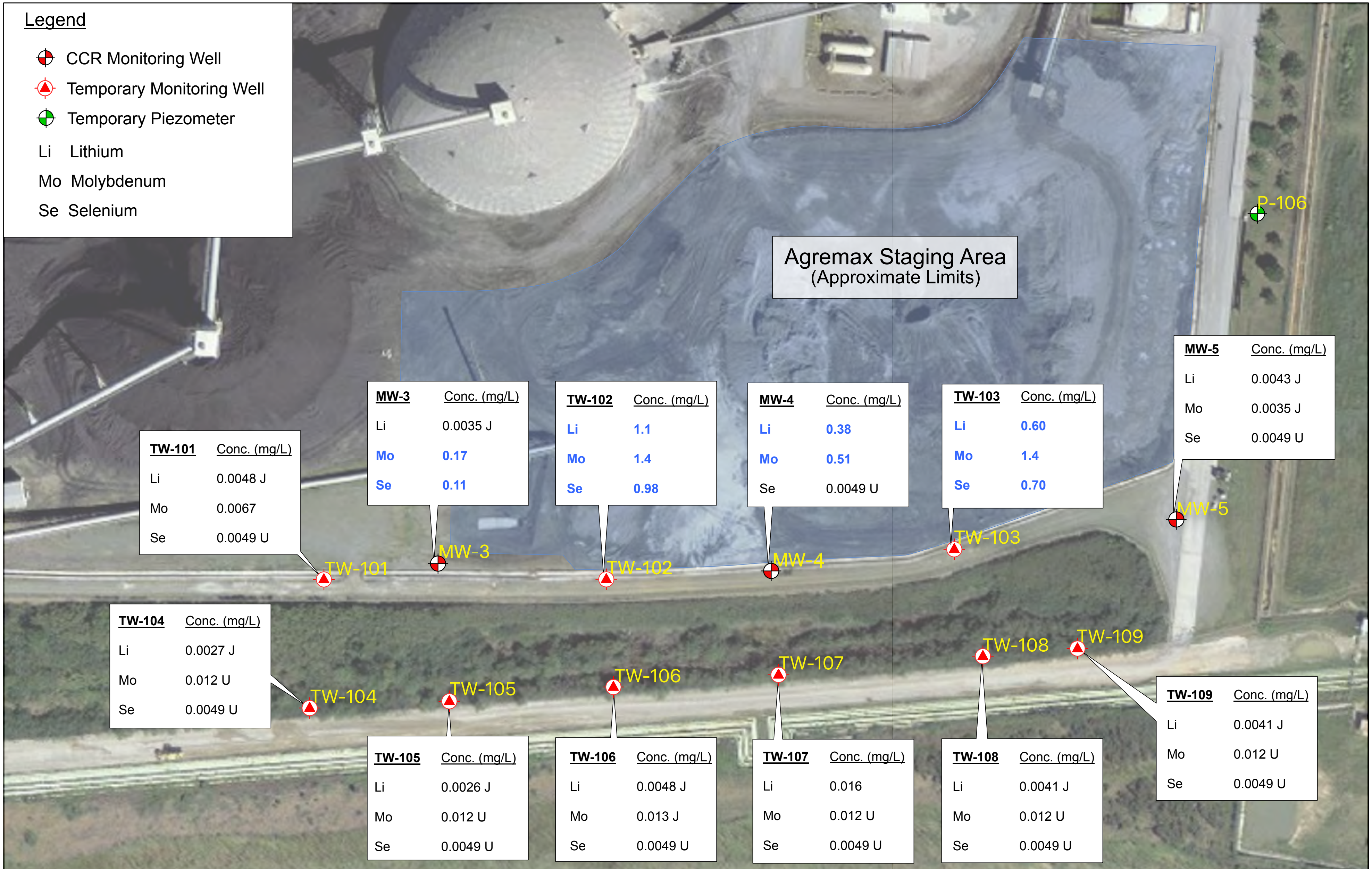


Figure 4

CCR Nature and Extent Groundwater Sampling Results

AES Puerto Rico, LP in Guayama, PR

N

0 100 200 300 ft

DNA-ENVIRONMENT, LLC

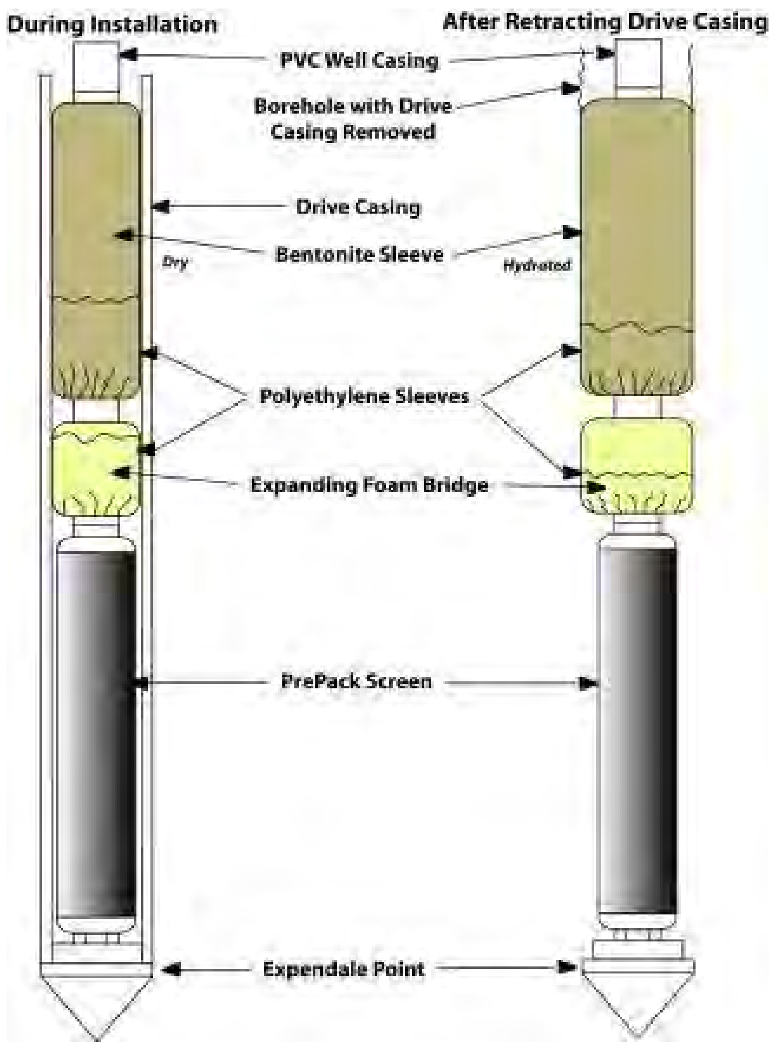
APPENDIX A

PREPACKED SCREEN MONITORING WELL SPECIFICATIONS

Pre-Pack Screen Monitoring Wells

1.5″ Metals Testing Prepack (2.4″ OD) x 5′ length

<u>Description</u>: Outer layer is food grade nylon mesh, sand packed with 20×40 silica sand over 0.010″ slotted Sch40 PVC Screen. No metal components are used.



- ♦ Assures accurate placement of filter media across desired interval.
- ♦ Quick Seal and Bentonite sleeves protects the sampling environment.
- ♦ Installed through cased borehole, provides high integrity well construction and sample quality.
- ♦ Meets ASTM standard D6725 for Direct Push Monitoring Well Installation.
- ♦ Meets basic EPA and RCRA construction requirements.
- ♦ DOD and EPA Studies reveal no statistically significant difference between water quality samples collected from paired Pre-Packs and conventional drilled wells.

ECT Pre-Pack Specifications

Pre-Pack Screen

Pipe Size	Length (feet)	Original Diameter (inch) ID/OD	Fits Casing (inchs OD)
0.50-inch	2 .5, 5	0 .625 / 1.4	2, 2-1/4
0 .75-inch	2 .5, 5	0 .81 / 1.4	2, 2-1/4
1-inch	2 .5, 5	1.03 / 1.7	3-1/4, 3-1/2
1-inch	2 .5, 5	1.03 / 2.4	3-1/4, 3-1/2
1.25-inch	2.5, 5	1.34 / 2.4	3-1/4, 3-1/2
1.50-inch	2 .5, 5	1.59 / 2.4	3-1/4, 3-1/2
2-inch	2.5, 5	2 .05 / 2.8	3-1/2, 3-3/4
2-inch	2.5, 5	2.05 / 3.5	4-1/2
3-inch	2.5, 5	3.04 / 5.5	4-1/4 HSA
4-inch	2.5, 5	3.99 / 5.5	4-1/4 HSA

Expanding Foam Bridge

Pipe Size	Length (feet)	Original Diameter (inch)	Fill Hole Approx. Diameter (inchs)
0 .75-inch	2 .5	1.4	>2.5
1-inch	2 .5	2 .4	>3.5
1.25-inch	2 .5	2 .4	>3.5
1.50-inch	2 .5	2 .4	>3.5
2-inch	2 .5	2 .8	>4

Bentonite Sleeve

Expansion times (example) - 3/4-inch model seals 2-inch hole in approx. 6-12 hours.

Pipe Size	Length (feet)	Original Diameter (inch)	Fill Hole Approx. Diameter (inchs)
0 .75-inch	2 .5	1.4	>2.5
1-inch	2 .5	2 .4	>3.5
1.25-inch	2.5	2 .4	>3.5
1.50-inch	2.5	2 .4	>3.5
2 -inch	2.5	2 .8	>4

Quick Seal Sleeve

Expansion times (example) - 3/4-inch model seals 2-inch hole in approx. 15-30 minutes.

Pipe Size	Length (feet)	Original Diameter (inch) ID/OD	Fill Hole Approx. Diameter (inchs)
0.75-inch	0 .5	0 .81 / 1.4	>2.5
1-inch	0 .5	1.03 / 1.7	>3.5
1.25-inch	0 .5	1.34 / 2.4	>3.5
1.50-inch	0 .5	1.59 / 2.4	>3.5
2 -inch	0 .5	2 .05 / 2.8	>4

Direct Push Drive Casing and Expendable Points

2-1/4 inch OD Casing	2-1/4-inch Expendable Point Steel 2-1/4-inch Expendable Pt. Aluminum
3-1/4 inch OD Casing	3-1/4-inch Expendable Point Steel 3-1/4-inch Expendable Pt. Aluminum
3-1/2 inch OD Casing	3-1/2-inch Expendable Point Steel
3-3/4 inch OD Casing	3-3/4-inch Expendable Point Steel
4-1/2 inch OD Casing	4-1/2-inch Expendable Point Steel

ECT

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Web Address: ectmfg.com

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APPENDIX B

SOIL BORING LOGS AND WELL CONSTRUCTION DIAGRAMS

GROUNDWATER LOG Temporary Well TW-101

DNA-Environment, LLC

PROJECT NUMBER: DNA-190167	DRILLING DATE: May 30, 2019	COORDINATES: Y=212183.1763, X =229833.1169
PROJECT NAME: CCR Groundwater Monitoring	WELL DEPTH: 24 Ft	COORD SYS: NAD 83, PR State Plane (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 1.5-in	ELEVATION REF: Orthometric, Geoid 12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 3.962 m (12.999 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 4.869 m (15.974 Ft)

DRILLING METHOD: Geoprobe 3.25-in ID Dual Tubes. Well was installed using metal-free prepacked well materials from ECT Manufacturing (i.e., 1.5" ID Metals Testing PrePacked PVC Well Screen").

LOGGED BY: Alberto Melendez
CHECKED BY: Juan D. Negron, PG

% Recovery | Depth (Ft) | Graphic Log | Lithologic Description | Well Diagram | Depth (Ft)

Lithologic Description

Silty sand with some angular rock fragments, light yellowish brown, medium dense, moderate estimated K, no odor, fill material.

Sandy silt, yellowish brown, moist, medium stiff, medium plasticity moderate estimated K, no odor, alluvial deposits.

Sandy clay, dark brown, moist, medium stiff, high plasticity, low estimated K, no odor, alluvial deposits.

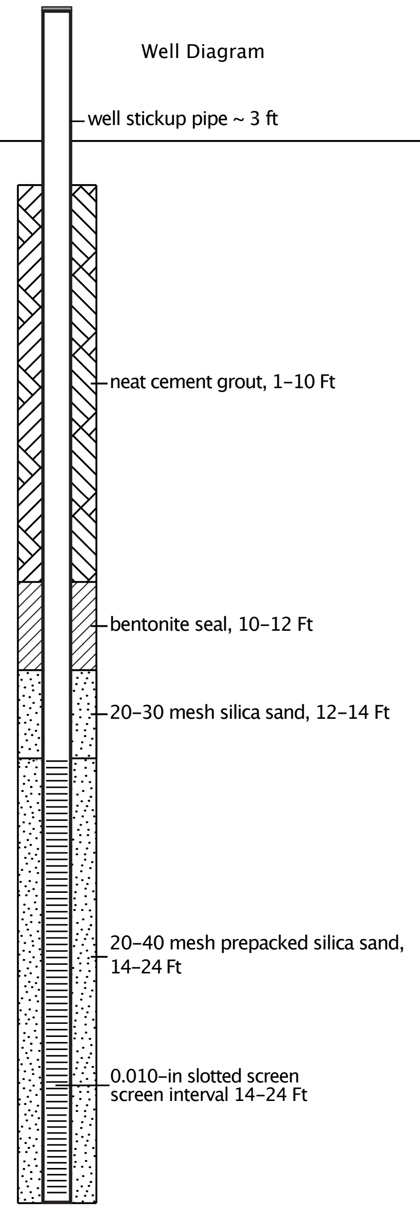
Clayey sand, dark brown, moist, loose, medium plasticity, moderate estimated K, no odor, alluvial deposits.

Fine to medium sand with some feldspars minerals, light brown, moist, loose, high estimated K, no odor, alluvial beach deposits.

Clayey sand, brown, moist, medium dense, medium plasticity, moderate estimated K, no odor, alluvial deposits.

Clay, yellowish brown, stiff, high plasticity, low estimated K, no odor, alluvial deposits.

Borehole Termination Depth: 25 Ft.
Water level while drilling intercepted at 9 Ft below ground surface.



GROUNDWATER LOG Temporary Well TW-102

DNA-Environment, LLC

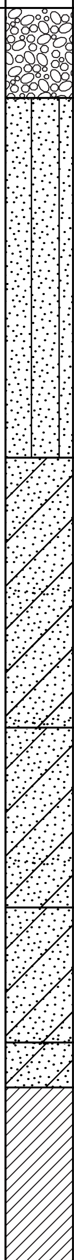
PROJECT NUMBER: DNA-190167	DRILLING DATE: May 6, 2019	COORDINATES: Y=212183.5493, X=229918.3735
PROJECT NAME: CCR Groundwater Monitoring	WELL DEPTH: 25 Ft	COORD SYS: NAD 83, PR State Plane (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 2-in	ELEVATION REF: Orthometric, Geoid12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 4.256 m (13.963 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 5.183 m (17.005 Ft)

DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

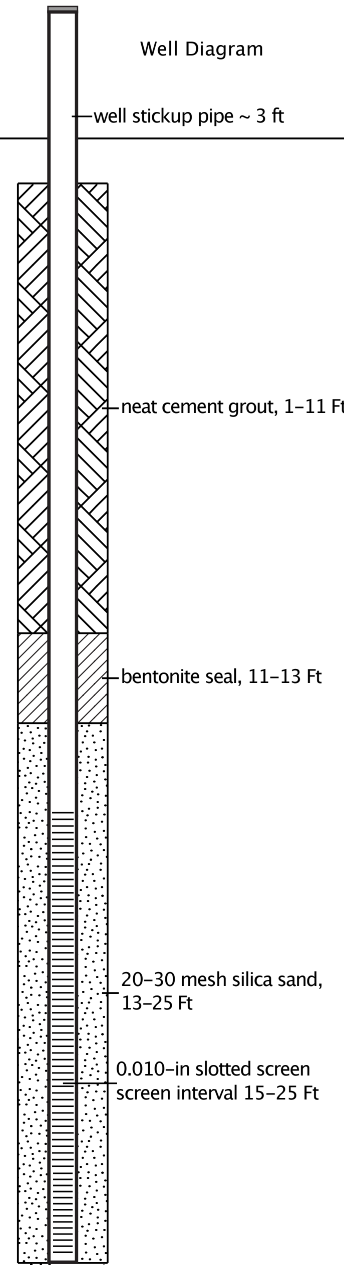
LOGGED BY: Juan D. Negron, PG

Depth (Ft)	Lithologic Description
0–2	Crushed angular gravel, gray, loose, high estimated K, fill material.
2–10	Sandy silt with angular gravel, yellowish brown, medium stiff, moderate estimated K, no odor, fill material.
10–16	Sandy clay, dark brown, moist, medium stiff, high plasticity, low estimated K, organic odor, alluvial deposits.
16–20	No recovery most likely due to collapse of rock fragment. However, on May 30, 2019 collected core sample from 15 -20 Ft depth interval at offset location and confirmed that lithology was sandy clay as above and below.
20–23	Sandy clay, dark brown, moist, medium stiff, high plasticity, low estimated K, organic odor, alluvial deposits.
23–24	Clayey sand, dark brown, moist, loose, medium plasticity, moderate estimated K, no odor, alluvial deposits.
24–28	Clay, yellowish brown, stiff, high plasticity, low estimated K, no odor, alluvial deposits.

Graphic Log



Well Diagram



Borehole Termination Depth at: 28 Ft.
Water level while drilling intercepted at 10 Ft. below ground surface.

GROUNDWATER LOG Temporary Well TW-103

DNA-Environment, LLC

PROJECT NUMBER: DNA-190167
PROJECT NAME: CCR Groundwater Monitoring
CLIENT: AES Puerto Rico, LP
ADDRESS: Guayama, Puerto Rico
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)

DRILLING DATE: May 7, 2019
WELL DEPTH: 24.5 Ft
DIAMETER: 2-in
CASING: PVC
SCREEN: PVC Factory Slotted (0.010-in)

COORDINATES: Y=212193.3289, X=230023.3263
COORD SYS: NAD 83, PR State Plane (m)
ELEVATION REF: Orthometric, Geoid12B
GROUND ELEVATION: 4.563 m (14.970 Ft)
WELL ELEVATION AT TOC: 5.479 m (17.976 Ft)

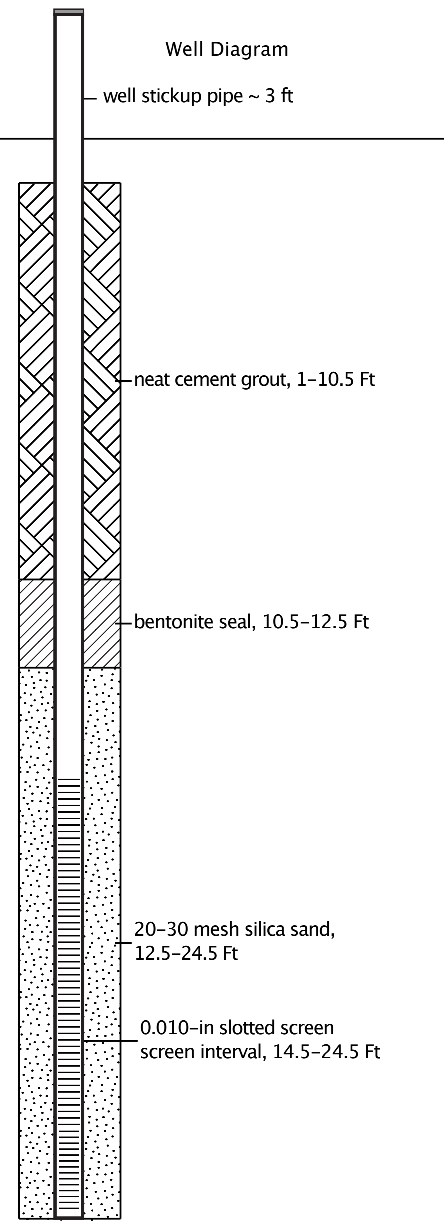
DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

%Recovery	Depth (Ft)	Graphic Log	Lithologic Description
	0–8		Silty sand with some angular rock fragments, light yellowish brown, medium dense hardness, low plasticity, moderate estimated K, no odor, fill material.
	8–12.5		Fine to medium sand with some angular rock fragments, light olive gray, medium dense hardness, non plasticity, high estimated K no odor, fill material.
	12.5–16		Sandy clay, dark brown, moist, stiff hardness, high plasticity, low estimated K, vague odor, some organic material, alluvial deposits.
	16–18		Clayey sand, brown, moist, loose, medium plasticity,moderate estimated K, no odor, alluvial deposits.
	18–21		Fine sand with some feldspars minerals, loose hardness, non plasticity, high estimated K, no odor, alluvial beach deposits.
	21–24		Sandy clay, light brown, moist, medium stiff hardness, high plasticity, low estimated K, no odor, alluvial beach deposits.
	24–25		Clay, yellowish brown, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.

Borehole Termination Depth: 25 Ft.
Water level while drilling intercepted at 15.5 Ft below ground surface.

Well Diagram



GROUNDWATER LOG Temporary Well TW-104

DNA-Environment, LLC

PROJECT NUMBER: DNA-190167	DRILLING DATE: May 8, 2019	COORDINATES: Y=212142.7859, X=229828.8634
PROJECT NAME: CCR Groundwater Monitoring	TOTAL DEPTH: 14 Ft	COORD SYS: NAD 83, PR State Plane (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 2-in	ELEVATION REF: Orthometric, Geoid12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 4.594 m (15.072 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 1.759 m (5.771 Ft)

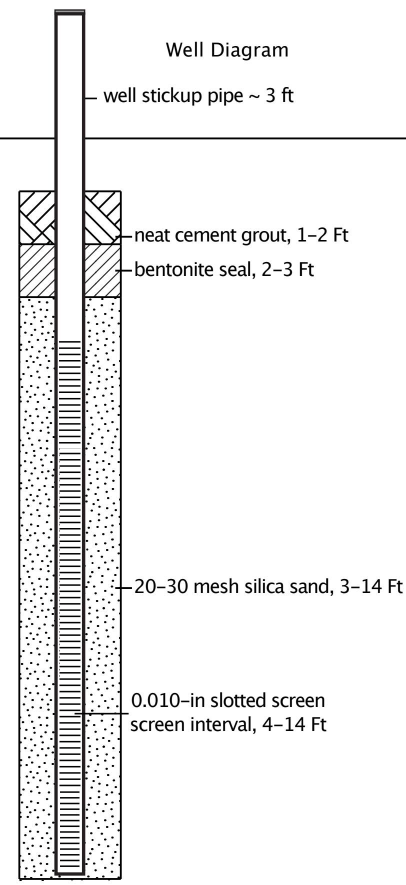
DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

Depth (Ft)	Lithologic Description
0–1	Silty sand with organic material, brown to light brown, medium dense hardness, moist, some subrounded rock fragments, very low plasticity, no odor, alluvial deposits.
1–7	Sandy silt, dark brown, soft, medium plasticity, moist, moderate estimated K, no odor, alluvial deposits.
7–9	Silty sand, yellowish brown, medium dense hardness, medium plasticity, moderate estimated K, no odor, alluvial deposits.
9–10	Clay, yellowish brown, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
10–11	Fine to medium sand with some feldspars minerals, brown, moist, non plasticity, high estimated K, no odor, alluvial beach deposits.
11–12	Medium to coarse sand with some feldspars minerals, brown, loose, non plasticity, high estimated K, no odor, alluvial beach deposits.
12–16	Clay, yellowish brown, moist, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
16–20	Clay, dark brown to dark olive gray, moist, stiff hardness, high plasticity, low estimated K, swamp deposits.

Borehole Termination Depth: 20 Ft.
Water level while drilling intercepted at 1.5 Ft. below ground surface.

