DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION
Interim Final 2/5/99
RCRA Corrective Action
Environmental Indicator (EI) RCRIS code (CA750)
Migration of Contaminated Groundwater Under Control

Facility Name: AdvanSix Resins &Chemicals LLC
Facility Address: 905 E Randolph Rd., Hopewell VA, 23860
Facility EPA ID #: VAD065385296

1. Has **all** available relevant/significant information on known and reasonably suspected releases to the groundwater media, subject to RCRA Corrective Action (e.g., from Solid Waste Management Units (SWMU), Regulated Units (RU), and Areas of Concern (AOC)), been **considered** in this EI determination?

☒ If yes - check here and continue with #2 below.

☐ If no - re-evaluate existing data, or

☐ If data are not available, skip to #8 and enter "IN" (more information needed) status code.

BACKGROUND

The Hopewell plant (Facility), encompasses about 484 acres at 905 East Randolph Road within the corporate limits of Hopewell, Virginia. It is currently owned and operated by AdvanSix Resins & Chemicals LLC (AdvanSix). Before October 1, 2016 it was owned and operated by Honeywell International Inc (Honeywell Resins & Chemicals LLC). The Facility's principal product is Caprolactam, the raw material for the manufacture of Nylon 6. Historically, various nitrogen products such as high nitrogen fertilizer, ammonia, ammonium nitrate, nitric acid, nitrogen tetroxide and smaller pilot operations of Kepone, THAIC, and TEIC have been produced or used at the Site. The site was historically operated by DuPont as a munitions and nitrocellulose manufacturing facility, which was shut down at the end of World War I.

A shallow water table aquifer occurs within fill material and the underlying unconsolidated sediments. Prior investigations found the depth to water in the shallow aquifer ranges from about 20 to 35 feet bgs. Groundwater flow within this unit moves preferentially through areas where fly ash and cinder fill extends below the water table, most notably in former stream valleys. Previous investigations have identified a groundwater divide in the shallow aquifer, dividing the middle portion of the main plant processing area from east to west. This divide separates the two main horizontal groundwater flow regimes beneath the facility; one flow regime results in flow to the northeast to the James River and the second flow regime results in flow to the south toward Gravelly Run, a small perennial stream influenced by non-contact cooling water discharges.

A deep aquifer unit is separated from the shallow water table aquifer by a nearly continuous confining layer consisting of organic silt. Where encountered, its surface is at approximately 0 feet MSL. Where this confining unit is absent, a medium dense silty sand is present. Groundwater in the deep aquifer flows generally from west to east to the James River.

Definition of Environmental Indicators (for the RCRA Corrective Action)

Environmental Indicators (EI) are measures being used by the RCRA Corrective Action program to go beyond programmatic activity measures (e.g., reports received and approved, etc.) to track changes in the quality of the environment. The two EI developed to-date indicate the quality of the environment in relation to current human exposures to contamination and the migration of contaminated groundwater. An EI for non-human (ecological) receptors is intended to be developed in the future.

Definition of "Migration of Contaminated Groundwater Under Control" EI

A positive "Migration of Contaminated Groundwater Under Control" EI determination ("YE" status code) indicates that the migration of "contaminated" groundwater has stabilized, and that monitoring will be conducted to confirm that contaminated groundwater remains within the original "area of contaminated groundwater" (for all groundwater "contamination" subject to RCRA corrective action at or from the identified facility (i.e., site-wide)).

Relationship of EI to Final Remedies

While Final remedies remain the long-term objective of the RCRA Corrective Action program the EI are near-term objectives which are currently being used as Program measures for the Government Performance and Results Act of 1993, (GPRA).

The "Migration of Contaminated Groundwater Under Control" EI pertains ONLY to the physical migration (i.e., further spread) of contaminated ground water and contaminants within groundwater (e.g., non-aqueous phase liquids or NAPLs). Achieving this EI does not substitute for achieving other stabilization or final remedy requirements and expectations associated with sources of contamination and the need to restore, wherever practicable, contaminated groundwater to be suitable for its designated current and future uses.

Duration / Applicability of EI Determinations

EI Determinations status codes should remain in RCRIS national database ONLY as long as they remain true (i.e., RCRIS status codes must be changed when the regulatory authorities become aware of contrary information).

Migration of Contaminated Groundwater Under Control
Environmental Indicator (EI) RCRIS code (CA750)

1. Is **groundwater** known or reasonably suspected to be **"contaminated"**[1] above appropriately protective "levels" (i.e., applicable promulgated standards, as well as other appropriate standards, guidelines, guidance, or criteria) from releases subject to RCRA Corrective Action, anywhere at, or from, the facility?