Well Diagram



GROUNDWATER LOG Temporary Well TW-105

DNA-Environment, LLC

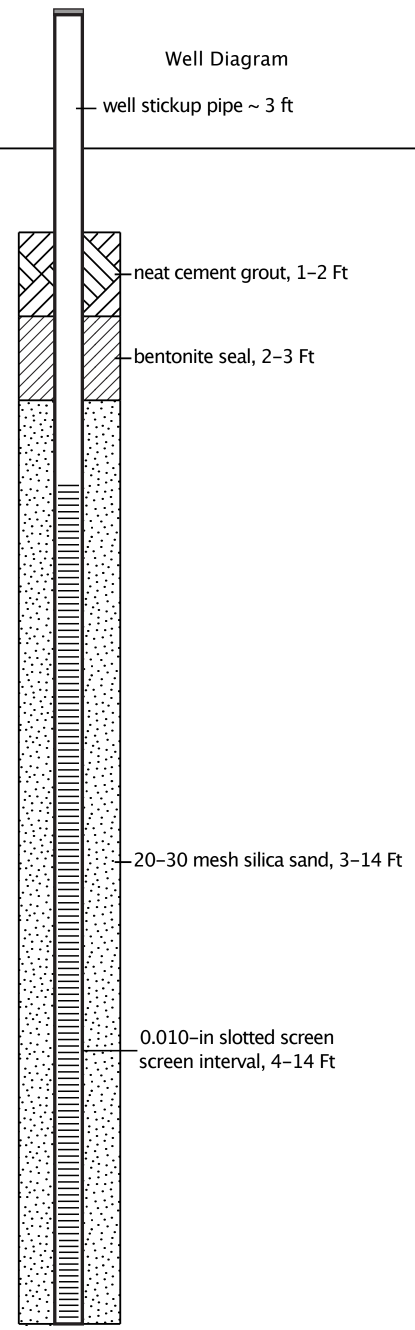
PROJECT NUMBER: DNA-190167	DRILLING DATE: May 7, 2019	COORDINATES: Y=212145.2408, X=229870.9677
PROJECT NAME: CCR Groundwater Monitoring	TOTAL DEPTH: 14 Ft	COORD SYS: NAD 83, PR State Plane (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 2-in	ELEVATION REF: Orthometric, Geoid12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 0.972 m (3.189 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 1.931 m (6.335 Ft)

DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

Depth (Ft)	Lithologic Description
0–2	Six inches of fill followed by clayey sand, dark brown, dense hardness, medium plasticity, moist at 2 Ft., low estimated K, no odor, alluvial deposits.
2–6	Sandy silt, dark brown, moist, medium stiff hardness, medium to high plasticity, low estimated K, no odor, alluvial deposits.
6–9	Sandy silt, dark brown, moist, medium stiff hardness, medium to high plasticity, low estimated K, no odor, alluvial deposits.
9–10	Silty sand, light brown, moist, loose hardness, medium plasticity, moderate estimated K, no odor, alluvial deposits.
10–12	Fine to medium sand with some feldspars minerals, moist, brown, medium dense hardness, non plasticity, high estimated K, no odor, alluvial beach deposits.
12–13	Clay, light brown, moist, soft, high plasticity, low estimated K, no odor, alluvial deposits.
13–15	Clay, light brown, moist, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
15	Borehole Termination Depth: 15 Ft. Water level while drilling intercepted at 2.5 Ft. below ground surface.

Well Diagram



GROUNDWATER LOG Temporary Well TW-106

DNA-Environment, LLC

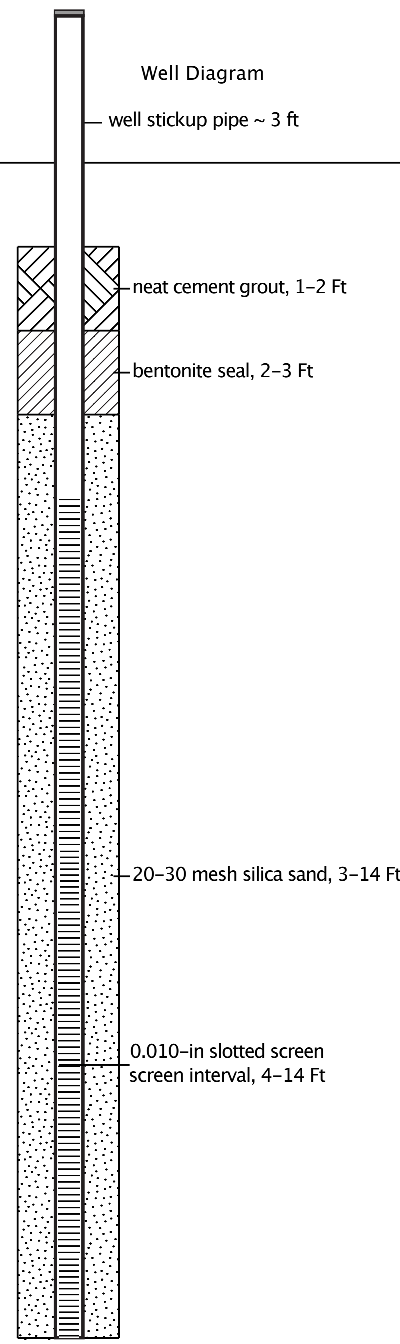
PROJECT NUMBER: DNA-190167	DRILLING DATE: May 8, 2019	COORDINATES: Y =212149.4473, X=229920.7523
PROJECT NAME: CCR Groundwater Monitoring	TOTAL DEPTH: 14 Ft	COORD SYS: NAD 83, PR STATE PLANE (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 2-in	ELEVATION REF: Orthometric, Geoid12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 1.257 m (4.124 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 2.189 m (7.182 Ft)

DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

Depth (Ft)	Lithologic Description
0–1	Fine to medium sand with some angular rock fragments, light brown, loose, non plasticity, high estimated K, no odor, fill material.
1–7	Sandy silt, dark brown, moist at 2 Ft., medium stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
7–11	Silty sand, dark brown, moist, dense hardness, medium plasticity, moderate estimated K, no odor, alluvial deposits.
11–13	Fine to medium sand with feldspars minerals, moist, non plasticity, high estimated K, no odor, alluvial beach deposits.
13–14	Medium to coarse sand with feldspars minerals, brown, moist, medium dense, non plasticity, high estimated K, no odor, alluvial beach deposits.
14–15	Clay, yellowish brown, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.

Well Diagram



Borehole Termination Depth: 15 Ft.
Water level while drilling intercepted at 2 Ft below ground surface.

GROUNDWATER LOG Temporary Well TW-107

DNA-Environment, LLC

PROJECT NUMBER: DNA-190167
PROJECT NAME: CCR Groundwater Monitoring
CLIENT: AES Puerto Rico, LP
ADDRESS: Guayama, Puerto Rico
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)

DRILLING DATE: May 8, 2019
WELL DEPTH: 17 Ft
DIAMETER: 2-in
CASING: PVC
SCREEN: PVC Factory Slotted (0.010-in)

COORDINATES: Y=212153.5554, X=229970.3777
COORD SYS: NAD 83, PR State Plane (m)
ELEVATION REF: Orthometric, Geoid12B
GROUND ELEVATION: 1.349 m (4.426 Ft)
WELL ELEVATION AT TOC: 2.254 m (7.395 Ft)

DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

%Recovery | Depth (Ft) | Graphic Log | Lithologic Description | Well Diagram | Depth (Ft)

Depth (Ft): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Lithologic Description

Six inches of fine sand with some organic material.

Silty sand, brown, moist at 2.5 Ft., medium dense hardness, low plasticity, moderate estimated K, no odor, alluvial deposits.

Sandy silt, dark brown, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.

Silty sand, yellowish brown, moist, soft, high plasticity, low estimated K, no odor, alluvial deposits.

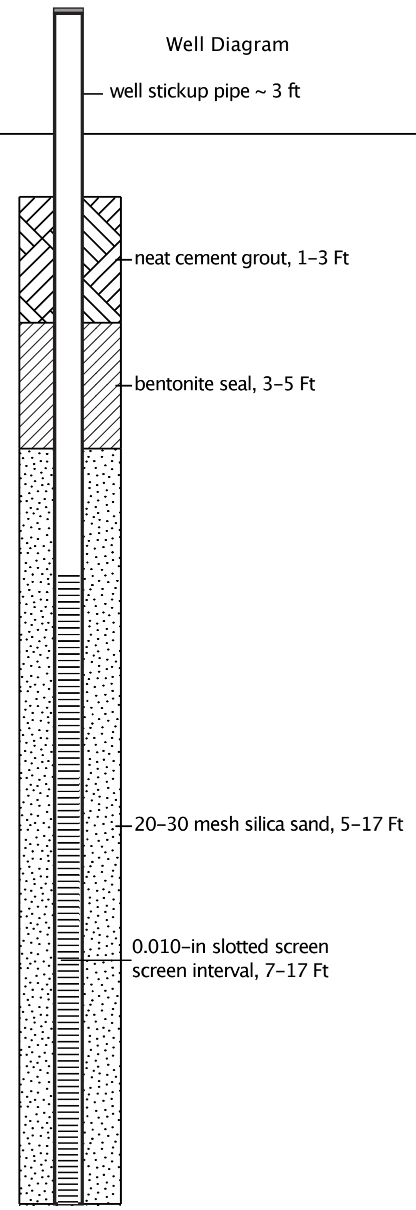
Fine to medium sand with feldspars minerals and calcareous material, brown, loose hardness, non plasticity, high estimated K, no odor, alluvial beach deposits.

Clay, yellowish brown, moist, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.

Clay, dark brown to dark olive green, stiff hardness, high plasticity, low estimated K, vague swamp, odor, swamp deposits.

Borehole Termination Depth: 20 Ft.
Water level while drilling intercepted at 2.5 Ft below ground surface.

Well Diagram



GROUNDWATER LOG Temporary Well TW-108

DNA-Environment, LLC

PROJECT NUMBER: DNA-190167
PROJECT NAME: CCR Groundwater Monitoring
CLIENT: AES Puerto Rico, LP
ADDRESS: Guayama, Puerto Rico
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)

DRILLING DATE: May 7, 2019
WELL DEPTH: 14 Ft
DIAMETER: 2-in
CASING: PVC
SCREEN: PVC Factory Slotted (0.010-in)

COORDINATES: Y=212159.3198, X=230031.9076
COORD SYS: NAD 83, PR State Plane (m)
ELEVATION REF: Orthometric, Geoid12B
GROUND ELEVATION: 1.280 m (4.199 Ft)
WELL ELEVATION AT TOC: 2.155 m (7.070 Ft)

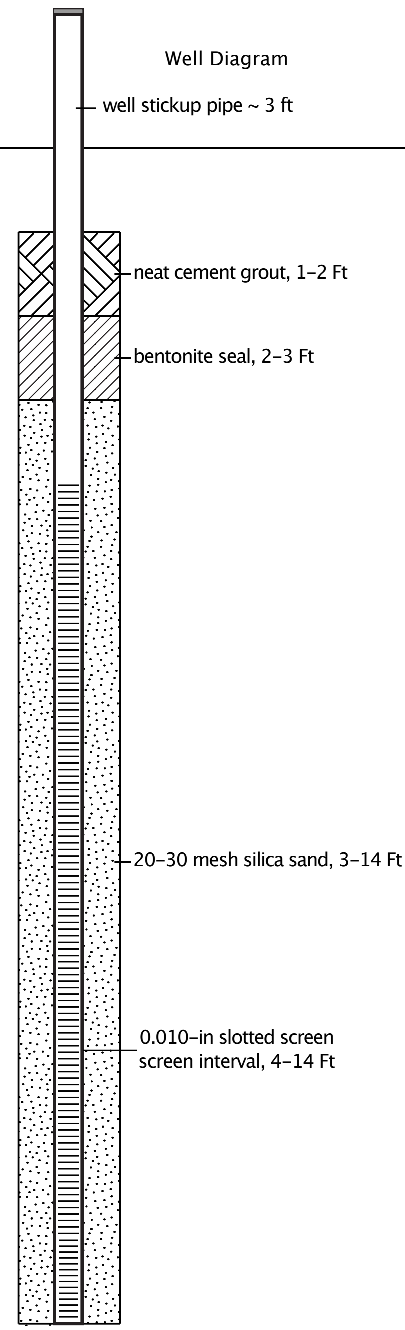
DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

Depth (Ft)	Lithologic Description
0–1	Fine to medium sand with some angular rock fragments, brown, loose, non plasticity, non odor, high estimated K, fill material.
1–2.5	Clayey sand, olive brown, moist, soft, medium plasticity,moderate estimated K, no odor, alluvial deposits.
2.5–10	Silty sand, dark yellowish brown, moist, medium dense hardness, medium plasticity, moderate estimated K, no odor, alluvial deposits.
10–11	Fine sand with some feldspars minerals, light brown, moist, medium dense hardness, non plasticity, high estimated K, no odor, alluvial beach deposits.
11–11.5	Silty sand, dark yellowish brown, moist, medium dense hardness, medium plasticity, moderate estimated K, no odor, alluvial deposits.
11.5–13	Clay, light yellowish brown, moist, medium stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
13–15	Clay, light yellowish brown, moist, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.

Borehole Termination Depth: 15 Ft.
Water level while drilling intercepted at 2.5 Ft. below ground surface.

Well Diagram



GROUNDWATER LOG Temporary Well TW-109

DNA-Environment, LLC

PROJECT NUMBER: DNA-190167	DRILLING DATE: May 8, 2019	COORDINATES: Y=212162.1096, X=230060.4476
PROJECT NAME: CCR Groundwater Monitoring	WELL DEPTH: 14 Ft	COORD SYS: NAD 83, PR State Plane (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 2-in	ELEVATION REF: Orthometric, Geoid12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 1.255 m (4.117 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 2.179 m (7.149 Ft)

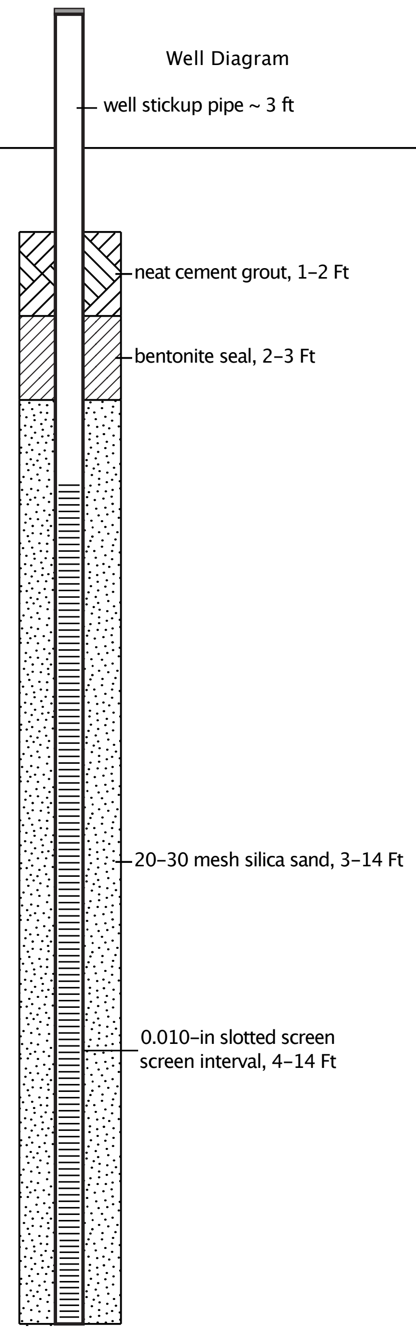
DRILLING METHOD: Geoprobe 4.25-in ID Hollow Stem Augers

LOGGED BY: Hardy Rodriguez

CHECKED BY: Juan D. Negron, PG

%Recovery	Depth (Ft)	Graphic Log	Lithologic Description
	0–1		Fill material with some organic matter.
	1–2.5		Silty sand, dark brown, moist, dense hardness, low plasticity, moderate estimated K, no odor, alluvial deposits.
	2.5–7		Sandy silt, brown, moist, medium stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
	7–9		Silty sand, brown, moist, medium dense hardness, low plasticity, moderate estimated K, no odor, alluvial deposits.
	9–11		Fine to medium sand with some feldspars minerals and calcareous material, light brown, moist, medium dense hardness, non plasticity, high estimated K, no odor, alluvial beach deposits.
	11–13		Clay, light yellowish brown, moist, medium stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
	13–15		Clay, yellowish brown, moist, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
	15		Borehole Termination Depth: 15 Ft. Water level while drilling intercepted at 3 Ft below ground surface.

Well Diagram



GROUNDWATER LOG Temporary Piezometer P-102

DNA-Environment, LLC

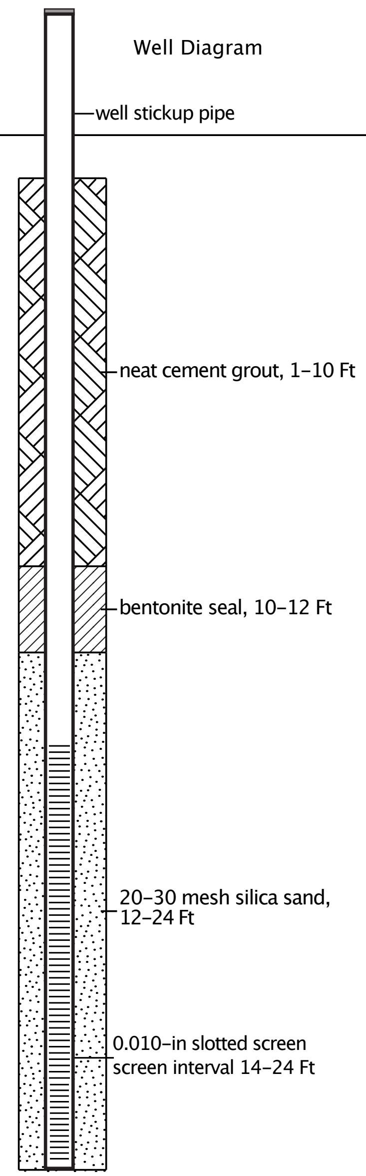
PROJECT NUMBER: DNA-190167	DRILLING DATE: May 10, 2019	COORDINATES: Y=212375.0089, X=229935.0988
PROJECT NAME: CCR Groundwater Monitoring	WELL DEPTH: 24 Ft	COORD SYS: NAD 83, PR State Plane (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 1.5-in	ELEVATION REF: Orthometric, Geoid12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 4.834 m (15.860 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 5.542 m (18.182 Ft)

DRILLING METHOD: Geoprobe 3.25-in ID Dual Tubes

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

Depth (Ft)	Lithologic Description
0–8	Fine to medium sand with some angular rock fragments, reddish brown, medium dense hardness, no plasticity, high estimated K, no odor, fill material.
8–10	Clayey sand with some angular to sub-angular rock fragments, dark yellowish brown, moist, medium dense hardness, medium plasticity, moderate estimated K, no odor, fill material.
10–14	Sandy clay, very dark brown, medium stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
14–17	Fine to medium sand with some sub-angular rock fragments, dark yellowish brown, moist, loose hardness, non plasticity, high estimated K, no odor, alluvial deposits.
17–20	Clayey silt, moist, very dark gray,soft, high plasticity, low estimated K, vague odor, alluvial deposits.
20–22	Fine sand with some feldspars, olive brown, moist, loose hardness, no plasticity, high estimated K, no odor, alluvial beach deposits.
22–23	Clayey sand, very dark gray,moist,medium dense, medium plasticity, moderate estimated K, vague swamp odor, swamp deposits.
23–28	Clay, dark yellowish brown, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.

Well Diagram



Borehole Termination Depth at: 28 Ft.
Water level intercepted at 15 Ft. below ground surface during soil description sampling conducted on 24 May 2017.

GROUNDWATER LOG Temporary Piezometer P-106

DNA-Environment, LLC

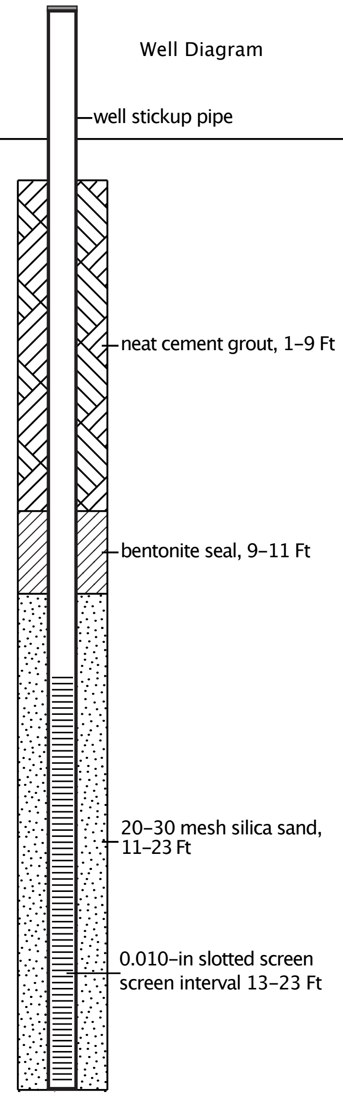
PROJECT NUMBER: DNA-190167	DRILLING DATE: May 10, 2019	COORDINATES: Y=212299.0367, X=230114.7307
PROJECT NAME: CCR Groundwater Monitoring	WELL DEPTH: 23 Ft	COORD SYS: NAD 83, PR State Plane (m)
CLIENT: AES Puerto Rico, LP	DIAMETER: 1.5-in	ELEVATION REF: Orthometric, Geoid12B
ADDRESS: Guayama, Puerto Rico	CASING: PVC	GROUND ELEVATION: 4.609 m(15.121 Ft)
DRILLERS: GeoEnviroTech, Inc. (Guaynabo, PR)	SCREEN: PVC Factory Slotted (0.010-in)	WELL ELEVATION AT TOC: 4.949 m(16.237 Ft)

DRILLING METHOD: Geoprobe 3.25-in ID Dual Tubes

LOGGED BY: Hardy Rodriguez
CHECKED BY: Juan D. Negron, PG

Depth (Ft)	Lithologic Description
0–4	Fine to medium sand with some angular rock fragments, yellowish brown, loose hardness, non plasticity, high estimated K, no odor, fill material.
4–10	Clayey sand with angular to sub-angular rock fragments, yellowish brown, medium dense hardness, medium plasticity, moderate estimated K, no odor, fill material.
10–17	Clayey sand, very dark gray,wet, loose hardness, low plasticity, moderate estimated K. no odor, alluvial deposits.
17–20	Sandy clay, olive brown, moist, medium stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
20–27	Clay, very dark grayish brown, medium stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.
27–30	Clay, dark yellowish brown, stiff hardness, high plasticity, low estimated K, no odor, alluvial deposits.

Well Diagram



Borehole Termination Depth at: 30 Ft.
Water level intercepted at 11 Ft. below ground surface during soil description sampling conducted on June 5, 2017.

APPENDIX B

Groundwater Risk Evaluation

www.haleyaldrich.com

REPORT ON

GROUNDWATER RISK EVALUATION
AES PUERTO RICO LP
GUAYAMA, PUERTO RICO

by
Haley & Aldrich, Inc.
Chicago, Illinois

for
AES Puerto Rico, LP
Guayama, Puerto Rico

File No. 133478-002
April 2019

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Appendix A - Surface Water Dilution Attenuation Factor

List of Tables

List of Figures

List of Acronyms

AES-PR	AES Puerto Rico LP
AWQC	Ambient Water Quality Criteria
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene
CCC	Continuous Concentration Chronic
CCR	Coal Combustion Residual
CPCPRC	Chevron Phillips Chemical Puerto Rico Core, LLC
CSM	Conceptual Site Model
MCL	Maximum Contaminant Level
PRASA	Puerto Rico Aqueduct and Sewer Authority
PREPA	Puerto Rico Electric Power Authority
RSL	Regional Screening Level
SMCL	Secondary Maximum Contaminant Level
SW-DAF	Surface Water Dilution Attenuation Factor
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
VOC	Volatile Organic Compound

1. Introduction

Haley & Aldrich, Inc. (Haley & Aldrich) prepared this groundwater risk assessment for the AES Puerto Rico LP (AES-PR) facility located in the municipality of Guayama, Puerto Rico (site).

AES-PR operates a 454-megawatt coal-fired power plant that produces electricity that is supplied to the Puerto Rico Electric Power Authority (PREPA). Coal combustion residual (CCR) material generated from energy production at the site is processed to produce AGREMAX™, which is placed in a temporary storage area located near the southeastern property boundary. The site is considered a zero-discharge facility that utilizes reclaimed water obtained from the Guayama wastewater treatment plant operated by Puerto Rico Aqueduct and Sewer Authority (PRASA), located approximately 0.5 mile east of the power plant. The reclaimed water is stored in a lagoon in the northern portion of the site. The site is bounded by the inactive former Chevron Phillips Chemical Plant to the east, open land and the inactive former pharmaceutical plant TAPI to the north, open land and the AES Ilumina, LLC solar energy farm to the west, and open land to the south. The location of the site is shown on **Figure 1**.

The temporary AGREMAX™ Storage Area is not a CCR management unit subject to the United States Environmental Protection Agency (USEPA) CCR Rule (USEPA, 2015). However, AES-PR voluntarily monitors groundwater at the temporary AGREMAX™ Storage Area following the USEPA CCR Rule requirements.

2. Objective

In this report, Haley & Aldrich examines groundwater monitoring data collected for the well network associated with the temporary AGREMAX™ Storage Area at the AES-PR facility and collected using the methods and procedures outlined in the USEPA CCR Rule. DNA-Environment, LLC, of Guaynabo, Puerto Rico, conducted the well installation and the groundwater and seawater sampling.

The risk assessment follows current USEPA guidance for risk assessment (USEPA, 1989) and includes consideration of Puerto Rico water quality regulations as appropriate.

3. Approach

The analysis presented in this report was conducted by evaluating the environmental setting of the AES-PR facility, including its location and where CCR management has occurred at the facility. Information on where groundwater is located at the facility, the rate(s) of groundwater flow, the direction(s) of groundwater flow, and where waterbodies may intercept groundwater flow are reviewed and summarized here.

A conceptual model was developed based on this physical setting information, and the model was used to identify what human populations could contact groundwater and/or surface water in the area of the facility. This information was also used to identify where ecological populations could come into contact with surface water. Groundwater data are evaluated on a human health risk basis and an ecological risk basis.

Human health risk assessment is a process used to estimate the chance that contact with constituents in the environment may result in harm to people. Generally, there are four components to the process (USEPA, 1989):

(1) Hazard Identification/Data Evaluation,
(2) Toxicity Assessment,
(3) Exposure Assessment, and
(4) Risk Characterization.

The USEPA develops "screening levels" of constituent concentrations in groundwater (and other media) that are considered to be protective of specific human exposures. These screening levels are referred to as "Regional Screening Levels," or RSLs, and are published by USEPA and updated twice yearly[1]. In developing the screening levels, USEPA uses a specific target risk level (component 4) combined with an assumed exposure scenario (component 3) and toxicity information from USEPA (component 2) to derive an estimate of a concentration of a constituent in an environmental medium, for example groundwater, (component 1) that is protective of a person in that exposure scenario (for example, drinking water). Similarly, ecological screening levels for surface water are developed by Federal and Puerto Rico agencies to be protective of the wide range of potential aquatic ecological resources, or receptors.

Risk-based screening levels are designed to provide a conservative estimate of the concentration to which a receptor (human or ecological) can be exposed without experiencing adverse health effects. Due to the conservative methods used to derive risk-based screening levels, it can be assumed with reasonable certainty that concentrations below screening levels will not result in adverse health effects, and that no further evaluation is necessary. Concentrations above conservative risk-based screening levels do not necessarily indicate that a potential risk exists, but indicate that further evaluation may be warranted. As described further below, through this evaluation which involves the evaluation of groundwater flow, groundwater analytical data, and surface water analytical data, it was confirmed that there is no impact on drinking water and there is no evidence of impact to human health or the environment.

The data in this report were evaluated using human health risk-based and ecological risk-based screening levels drawn from Federal and Puerto Rico sources. The screening levels are used to determine if the concentration levels of constituents could pose a risk to human health or the environment. The evaluation also considers whether constituents that may be present in groundwater and surface water above screening levels could be due to the CCR management operations.

4. Conceptual Site Model

A conceptual site model (CSM) is used to evaluate the potential for human or ecological exposure to constituents that may have been released to the environment. Some of the questions posed during the CSM evaluation include:

[1] USEPA Regional Screening Levels (November 2018). http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm

What is the source? How can constituents be released from the source? What environmental media may be affected by constituent release? How and where do constituents travel within a medium? Is there a point where a receptor (human or ecological) could contact the constituents in the medium? Are the constituent concentrations high enough to potentially exert a toxic effect?

AES-PR is located in the municipality of Guayama, Puerto Rico. The site is 1870 feet north of the Caribbean Sea at Las Mareas Harbor (approximately 1/3 mile). See **Figure 1**.

AES-PR is in an industrial area of Guayama. The neighboring inactive Chevron Phillips Chemical Puerto Rico Core, LLC (CPCPRC) facility to the east of the AES-PR site is a source of organic and potentially other constituents in groundwater at AES-PR. Sulfolane and benzene, toluene, ethylbenzene, and xylene (BTEX) plumes in the upper and lower aquifers at CPCPRC[2] have migrated to the southeastern portion of the AES-PR property. The inactive former pharmaceutical plant TAPI[3] to the north, and upgradient (similar to upstream) of AES-PR has also released organics to the groundwater. AES-PR is not the source of plumes or releases from neighboring sites. In addition, a USEPA Superfund site (Fibers Public Supply Wells[4]) is located approximately one mile to the northeast.

For the evaluation of the AGREMAX™ management operations at AES-PR, the temporary AGREMAX™ Storage Area in the southeastern area of the site is the potential source. The storage area is located on the ground surface and does not extend into the subsurface or the water table. Constituents present in the AGREMAX™ can be dissolved into infiltrating water (from precipitation and wetting for dust control) and those constituents may move through the subsurface and could then be present in shallow groundwater. Constituents could move with groundwater as it flows, usually in a downgradient/downhill direction. The general direction of groundwater flow at the site is south/southwest toward Las Mareas Harbor.

AES-PR is located in what is defined by the US Geological Survey (USGS) as the south coast alluvial aquifer (**Figure 2**) (USGS). The USGS has delineated the hydrologic units in the area of the south coast alluvial aquifer according to the surface topography and hydrologic data. Each hydrologic unit is associated with a code; AES-PR is located in the hydrologic unit: 210100040416 (**Figure 3**). Within these hydrologic units, surface water flows from areas of high elevation to areas of low elevations; surface water in this hydrologic unit is expected to generally move southward and discharge to the sea.

Groundwater moves slowly through the rock and soils beneath the ground. Like surface water, it also moves from areas of high elevation to areas of low elevation and can move into adjacent surface water. The general groundwater direction within the hydrologic unit is from north to south towards the sea – on the eastern edge of the watershed, groundwater can flow in a southeast direction – and on the western edge of the watershed, groundwater can flow in a southwest direction. Therefore, any potential release of constituents to groundwater from either the Chevron site, the TAPI site, or AES-PR will be limited in extent by the direction of groundwater flow and will not impact areas further inland.

At AES-PR, groundwater flows generally towards Las Mareas Harbor. This means that if there is a release of constituents to groundwater from the AES-PR facility, it will be confined to the area of

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[2] https://www.epa.gov/hwcorrectiveactionsites/hazardous-waste-cleanup-chevron-phillips-chemical-puerto-rico-core-guayama
[3] https://www.epa.gov/hwcorrectiveactionsites/hazardous-waste-cleanup-tapi-puerto-rico-incorporated-guayama-puerto-rico
[4] https://cumulis.epa.gov/supercpad/cursites/csitinfo.cfm?id=0202559

groundwater at the plant and downgradient. Any impacted groundwater beneath the site is not expected to migrate inland. As the plant is very close to the ocean (1870 feet), the area of groundwater that could be affected by facility operations is also very small and limited. Along the coastlines there is saltwater intrusion into groundwater; the extent of this intrusion varies along coastlines, see **Figure 4**.

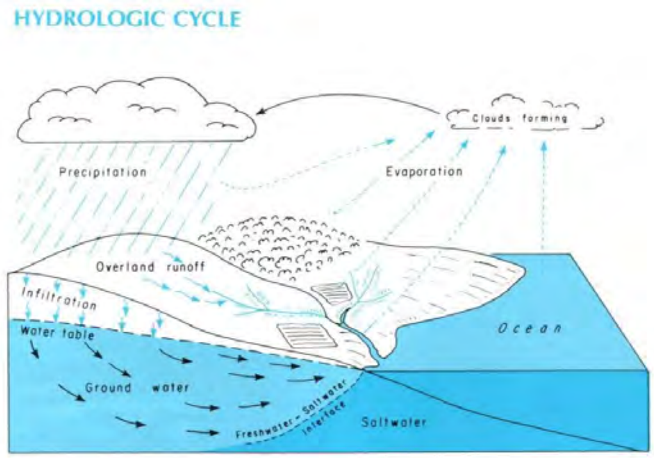

Figure 4: Illustration of Hydrologic Cycle

CCR-derived constituents present in groundwater may move to adjacent surface water; here, that could be the Caribbean Sea at Las Mareas Harbor. Thus, the environmental media of interest for this evaluation are:

- Groundwater at the facility; and
- Las Mareas Harbor surface water.

Las Mareas Harbor is used for ship loading and unloading, but there are public access areas and small beaches present and, therefore, it could also be used for recreation. The area surrounding Las Mareas Harbor can be used for human recreation – wading, swimming, boating, fishing, and as habitat for marine aquatic species and avian receptors.

The neighboring inactive Chevron Phillips Chemical Puerto Rico Core, LLC (CPCPRC) facility to the east of the AES-PR site is another potential source of constituents in groundwater. CPCPRC processed naphtha into refined hydrocarbon products from 1966 to 2008. Sulfolane and benzene, toluene, ethylbenzene, and xylene (BTEX) plumes in the upper and lower aquifers at CPCPRC have migrated to the southeastern portion of the AES-PR property. In 2017, USEPA issued a request for public comments on the proposed remedy decision for CPCPRC, which includes groundwater remediation for BTEX and sulfolane impacts (USEPA, 2017).

There are no on-site users of shallow groundwater adjacent to AES-PR. CPCPRC conducted a private well investigation as part of a sitewide risk characterization (CPCPRC, 2007). As documented in the 2007 CPCPRC Risk Characterization Report, there are some census-designated communities and smaller villages near the CPCPRC and AES-PR facilities (Guayama, Quebrada, Corazon, Jobos and Puerto Jobos, and Barrancas), however none of these communities is considered downgradient (i.e., south of AES-PR and CPCPRC) and, therefore, would not be impacted by groundwater from either facility. Las Mareas is the only community downgradient of CPCPRC and AES-PR, and according to the 2007 CPCPRC Risk Characterization Report, houses in Las Mareas obtain water from a PRASA potable water pipeline and no existing private wells were found in the area. The 2007 CPCPRC Report also did not find any domestic wells constructed near the CPCPRC facility.

Thus, with respect to shallow groundwater, there are no users of the groundwater near the AES-PR facility. Depth to groundwater in this area is approximately 10 feet, thus contact with groundwater during a short-term construction/excavation event is unlikely.

A depiction of the conceptual site model is shown in **Figure 5**. The potentially complete exposure pathways identified in the figure are those evaluated here.

Figure 6 shows the locations of groundwater sample locations, and the location in Las Mareas harbor where a seawater sample was collected. Based on this conceptual site model and the facility setting, samples collected from groundwater monitoring wells and Las Mareas Harbor have been included in the evaluation. The samples have been analyzed for constituents that are commonly associated with CCR, as discussed below. However, it is recognized by the USEPA that all of these constituents can also be naturally occurring and can be found in rocks, soils, water and sediments; thus, the it is necessary to understand what the naturally occurring background levels are for these constituents. The CCR Rule requires sampling and analysis of upgradient and/or background groundwater just for this reason. The sampling is detailed in the next section. Groundwater samples have also been analyzed for volatile and semi-volatile organic compounds to evaluate groundwater impacts at AES-PR from the adjoining property to the east, as discussed above.

To answer the question, “Are the constituent concentrations high enough to potentially exert a toxic effect?” health risk-based screening levels from Federal and Puerto Rico sources are used for comparison to the data. Groundwater is evaluated using a tiered approach. As a first conservative step, all groundwater data are compared to risk-based drinking water screening levels, even though there are no on-site users of groundwater adjacent to AES-PR. Groundwater results are also compared to human recreational screening levels and ecological screening levels as a conservative evaluation, even though there is no direct exposure to groundwater by human or ecological receptors. The Las Mareas Harbor sample is compared to risk-based human recreational screening levels, and to ecological screening levels.

For the second step, a surface water dilution and attenuation factor (SW-DAF) has been derived for groundwater that may flow to the Caribbean Sea at Las Mareas Harbor. If the concentrations in groundwater are below the SW-DAF-applied risk-based screening levels for ecological receptors and human health recreational receptors, no further evaluation is necessary. If a groundwater concentration is above a SW-DAF-applied risk-based screening level, that does not necessarily mean that surface water will be adversely impacted by the groundwater, only that further evaluation may be warranted, as discussed further below.

5. Samples Used for Evaluation

5.1 GROUNDWATER

Five (5) groundwater monitoring wells and four (4) temporary wells were installed to evaluate groundwater in the uppermost aquifer at AES-PR under the CCR Rule. The monitoring wells are summarized below and shown in **Figure 6**.

- MW-1 and MW-2 – Upgradient. These wells were installed to represent background groundwater in the uppermost aquifer. MW-2 was installed outside of site operation areas to evaluate groundwater potentially impacted by the CPCPRC facility to the east.
- MW-3 through MW-5 – Downgradient. These wells were installed downgradient of the temporary AGREMAX™ Storage Area to evaluate the potential impacts to groundwater in the uppermost aquifer.
- TW-A, TW-B, TW-C, and TW-D. These four temporary monitoring wells were installed within property boundaries along the north-south axis of AES-PR and the AES Ilumina, LLC solar energy farm properties to evaluate potential effects of saltwater intrusion on the water quality of downgradient monitoring wells.

5.2 LAS MAREAS HARBOR

One seawater sample (not required by the CCR Rule for compliance) from Las Mareas Harbor was taken in July 2018. The location of the Las Mareas Harbor sample is shown on **Figure 6**.

5.3 SAMPLE ANALYSIS

The CCR Rule identifies the constituents that are included for groundwater testing; these are:

Boron	Antimony	Lead
Calcium	Arsenic	Lithium
Chloride	Barium	Mercury
pH	Beryllium	Molybdenum
Sulfate	Cadmium	Selenium
TDS	Chromium	Thallium
Fluoride	Cobalt	Radium 226/228

Seven rounds of monitoring groundwater samples collected from August 2017 through June 2018 and two rounds of temporary well samples collected from December 2017 and July 2018 were analyzed for the above constituents. The monitoring wells were resampled in October 2018 and analyzed for a subset of constituents, per the CCR Rule.

So as to create an appropriate dataset for comparison, the Las Mareas Harbor sample collected in July 2018 was analyzed for all the above parameters except for radium 226/228, which was not detected in groundwater above the drinking water standard. Two sets of analyses were conducted on the Las Mareas Harbor sample. The sample was analyzed for the list above (referred to as the "total [unfiltered]" results), and then an aliquot of each sample was filtered to remove sediments/particulates and then analyzed (referred to as the "dissolved [filtered]" results). This is an important step for the analysis of surface water samples for two reasons:

- Surface water can carry a large sediment load – the total (unfiltered results) include constituent concentrations that are associated with sediment and not the water; and
- Some of the ecological screening levels used to evaluate the results apply only to dissolved (filtered) data.

5.4 SAMPLE RESULTS

Table 1 provides the results of the groundwater and seawater sampling.

6. Risk-Based Screening Levels

A comprehensive set of risk-based screening levels have been compiled for this evaluation for the types of potential exposures identified in the conceptual site model discussion above:

- Human health drinking water consumption;
- Human health recreational use of marine surface water; and
- Aquatic ecological receptors for marine surface water.

Table 2 provides the human health drinking water levels available from the Puerto Rico sources and from Federal sources. **Table 3** provides the marine human health recreational and ecological screening levels available from the Puerto Rico sources and from Federal sources.

6.1 DRINKING WATER SCREENING LEVELS

The human health screening levels for drinking water are obtained from USEPA and Puerto Rico sources and address the drinking water exposure pathway. These sources are:

- Puerto Rico Water Quality Standards Regulation. Environmental Quality Board. Rule 1303.1 Water Quality Standards. Class SG Groundwater (PR EQB, 2016).

- USEPA 2018 Edition of the Drinking Water Standards and Health Advisories (USEPA, 2018b).

- USEPA Regional Screening Levels (RSLs), November 2018, Values for Tap Water (USEPA, 2018a).

It is important to note that the CCR Rule limits the evaluation of groundwater monitoring data of CCR management areas to Federal USEPA Maximum Contaminant Levels (MCLs), to risk-based screening levels for cobalt, lead, lithium, and molybdenum (USEPA, 2018c), or to a comparison with site-specific background. In addition to the MCLs that are enforceable for municipal drinking water supplies, there are Federal secondary MCLs, or SMCLs, that are generally based on aesthetics (taste, color) and are not risk-based. The USEPA also provides RSLs for tapwater (drinking water) that are used to supplement this evaluation. The tapwater RSLs are based on a target risk level of one in one million (10^{-6}) and a target noncancer hazard index of 1.

Table 2 shows the hierarchy of drinking water-based screening levels used in this evaluation. For the selected Federal screening levels, the hierarchy is: USEPA MCL; where an MCL is not available the USEPA tap water RSL is selected, where an RSL is not available the USEPA SMCL is selected. For the selected Puerto Rico screening levels the hierarchy is: Puerto Rico Groundwater Quality Standards, USEPA MCL; USEPA tap water RSL, USEPA SMCL. The selected Puerto Rico screening levels are used in this evaluation – the Federal levels are provided for comparison.

The use of a more comprehensive set of screening levels in this evaluation versus the MCLs as supplemented by USEPA RSLs and SMCLs (2018a,b) provides a broader risk-based evaluation of the groundwater data than would be provided by the CCR Rule requirements.

6.2 RECREATIONAL SCREENING LEVELS

The human health recreational screening levels for marine surface water are obtained from USEPA and Puerto Rico sources and address the fish/shellfish consumption pathway (where such values are available). These sources are:

- Puerto Rico Water Quality Standards Regulation. Environmental Quality Board. Rule 1303.1 Water Quality Standards. Class SB and SC Coastal and Estuarine Waters. Values based on protection of the water body or aquatic life for reasons of human health. (PR EQB, 2016).
- USEPA Ambient Water Quality Criteria (AWQC) Human Health Consumption of Organism Only (USEPA, 2019a). Human Health Consumption Organism Only values apply to freshwater and estuarine water and use a fish ingestion rate based on consumption of freshwater and estuarine finfish and shellfish.

Table 3 presents the human health screening levels for recreational exposures and identifies the selected Federal and Puerto Rico human health risk-based screening levels for further evaluation. The selected Puerto Rico based screening levels are used in this evaluation; the selected Federal based screening levels are provided for comparison. Note that this evaluation of human uses of surface water are above and beyond the requirements of the CCR Rule.

6.3 ECOLOGICAL SCREENING LEVELS

The ecological risk-based screening levels for marine surface water are also provided in **Table 3**. Some screening levels apply only to total surface water concentrations, and some screening levels apply to only dissolved surface water concentrations. Values for both scenarios are provided. The table also identifies the selected ecological risk-based screening levels for further evaluation. Note that this ecological evaluation of surface water is above and beyond the requirements of the CCR Rule.

Ecological screening levels were obtained from both Puerto Rico and USEPA sources:

- Puerto Rico Water Quality Standards Regulation. Environmental Quality Board. Rule 1303.1 Water Quality Standards. Class SB and SC Coastal and Estuarine Waters. Values based on protection of the water body for the propagation and preservation of aquatic species or species dependent on the water body. (PR EQB, 2016).
- USEPA chronic saltwater AWQC (USEPA, 2019b). The continuous concentration criterion (CCC) (Chronic AWQC) is the USEPA national water quality criteria recommendation for the highest concentration of a toxicant or an effluent to which organisms can be exposed indefinitely without causing unacceptable effect.

7. Risk-Based Evaluation

This section describes the risk-based approach for evaluation of the groundwater and surface water data from AES-PR. The level of analysis and comparison to risk-based screening levels presented below is above and beyond the requirements of the CCR Rule. This report serves to supplement those requirements by providing the risk-based analysis of groundwater and surface water, so that the groundwater results can be understood in their broader environmental context.

7.1 RISK-BASED EVALUATION OF GROUNDWATER

Groundwater data from eight rounds of groundwater monitoring, and two rounds of temporary well groundwater monitoring were compared to the Puerto Rico based human health risk-based drinking water screening levels. **Figure 6** shows the location of the monitoring wells and temporary wells that are all located at the edge of the AES-PR facility and AES Ilumina, LLC solar energy farm.

Tables 4 and 5 compare the results of all sampling rounds to Puerto Rico based human health drinking water screening levels, for total and dissolved groundwater concentrations, respectively. The majority of the results indicate concentration levels below the human health risk-based drinking water screening levels.

A limited number of parameters are above screening values for some, but not all, sampling events. Of all of the laboratory analyses conducted for these wells, lithium and molybdenum are above drinking water screening levels in MW-4, and molybdenum and selenium are above drinking water screening levels in MW-3. For the constituents with the most results above the screening levels (chloride, sulfate, and TDS (total dissolved solids)), results are also above screening levels in the background wells MW-1 and MW-2, although at lower concentrations.

The groundwater data are also compared to Puerto Rico based human health recreational and ecological screening levels and are presented in **Tables 6 through 9**. Note that groundwater is not used for "recreation" and ecological receptors are not directly exposed to groundwater, so this comparison serves as a conservative approach.

- **Tables 6 and 7** – Comparison to human health recreational screening levels – Only total and dissolved concentrations of arsenic are above their screening levels.
- **Tables 8 and 9** – Comparison to ecological screening levels – Only total and dissolved concentrations of selenium in MW-3 are above their screening levels. Two sample results for pH in MW-5 and TW-D are below the pH screening level range.

As described further within this report, concentrations above screening levels alone does not indicate a human health risk basis or an ecological risk basis. Rather, as discussed below, this report concludes that these concentrations of constituents in groundwater at AES-PR do not pose a risk to human health or the environment.

7.2 RISK-BASED EVALUATION OF HARBOR SAMPLE

As noted in Section 4, groundwater in the south coast alluvial aquifer is limited in extent in the vicinity of the AES-PR site (see **Figures 3 and 4**). Groundwater moves from areas of high elevation to areas of low elevation and can move into adjacent surface water. In the vicinity of the AES-PR site, the predominant direction of groundwater flow is to the south towards Las Mareas Harbor. Thus, a sample of sea water collected at Las Mareas Harbor was used for this evaluation. The comparison to risk-based screening levels of the analytical results for the Las Mareas Harbor Sea sample are presented in **Table 10**.

- **Table 10** – Only total and dissolved concentrations of arsenic are above the human health based recreational screening level. However, these concentrations are comparable to seawater concentrations worldwide. All results are below risk-based ecological screening levels.

There are no analytical results for the Las Mareas Harbor sample that are above marine ecological screening levels, and with the exception of arsenic no analytical results above human health recreational screening levels. Thus, the Las Mareas Harbor sample results do not show evidence of impact of constituents derived from AES-PR. This is important in that the absence of concentrations above risk-based screening levels means that there is not a significant pathway of exposure.

Table 11 provides literature data for seawater from two sources (USGS, 1985; Antoni, 2006), and the data from the Las Mareas Harbor sample. The results from the Las Mareas Harbor sample are consistent with natural levels of these constituents in seawater. This indicates that there is no measurable effect of groundwater at the AES-PR facility on surface water in the harbor. Note that the background concentration of arsenic in the world's seawater (0.0026-0.003 mg/L) is also above the human health recreational screening level of 0.00014 mg/L.

7.3 DEVELOPMENT AND APPLICATION OF A GROUNDWATER TO SURFACE WATER DILUTION ATTENUATION FACTOR

If a groundwater concentration is above a surface water screening level, that does not mean that surface water will be adversely impacted by the groundwater. Dilution and attenuation mechanisms can occur as groundwater moves to surface water. This section describes the approach to evaluating the magnitude of dilution effects resulting from the mixing of groundwater that may flow from beneath the temporary AGREMAX™ Storage Area to the nearby surface water body – the Las Mareas Harbor (**Figure 1**), through the development of a Surface Water Dilution Attenuation Factor (SW-DAF). This factor is then applied to the target risk-based marine water concentrations to identify target groundwater concentrations that are protective of surface water. These risk-based target groundwater concentrations (protective of the Las Mareas Harbor) are used to evaluate the current groundwater data, and can be used to evaluate future groundwater data.

The primary driving force responsible for migration of constituents from the temporary AGREMAX™ Storage Area is infiltration of precipitation from ground surface to groundwater. The direction of groundwater flow is generally toward the Las Mareas Harbor.

To make a conservative estimate of the potential impacts of groundwater to the Las Mareas Harbor, a SW-DAF has been calculated. The SW-DAF describes the effect of mixing on constituent concentrations expected for the surface water body potentially receiving the groundwater. Currently available on-site groundwater information, groundwater elevation data and other hydrogeological data, and Las Mareas Harbor data were used for this evaluation.

The details of the SW-DAF development and results are provided in **Appendix A**. The evaluation took into account the potential for infiltration in the temporary AGREMAX™ Storage Area and the subsurface, groundwater flow to Las Mareas Harbor, and the flow rate of the seawater flushing in the Las Mareas Harbor. Tidal data for the National Oceanic & Atmospheric Administration station in Las Mareas, Puerto Rico (Station ID: 9755679) were used to calculate a conservative estimate of the seawater flushing volume each day for Las Mareas Harbor.

7.4 SURFACE WATER DILUTION ATTENUATION FACTOR

The SW-DAF was calculated to quantify the dilution of groundwater that may flow from beneath the temporary AGREMAX™ Storage Area towards the Las Mareas Harbor. The most conservative assumptions were used wherever possible. For groundwater that may flow to the Las Mareas Harbor, the conservatively calculated SW-DAF is **1,300** (a unitless value).

7.5 APPLICATION OF THE SW-DAF

Table 12 presents the selected Federal and Puerto Rico human health and ecological screening levels (from **Table 2**) and identifies the lowest screening level for surface water for the potential exposure scenarios. **Table 12** also shows the application of the SW-DAF to calculate risk-based screening levels for each of the Appendix III and Appendix IV groundwater constituents. For each constituent, the human health recreational screening levels and the ecological screening levels are presented. The lowest of the screening levels is then identified for surface water. The SW-DAF is then applied to this lowest screening level for surface water to result in the target groundwater concentrations developed based on the SW-DAF for the Las Mareas Harbor of 1,300.

Table 12 identifies the maximum groundwater concentration of each constituent detected in the AES-PR monitoring wells. The comparison between the target levels and the maximum concentrations indicates that there is a wide margin of safety between the two values. This margin is shown in the last column of the tables. To illustrate, concentration levels of arsenic and lead would need to be more than 20 and 400 times higher, respectively, than currently measured levels before an adverse impact in the Las Mareas Harbor could occur. As noted above, even the naturally occurring concentration of arsenic in seawater is above the human health recreational screening level.

This means that not only do the present concentrations of constituents in groundwater at AES-PR not pose a risk to human health or the environment, but even much higher concentrations would not be harmful. This comprehensive evaluation demonstrates that there are no adverse impacts on human health from either Las Mareas Harbor or groundwater uses resulting from AGREMAX™ management practices at AES-PR.

8. Conclusion

Table 13 provides a summary of groundwater and Las Mareas results that are above Puerto Rico selected human health drinking water, human health recreational, and ecological screening levels. The screening and the Las Mareas seawater sample results indicate that there is no impact of the AGREMAX™ management practices at AES-PR on surface water. The striking aspect of the analysis shown in **Table 13** is how few results are above a conservative risk-based drinking water screening level for human health, given that the wells are located at the base of the AGREMAX™ storage area.

This investigation demonstrates that the impacts of the temporary AGREMAX™ Storage Area are limited. There is no impact on drinking water and there is no evidence of impact to human health or the environment. There are no downgradient users of groundwater as drinking water – thus, there is no impact on drinking water. Las Mareas Harbor does not show impacts. There is no exposure to CCR-derived constituents detected in groundwater at the AES-PR facility – either via groundwater use or surface water. Even for the very few results that may be above screening values for some of the sampling events, there is no complete drinking water exposure pathway to groundwater. Where there is no exposure, there is no risk.

AES-PR is continuing with further evaluation and actions at the facility, consistent with the requirements of the CCR Rule.

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TABLES

TABLE 1
CCR RULE GROUNDWATER MONITORING, TEMPORARY WELL, AND HARBOR SAMPLE ANALYTICAL RESULTS
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

			Appendix III (a)						Appendix III and IV (a, b)	Appendix IV (b)														Sulfolane and VOCs (c)			
		Constituent	Boron	Calcium	Chloride	pH	Sulfate	TDS	Fluoride	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226/228	Chlorobenzene	Isopropylbenzene	Methyl tert-butyl ether	Sulfolane
Location ID	Sampling Event Date	Fraction	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	mg/L	mg/L	mg/L	mg/L
AES MW-1 - Background Well	8/8/2017	Total	0.26	140	240	6.87	340	1100	0.47	< 0.001	< 0.00046	0.05	< 0.00034	< 0.00034	< 0.0011	0.00058 J	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.0073	< 0.000085	< 0.0899	NA	NA	NA	NA
	8/15/2017	Total	0.26	150	260	7.07	410	1400	0.53	< 0.001	0.00055 J	0.056	< 0.00034	< 0.00034	< 0.0011	0.00055 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0062	< 0.000085	0.205	NA	NA	NA	NA
	8/22/2017	Total	0.25	150	220	6.74	400	1400	0.55	< 0.001	< 0.00046	0.058	< 0.00034	< 0.00034	< 0.0011	0.00068 J	< 0.00035	< 0.0032	< 0.00007	0.0023 J	0.0065	< 0.000085	0.270	NA	NA	NA	NA
	8/29/2017	Total	0.25 B	160	240	6.92	390	1400	0.58 B	< 0.001	< 0.00046	0.055	< 0.00034	< 0.00034	< 0.0011	0.00062 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0057	< 0.000085	0.576	NA	NA	NA	NA
	9/12/2017	Total	0.26	160	220	6.9	410	1400	0.47	< 0.001	0.00046 J	0.057	< 0.00034	< 0.00034	< 0.0011	0.00075 J	< 0.00035	< 0.0032	< 0.00007	0.0018 J	0.0057	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	Total	0.25	130	260 F1	7.13	510 F1	1500	0.61	< 0.0010	< 0.00046	0.039	< 0.00034	< 0.00034	< 0.0011	< 0.00040	0.00077 J	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	< 0.00058
	6/25/2018	Dissolved	0.28	130	260 F1	NA	490 F1	1600	0.61	< 0.0010	< 0.00046	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085	NA	NA	NA	NA	NA
	10/1/2018	Total	0.24	120	200	7.33	400	1300	0.69	< 0.0010	< 0.00046	0.032	NA	< 0.00034	NA	0.00050 J	NA	< 0.0011	NA	< 0.00085	0.015	NA	0.495	NA	NA	NA	NA
AES MW-2 - Background Well	8/8/2017	Total	0.16	88	37	6.53	7.7	460	0.36	< 0.001	< 0.00046	0.1	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00035 J	< 0.000085	< 0.129	NA	NA	NA	NA
	8/15/2017	Total	0.17	88	37	6.83	7.1	470	0.4	< 0.001	0.00047 J	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	< 0.00024	< 0.000085	0.545	NA	NA	NA	NA
	8/22/2017	Total	0.16	89	37	6.54	10	450	0.4	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.0010 J	0.00061 J	< 0.000085	< 0.0379	NA	NA	NA	NA
	8/29/2017	Total	0.17 B	100	37	6.68	16	470	0.42 B	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00044 J	< 0.000085	0.113	NA	NA	NA	NA
	9/12/2017	Total	0.17	94	36	6.65	9.8	480	0.35	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.00094 J	0.00046 J	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	Total	0.16	110	140	6.84	43	740	0.52	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00040 J	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0069 J
	6/25/2018	Dissolved	0.17	110	130	NA	44	730	0.5	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00030 J	< 0.000085	NA	NA	NA	NA	NA
	10/1/2018	Total	0.16	110	85	7.04	15	690	0.67	< 0.0010	< 0.00046	0.13	NA	< 0.00034	NA	0.00058 J	NA	0.0014 J	NA	< 0.00085	< 0.00024	NA	< 0.321	NA	NA	NA	NA
AES MW-3	8/8/2017	Total	0.78	290	2900	6.74	630	6000	2	< 0.001	0.0038	0.33	< 0.00034	< 0.00034	< 0.0011	0.0018 J	< 0.00035	0.0068	< 0.00007	0.096	0.052	< 0.000085	0.099	NA	NA	NA	NA
	8/15/2017	Total	0.85	320	3400	7.1	1300	7600	2.1	< 0.001	0.0034	0.29	< 0.00034	< 0.00034	< 0.0011	0.0019 J	< 0.00035	0.0077	< 0.00007	0.16	0.098	< 0.000085	0.142	NA	NA	NA	NA
	8/22/2017	Total	0.83	340	3600	6.78	1500	8600	2.2	< 0.001	0.0021	0.37	< 0.00034	< 0.00034	< 0.0011	0.0023 J	< 0.00035	0.0075	< 0.00007	0.2	0.13	< 0.000085	0.212	NA	NA	NA	NA
	8/29/2017	Total	0.90 B	390	3700	7.01	1700	8300	2.3 B	< 0.001	0.0024	0.25	< 0.00034	< 0.00034	< 0.0011	0.0022 J	< 0.00035	0.0075	< 0.00007	0.22	0.14	< 0.000085	0.0888	NA	NA	NA	NA
	9/12/2017	Total	0.9	370	3900	7.03	2300	9900	1.9	0.0012 J	0.0029	0.23	< 0.00034	< 0.00034	< 0.0011	0.0025	< 0.00035	0.0056	< 0.00007	0.28	0.18	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	Total	1.2	330	4400	7.23	2800	11000	1.6	< 0.0010	0.0018	0.24	< 0.00034	0.00042 J	< 0.0011	0.0031	< 0.00035	0.0073	< 0.000070	0.22	0.21	< 0.000085	NA	0.0027	0.00053 J	< 0.00074	0.004 J
	6/25/2018	Dissolved	1.1	320	4300	NA	2500	10000	1.7	< 0.0010	0.0016	0.26	< 0.00034	0.00034 J	< 0.0011	0.0034	< 0.00035	0.0064	< 0.000070	0.2	0.2	< 0.000085	NA	NA	NA	NA	NA
	10/1/2018	Total	1.0	330	4700	7.43	3300	13000	1.6	< 0.0010	0.0024	0.19	NA	< 0.00034	NA	0.0031	NA	0.021	NA	0.22	0.23	NA	0.511	NA	NA	NA	NA
AES MW-4	8/8/2017	Total	3.4	590	9800	6.91	15000	41000	0.63	< 0.001	0.0036	0.057	< 0.00034	0.00036 J	< 0.0011	0.0018 J	< 0.00035	1	< 0.00007	0.44	0.011	< 0.000085	0.527	NA	NA	NA	NA
	8/8/2017 Dup	Total	3.4	620	9900	6.91	15000	41000	0.61	0.0014 J	0.0031	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1	< 0.00007	0.45	0.011	< 0.000085	0.137	NA	NA	NA	NA
	8/16/2017	Total	3.7	620	11000	7.08	16000	43000	0.63	< 0.001	0.0037	0.06	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1.1	< 0.00007	0.4	0.0048	< 0.000085	0.112	NA	NA	NA	NA
	8/16/2017 Dup	Total	4.1	630	10000	7.08	16000	43000	0.61	< 0.001	0.0033	0.06	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	1.1	< 0.00007	0.38	0.0061	< 0.000085	0.507	NA	NA	NA	NA
	8/23/2017	Total	3.8	620	9800	7.09	15000	42000	0.65	< 0.001	0.0026	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.88	< 0.00007	0.44	0.006	< 0.000085	< 0.0545	NA	NA	NA	NA
	8/23/2017 Dup	Total	3.7	590	9900	7.09	15000	42000	0.65	< 0.001	0.0025	0.058	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1.1	< 0.00007	0.38	0.0065	< 0.000085	0.0942	NA	NA	NA	NA
	8/30/2017	Total	3.6 B	670	11000	7.14	16000	42000	0.68	< 0.001	0.0027	0.055	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.9	< 0.00007	0.4	0.0058	< 0.000085	0.403	NA	NA	NA	NA
	8/30/2017 Dup	Total	3.6 B	670	11000	7.14	16000	41000	0.68	< 0.001	0.0024	0.054	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	0.98	< 0.00007	0.42	0.0054	< 0.000085	< 0.146	NA	NA	NA	NA
	9/12/2017	Total	3.2	600	10000	7.12	17000	42000	0.53	< 0.001	0.0035	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.75	< 0.00007	0.41	0.013	< 0.000085	NA	NA	NA	NA	NA
	9/12/2017 Dup	Total	3.4	610	10000	7.12	17000	43000	0.63	< 0.001	0.0038	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.86	< 0.00007	0.42	0.014	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	Total	3.2	460	9100	7.27	12000	16000	0.76	0.0023 J	0.0024	0.044	< 0.00034	0.00034 J	< 0.0011	0.0016 J	< 0.00035	0.54	< 0.000070	0.55	0.0064	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0053 J
	6/26/2018 Dup	Total	3.2	440	8900	7.27	12000	17000	0.76	0.0019 J	0.0021	0.046	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	0.57	< 0.000070	0.58	0.0055	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0046 J
	6/26/2018	Dissolved	3.4	450	9100	NA	11000	13000	0.76	< 0.0010	0.0024	0.045	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.56	< 0.000070	0.58	0.005	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018 Dup	Dissolved	3.5	450	8700	NA	11000	14000	0.74	< 0.0010	0.0022	0.046	< 0.00034	0.00035	< 0.0011	0.0016 J	< 0.00035	0.59	< 0.000070	0.6	0.0054	< 0.000085	NA	NA	NA	NA	NA
	10/2/2018	Total	2.6	280	5600	7.41	6000	21000	1.0	< 0.0010	0.0031	0.035	NA	0.00057 J	NA	0.0016 J	NA	0.38	NA	0.74	0.0043	NA	< 0.0708	NA	NA	NA	NA
	10/2/2018 Dup	Total	2.6	250	5300	7.41	6200	22000	1.0	< 0.0010	0.0027	0.036	NA	0.00051 J	NA	0.0016 J	NA	0.34	NA	0.76	0.0048	NA	< 0.168	NA	NA	NA	NA
AES MW-5	8/9/2017	Total	0.37	850	3800	6.52	2500	8200	0.42	< 0.001	0.0032	0.041	< 0.00034	< 0.00034	< 0.0011	0.0034	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.01	< 0.000085	0.473	NA	NA	NA	NA
	8/16/2017	Total	0.46	890	3800	6.61	2700	7900	0.45	< 0.001	0.0024	0.043	< 0.00034	< 0.00034	< 0.0011	0.0035	< 0.00035	0.0047	< 0.00007	0.0086 J	0.013	< 0.000085	0.576	NA	NA	NA	NA
	8/22/2017	Total	0.39	800	3700	6.49	2500	11000	0.46	< 0.001	0.0018	0.039	< 0.00034	< 0.00034	< 0.0011	0.0036	< 0.00035	0.0044	< 0.00007	0.0080 J	0.014	< 0.000085	0.102	NA	NA	NA	NA
	8/29/2017	Total	0.39 B	930	3700	6.79	2600	9800	0.48	< 0.001	0.0021	0.036	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	0.0039	< 0.00007	0.0057 J	0.0099	< 0.000085	0.601	NA	NA	NA	NA
	9/12/2017	Total	0.37	830	3400	6.76	2600	9700	0.29	< 0.001	0.0041	0.038	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	< 0.0032	< 0.00007	0.0048 J	0.0053	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	Total	0.47	690	3700	6.72	2100	8700	0.49	< 0.0010	0.0071	0.036	< 0.00034	< 0.00034	< 0.0011	0.003	< 0.00035	0.0038 J	< 0.000070	0.0042 J	< 0.00024	< 0.000085	NA	< 0.00050	< 0.00053	0.046	0.75
	6/26/2018	Dissolved	0.44	670	3400	NA	2100	8800	0.48	< 0.0010	0.0059	0.036	< 0.00034	< 0.00034	< 0.0011	0.003	< 0.00035	0.0047 J	< 0.000070	0.0034 J	< 0.00024	< 0.000085	NA	NA	NA	NA	NA
	10/2/2018	Total	0.39	710	3700	6.73	2200	10000	0.5	< 0.0010	0.0088	0.032	NA	< 0.00034	NA	0.0030 J	NA	0.0038	NA	0.0053	0.00046	NA	< -0.0397	NA	NA	NA	NA
TW-A	12/12/2017	Total	0.14	170	49	6.92	280	930	0.26	< 0.001	0.0008 J	0.26	<0.00034	<0.00034	<0.0011	0.00071 J	<0.00035	<0.0011	<0.00007	0.0014 J	0.021	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	Total	0.14	110	54	6.96	79	620	0.3	< 0.001	<0.00046	0.19	<0.00034	<0.00034	<0.0011	0.00098 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0015	<0.000085	NA	NA	NA	NA	<0.00061
	7/10/2018	Dissolved	0.13	110	55	NA	78	610	0.3	< 0.0010	< 0.00046	0.18	< 0.00034	< 0.00034	< 0.0011	0.00044 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.0014	< 0.000085	NA	NA	NA	NA	NA
TW-B	12/12/2017	Total	0.59	170	300	7.07	670 F1	2300	1.2	< 0.001	0.00069 J	0.035	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0035 J	<0.00007	0.0044 J	0.0004 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	Total	0.54	140	240	6.96	660	2000	1.3	< 0.001	<0.00046	0.033	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0033 J	<0.00007	0.0028 J	0.00081 J	<0.000085	NA	NA	NA	NA	<0.00062
	7/10/2018	Dissolved	0.51	140	240	NA	670	2000	1.3	< 0.0010	0.00071	0.03	< 0.00034	< 0.00034	< 0.0011	0.0008 J	< 0.00035	0.0031 J	< 0.000070	0.0041 J	0.00033 J	< 0.000085	NA	NA	NA	NA	NA
TW-C	12/12/2017	Total	3.6	310	13000	7.54	1700	25000	1.1	0.0014 J	0.0038	0.15	<0.00034	<0.00034	0.0015 J	<0.0004	<0.00035	0.073	<0.00007	0.0018 J	0.00064 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	Total	2.3	310	6900	7.18	3100	17000	1.7	< 0.001	0.0023	0.04	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.014	<0.00007	0.0061 J	0.00061 J	<0.000085	NA	NA	NA	NA	<0.00066
	7/10/2018	Dissolved	2.3	310	6600	NA	3000	18000	1.7	< 0.0010	0.0029	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	0.014	< 0.000070	0.0076 J	0.00026 J	< 0.000085	NA	NA	NA	NA	NA
TW-D	12/12/2017	Total	0.27	170	300	6.45	250	1400	0.35	< 0.001	0.0023	0.11	<0.00034	<0.00034	<0.0011	0.0021 J	<0.00035	<0.0011	<0.00007	0.0029 J	0.0024	<0.000085	NA	NA	NA	NA	NA
	7/11/2018	Total	0.17	74	96	6.99	110	620	0.44	< 0.001	<0.00046	0.055	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.00027 J	<0.000085	NA	NA	NA	NA	0.0022 J
	7/11/18 DUP	Total	0.2	85	99	NA	110	620	0.5	< 0.001	<0.00046	0.064	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0004 J	<0.000085	NA	NA	NA	NA	0.0022 J
	7/11/2018	Dissolved	0.22	82	100	NA	110	590	0.45	< 0.0010	0.00084	0.063	< 0.00034	< 0.00034	< 0.0011	0.0009 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085	NA	NA	NA	NA	NA
	7/11/18 DUP	Dissolved	0.21	79	99	NA	110	610	0.5	< 0.0010	0.00086	0.061	< 0.00034	< 0.00034	< 0.0011	0.0009 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085	NA	NA	NA	NA	NA
AES-SEA	7/10/2018	Dissolved	4.2	370	20000	NA	2400	39000	0.88	<0.001	0.0032	0.008	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.18	<0.00007	0.0096 J	0.00066 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	Total	4.4	390	20000	8.4	2400	40000	0.88	<0.001	0.0024	0.008	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.19	<0.00007	0.009 J	0.00079 J	<0.000085	NA	NA	NA	NA	NA
Frequency of Detection (d)			51:51	51:51	51:51	50:50	51:51	51:51	51:51	5:51	36:51	51:51	0:45	5:51	1:45	43:51	1:45	31:51	0:45	39:51	48:51	0:45	21:30	1:6	1:6	1:6	7:11

Notes:
- CCR - Coal Combustion Residuals.
- mg/L - milligram per liter.
- MS/MSD - Matrix spike/Matrix spike duplicate.
- NA - Not available/Constituent not analyzed.
- pCi/L - picoCurie per liter.
- S.U. - Standard Units.
- TDS - Total Dissolved Solids.

Qualifiers:
- < - Not Detected, value is the reporting limit.
- B - Analyte found in sample and associated blank.
- J - Value is estimated.
- F1 - MS/MSD Recovery was outside acceptance limits.

(a) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(b) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(c) - Volatile organic compounds (VOCs) detected in one or more samples are shown.
VOCs are not associated with CCR, but are known to be present in groundwater due to the activities at the neighboring facility
(d) - Frequency of detection for groundwater (total concentrations) = Number of detected concentrations : total number of samples.

TABLE 2
HUMAN HEALTH DRINKING WATER SCREENING LEVELS
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

Constituent (n)	CASRN	Units	USEPA MCLs (a)	USEPA SMCLs (a)	November 2018 USEPA Tapwater RSLs (b)	Puerto Rico Groundwater Quality Standards (c)	Selected Federal Drinking Water Screening Level (d)	Selected Puerto Rico Drinking Water Screening Level (e, m)
Inorganics								
Antimony	7440-36-0	mg/L	0.006	NA	0.0078 (j)	0.0056	0.006	0.0056
Arsenic	7440-38-2	mg/L	0.01	NA	0.000052	0.01	0.01	0.01
Barium	7440-39-3	mg/L	2	NA	3.8	NA	2	2
Beryllium	7440-41-7	mg/L	0.004	NA	0.025	NA	0.004	0.004
Boron	7440-42-8	mg/L	NA	NA	4	NA	4	4
Cadmium	7440-43-9	mg/L	0.005	NA	0.0092	0.005	0.005	0.005
Calcium	7440-70-2	mg/L	NA	NA	NA	NA	NA	NA
Chloride	7647-14-5	mg/L	NA	250	NA	NA	250	250
Chromium	7440-47-3	mg/L	0.1 (f)	NA	22 (l)	0.1 (f)	0.1	0.1
Cobalt	7440-48-4	mg/L	NA	NA	0.006	NA	0.006	0.006
Fluoride	16984-48-8	mg/L	4	2	0.8	4	4	4
Lead	7439-92-1	mg/L	0.015 (g)	NA	0.015 (g)	0.015	0.015	0.015
Lithium	7439-93-2	mg/L	NA	NA	0.04	NA	0.04	0.04
Mercury	7439-97-6	mg/L	0.002 (h)	NA	0.0057 (i)	0.00005	0.002	0.00005
Molybdenum	7439-98-7	mg/L	NA	NA	0.1	NA	0.1	0.1
Radium 226/228	RADIUM226228	pCi/L	5	NA	NA	NA	5	5
Selenium	7782-49-2	mg/L	0.05	NA	0.1	0.05	0.05	0.05
Sulfate	7757-82-6	mg/L	NA	250	NA	NA	250	250
Thallium	7440-28-0	mg/L	0.002 (k)	NA	0.0002 (k)	0.00024	0.002	0.00024
Total Dissolved Solids	TDS	mg/L	NA	500	NA	NA	500	500
pH	PHFLD	S.U.	NA	6.5 - 8.5	NA	NA	6.5 - 8.5	6.5 - 8.5
VOCs and Sulfolane (o)								
Chlorobenzene	108-90-7	mg/L	0.1	NA	0.078	0.1	0.1	0.1
Isopropylbenzene	98-82-8	mg/L	NA	NA	0.45	NA	0.45	0.45
Methyl tert-butyl ether	1634-04-4	mg/L	NA	NA	0.014	NA	0.014	0.014
Sulfolane	126-33-0	mg/L	NA	NA	0.02	NA	0.02	0.02

Notes:
CASRN - Chemical Abstracts Service Registry Number.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
NA - Not Available.
pCi/L - picoCurie per liter.
RSL - Regional Screening Levels (USEPA).
SMCL - Secondary Maximum Contaminant Level.
S.U. - Standard Units.
USEPA - United States Environmental Protection Agency.
VOC - Volatile Organic Compound.

(a) - USEPA 2018 Edition of the Drinking Water Standards and Health Advisories. Spring 2018.
http://water.epa.gov/drink/contaminants/index.cfm
(b) - USEPA Regional Screening Levels (November 2018). Values for tapwater.
http://www.epa.gov/reg3hwmd/risk/human/rb-concentration_table/Generic_Tables/index.htm
(c) - Puerto Rico Water Quality Standards Regulation as amended on April 2016. Commonwealth of Puerto Rico Office of the Governor Environmental Quality Board.
Rule 1303.1 Water Quality Standards. Class SG Groundwater. Numbers represent a total recoverable value.
Ground waters intended for use as source of drinking water supply and agricultural uses including irrigation.
Also included under this class are those ground waters that flow into coastal, surface, and estuarine waters and wetlands.
Available at: https://www.epa.gov/sites/production/files/2014-12/documents/prwqs.pdf
(d) - The hierarchy for selecting the Federal Human Health Screening Level for Drinking Water is: USEPA MCL for Drinking Water;
USEPA Tapwater RSL; USEPA SMCL for Drinking Water.
(e) - The hierarchy for selecting the Puerto Rico Human Health Screening Level for Drinking Water is: Puerto Rico Groundwater Quality Standards;
USEPA MCL for Drinking Water (a); USEPA Tapwater RSL; USEPA SMCL for Drinking Water.
(f) - Value for Total Chromium.
(g) - Lead Treatment Technology Action Level is 0.015 mg/L.
(h) - Value for Inorganic Mercury.
(i) - RSL for Mercuric Chloride used for Mercury.
(j) - RSL for Antimony (metallic) used for Antimony.
(k) - RSL for Thallium (Soluble Salts) used for Thallium.
(l) - RSL for Chromium (III), Insoluble Salts used for Chromium.
(m) - The only differences between the Puerto Rico and Federal screening levels are the values for mercury and thallium.
(n) - The CCR Rule does not include values for boron, chloride, sulfate, pH or TDS, but these have been included here for this evaluation.
(o) - VOCs are not associated with CCR, but are known to be present in groundwater due to the activities at the neighboring facility

TABLE 3
HUMAN HEALTH AND ECOLOGICAL MARINE WATER QUALITY CRITERIA
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

			Human Health Recreational		Ecological			Human Health Recreational		Ecological		
Constituent	**CASRN**	**Units**	**USEPA AWQC Consumption of Organism Only (a)**	**Puerto Rico Coastal and Estuarine Water Quality Standards - Human Health (b)**	**USEPA Ambient Water Quality Criteria for Saltwater (chronic) (c)**	**USEPA Ambient Water Quality Criteria for Saltwater (chronic) (c)**	**Puerto Rico Coastal and Estuarine Water Quality Standards - Aquatic (d)**	**Selected Federal Human Health Recreational Screening Level (e)**	**Selected Federal and Puerto Rico Human Health Recreational Screening Level (f)**	**Selected Federal Ecological Screening Level (g)**	**Selected Puerto Rico Ecological Screening Level (h)**	**Selected Federal and Puerto Rico Ecological Screening Level (g, i)**
					Total	**Dissolved**	**Total**			**Total**		**Dissolved**
Inorganics												
Antimony	7440-36-0	mg/L	0.64	0.64	NA	NA	NA	0.64	0.64	NA	NA	NA
Arsenic	7440-38-2	mg/L	0.00014	NA	0.036 (j)	0.036 (j)	0.036	0.00014	0.00014	0.036	0.036	0.036
Barium	7440-39-3	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Beryllium	7440-41-7	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Boron	7440-42-8	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Cadmium	7440-43-9	mg/L	NA	NA	0.0079	0.0079	0.00885	NA	NA	0.0079	0.00885	0.0079
Calcium	7440-70-2	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloride	7647-14-5	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chromium	7440-47-3	mg/L	NA	NA	0.050 (k)	0.050 (k)	0.050 (k)	NA	NA	0.05	0.05	0.050
Cobalt	7440-48-4	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Fluoride	16984-48-8	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	7439-92-1	mg/L	NA	NA	0.0081	0.0077	0.00852	NA	NA	0.0081	0.00852	0.0077
Lithium	7439-93-2	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mercury	7439-97-6	mg/L	NA	0.000051	0.00094	0.00080	NA	NA	0.000051	0.00094	0.00094	0.00080
Molybdenum	7439-98-7	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Radium 226/228	RADIUM226228	pCi/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Selenium	7782-49-2	mg/L	4.2	NA	0.071	0.071	0.07114	4.2	4.2	0.071	0.07114	0.071
Sulfate	7757-82-6	mg/L	NA	2800 (l)	NA	NA	2800 (l)	NA	2800	NA	2800	NA
Thallium	7440-28-0	mg/L	0.00047	0.00047	NA	NA	NA	0.00047	0.00047	NA	NA	NA
Total Dissolved Solids	TDS	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
pH	PHFLD	S.U.	NA	7.3-8.5 (l)	6.5 - 8.5	NA	7.3-8.5 (l)	NA	7.3-8.5	6.5 - 8.5	7.3-8.5	NA
VOCs and Sulfolane (m)												
Chlorobenzene	108-90-7	mg/L	0.8	1.6	NA	NA	NA	0.8	1.6	NA	NA	NA
Isopropylbenzene	98-82-8	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Methyl tert-butyl ether	1634-04-4	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Sulfolane	126-33-0	mg/L	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

TABLE 3
HUMAN HEALTH AND ECOLOGICAL MARINE WATER QUALITY CRITERIA
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

Notes:

AWQC - Ambient Water Quality Criteria.
CASRN - Chemical Abstracts Service Registry Number.
mg/L - milligram per liter.
NA - Not Available.
pCi/L - picoCurie per liter.
S.U. - Standard Units.
USEPA - United States Environmental Protection Agency.
VOC - Volatile Organic Compound.

(a) - USEPA National Recommended Water Quality Criteria. USEPA Office of Water and Office of Science and Technology.
http://www.epa.gov/wqc/national-recommended-water-quality-criteria-human-health-criteria-table
USEPA AWQC Human Health for the Consumption of Organism Only apply to total concentrations.
(b) - Puerto Rico Water Quality Standards Regulation as amended on April 2016.
Commonwealth of Puerto Rico Office of the Governor Environmental Quality Board.
Rule 1303.1 Water Quality Standards. Class SB and SC Coastal and Estuarine Waters. Numbers represent a total recoverable value.
Values based on protection of the water body or aquatic life for reasons of human health.
Available at: https://www.epa.gov/sites/production/files/2014-12/documents/prwqs.pdf
(c) - USEPA Ambient Water Quality Criteria for Saltwater (chronic).
https://www.epa.gov/wqc/national-recommended-water-quality-criteria-aquatic-life-criteria-table
(d) - Puerto Rico Water Quality Standards Regulation as amended on April 2016.
Commonwealth of Puerto Rico Office of the Governor Environmental Quality Board.
Rule 1303.1 Water Quality Standards. Class SB and SC Coastal and Estuarine Waters. Numbers represent a total recoverable value.
Values based on protection of the water body for the propagation and preservation of aquatic species or species dependent on the water body.
Available at: https://www.epa.gov/sites/production/files/2014-12/documents/prwqs.pdf
(e) - The Federal Human Health Recreational Screening Level for Drinking Water is: USEPA AWQC Human Health for the Consumption of Organism Only.
(f) - The hierarchy for selecting the Puerto Rico Human Health Recreational Screening Level is: Puerto Rico Coastal and Estuarine Water Quality Standards - Human Health;
USEPA AWQC Human Health for the Consumption of Organism Only.
(g) - The Federal Ecological Screening Level is: USEPA Ambient Water Quality Criteria for Saltwater (chronic).
(h) - The hierarchy for selecting the Puerto Rico Ecological Screening Level is: Puerto Rico Coastal and Estuarine Water Quality Standards - Aquatic;
USEPA Ambient Water Quality Criteria for Saltwater (chronic).
(i) - Puerto Rico Coastal and Estuarine Water Quality Standards - Aquatic apply to total concentrations, therefore the USEPA Ambient Water Quality Criteria for Saltwater (chronic) dissolved screening levels are used.
(j) - Value for total arsenic.
(k) - Value for chromium (VI).
(l) - Standards for Class SB Coastal and Estuarine Waters.
(m) - VOCs are not associated with CCR, but are known to be present in groundwater due to the activities at the neighboring facility

TABLE 4
COMPARISON OF CCR RULE GROUNDWATER MONITORING AND TEMPORARY WELL RESULTS TO SELECTED HUMAN HEALTH DRINKING WATER SCREENING LEVELS - TOTAL (UNFILTERED)
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

		Appendix III (b)						Appendix III and IV (b, c)	Appendix IV (c)														Sulfolane and VOCs (d)			
	Constituent	Boron	Calcium	Chloride	pH	Sulfate	TDS	Fluoride	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury (e)	Molybdenum	Selenium	Thallium (e)	Radium 226/228	Chlorobenzene	Isopropylbenzene	Methyl tert-butyl ether	Sulfolane
	Puerto Rico HH DW SL (a)	4	NA	250	6.5-8.5	250	500	4	0.0056	0.01	2	0.004	0.005	0.1	0.006	0.015	0.04	0.00005	0.1	0.05	0.00024	5	0.1	0.45	0.014	0.02
Well ID	**Sampling Event Date**	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	mg/L	mg/L	mg/L	mg/L
AES MW-1 - Background Well	8/8/2017	0.26	140	240	6.87	**340**	**1100**	0.47	< 0.001	< 0.00046	0.05	< 0.00034	< 0.00034	< 0.0011	0.00058 J	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.0073	< 0.000085	< 0.0899	NA	NA	NA	NA
	8/15/2017	0.26	150	**260**	7.07	**410**	**1400**	0.53	< 0.001	0.00055 J	0.056	< 0.00034	< 0.00034	< 0.0011	0.00055 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0062	< 0.000085	0.205	NA	NA	NA	NA
	8/22/2017	0.25	150	220	6.74	**400**	**1400**	0.55	< 0.001	< 0.00046	0.058	< 0.00034	< 0.00034	< 0.0011	0.00068 J	< 0.00035	< 0.0032	< 0.00007	0.0023 J	0.0065	< 0.000085	0.270	NA	NA	NA	NA
	8/29/2017	0.25 B	160	240	6.92	**390**	**1400**	0.58 B	< 0.001	< 0.00046	0.055	< 0.00034	< 0.00034	< 0.0011	0.00062 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0057	< 0.000085	0.576	NA	NA	NA	NA
	9/12/2017	0.26	160	220	6.9	**410**	**1400**	0.47	< 0.001	0.00046 J	0.057	< 0.00034	< 0.00034	< 0.0011	0.00075 J	< 0.00035	< 0.0032	< 0.00007	0.0018 J	0.0057	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	0.25	130	**260 F1**	7.13	**510 F1**	**1500**	0.61	< 0.0010	< 0.00046	0.039	< 0.00034	< 0.00034	< 0.0011	< 0.00040	0.00077 J	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	< 0.00058
	10/1/2018	0.24	120	200	7.33	**400**	**1300**	0.69	< 0.0010	< 0.00046	0.032	NA	< 0.00034	NA	0.00050 J	NA	< 0.0011	NA	< 0.00085	0.015	NA	0.495	NA	NA	NA	NA
AES MW-2 - Background Well	8/8/2017	0.16	88	37	6.53	7.7	460	0.36	< 0.001	< 0.00046	0.1	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00035 J	< 0.000085	< 0.129	NA	NA	NA	NA
	8/15/2017	0.17	88	37	6.83	7.1	470	0.4	< 0.001	0.00047 J	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	< 0.00024	< 0.000085	0.545	NA	NA	NA	NA
	8/22/2017	0.16	89	37	6.54	10	450	0.4	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.0010 J	0.00061 J	< 0.000085	< 0.0379	NA	NA	NA	NA
	8/29/2017	0.17 B	100	37	6.68	16	470	0.42 B	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00044 J	< 0.000085	0.113	NA	NA	NA	NA
	9/12/2017	0.17	94	36	6.65	9.8	480	0.35	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.00094 J	0.00046 J	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	0.16	110	140	6.84	43	**740**	0.52	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00040 J	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0069 J
	10/1/2018	0.16	110	85	7.04	15	**690**	0.67	< 0.0010	< 0.00046	0.13	NA	< 0.00034	NA	0.00058 J	NA	0.0014 J	NA	< 0.00085	< 0.00024	NA	< 0.321	NA	NA	NA	NA
AES MW-3	8/8/2017	0.78	290	**2900**	6.74	**630**	**6000**	2	< 0.001	0.0038	0.33	< 0.00034	< 0.00034	< 0.0011	0.0018 J	< 0.00035	0.0068	< 0.00007	0.096	**0.052**	< 0.000085	0.099	NA	NA	NA	NA
	8/15/2017	0.85	320	**3400**	7.1	**1300**	**7600**	2.1	< 0.001	0.0034	0.29	< 0.00034	< 0.00034	< 0.0011	0.0019 J	< 0.00035	0.0077	< 0.00007	**0.16**	**0.098**	< 0.000085	0.142	NA	NA	NA	NA
	8/22/2017	0.83	340	**3600**	6.78	**1500**	**8600**	2.2	< 0.001	0.0021	0.37	< 0.00034	< 0.00034	< 0.0011	0.0023 J	< 0.00035	0.0075	< 0.00007	**0.2**	**0.13**	< 0.000085	0.212	NA	NA	NA	NA
	8/29/2017	0.90 B	390	**3700**	7.01	**1700**	**8300**	2.3 B	< 0.001	0.0024	0.25	< 0.00034	< 0.00034	< 0.0011	0.0022 J	< 0.00035	0.0075	< 0.00007	**0.22**	**0.14**	< 0.000085	0.0888	NA	NA	NA	NA
	9/12/2017	0.9	370	**3900**	7.03	**2300**	**9900**	1.9	0.0012 J	0.0029	0.23	< 0.00034	< 0.00034	< 0.0011	0.0025	< 0.00035	0.0056	< 0.00007	**0.28**	**0.18**	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	1.2	330	**4400**	7.23	**2800**	**11000**	1.6	< 0.0010	0.0018	0.24	< 0.00034	0.00042 J	< 0.0011	0.0031	< 0.00035	0.0073	< 0.000070	**0.22**	**0.21**	< 0.000085	NA	0.0027	0.00053 J	< 0.00074	0.004 J
	10/1/2018	1.0	330	**4700**	7.43	**3300**	**13000**	1.6	< 0.0010	0.0024	0.19	NA	< 0.00034	NA	0.0031	NA	0.021	NA	**0.22**	**0.23**	NA	0.511	NA	NA	NA	NA
AES MW-4	8/8/2017	3.4	590	**9800**	6.91	**15000**	**41000**	0.63	< 0.001	0.0036	0.057	< 0.00034	0.00036 J	< 0.0011	0.0018 J	< 0.00035	**1**	< 0.00007	**0.44**	0.011	< 0.000085	0.527	NA	NA	NA	NA
	8/8/2017 Dup	3.4	620	**9900**	6.91	**15000**	**41000**	0.61	0.0014 J	0.0031	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**1**	< 0.00007	**0.45**	0.011	< 0.000085	0.137	NA	NA	NA	NA
	8/16/2017	3.7	620	**11000**	7.08	**16000**	**43000**	0.63	< 0.001	0.0037	0.06	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**1.1**	< 0.00007	**0.4**	0.0048	< 0.000085	0.112	NA	NA	NA	NA
	8/16/2017 Dup	**4.1**	630	**10000**	7.08	**16000**	**43000**	0.61	< 0.001	0.0033	0.06	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	**1.1**	< 0.00007	**0.38**	0.0061	< 0.000085	0.507	NA	NA	NA	NA
	8/23/2017	3.8	620	**9800**	7.09	**15000**	**42000**	0.65	< 0.001	0.0026	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**0.88**	< 0.00007	**0.44**	0.006	< 0.000085	< 0.0545	NA	NA	NA	NA
	8/23/2017 Dup	3.7	590	**9900**	7.09	**15000**	**42000**	0.65	< 0.001	0.0025	0.058	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**1.1**	< 0.00007	**0.38**	0.0065	< 0.000085	0.0942	NA	NA	NA	NA
	8/30/2017	3.6 B	670	**11000**	7.14	**16000**	**42000**	0.68	< 0.001	0.0027	0.055	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**0.9**	< 0.00007	**0.4**	0.0058	< 0.000085	0.403	NA	NA	NA	NA
	8/30/2017 Dup	3.6 B	670	**11000**	7.14	**16000**	**41000**	0.68	< 0.001	0.0024	0.054	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	**0.98**	< 0.00007	**0.42**	0.0054	< 0.000085	< 0.146	NA	NA	NA	NA
	9/12/2017	3.2	600	**10000**	7.12	**17000**	**42000**	0.53	< 0.001	0.0035	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**0.75**	< 0.00007	**0.41**	0.013	< 0.000085	NA	NA	NA	NA	NA
	9/12/2017 Dup	3.4	610	**10000**	7.12	**17000**	**43000**	0.63	< 0.001	0.0038	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**0.86**	< 0.00007	**0.42**	0.014	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	3.2	460	**9100**	7.27	**12000**	**16000**	0.76	0.0023 J	0.0024	0.044	< 0.00034	0.00034 J	< 0.0011	0.0016 J	< 0.00035	**0.54**	< 0.000070	**0.55**	0.0064	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0053 J
	6/26/2018 Dup	3.2	440	**8900**	7.27	**12000**	**17000**	0.76	0.0019 J	0.0021	0.046	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	**0.57**	< 0.000070	**0.58**	0.0055	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0046 J
	10/2/2018	2.6	280	**5600**	7.41	**6000**	**21000**	1.0	< 0.0010	0.0031	0.035	NA	0.00057 J	NA	0.0016 J	NA	**0.38**	NA	**0.74**	0.0043	NA	< 0.0708	NA	NA	NA	NA
	10/2/2018 Dup	2.6	250	**5300**	7.41	**6200**	**22000**	1.0	< 0.0010	0.0027	0.036	NA	0.00051 J	NA	0.0016 J	NA	**0.34**	NA	**0.76**	0.0048	NA	< 0.168	NA	NA	NA	NA
AES MW-5	8/9/2017	0.37	850	**3800**	6.52	**2500**	**8200**	0.42	< 0.001	0.0032	0.041	< 0.00034	< 0.00034	< 0.0011	0.0034	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.01	< 0.000085	0.473	NA	NA	NA	NA
	8/16/2017	0.46	890	**3800**	6.61	**2700**	**7900**	0.45	< 0.001	0.0024	0.043	< 0.00034	< 0.00034	< 0.0011	0.0035	< 0.00035	0.0047	< 0.00007	0.0086 J	0.013	< 0.000085	0.576	NA	NA	NA	NA
	8/22/2017	0.39	800	**3700**	**6.49**	**2500**	**11000**	0.46	< 0.001	0.0018	0.039	< 0.00034	< 0.00034	< 0.0011	0.0036	< 0.00035	0.0044	< 0.00007	0.0080 J	0.014	< 0.000085	0.102	NA	NA	NA	NA
	8/29/2017	0.39 B	930	**3700**	6.79	**2600**	**9800**	0.48	< 0.001	0.0021	0.036	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	0.0039	< 0.00007	0.0057 J	0.0099	< 0.000085	0.601	NA	NA	NA	NA
	9/12/2017	0.37	830	**3400**	6.76	**2600**	**9700**	0.29	< 0.001	0.0041	0.038	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	< 0.0032	< 0.00007	0.0048 J	0.0053	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	0.47	690	**3700**	6.72	**2100**	**8700**	0.49	< 0.0010	0.0071	0.036	< 0.00034	< 0.00034	< 0.0011	0.003	< 0.00035	0.0038 J	< 0.000070	0.0042 J	< 0.00024	< 0.000085	NA	< 0.00050	< 0.00053	**0.046**	**0.75**
	10/2/2018	0.39	710	**3700**	6.73	**2200**	**10000**	0.5	< 0.0010	0.0088	0.032	NA	< 0.00034	NA	0.0030 J	NA	0.0038	NA	0.0053	0.00046	NA	< -0.0397	NA	NA	NA	NA
TW-A	12/12/2017	0.14	170	49	6.92	**280**	**930**	0.26	< 0.001	0.0008 J	0.26	<0.00034	<0.00034	<0.0011	0.00071 J	<0.00035	<0.0011	<0.00007	0.0014 J	0.021	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	0.14	110	54	6.96	79	**620**	0.3	< 0.001	<0.00046	0.19	<0.00034	<0.00034	<0.0011	0.00098 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0015	<0.000085	NA	NA	NA	NA	<0.00061
TW-B	12/12/2017	0.59	170	**300**	7.07	**670 F1**	**2300**	1.2	< 0.001	0.00069 J	0.035	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0035 J	<0.00007	0.0044 J	0.0004 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	0.54	140	240	6.96	**660**	**2000**	1.3	< 0.001	<0.00046	0.033	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0033 J	<0.00007	0.0028 J	0.00081 J	<0.000085	NA	NA	NA	NA	<0.00062
TW-C	12/12/2017	3.6	310	**13000**	7.54	**1700**	**25000**	1.1	0.0014 J	0.0038	0.15	<0.00034	<0.00034	0.0015 J	<0.0004	<0.00035	**0.073**	<0.00007	0.0018 J	0.00064 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	2.3	310	**6900**	7.18	**3100**	**17000**	1.7	< 0.001	0.0023	0.04	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.014	<0.00007	0.0061 J	0.00061 J	<0.000085	NA	NA	NA	NA	<0.00066
TW-D	12/12/2017	0.27	170	**300**	**6.45**	250	**1400**	0.35	< 0.001	0.0023	0.11	<0.00034	<0.00034	<0.0011	0.0021 J	<0.00035	<0.0011	<0.00007	0.0029 J	0.0024	<0.000085	NA	NA	NA	NA	NA
	7/11/2018	0.17	74	96	6.99	110	**620**	0.44	< 0.001	<0.00046	0.055	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.00027 J	<0.000085	NA	NA	NA	NA	0.0022 J
	7/11/18 DUP	0.2	85	99	NA	110	**620**	0.5	< 0.001	<0.00046	0.064	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0004 J	<0.000085	NA	NA	NA	NA	0.0022 J

Notes:
- DW - Drinking Water.
- CCR - Coal Combustion Residuals.
- HH - Human Health.
- MCL - Maximum Contaminant Level.
- mg/L - milligram per liter.
- MS/MSD - Matrix spike/Matrix spike duplicate.
- NA - Not available/Constituent not analyzed.
- pCi/L - picoCurie per liter.
- RSL - Regional Screening Level.
- SL - Screening Level.
- SMCL - Secondary Maximum Contaminant Level.
- S.U. - Standard Units.
- TDS - Total Dissolved Solids.
- USEPA - United States Environmental Protection Agency.

Qualifiers:
- < - Not Detected, value is the reporting limit.
- J - Value is estimated.
- F1 - MS/MSD Recovery was outside acceptance limits.
- B - Analyte found in sample and associated blank.

(a) - Puerto Rico Human Health Drinking Water Screening Levels selected in Table 2 using the following hierarchy:
  Puerto Rico Groundwater Quality Standards.
  Federal USEPA MCL for Drinking Water.
  Federal USEPA Tapwater RSL, November 2018.
  Federal USEPA SMCL for Drinking Water.
(b) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(d) - Volatile organic compounds (VOCs) detected in one or more samples are shown.
  VOCs are not associated with CCR, but are known to be present in groundwater due to the activities at the neighboring facility
(e) - The selected Federal Human Health Drinking Water Screening Level for both mercury and thallium is 0.002 mg/L, as shown on Table 2.
  All results for mercury and thallium are also below the selected Federal Human Health Drinking Water Screening Level.

[highlighted] greater than the Selected Puerto Rico Human Health Drinking Water Screening Level.

TABLE 5
COMPARISON OF CCR RULE GROUNDWATER MONITORING AND TEMPORARY WELL RESULTS TO HUMAN HEALTH DRINKING WATER SCREENING LEVELS - DISSOLVED (FILTERED)
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

		Appendix III (b)					Appendix III and IV (b, c)	Appendix IV (c)												
	Constituent	Boron	Calcium	Chloride	Sulfate	TDS	Fluoride	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury (d)	Molybdenum	Selenium	Thallium (d)
	Puerto Rico HH DW SL (a)	4	NA	250	250	500	4	0.0056	0.01	2	0.004	0.005	0.1	0.006	0.015	0.04	0.00005	0.1	0.05	0.00024
Well ID	**Sampling Event Date**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AES MW-1 - Background Well	6/25/2018	0.28	130	**260 F1**	**490 F1**	**1600**	0.61	< 0.0010	< 0.00046	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085
AES MW-2 - Background Well	6/25/2018	0.17	110	130	44	**730**	0.5	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00030 J	< 0.000085
AES MW-3	6/25/2018	1.1	320	**4300**	**2500**	**10000**	1.7	< 0.0010	0.0016	0.26	< 0.00034	0.00034 J	< 0.0011	0.0034 J	< 0.00035	0.0064	< 0.000070	**0.2**	**0.2**	< 0.000085
AES MW-4	6/26/2018	3.4	450	**9100**	**11000**	**13000**	0.76	< 0.0010	0.0024	0.045	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	**0.56**	< 0.000070	**0.58**	0.005	< 0.000085
	6/26/2018 Dup	3.5	450	**8700**	**11000**	**14000**	0.74	< 0.0010	0.0022	0.046	< 0.00034	0.00035 J	< 0.0011	0.0016 J	< 0.00035	**0.59**	< 0.000070	**0.6**	0.0054	< 0.000085
AES MW-5	6/26/2018	0.44	670	**3400**	**2100**	**8800**	0.48	< 0.0010	0.0059	0.036	< 0.00034	< 0.00034	< 0.0011	0.003	< 0.00035	0.0047 J	< 0.000070	0.0034 J	< 0.00024	< 0.000085
TW-A	7/10/2018	0.13	110	55	78	**610**	0.28	< 0.0010	< 0.00046	0.18	< 0.00034	< 0.00034	< 0.0011	0.00044 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.0014	< 0.000085
TW-B	7/10/2018	0.51	140	240	**670**	**2000**	1.3	< 0.0010	0.00071 J	0.03	< 0.00034	< 0.00034	< 0.0011	0.00082 J	< 0.00035	0.0031 J	< 0.000070	0.0041 J	0.00033 J	< 0.000085
TW-C	7/10/2018	2.3	310	**6600**	**3000**	**18000**	1.7	< 0.0010	0.0029	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	0.014	< 0.000070	0.0076 J	0.00026 J	< 0.000085
TW-D	7/11/2018	0.22	82	100	110	**590**	0.45	< 0.0010	0.00084 J	0.063	< 0.00034	< 0.00034	< 0.0011	0.00092 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085
	7/11/18 DUP	0.21	79	99	110	**610**	0.47	< 0.0010	0.00086 J	0.061	< 0.00034	< 0.00034	< 0.0011	0.00093 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085

Notes:

DW - Drinking Water.
CCR - Coal Combustion Residuals.
HH - Human Health.
MCL - Maximum Contaminant Level.
mg/L - milligram per liter.
MS/MSD - Matrix spike/Matrix spike duplicate.

NA - Not Available.
RSL - Risk-Based Screening Level.
SL - Screening Level.
SMCL - Secondary Maximum Contaminant Level.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

Qualifiers:
< - Not Detected, value is the reporting limit.
B - Analyte found in sample and associated blank.
F1 - MS/MSD Recovery was outside acceptance limits.
J - Value is estimated.

(a) - Puerto Rico Human Health Drinking Water Screening Levels selected in Table 2 using the following hierarchy:
Puerto Rico Groundwater Quality Standards.
Federal USEPA MCL for Drinking Water.
Federal USEPA Tapwater RSL, November 2018.
Federal USEPA SMCL for Drinking Water.
(b) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(d) - The selected Federal Human Health Drinking Water Screening Level for both mercury and thallium is 0.002 mg/L, as shown on Table 2.
All results for mercury and thallium are also below the selected Federal Human Health Drinking Water Screening Level.

[highlighted] greater than the Selected Puerto Rico Human Health Drinking Water Screening Level.

TABLE 6
COMPARISON OF CCR RULE GROUNDWATER MONITORING AND TEMPORARY WELL RESULTS TO SELECTED HUMAN HEALTH RECREATIONAL SCREENING LEVELS - TOTAL (UNFILTERED)
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

		Appendix III (b)						Appendix III and IV (b, c)	Appendix IV (c)														Sulfolane and VOCs (d)			
	Constituent	Boron	Calcium	Chloride	pH	Sulfate	TDS	Fluoride	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226/228	Chlorobenzene	Isopropylbenzene	Methyl tert-butyl ether	Sulfolane
	Federal and Puerto Rico HH Rec SL (a)	NA	NA	NA	7.3 - 8.5	2800	NA	NA	0.64	0.00014	NA	NA	NA	NA	NA	NA	NA	0.000051	NA	4.2	0.00047	NA	1.6	NA	NA	NA
Well ID	Sampling Event Date	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	mg/L	mg/L	mg/L	mg/L
AES MW-1 - Background Well	8/8/2017	0.26	140	240	**6.87**	340	1100	0.47	< 0.001	< 0.00046	0.05	< 0.00034	< 0.00034	< 0.0011	0.00058 J	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.0073	< 0.000085	< 0.0899	NA	NA	NA	NA
	8/15/2017	0.26	150	260	**7.07**	410	1400	0.53	< 0.001	**0.00055 J**	0.056	< 0.00034	< 0.00034	< 0.0011	0.00055 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0062	< 0.000085	0.205	NA	NA	NA	NA
	8/22/2017	0.25	150	220	**6.74**	400	1400	0.55	< 0.001	< 0.00046	0.058	< 0.00034	< 0.00034	< 0.0011	0.00068 J	< 0.00035	< 0.0032	< 0.00007	0.0023 J	0.0065	< 0.000085	0.270	NA	NA	NA	NA
	8/29/2017	0.25 B	160	240	**6.92**	390	1400	0.58 B	< 0.001	< 0.00046	0.055	< 0.00034	< 0.00034	< 0.0011	0.00062 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0057	< 0.000085	0.576	NA	NA	NA	NA
	9/12/2017	0.26	160	220	**6.9**	410	1400	0.47	< 0.001	**0.00046 J**	0.057	< 0.00034	< 0.00034	< 0.0011	0.00075 J	< 0.00035	< 0.0032	< 0.00007	0.0018 J	0.0057	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	0.25	130	260 F1	**7.13**	510 F1	1500	0.61	< 0.0010	< 0.00046	0.039	< 0.00034	< 0.00034	< 0.0011	< 0.00040	0.00077 J	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	< 0.00058
	10/1/2018	0.24	120	200	7.33	400	1300	0.69	< 0.0010	< 0.00046	0.032	NA	< 0.00034	NA	0.00050 J	NA	< 0.0011	NA	< 0.00085	0.015	NA	0.495	NA	NA	NA	NA
AES MW-2 - Background Well	8/8/2017	0.16	88	37	**6.53**	7.7	460	0.36	< 0.001	< 0.00046	0.1	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00035 J	< 0.000085	< 0.129	NA	NA	NA	NA
	8/15/2017	0.17	88	37	**6.83**	7.1	470	0.4	< 0.001	**0.00047 J**	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	< 0.00024	< 0.000085	0.545	NA	NA	NA	NA
	8/22/2017	0.16	89	37	**6.54**	10	450	0.4	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.0010 J	0.00061 J	< 0.000085	< 0.0379	NA	NA	NA	NA
	8/29/2017	0.17 B	100	37	**6.68**	16	470	0.42 B	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00044 J	< 0.000085	0.113	NA	NA	NA	NA
	9/12/2017	0.17	94	36	**6.65**	9.8	480	0.35	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.00094 J	0.00046 J	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	0.16	110	140	**6.84**	43	740	0.52	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00040 J	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0069 J
	10/1/2018	0.16	110	85	**7.04**	15	690	0.67	< 0.0010	< 0.00046	0.13	NA	< 0.00034	NA	0.00058 J	NA	0.0014 J	NA	< 0.00085	< 0.00024	NA	< 0.321	NA	NA	NA	NA
AES MW-3	8/8/2017	0.78	290	2900	**6.74**	630	6000	2	< 0.001	**0.0038**	0.33	< 0.00034	< 0.00034	< 0.0011	0.0018 J	< 0.00035	0.0068	< 0.00007	0.096	0.052	< 0.000085	0.099	NA	NA	NA	NA
	8/15/2017	0.85	320	3400	**7.1**	1300	7600	2.1	< 0.001	**0.0034**	0.29	< 0.00034	< 0.00034	< 0.0011	0.0019 J	< 0.00035	0.0077	< 0.00007	0.16	0.098	< 0.000085	0.142	NA	NA	NA	NA
	8/22/2017	0.83	340	3600	**6.78**	1500	8600	2.2	< 0.001	**0.0021**	0.37	< 0.00034	< 0.00034	< 0.0011	0.0023 J	< 0.00035	0.0075	< 0.00007	0.2	0.13	< 0.000085	0.212	NA	NA	NA	NA
	8/29/2017	0.90 B	390	3700	**7.01**	1700	8300	2.3 B	< 0.001	**0.0024**	0.25	< 0.00034	< 0.00034	< 0.0011	0.0022 J	< 0.00035	0.0075	< 0.00007	0.22	0.14	< 0.000085	0.0888	NA	NA	NA	NA
	9/12/2017	0.9	370	3900	**7.03**	2300	9900	1.9	0.0012 J	**0.0029**	0.23	< 0.00034	< 0.00034	< 0.0011	0.0025	< 0.00035	0.0056	< 0.00007	0.28	0.18	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	1.2	330	4400	**7.23**	2800	11000	1.6	< 0.0010	**0.0018**	0.24	< 0.00034	0.00042 J	< 0.0011	0.0031	< 0.00035	0.0073	< 0.000070	0.22	0.21	< 0.000085	NA	0.0027	0.00053 J	< 0.00074	0.004 J
	10/1/2018	1.0	330	4700	7.43	**3300**	13000	1.6	< 0.0010	**0.0024**	0.19	NA	< 0.00034	NA	0.0031	NA	0.021	NA	0.22	0.23	NA	0.511	NA	NA	NA	NA
AES MW-4	8/8/2017	3.4	590	9800	**6.91**	**15000**	41000	0.63	< 0.001	**0.0036**	0.057	< 0.00034	0.00036 J	< 0.0011	0.0018 J	< 0.00035	1	< 0.00007	0.44	0.011	< 0.000085	0.527	NA	NA	NA	NA
	8/8/2017 Dup	3.4	620	9900	**6.91**	**15000**	41000	0.61	0.0014 J	**0.0031**	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1	< 0.00007	0.45	0.011	< 0.000085	0.137	NA	NA	NA	NA
	8/16/2017	3.7	620	11000	**7.08**	**16000**	43000	0.63	< 0.001	**0.0037**	0.06	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1.1	< 0.00007	0.4	0.0048	< 0.000085	0.112	NA	NA	NA	NA
	8/16/2017 Dup	4.1	630	10000	**7.08**	**16000**	43000	0.61	< 0.001	**0.0033**	0.06	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	1.1	< 0.00007	0.38	0.0061	< 0.000085	0.507	NA	NA	NA	NA
	8/23/2017	3.8	620	9800	**7.09**	**15000**	42000	0.65	< 0.001	**0.0026**	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.88	< 0.00007	0.44	0.006	< 0.000085	< 0.0545	NA	NA	NA	NA
	8/23/2017 Dup	3.7	590	9900	**7.09**	**15000**	42000	0.65	< 0.001	**0.0025**	0.058	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1.1	< 0.00007	0.38	0.0065	< 0.000085	0.0942	NA	NA	NA	NA
	8/30/2017	3.6 B	670	11000	**7.14**	**16000**	42000	0.68	< 0.001	**0.0027**	0.055	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.9	< 0.00007	0.4	0.0058	< 0.000085	0.403	NA	NA	NA	NA
	8/30/2017 Dup	3.6 B	670	11000	**7.14**	**16000**	41000	0.68	< 0.001	**0.0024**	0.054	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	0.98	< 0.00007	0.42	0.0054	< 0.000085	< 0.146	NA	NA	NA	NA
	9/12/2017	3.2	600	10000	**7.12**	**17000**	42000	0.53	< 0.001	**0.0035**	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.75	< 0.00007	0.41	0.013	< 0.000085	NA	NA	NA	NA	NA
	9/12/2017 Dup	3.4	610	10000	**7.12**	**17000**	43000	0.63	< 0.001	**0.0038**	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.86	< 0.00007	0.42	0.014	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	3.2	460	9100	**7.27**	**12000**	16000	0.76	0.0023 J	**0.0024**	0.044	< 0.00034	0.00034 J	< 0.0011	0.0016 J	< 0.00035	0.54	< 0.000070	0.55	0.0064	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0053 J
	6/26/2018 Dup	3.2	440	8900	**7.27**	**12000**	17000	0.76	0.0019 J	**0.0021**	0.046	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	0.57	< 0.000070	0.58	0.0055	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0046 J
	10/2/2018	2.6	280	5600	7.41	**6000**	21000	1.0	< 0.0010	**0.0031**	0.035	NA	0.00057 J	NA	0.0016 J	NA	0.38	NA	0.74	0.0043	NA	< 0.0708	NA	NA	NA	NA
	10/2/2018 Dup	2.6	250	5300	7.41	**6200**	22000	1.0	< 0.0010	**0.0027**	0.036	NA	0.00051 J	NA	0.0016 J	NA	0.34	NA	0.76	0.0048	NA	< 0.168	NA	NA	NA	NA
AES MW-5	8/9/2017	0.37	850	3800	**6.52**	2500	8200	0.42	< 0.001	**0.0032**	0.041	< 0.00034	< 0.00034	< 0.0011	0.0034	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.01	< 0.000085	0.473	NA	NA	NA	NA
	8/16/2017	0.46	890	3800	**6.61**	2700	7900	0.45	< 0.001	**0.0024**	0.043	< 0.00034	< 0.00034	< 0.0011	0.0035	< 0.00035	0.0047	< 0.00007	0.0086 J	0.013	< 0.000085	0.576	NA	NA	NA	NA
	8/22/2017	0.39	800	3700	**6.49**	2500	11000	0.46	< 0.001	**0.0018**	0.039	< 0.00034	< 0.00034	< 0.0011	0.0036	< 0.00035	0.0044	< 0.00007	0.0080 J	0.014	< 0.000085	0.102	NA	NA	NA	NA
	8/29/2017	0.39 B	930	3700	**6.79**	2600	9800	0.48	< 0.001	**0.0021**	0.036	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	0.0039	< 0.00007	0.0057 J	0.0099	< 0.000085	0.601	NA	NA	NA	NA
	9/12/2017	0.37	830	3400	**6.76**	2600	9700	0.29	< 0.001	**0.0041**	0.038	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	< 0.0032	< 0.00007	0.0048 J	0.0053	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	0.47	690	3700	**6.72**	2100	8700	0.49	< 0.0010	**0.0071**	0.036	< 0.00034	< 0.00034	< 0.0011	0.003	< 0.00035	0.0038 J	< 0.000070	0.0042 J	< 0.00024	< 0.000085	NA	< 0.00050	< 0.00053	0.046	0.75
	10/2/2018	0.39	710	3700	**6.73**	2200	10000	0.5	< 0.0010	**0.0088**	0.032	NA	< 0.00034	NA	0.0030 J	NA	0.0038	NA	0.0053	0.00046	NA	< -0.0397	NA	NA	NA	NA
TW-A	12/12/2017	0.14	170	49	**6.92**	280	930	0.26	< 0.001	**0.0008 J**	0.26	<0.00034	<0.00034	<0.0011	0.00071 J	<0.00035	<0.0011	<0.00007	0.0014 J	0.021	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	0.14	110	54	**6.96**	79	620	0.3	< 0.001	<0.00046	0.19	<0.00034	<0.00034	<0.0011	0.00098 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0015	<0.000085	NA	NA	NA	NA	<0.00061
TW-B	12/12/2017	0.59	170	300	**7.07**	670 F1	2300	1.2	< 0.001	**0.00069 J**	0.035	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0035 J	<0.00007	0.0044 J	0.0004 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	0.54	140	240	**6.96**	660	2000	1.3	< 0.001	<0.00046	0.033	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0033 J	<0.00007	0.0028 J	0.00081 J	<0.000085	NA	NA	NA	NA	<0.00062
TW-C	12/12/2017	3.6	310	13000	7.54	1700	25000	1.1	0.0014 J	**0.0038**	0.15	<0.00034	<0.00034	0.0015 J	<0.0004	<0.00035	0.073	<0.00007	0.0018 J	0.00064 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	2.3	310	6900	**7.18**	**3100**	17000	1.7	< 0.001	**0.0023**	0.04	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.014	<0.00007	0.0061 J	0.00061 J	<0.000085	NA	NA	NA	NA	<0.00066
TW-D	12/12/2017	0.27	170	300	**6.45**	250	1400	0.35	< 0.001	**0.0023**	0.11	<0.00034	<0.00034	<0.0011	0.0021 J	<0.00035	<0.0011	<0.00007	0.0029 J	0.0024	<0.000085	NA	NA	NA	NA	NA
	7/11/2018	0.17	74	96	**6.99**	110	620	0.44	< 0.001	<0.00046	0.055	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.00027 J	<0.000085	NA	NA	NA	NA	0.0022 J
	7/11/18 DUP	0.2	85	99	NA	110	620	0.5	< 0.001	<0.00046	0.064	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0004 J	<0.000085	NA	NA	NA	NA	0.0022 J

Notes:
- CCR - Coal Combustion Residuals.
- HH - Human Health.
- mg/L - milligram per liter.
- MS/MSD - Matrix spike/Matrix spike duplicate.
- NA - Not available/Constituent not analyzed.
- pCi/L - picoCurie per liter.
- Rec - Recreational.
- RSL - Regional Screening Level.
- SL - Screening Level.
- S.U. - Standard Units.
- TDS - Total Dissolved Solids.
- USEPA - United States Environmental Protection Agency.

Qualifiers:
- < - Not Detected, value is the reporting limit.
- J - Value is estimated.
- F1 - MS/MSD Recovery was outside acceptance limits.
- B - Analyte found in sample and associated blank.

(a) - Puerto Rico Human Health Recreational Screening Levels selected in Table 3 as:
Puerto Rico Coastal and Estuarine Water Quality Standards - Human Health.
USEPA National Recommended Water Quality Criteria - Human Health for the Consumption of Organism Only. Applies to total concentrations.
(b) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(d) - Volatile organic compounds (VOCs) detected in one or more samples are shown.

[highlighted] greater than the Selected Federal and Puerto Rico Human Health Recreational Screening Level.

TABLE 7
COMPARISON OF CCR RULE GROUNDWATER MONITORING AND TEMPORARY WELL RESULTS TO HUMAN HEALTH RECREATIONAL SCREENING LEVELS - DISSOLVED (FILTERED)
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

		Appendix III (b)					Appendix III and IV (b, c)	Appendix IV (c)												
	Constituent	Boron	Calcium	Chloride	Sulfate	TDS	Fluoride	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
	Federal and Puerto Rico HH Rec SL (a)	NA	NA	NA	2800	NA	NA	0.64	0.00014	NA	NA	NA	NA	NA	NA	NA	0.000051	NA	4.2	0.00047
Well ID	**Sampling Event Date**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AES MW-1 - Background Well	6/25/2018	0.28	130	260 F1	490 F1	1600	0.61	< 0.0010	< 0.00046	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085
AES MW-2 - Background Well	6/25/2018	0.17	110	130	44	730	0.5	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00030 J	< 0.000085
AES MW-3	6/25/2018	1.1	320	4300	2500	10000	1.7	< 0.0010	**0.0016**	0.26	< 0.00034	0.00034 J	< 0.0011	0.0034 J	< 0.00035	0.0064	< 0.000070	0.2	0.2	< 0.000085
AES MW-4	6/26/2018	3.4	450	9100	**11000**	13000	0.76	< 0.0010	**0.0024**	0.045	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.56	< 0.000070	0.58	0.005	< 0.000085
	6/26/2018 Dup	3.5	450	8700	**11000**	14000	0.74	< 0.0010	**0.0022**	0.046	< 0.00034	0.00035 J	< 0.0011	0.0016 J	< 0.00035	0.59	< 0.000070	0.6	0.0054	< 0.000085
AES MW-5	6/26/2018	0.44	670	3400	2100	8800	0.48	< 0.0010	**0.0059**	0.036	< 0.00034	< 0.00034	< 0.0011	0.003	< 0.00035	0.0047 J	< 0.000070	0.0034 J	< 0.00024	< 0.000085
TW-A	7/10/2018	0.13	110	55	78	610	0.28	< 0.0010	< 0.00046	0.18	< 0.00034	< 0.00034	< 0.0011	0.00044 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.0014	< 0.000085
TW-B	7/10/2018	0.51	140	240	670	2000	1.3	< 0.0010	**0.00071 J**	0.03	< 0.00034	< 0.00034	< 0.0011	0.00082 J	< 0.00035	0.0031 J	< 0.000070	0.0041 J	0.00033 J	< 0.000085
TW-C	7/10/2018	2.3	310	6600	**3000**	18000	1.7	< 0.0010	**0.0029**	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	0.014	< 0.000070	0.0076 J	0.00026 J	< 0.000085
TW-D	7/11/2018	0.22	82	100	110	590	0.45	< 0.0010	**0.00084 J**	0.063	< 0.00034	< 0.00034	< 0.0011	0.00092 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085
	7/11/18 DUP	0.21	79	99	110	610	0.47	< 0.0010	**0.00086 J**	0.061	< 0.00034	< 0.00034	< 0.0011	0.00093 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085

Notes:

CCR - Coal Combustion Residuals.
HH - Human Health.
mg/L - milligram per liter.
MS/MSD - Matrix spike/Matrix spike duplicate.
NA - Not Available.

Rec - Recreational.
RSL - Risk-Based Screening Level.
SL - Screening Level.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

Qualifiers:
< - Not Detected, value is the reporting limit.
B - Analyte found in sample and associated blank.
F1 - MS/MSD Recovery was outside acceptance limits.
J - Value is estimated.

(a) - Puerto Rico Human Health Recreational Screening Levels selected in Table 3 as:
Puerto Rico Coastal and Estuarine Water Quality Standards - Human Health.
USEPA National Recommended Water Quality Criteria - Human Health for the Consumption of Organism Only. Applies to total concentrations.
(b) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).

[yellow highlight] greater than the Selected Federal and Puerto Rico Human Health Recreational Screening Level.

TABLE 8
COMPARISON OF CCR RULE GROUNDWATER MONITORING AND TEMPORARY WELL RESULTS TO ECOLOGICAL SCREENING LEVELS - TOTAL (UNFILTERED)
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

		Appendix III (b)						Appendix III and IV (b, c)	Appendix IV (c)														Sulfolane and VOCs (d)			
	Constituent	Boron	Calcium	Chloride	pH	Sulfate	TDS	Fluoride	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium	Radium 226/228	Chlorobenzene	Isopropylbenzene	Methyl tert-butyl ether	Sulfolane
	Eco SL (a)	NA	NA	NA	7.3 - 8.5	NA	NA	NA	NA	0.036	NA	NA	0.00885	0.05	NA	0.00852	NA	0.00094	NA	0.07114	NA	NA	NA	NA	NA	NA
Well ID	Sampling Event Date	mg/L	mg/L	mg/L	S.U.	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	pCi/L	mg/L	mg/L	mg/L	mg/L
AES MW-1 - Background Well	8/8/2017	0.26	140	240	**6.87**	340	1100	0.47	< 0.001	< 0.00046	0.05	< 0.00034	< 0.00034	< 0.0011	0.00058 J	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.0073	< 0.000085	< 0.0899	NA	NA	NA	NA
	8/15/2017	0.26	150	260	**7.07**	410	1400	0.53	< 0.001	0.00055 J	0.056	< 0.00034	< 0.00034	< 0.0011	0.00055 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0062	< 0.000085	0.205	NA	NA	NA	NA
	8/22/2017	0.25	150	220	**6.74**	400	1400	0.55	< 0.001	< 0.00046	0.058	< 0.00034	< 0.00034	< 0.0011	0.00068 J	< 0.00035	< 0.0032	< 0.00007	0.0023 J	0.0065	< 0.000085	0.270	NA	NA	NA	NA
	8/29/2017	0.25 B	160	240	**6.92**	390	1400	0.58 B	< 0.001	< 0.00046	0.055	< 0.00034	< 0.00034	< 0.0011	0.00062 J	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.0057	< 0.000085	0.576	NA	NA	NA	NA
	9/12/2017	0.26	160	220	**6.9**	410	1400	0.47	< 0.001	0.00046 J	0.057	< 0.00034	< 0.00034	< 0.0011	0.00075 J	< 0.00035	< 0.0032	< 0.00007	0.0018 J	0.0057	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	0.25	130	260 F1	**7.13**	510 F1	1500	0.61	< 0.0010	< 0.00046	0.039	< 0.00034	< 0.00034	< 0.0011	< 0.00040	0.00077 J	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	< 0.00058
	10/1/2018	0.24	120	200	7.33	400	1300	0.69	< 0.0010	< 0.00046	0.032	NA	< 0.00034	NA	0.00050 J	NA	< 0.0011	NA	< 0.00085	0.015	NA	0.495	NA	NA	NA	NA
AES MW-2 - Background Well	8/8/2017	0.16	88	37	**6.53**	7.7	460	0.36	< 0.001	< 0.00046	0.1	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00035 J	< 0.000085	< 0.129	NA	NA	NA	NA
	8/15/2017	0.17	88	37	**6.83**	7.1	470	0.4	< 0.001	0.00047 J	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	< 0.00024	< 0.000085	0.545	NA	NA	NA	NA
	8/22/2017	0.16	89	37	**6.54**	10	450	0.4	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.0010 J	0.00061 J	< 0.000085	< 0.0379	NA	NA	NA	NA
	8/29/2017	0.17 B	100	37	**6.68**	16	470	0.42 B	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	< 0.00085	0.00044 J	< 0.000085	0.113	NA	NA	NA	NA
	9/12/2017	0.17	94	36	**6.65**	9.8	480	0.35	< 0.001	< 0.00046	0.11	< 0.00034	< 0.00034	< 0.0011	< 0.0004	< 0.00035	< 0.0032	< 0.00007	0.00094 J	0.00046 J	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	0.16	110	140	**6.84**	43	740	0.52	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00040 J	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0069 J
	10/1/2018	0.16	110	85	**7.04**	15	690	0.67	< 0.0010	< 0.00046	0.13	NA	< 0.00034	NA	0.00058 J	NA	0.0014 J	NA	< 0.00085	< 0.00024	NA	< 0.321	NA	NA	NA	NA
AES MW-3	8/8/2017	0.78	290	2900	**6.74**	630	6000	2	< 0.001	0.0038	0.33	< 0.00034	< 0.00034	< 0.0011	0.0018 J	< 0.00035	0.0068	< 0.00007	0.096	0.052	< 0.000085	0.099	NA	NA	NA	NA
	8/15/2017	0.85	320	3400	**7.1**	1300	7600	2.1	< 0.001	0.0034	0.29	< 0.00034	< 0.00034	< 0.0011	0.0019 J	< 0.00035	0.0077	< 0.00007	0.16	**0.098**	< 0.000085	0.142	NA	NA	NA	NA
	8/22/2017	0.83	340	3600	**6.78**	1500	8600	2.2	< 0.001	0.0021	0.37	< 0.00034	< 0.00034	< 0.0011	0.0023 J	< 0.00035	0.0075	< 0.00007	0.2	**0.13**	< 0.000085	0.212	NA	NA	NA	NA
	8/29/2017	0.90 B	390	3700	**7.01**	1700	8300	2.3 B	< 0.001	0.0024	0.25	< 0.00034	< 0.00034	< 0.0011	0.0022 J	< 0.00035	0.0075	< 0.00007	0.22	**0.14**	< 0.000085	0.0888	NA	NA	NA	NA
	9/12/2017	0.9	370	3900	**7.03**	2300	9900	1.9	0.0012 J	0.0029	0.23	< 0.00034	< 0.00034	< 0.0011	0.0025	< 0.00035	0.0056	< 0.00007	0.28	**0.18**	< 0.000085	NA	NA	NA	NA	NA
	6/25/2018	1.2	330	4400	**7.23**	2800	11000	1.6	< 0.0010	0.0018	0.24	< 0.00034	0.00042 J	< 0.0011	0.0031	< 0.00035	0.0073	< 0.000070	0.22	**0.21**	< 0.000085	NA	0.0027	0.00053 J	< 0.00074	0.004 J
	10/1/2018	1.0	330	4700	7.43	3300	13000	1.6	< 0.0010	0.0024	0.19	NA	< 0.00034	NA	0.0031	NA	0.021	NA	0.22	**0.23**	NA	0.511	NA	NA	NA	NA
AES MW-4	8/8/2017	3.4	590	9800	**6.91**	15000	41000	0.63	< 0.001	0.0036	0.057	< 0.00034	0.00036 J	< 0.0011	0.0018 J	< 0.00035	1	< 0.00007	0.44	0.011	< 0.000085	0.527	NA	NA	NA	NA
	8/8/2017 Dup	3.4	620	9900	**6.91**	15000	41000	0.61	0.0014 J	0.0031	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1	< 0.00007	0.45	0.011	< 0.000085	0.137	NA	NA	NA	NA
	8/16/2017	3.7	620	11000	**7.08**	16000	43000	0.63	< 0.001	0.0037	0.06	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1.1	< 0.00007	0.4	0.0048	< 0.000085	0.112	NA	NA	NA	NA
	8/16/2017 Dup	4.1	630	10000	**7.08**	16000	43000	0.61	< 0.001	0.0033	0.06	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	1.1	< 0.00007	0.38	0.0061	< 0.000085	0.507	NA	NA	NA	NA
	8/23/2017	3.8	620	9800	**7.09**	15000	42000	0.65	< 0.001	0.0026	0.057	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.88	< 0.00007	0.44	0.006	< 0.000085	< 0.0545	NA	NA	NA	NA
	8/23/2017 Dup	3.7	590	9900	**7.09**	15000	42000	0.65	< 0.001	0.0025	0.058	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	1.1	< 0.00007	0.38	0.0065	< 0.000085	0.0942	NA	NA	NA	NA
	8/30/2017	3.6 B	670	11000	**7.14**	16000	42000	0.68	< 0.001	0.0027	0.055	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.9	< 0.00007	0.4	0.0058	< 0.000085	0.403	NA	NA	NA	NA
	8/30/2017 Dup	3.6 B	670	11000	**7.14**	16000	41000	0.68	< 0.001	0.0024	0.054	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	0.98	< 0.00007	0.42	0.0054	< 0.000085	< 0.146	NA	NA	NA	NA
	9/12/2017	3.2	600	10000	**7.12**	17000	42000	0.53	< 0.001	0.0035	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.75	< 0.00007	0.41	0.013	< 0.000085	NA	NA	NA	NA	NA
	9/12/2017 Dup	3.4	610	10000	**7.12**	17000	43000	0.63	< 0.001	0.0038	0.056	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.86	< 0.00007	0.42	0.014	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	3.2	460	9100	**7.27**	12000	16000	0.76	0.0023 J	0.0024	0.044	< 0.00034	0.00034 J	< 0.0011	0.0016 J	< 0.00035	0.54	< 0.000070	0.55	0.0064	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0053 J
	6/26/2018 Dup	3.2	440	8900	**7.27**	12000	17000	0.76	0.0019 J	0.0021	0.046	< 0.00034	< 0.00034	< 0.0011	0.0016 J	< 0.00035	0.57	< 0.000070	0.58	0.0055	< 0.000085	NA	< 0.00050	< 0.00053	< 0.00074	0.0046 J
	10/2/2018	2.6	280	5600	7.41	6000	21000	1.0	< 0.0010	0.0031	0.035	NA	0.00057 J	NA	0.0016 J	NA	0.38	NA	0.74	0.0043	NA	< 0.0708	NA	NA	NA	NA
	10/2/2018 Dup	2.6	250	5300	7.41	6200	22000	1.0	< 0.0010	0.0027	0.036	NA	0.00051	NA	0.0016 J	NA	0.34	NA	0.76	0.0048	NA	< 0.168	NA	NA	NA	NA
AES MW-5	8/9/2017	0.37	850	3800	**6.52**	2500	8200	0.42	< 0.001	0.0032	0.041	< 0.00034	< 0.00034	< 0.0011	0.0034	< 0.00035	< 0.0032	< 0.00007	0.0022 J	0.01	< 0.000085	0.473	NA	NA	NA	NA
	8/16/2017	0.46	890	3800	**6.61**	2700	7900	0.45	< 0.001	0.0024	0.043	< 0.00034	< 0.00034	< 0.0011	0.0035	< 0.00035	0.0047	< 0.00007	0.0086 J	0.013	< 0.000085	0.576	NA	NA	NA	NA
	8/22/2017	0.39	800	3700	**6.49**	2500	11000	0.46	< 0.001	0.0018	0.039	< 0.00034	< 0.00034	< 0.0011	0.0036	< 0.00035	0.0044	< 0.00007	0.0080 J	0.014	< 0.000085	0.102	NA	NA	NA	NA
	8/29/2017	0.39 B	930	3700	**6.79**	2600	9800	0.48	< 0.001	0.0021	0.036	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	0.0039	< 0.00007	0.0057 J	0.0099	< 0.000085	0.601	NA	NA	NA	NA
	9/12/2017	0.37	830	3400	**6.76**	2600	9700	0.29	< 0.001	0.0041	0.038	< 0.00034	< 0.00034	< 0.0011	0.0033	< 0.00035	< 0.0032	< 0.00007	0.0048 J	0.0053	< 0.000085	NA	NA	NA	NA	NA
	6/26/2018	0.47	690	3700	**6.72**	2100	8700	0.49	< 0.0010	0.0071	0.036	< 0.00034	< 0.00034	< 0.0011	0.0030	< 0.00035	0.0038 J	< 0.000070	0.0042 J	< 0.00024	< 0.000085	NA	< 0.00050	< 0.00053	0.046	0.75
	10/2/2018	0.39	710	3700	**6.73**	2200	10000	0.5	< 0.0010	0.0088	0.032	NA	< 0.00034	NA	0.0030 J	NA	0.0038	NA	0.0053	0.00046	NA	< -0.0397	NA	NA	NA	NA
TW-A	12/12/2017	0.14	170	49	**6.92**	280	930	0.26	< 0.001	0.0008 J	0.26	<0.00034	<0.00034	<0.0011	0.00071 J	<0.00035	<0.0011	<0.00007	0.0014 J	0.021	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	0.14	110	54	**6.96**	79	620	0.3	< 0.001	<0.00046	0.19	<0.00034	<0.00034	<0.0011	0.00098 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0015	<0.000085	NA	NA	NA	NA	<0.00061
TW-B	12/12/2017	0.59	170	300	**7.07**	670 F1	2300	1.2	< 0.001	0.00069 J	0.035	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0035 J	<0.00007	0.0044 J	0.0004 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	0.54	140	240	**6.96**	660	2000	1.3	< 0.001	<0.00046	0.033	<0.00034	<0.00034	<0.0011	0.0012 J	<0.00035	0.0033 J	<0.00007	0.0028 J	0.00081 J	<0.000085	NA	NA	NA	NA	<0.00062
TW-C	12/12/2017	3.6	310	13000	7.54	1700	25000	1.1	0.0014 J	0.0038	0.15	<0.00034	<0.00034	0.0015 J	<0.0004	<0.00035	0.073	<0.00007	0.0018 J	0.00064 J	<0.000085	NA	NA	NA	NA	NA
	7/10/2018	2.3	310	6900	**7.18**	3100	17000	1.7	< 0.001	0.0023	0.04	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.014	<0.00007	0.0061 J	0.00061 J	<0.000085	NA	NA	NA	NA	<0.00066
TW-D	12/12/2017	0.27	170	300	**6.45**	250	1400	0.35	< 0.001	0.0023	0.11	<0.00034	<0.00034	<0.0011	0.0021 J	<0.00035	<0.0011	<0.00007	0.0029 J	0.0024	<0.000085	NA	NA	NA	NA	NA
	7/11/2018	0.17	74	96	**6.99**	110	620	0.44	< 0.001	<0.00046	0.055	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.00027 J	<0.000085	NA	NA	NA	NA	0.0022 J
	7/11/18 DUP	0.2	85	99	NA	110	620	0.5	< 0.001	<0.00046	0.064	<0.00034	<0.00034	<0.0011	0.0014 J	<0.00035	<0.0011	<0.00007	<0.00085	0.0004 J	<0.000085	NA	NA	NA	NA	0.0022 J

Notes:
CCR - Coal Combustion Residuals.
mg/L - milligram per liter.
MS/MSD - Matrix spike/Matrix spike duplicate.
NA - Not available/Constituent not analyzed.
pCi/L - picoCurie per liter.

SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.
VOC - Volatile Organic Compound.

Qualifiers:
< - Not Detected, value is the reporting limit.
B - Analyte found in sample and associated blank.
F1 - MS/MSD Recovery was outside acceptance limits.
J - Value is estimated.

(a) - Puerto Rico Ecological Screening Levels selected in Table 3 as:
Puerto Rico Coastal and Estuarine Water Quality Standards - Aquatic.
USEPA National Recommended Ambient Water Quality Criteria - Aquatic Life Saltwater (chronic).
(b) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(d) - Volatile organic compounds (VOCs) detected in one or more samples are shown.

(highlighted) greater than the Selected Ecological Screening Level.

TABLE 9
COMPARISON OF CCR RULE GROUNDWATER MONITORING AND TEMPORARY WELL RESULTS TO ECOLOGICAL SCREENING LEVELS - DISSOLVED (FILTERED)
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

		Appendix III (b)					Appendix III and IV (b, c)	Appendix IV (c)												
	Constituent	Boron	Calcium	Chloride	Sulfate	TDS	Fluoride	Antimony	Arsenic	Barium	Beryllium	Cadmium	Chromium	Cobalt	Lead	Lithium	Mercury	Molybdenum	Selenium	Thallium
	Eco SL (a)	NA	NA	NA	NA	NA	NA	NA	0.036	NA	NA	0.0079	0.05	NA	0.0077	NA	0.0008	NA	0.071	NA
Well ID	**Sampling Event Date**	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
AES MW-1 - Background Well	6/25/2018	0.28	130	260 F1	490 F1	1600	0.61	< 0.0010	< 0.00046	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.025	< 0.000085
AES MW-2 - Background Well	6/25/2018	0.17	110	130	44	730	0.5	< 0.0010	< 0.00046	0.15	< 0.00034	< 0.00034	< 0.0011	0.00067 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.00030 J	< 0.000085
AES MW-3	6/25/2018	1.1	320	4300	2500	10000	1.7	< 0.0010	0.0016	0.26	< 0.00034	0.00034 J	< 0.0011	0.0034 J	< 0.00035	0.0064	< 0.000070	0.2	**0.2**	< 0.000085
AES MW-4	6/26/2018	3.4	450	9100	11000	13000	0.76	< 0.0010	0.0024	0.045	< 0.00034	< 0.00034	< 0.0011	0.0017 J	< 0.00035	0.56	< 0.000070	0.58	0.005	< 0.000085
	6/26/2018 Dup	3.5	450	8700	11000	14000	0.74	< 0.0010	0.0022	0.046	< 0.00034	0.00035 J	< 0.0011	0.0016 J	< 0.00035	0.59	< 0.000070	0.6	0.0054	< 0.000085
AES MW-5	6/26/2018	0.44	670	3400	2100	8800	0.48	< 0.0010	0.0059	0.036	< 0.00034	< 0.00034	< 0.0011	0.003	< 0.00035	0.0047 J	< 0.000070	0.0034 J	< 0.00024	< 0.000085
TW-A	7/10/2018	0.13	110	55	78	610	0.28	< 0.0010	< 0.00046	0.18	< 0.00034	< 0.00034	< 0.0011	0.00044 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	0.0014	< 0.000085
TW-B	7/10/2018	0.51	140	240	670	2000	1.3	< 0.0010	0.00071 J	0.03	< 0.00034	< 0.00034	< 0.0011	0.00082 J	< 0.00035	0.0031 J	< 0.000070	0.0041 J	0.00033 J	< 0.000085
TW-C	7/10/2018	2.3	310	6600	3000	18000	1.7	< 0.0010	0.0029	0.04	< 0.00034	< 0.00034	< 0.0011	< 0.00040	< 0.00035	0.014	< 0.000070	0.0076 J	0.00026 J	< 0.000085
TW-D	7/11/2018	0.22	82	100	110	590	0.45	< 0.0010	0.00084 J	0.063	< 0.00034	< 0.00034	< 0.0011	0.00092 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085
	7/11/18 DUP	0.21	79	99	110	610	0.47	< 0.0010	0.00086 J	0.061	< 0.00034	< 0.00034	< 0.0011	0.00093 J	< 0.00035	< 0.0011	< 0.000070	< 0.00085	< 0.00024	< 0.000085

Notes:
- CCR - Coal Combustion Residuals.
- mg/L - milligram per liter.
- MS/MSD - Matrix spike/Matrix spike duplicate.
- NA - Not Available.
- SL - Screening Level.
- TDS - Total Dissolved Solids.
- USEPA - United States Environmental Protection Agency.

Qualifiers:
- < - Not Detected, value is the reporting limit.
- B - Analyte found in sample and associated blank.
- F1 - MS/MSD Recovery was outside acceptance limits.
- J - Value is estimated.

(a) - Puerto Rico Ecological Screening Levels selected in Table 3 as:
Puerto Rico Coastal and Estuarine Water Quality Standards - Aquatic.
USEPA National Recommended Ambient Water Quality Criteria - Aquatic Life Saltwater (chronic).
(b) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(c) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).

[yellow highlight] greater than the Selected Ecological Screening Level.

TABLE 10
COMPARISON OF HARBOR WATER SAMPLE RESULTS TO HUMAN HEALTH RECREATIONAL AND ECOLOGICAL SCREENING LEVEL
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

			Appendix III (c)						Appendix III and IV (c, d)	Appendix IV (d)												
	Fraction	**Constituent**	**Boron**	**Calcium**	**Chloride**	**pH**	**Sulfate**	**TDS**	**Fluoride**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Lead**	**Lithium**	**Mercury**	**Molybdenum**	**Selenium**	**Thallium**
	Total	**Federal and Puerto Rico HH Rec SL (a)**	NA	NA	NA	7.3 - 8.5	2800	NA	NA	0.64	0.00014	NA	NA	NA	NA	NA	NA	NA	0.000051	NA	4.2	0.00047
	Dissolved	**Federal and Puerto Rico HH Rec SL (a)**	NA	NA	NA	NA	2800	NA	NA	0.64	0.00014	NA	NA	NA	NA	NA	NA	NA	0.000051	NA	4.2	0.00047
	Total	**Eco SL (b)**	NA	NA	NA	7.3 - 8.5	NA	NA	NA	NA	0.036	NA	NA	0.00885	0.050	NA	0.00852	NA	0.00094	NA	0.07114	NA
	Dissolved	**Eco SL (b)**	NA	NA	NA	NA	NA	NA	NA	NA	0.036	NA	NA	0.0079	0.050	NA	0.0077	NA	0.00080	NA	0.071	NA
Harbor Water Sample ID	**Fraction**	**Sampling Event Date**	**mg/L**	**mg/L**	**mg/L**	**S.U.**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
AES-SEA	Total	7/10/2018	4.4	390	20000	8.4	2400	40000	0.88	<0.001	**0.0024**	0.0084	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.19	<0.00007	0.009 J	0.00079 J	<0.000085
AES-SEA	Dissolved	7/10/2018	4.2	370	20000	NA	2400	39000	0.88	<0.001	**0.0032**	0.0081	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.18	<0.00007	0.0096 J	0.00066 J	<0.000085

Notes:
CCR - Coal Combustion Residuals.
HH - Human Health.
mg/L - milligram per liter.
NA - Not available.
Rec - Recreational.
SL - Screening Level.
S.U. - Standard Units.
TDS - Total Dissolved Solids.
USEPA - United States Environmental Protection Agency.

Qualifiers:
< - Not Detected, value is the reporting limit.
J - Value is estimated.

(a) - Puerto Rico Human Health Recreational Screening Levels selected in Table 3 as:
Puerto Rico Coastal and Estuarine Water Quality Standards - Human Health.
USEPA National Recommended Water Quality Criteria - Human Health for the Consumption of Organism Only. Applies to total concentrations.
(b) - Ecological Screening Levels selected in Table 3 as:
Puerto Rico Coastal and Estuarine Water Quality Standards - Aquatic.
USEPA National Recommended Ambient Water Quality Criteria - Aquatic Life Saltwater (chronic).
(c) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(d) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).

[yellow highlight] greater than the Selected Federal and Puerto Rico Human Health Recreational Screening Level.

TABLE 11
COMPARISON OF HARBOR SAMPLE ANALYTICAL RESULTS TO TYPICAL SEAWATER COMPOSITION
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

			Appendix III (d)						Appendix III and IV (d, e)	Appendix IV (e)												
		Constituent	**Boron**	**Calcium**	**Chloride**	**pH**	**Sulfate**	**TDS**	**Fluoride**	**Antimony**	**Arsenic**	**Barium**	**Beryllium**	**Cadmium**	**Chromium**	**Cobalt**	**Lead**	**Lithium**	**Mercury**	**Molybdenum**	**Selenium**	**Thallium**
	Seawater Composition (a)		4.45	411	19345	7.3 - 9.5. (c)	2701	NA	1	0.00033	0.0026	0.021	0.0000006	0.00011	0.0002	0.00039	0.00003	0.17	0.00015	0.01	0.0009	NA
Harbor Water	Seawater Composition (b)		4.5	410	19000	NA	2700	NA	1.3	0.0003	0.003	0.02	0.0000006	0.00011	0.00005	0.0004	0.00003	0.17	0.0002	0.01	0.00009	NA
Sample ID	**Sampling**	**Fraction**	**mg/L**	**mg/L**	**mg/L**	**S.U.**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
AES-SEA	7/10/2018	Dissolved	4.2	370	20000	NA	2400	39000	0.88	<0.001	0.0032	0.0081	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.18	<0.00007	0.0096 J	0.00066 J	<0.000085
AES-SEA	7/10/2018	Total	4.4	390	20000	8.4	2400	40000	0.88	<0.001	0.0024	0.0084	<0.00034	<0.00034	<0.0011	<0.0004	<0.00035	0.19	<0.00007	0.009 J	0.00079 J	<0.000085

Notes:
Blank cells indicate constituent not analyzed.
J - Value is estimated.
mg/L - milligram per liter.
S.U. - Standard Units.
< - Not Detected, value is the reporting limit.

(a) - Values from The chemical composition of seawater. 2006. Dr J Floor Anthoni.
Detailed composition of seawater. (Source cited as: Karl K Turekian: Oceans. 1968. Prentice-Hall).
http://www.seafriends.org.nz/oceano/seawater.htm#gases
(b) - Values from USGS. 1985. Study and Interpretation of the Chemical Characteristics of Natural Water. U.S. Geological Survey.
Table 2. Composition of Seawater (Source cited as: Goldberg and others (1971)).
https://pubs.usgs.gov/wsp/wsp2254/pdf/intro.pdf
(c) - Ocean pH varies from about 7.90 to 8.20 but along the coast one may find much larger variations from 7.3 inside deep estuaries to 8.6 in productive coastal plankton blooms and 9.5 in tide pools.
(d) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(e) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).

TABLE 12
DERIVATION OF GROUNDWATER RISK-BASED SCREENING LEVELS PROTECTIVE OF HARBOR WATER
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

Constituents	Selected Federal and Puerto Rico HH REC SL (b) (mg/L)	Selected Puerto Rico Eco SL - Total (c) (mg/L)	Selected Federal and Puerto Rico Eco SL - Dissolved (c) (mg/L)	Lowest of the Human Health and Ecological Screening Levels (mg/L)	Groundwater Risk-Based Screening Level (c) (mg/L)	Maximum Groundwater Concentration (mg/L)		Ratio Between Groundwater Risk-Based Screening Level and the Maximum RIEC Groundwater Concentration
	Estimated Dilution Attenuation Factor - Las Mareas Harbor (d) =				1,300			
Inorganics								
Antimony	0.64	NA	NA	0.64	832	0.0023	AES MW-4	>360,000
Arsenic	0.00014	0.036	0.036	0.00014	0.182	0.0088	AES MW-5	>20
Barium	NA	NA	NA	NA	NA	0.37	AES MW-3	NA
Beryllium	NA	NA	NA	NA	NA	ND		ND
Boron	NA	NA	NA	NA	NA	4.1	AES MW-4	NA
Cadmium	NA	0.00885	0.0079	0.0079	10.2	0.00057	AES MW-4	>17,000
Calcium	NA	NA	NA	NA	NA	930	AES MW-5	NA
Chloride	NA	NA	NA	NA	NA	13000	TW-C	NA
Chromium	NA	0.05	0.050	0.050	64.5	0.0015	TW-C	>43,000
Cobalt	NA	NA	NA	NA	NA	0.0036	AES MW-5	NA
Fluoride	NA	NA	NA	NA	NA	2.3	AES MW-3	NA
Lead	NA	0.00852	0.0077	0.0077	10.0	0.00077	AES MW-1 (e)	>13,000
Lithium	NA	NA	NA	NA	NA	1.1	AES MW-4	NA
Mercury	0.000051	0.00094	0.00080	0.00005	0.0663	ND		ND
Molybdenum	NA	NA	NA	NA	NA	0.76	AES MW-4	NA
Radium 226/228	NA	NA	NA	NA	NA	0.601	AES MW-5	NA
Selenium	4.2	0.07114	0.071	0.071	92.1	0.23	AES MW-3	>400
Sulfate	2800	2800	NA	2800	3640000	17000	AES MW-4	>200
Thallium	0.00047	NA	NA	0.00047	0.611	ND		ND
Total Dissolved Solids	NA	NA	NA	NA	NA	43000	AES MW-4	NA
pH	7.3-8.5	7.3-8.5	NA	NA	NA	7.54	TW-C	NA
VOCs and Sulfolane								
Chlorobenzene	1.6	NA	NA	1.6	2080	0.0027	AES MW-3	>770,370
Isopropylbenzene	NA	NA	NA	NA	NA	0.00053	AES MW-3	NA
Methyl tert-butyl ether	NA	NA	NA	NA	NA	0.046	AES MW-5	NA
Sulfolane	NA	NA	NA	NA	NA	0.75	AES MW-5	NA

Notes:
ECO SL - Ecological Screening Level.
HH REC SL - Human Health Recreational Use Screening Level.
mg/L - milligram per liter.
NA - Not Available.

(a) - The hierarchy for selecting the Puerto Rico Human Health Recreational Screening Level is: Puerto Rico Coastal and Estuarine Water Quality Standards - Human Health; USEPA AWQC Human Health for the Consumption of Organism Only.
(b) - The hierarchy for selecting the Puerto Rico Ecological Screening Level is: Puerto Rico Coastal and Estuarine Water Quality Standards - Aquatic; USEPA Ambient Water Quality Criteria for Saltwater (chronic).
(c) - Where the Groundwater Risk-Based Screening Level = Screening Level x Dilution Factor.
(d) - Estimated value, see text for derivation.
(d) - MW-1 is a background well.

TABLE 13a
SUMMARY OF GROUNDWATER AND HARBOR SAMPLE SCREENING RESULTS
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

Constituent		Screening Level Results									
		Groundwater - Human Health Drinking Water Screening Levels		Groundwater - Human Health Recreational Screening Levels		Groundwater - Ecological Screening Levels		Harbor - Human Health Recreational Screening Levels		Harbor - Ecological Screening Levels	
		Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Appendix III (a)	Boron		1 : 51 2%								
	Calcium										
	Chloride	6 : 11 55%	34 : 51 67%								
	pH		2 : 50 4%		45 : 50 90%		45 : 50 90%				
	Sulfate	7 : 11 64%	40 : 51 78%	3 : 11 27%	16 : 51 31%						
	TDS	11 : 11 100%	46 : 51 90%								
Appendix III and IV (a, b)	Fluoride										
Appendix IV (b)	Antimony										
	Arsenic			8 : 11 73%	36 : 51 71%			1 : 1 100%	1 : 1 100%		
	Barium										
	Beryllium										
	Cadmium										
	Chromium										
	Cobalt										
	Lead										
	Lithium	2 : 11 18%	15 : 51 29%								
	Mercury										
	Molybdenum	3 : 11 27%	20 : 51 39%								
	Selenium	1 : 11 9%	7 : 51 14%			1 : 11 9%	6 : 51 12%				
	Thallium										
	Radium 226/228							NA	NA	NA	NA
Sulfolane and VOCs (c)	Chlorobenzene							NA	NA	NA	NA
	Isopropylbenzene							NA	NA	NA	NA
	ether		1 : 6 17%					NA	NA	NA	NA
	Sulfolane		1 : 11 9%					NA	NA	NA	NA

Notes:

Number of exceedances : total number of samples.
Blank cells - no results above screening levels for the specified constituent / media.
CCR - Coal Combustion Residuals.
NA - Constituent/media not analyzed.
TDS - Total Dissolved Solids.
VOC - Volatile Organic Compound.

(a) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(b) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(c) - VOCs are not associated with CCR, but are known to be present in groundwater due to the activities at the neighboring facility.

TABLE 13b
SUMMARY OF GROUNDWATER AND HARBOR SAMPLE SCREENING RESULTS
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO

Constituent		Screening Level Results									
		Groundwater - Human Health Drinking Water Screening Levels		Groundwater - Human Health Recreational Screening Levels		Groundwater - Ecological Screening Levels		Harbor - Human Health Recreational Screening Levels		Harbor - Ecological Screening Levels	
		Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total	Dissolved	Total
Appendix III (a)	Boron		1 : 51								
	Calcium										
	Chloride	6 : 11	34 : 51								
	pH		2 : 50		45 : 50		45 : 50				
	Sulfate	7 : 11	40 : 51	3 : 11	16 : 51						
	TDS	11 : 11	46 : 51								
Appendix III and IV (a, b)	Fluoride										
Appendix IV (b)	Antimony										
	Arsenic			8 : 11	36 : 51			1 : 1	1 : 1		
	Barium										
	Beryllium										
	Cadmium										
	Chromium										
	Cobalt										
	Lead										
	Lithium	2 : 11	15 : 51								
	Mercury										
	Molybdenum	3 : 11	20 : 51								
	Selenium	1 : 11	7 : 51			1 : 11	6 : 51				
	Thallium										
	Radium 226/228							NA	NA	NA	NA
Sulfolane and VOCs (c)	Chlorobenzene							NA	NA	NA	NA
	Isopropylbenzene							NA	NA	NA	NA
	ether		1 : 6					NA	NA	NA	NA
	Sulfolane		1 : 11					NA	NA	NA	NA

Notes:

Number of exceedances : total number of samples.
Blank cells - no results above screening levels for the specified constituent / media.
CCR - Coal Combustion Residuals.
NA - Constituent/media not analyzed.
TDS - Total Dissolved Solids.
VOC - Volatile Organic Compound.

(a) - The CCR Rule lists these constituents as Constituents for Detection Monitoring (Appendix III).
(b) - The CCR Rule lists these constituents as Constituents for Assessment Monitoring (Appendix IV).
(c) - VOCs are not associated with CCR, but are known to be present in groundwater due to the activities at the neighboring facility.

FIGURES

Figure 1

Site Location Map

AES Puerto Rico, LP
Guayama, Puerto Rico

Legend

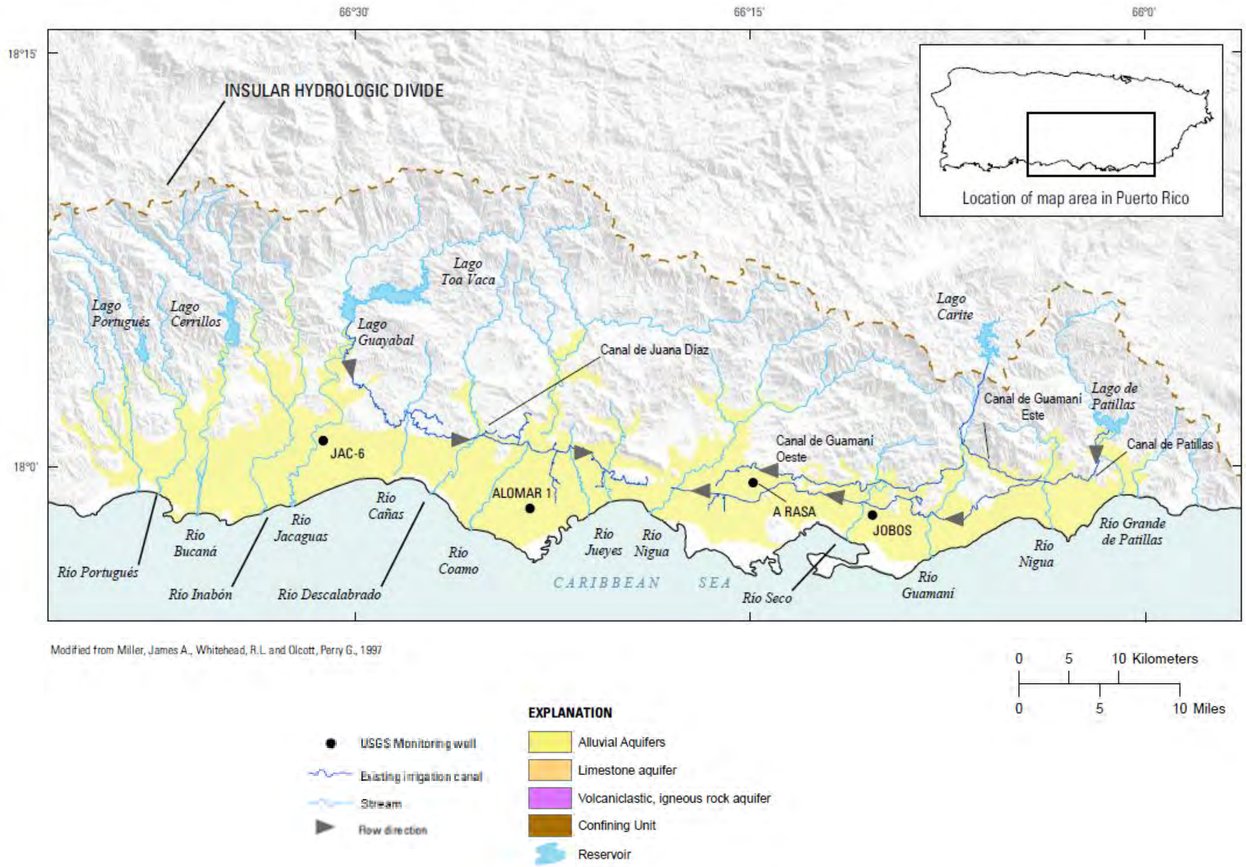
AES Puerto Rico Approximate Property Boundary

N

0 250 500 750 1000 1250 ft

DNA-ENVIRONMENT, LLC

FIGURE 2
SOUTH COAST ALLUVIAL AQUIFER
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO



Source: USGS. 2016. Hydrologic Conditions in the South Coast Aquifer, Puerto Rico, 2010–15. U.S. Department of the Interior. U.S. Geological Survey. Available at: https://pubs.er.usgs.gov/publication/ofr20151215

LEGEND

APPROXIMATE PREDOMINANT GROUNDWATER FLOW DIRECTION

SUB-WATERSHED BOUNDARY

WATERSHED BOUNDARY

SITE BOUNDARY

NOTES
1. WATERSHED BOUNDARY SOURCE: USGS
2. BASE MAP SOURCE: ESRI

0 1,700 3,400
SCALE IN FEET

HALEY ALDRICH

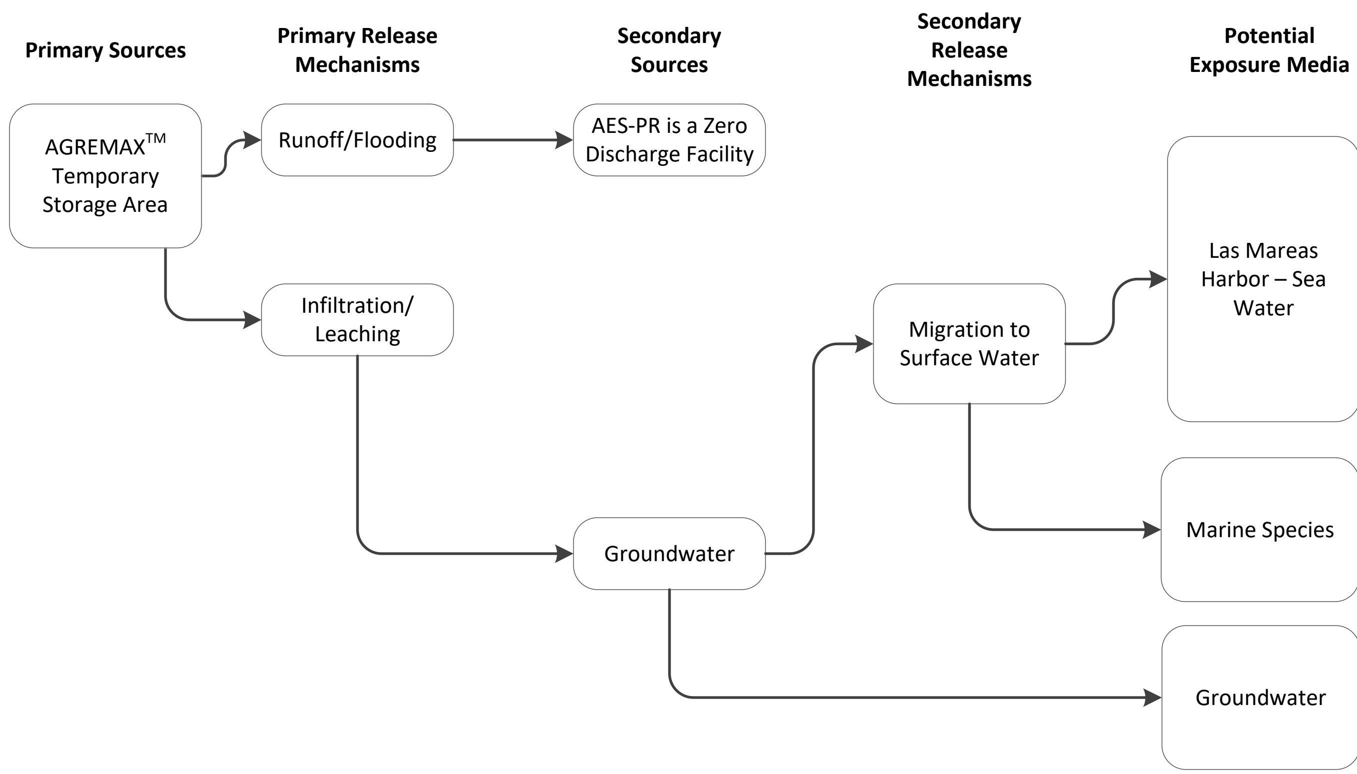
AES PUERTO RICO
GUYAMA, PUERTO RICO

WATERSHED BOUNDARIES

MARCH 2019

FIGURE 3

FIGURE 5
CONCEPTUAL SITE MODEL
AES PUERTO RICO LP, GUAYAMA, PUERTO RICO



	Potential Human Health Receptors						Potential Ecological Receptors
Potential Exposure Route	**Current/Future Off-Site Resident Adult/Child**	**Current/Future Off-Site Recreational Swimmer**	**Current/Future Off-Site Recreational Wader**	**Current/Future Off-Site Recreational Boater**	**Current/Future Off-Site Recreational Fisher**	**Marine Receptors**	
Drinking Water Use	O	O	O	O	O	NA	
Incidental Ingestion	O	⊙	⊙	⊙	⊙	NA	
Dermal Contact	O	⊙	⊙	⊙	⊙	NA	
Aquatic Exposure	NA	NA	NA	NA	NA	⊙	
Ingestion	O	O	O	O	⊙	NA	
Aquatic Exposure	NA	NA	NA	NA	NA	⊙	
Drinking Water Use	O (a)	O	O	O	O	NA	
Aquatic Exposure	NA	NA	NA	NA	NA	O (b)	

Notes:

⊙ Pathway potentially complete – pathway evaluated in this risk assessment; results indicate no risk to human health or the environment.

O Pathway evaluated and found incomplete; results indicate no risk to human health or the environment.

(a) The groundwater in the vicinity of AES-PR is not used for drinking water purposes.

(b) Ecological Receptors are not exposed to groundwater.

NA – Not Applicable.

HALEY ALDRICH

GIS FILE PATH: \\haleyaldrich.com\share\phx_common\Projects\AES Puerto Rico\GIS\Maps\2018_09\127807_004_0001_SAMPLE_LOCATION_MAP_B_P_C.mxd — USER: jchu — LAST SAVED: 2/28/2019 10:28:32 AM

LEGEND

- SEAWATER SAMPLING LOCATION
- MONITORING WELL
- APPROXIMATE SITE BOUNDARY

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE.
2. AERIAL IMAGERY SOURCE: ESRI

N

0 500 1,000
SCALE IN FEET

HALEY ALDRICH

AES PUERTO RICO, LP
GUAYAMA, PUERTO RICO

SITE LAYOUT AND APPROXIMATE SAMPLE LOCATION MAP

MARCH 2019

FIGURE 6

APPENDIX A

Surface Water Dilution Attenuation Factor

APPENDIX A

SURFACE WATER DILUTION ATTENUATION FACTOR

This appendix describes the evaluation of the magnitude of dilution effects resulting from the mixing of groundwater that may flow from beneath the AGREMAX™ temporary storage area to the nearby surface water body – the Las Mareas Harbor (**Figure A-1**) and documents the development of a surface water dilution attenuation factor (SW – DAF) between groundwater and surface water. The groundwater flow direction shown in Figure A-1 is based on the configuration of the concentration contour lines for sulfolane, which is a groundwater contaminant originated from an adjacent industrial site (PEI, 2016).

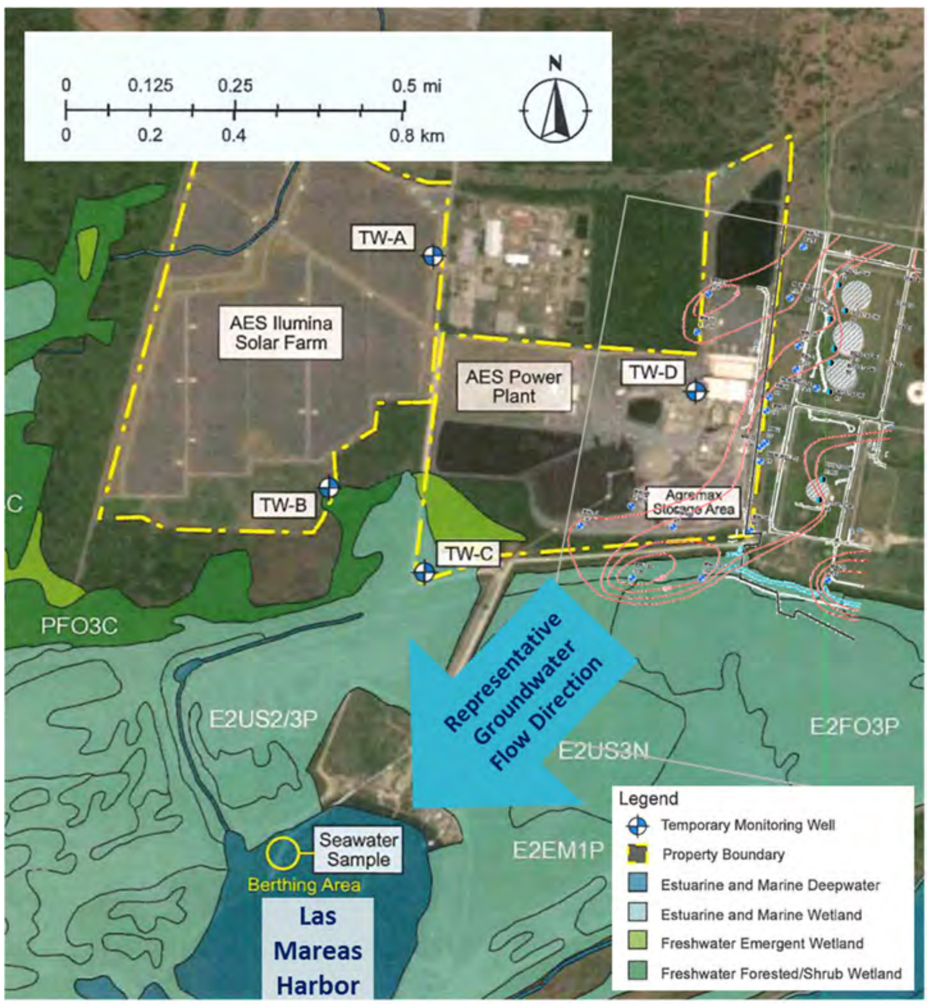


Figure A-1: Site settings. The red contour lines show the concentration contours of sulfolane originating from the neighboring site. The approximate location of the AGREMAX™ temporary storage area is shown.

The magnitude of the dilution effect is estimated using the approach below:

- Estimate the flow rate of shallow groundwater beneath the AGREMAX™ temporary storage area across the property boundary (Qgw);
- Estimate the flow rate of the sea water flushing in the Las Mareas Harbor (Qsea); and
- Calculate the SW – DAF using the equation: SW – DAF = Qsea ÷ Qgw.

Evaluation of Shallow Groundwater Flow Rate Beneath the AGREMAX™ Temporary Storage Area

The rate of shallow groundwater flow beneath the AGREMAX™ temporary storage area was estimated based on the following assumptions and approach:

- Groundwater flow follows Darcy's law: Qgw = K · i · Ac, where Qgw is the groundwater flow rate, K is horizontal hydraulic conductivity, i is horizontal hydraulic gradient, and Ac is the vertical cross-section area that groundwater potentially impacted by leachate from the AGREMAX™ temporary storage area may flow through;
- A conservative K value of 1 feet per day was assumed for the Qgw calculation. This K value is higher than the range of the K values (0.035 – 0.67 feet per day) found through site-specific slug tests (DNA-Environment, 2017);
- A conservative i value of 0.02 feet was assumed for the Qgw calculation. This gradient is higher than the estimated gradient of 0.0105 (DNA-Environment, 2017);
- The cross-section area, Ac, was estimated using a width of 1,400 feet and the saturated thickness of 20 feet (Figure A-2). Both are conservative assumptions based on the groundwater characterization results (DNA-Environment, 2017); the resulting Ac is 280,000 square feet; and
- Based on the assumed values above, Qgw was estimated to be 560 cubic feet per day.

Evaluation of Sea Water Flushing Rate in the Las Mareas Harbor

The direction of groundwater flow is toward the Las Mareas Harbor (Figure A-1). The mechanism of and physical processes involved in submarine groundwater discharge are shown in Figure A-3 (Urish, and McKenna, 2004, Robinson et al., 2007). Based on the flow dynamics near the shore, shallow groundwater typically discharges to the sea near the base of the low tide area in the intertidal zone (Figure A-3); therefore, mixing between the discharged shallow groundwater and seawater flushing in the harbor due to tidal fluctuation can readily occur. Based on the tidal data obtained from the National Oceanic & Atmospheric Administration website for the station in Las Mareas, Puerto Rico (Station ID: 9755679), the mean tidal fluctuation range is 0.64 feet. To conservatively estimate the daily seawater flushing rate, the tidal fluctuation range was assumed to be 0.3 feet, which represents the neap tide conditions. The area of the harbor was estimated to be 0.09 square miles (Figure A-4). Based on this information, a conservative estimate of the seawater flushing volume for the harbor (Qsea) is 753,000 cubic feet per day (= 0.09 square miles x 0.3 feet per day).

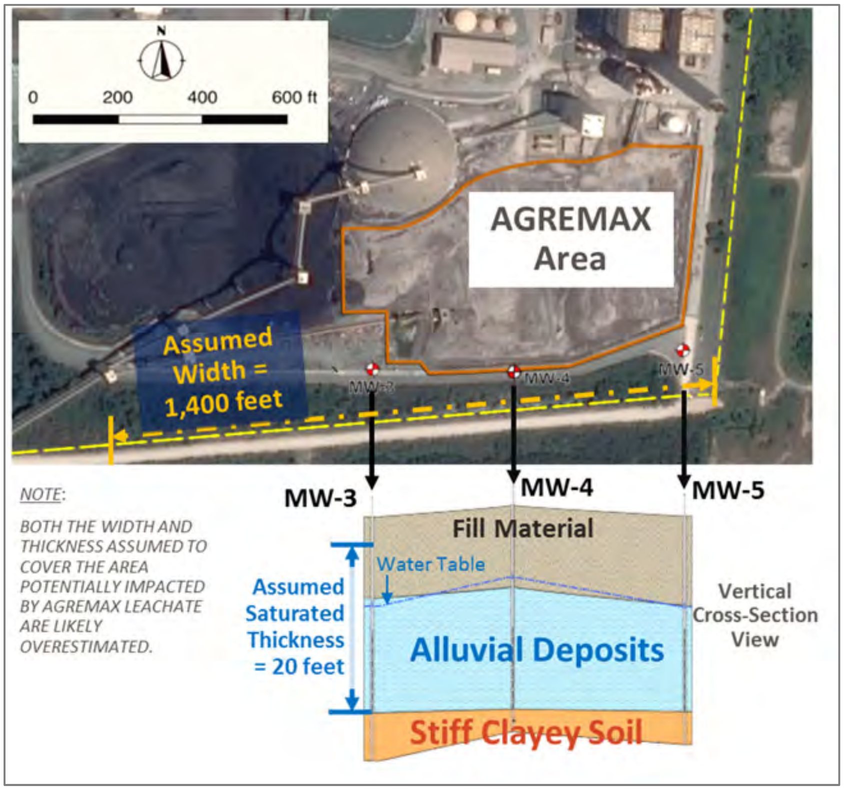


Figure A-2: Conservative assumptions for the cross-section area that AGREMAX™*-impacted groundwater may flow through. The approximate location of the AGREMAX™ temporary storage area is shown.*

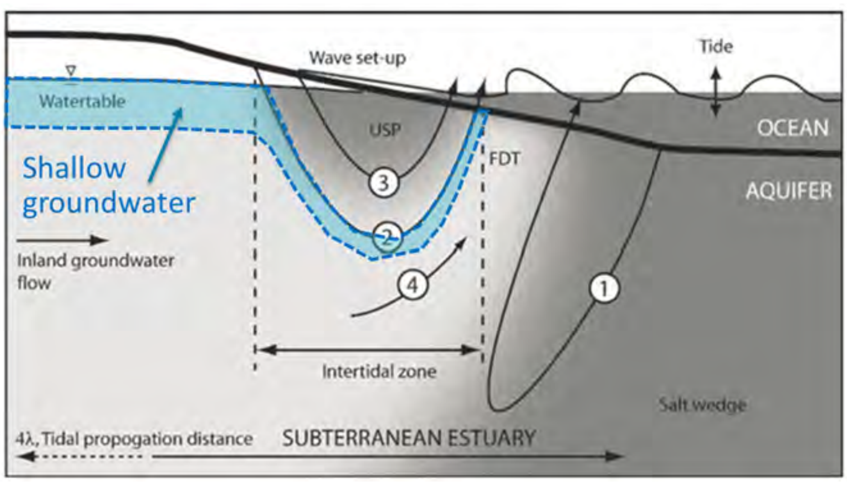


Figure A-3: Conceptual diagram of subterranean estuary including major nearshore flow processes: (1) density-driven circulation (2) tide-induced circulation (3) wave set-up driven circulation and (4) fresh groundwater discharge through the freshwater discharge ''tube'' (FDT). The blue shaded area shows that the shallow groundwater typically discharges near the base of the low tide area in the intertidal zone.

Figure A-4: Surface area of the Las Mareas Harbor.

Dilution and Attenuation Effects

Based on the conservative Qgw and Qsea values estimated above, the Surface Water Dilution Attenuation Factor (SW – DAF) is calculated:

$$SW - DAF = \frac{Q_{sea}}{Q_{GW}} = \frac{753{,}000\ cubic\ feet\ per\ day}{560\ cubic\ feet\ per\ day} = \mathbf{1300}$$

This value represents a conservative estimate of the magnitude of dilution for potentially impacted groundwater discharging directly to the Las Mareas Harbor.

REEERENCES

1. DNA-Environment. 2017. Groundwater Monitoring System & Sampling and Analysis Program, AES Puerto Rico LP, Guayama, Puerto Rico. August.

2. PEI. 2016. Corrective Measures Study Report, Chevron Phillips Chemical Puerto Rico Core, LLC, Guayama, Puerto Rico. April.

3. Robinson, C., Li, L. and Prommer, H. 2007. Tide-induced recirculation across the aquifer-ocean interface. Water Resources Research, 43(7).

4. Urish, D.W. and McKenna, T.E. 2004. Tidal effects on ground water discharge through a sandy marine beach. Ground Water, 42(7), pp.971-982.