   ☒ If yes - continue after identifying key contaminants, citing appropriate "levels," and referencing supporting documentation.

   ☐ If no - skip to #8 and enter "YE" status code, after citing appropriate "levels," and referencing supporting documentation to demonstrate that groundwater is not "contaminated."

   ☐ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

RFI studies have identified key contaminants at the Facility including volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) and certain dissolved metals. The June 2016 Comprehensive Groundwater Monitoring Report documented concentrations of the parameters listed below in perched and shallow aquifer groundwater exceeding the USEPA Risk Based Screening (RSL) for Tap Water (January 2015) and/or the USEPA Maximum Contaminant Level (MCL):

VOCs	SVOCs	Dissolved Metals
• Benzene • Chloroform • 1,1-Dichloroethane • 1,2-Dichloroethene, Cis-1,2-Dichlorethene • Ethylbenzene • Methylene Chloride • Tetrachloroethene • Trichlorethene • Vinyl Chloride	• 1,1-Biphenyl • Caprolactam • Naphthalene	• Antimony • Arsenic • Beryllium • Cadmium • Chromium • Cobalt • Iron • Lead • Manganese • Nickel • Thallium

Comprehensive Groundwater Sampling Event and SWMU 3 Delineation Report; Amec Foster Wheeler Environment & Infrastructure, Inc.; September 2016.

Footnotes:
[1]"Contamination" and "contaminated" describes media containing contaminants (in any form, NAPL and/or dissolved, vapors, or solids, that are subject to RCRA) in concentrations in excess of appropriate "levels" (appropriate for the protection of the groundwater resource and its beneficial uses).

Migration of Contaminated Groundwater Under Control
Environmental Indicator (EI) RCRIS code (CA750)

2. Has the **migration** of contaminated groundwater **stabilized** (such that contaminated groundwater is expected to remain within "existing area of contaminated groundwater"[2] as defined by the monitoring locations designated at the time of this determination)?

☒ If yes - continue, after presenting or referencing the physical evidence (e.g., groundwater sampling/measurement/migration barrier data) and rationale why contaminated groundwater is expected to remain within the (horizontal or vertical) dimensions of the "existing area of groundwater contamination"[2]).

☐ If no (contaminated groundwater is observed or expected to migrate beyond the designated locations defining the "existing area of groundwater contamination"[2]) – skip to #8 and enter "NO" status code, after providing an explanation.

☐ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

The Phase I and Phase II RFI work conducted in 1993 and 1995 and site-wide groundwater sampling events in 2004 and again in 2016 demonstrate consistent groundwater flow patterns over time. Comparing groundwater contaminant data from the 1995 Phase II RFI, 2004 Groundwater Sampling Event and the 2016 Groundwater Sampling Event indicate that within the shallow aquifer contaminant concentrations are generally stable to declining. Within the deep aquifer a comparison of the concentration data concludes the same Overall, the extent and magnitude of groundwater impacts within the shallow aquifer and the deep aquifer by VOCs, SVOCs and metals as observed in key monitoring wells along the James River, the eastern property line and Gravelly Run to the south appear to be stable to declining. Consequently, the data suggest that impacted groundwater remains within the original "area of contaminated groundwater" subject to RCRA corrective action.

- Phase I RCRA Facility Investigation Report, AlliedSignal Inc., Hopewell Plant, Hopewell, Virginia; Brown & Root International; May 1993.
- Phase II RCRA Facility Investigation Report, AlliedSignal Inc., Hopewell Plant, Hopewell, Virginia; Brown & Root International; April 1996.
- 2004 Groundwater Sampling Event Report, Honeywell Facility, Hopewell, Virginia; MWH Americas, Inc.; October 2004.
- Results of Supplemental Soil & Groundwater Investigation Conducted at the Honeywell Hopewell Facility, Hopewell, Virginia; MACTEC Engineering and Consulting, Inc.; February 2007.
- Comprehensive Groundwater Sampling Event and SWMU 3 Delineation Report; Amec Foster Wheeler Environment & Infrastructure, Inc.; September 2016.

[2] "existing area of contaminated groundwater" is an area (with horizontal and vertical dimensions) that has been verifiably demonstrated to contain all relevant groundwater contamination for this determination, and is defined by designated (monitoring) locations proximate to the outer perimeter of "contamination" that can and will be sampled/tested in the future to physically verify that all "contaminated" groundwater remains within this area, and that the further migration of "contaminated" groundwater is not occurring. Reasonable allowances in the proximity of the monitoring locations are permissible to incorporate formal remedy decisions (i.e., including public participation) allowing a limited area for natural attenuation.

Migration of Contaminated Groundwater Under Control
Environmental Indicator (EI) RCRIS code (CA750)

3. Does "contaminated" groundwater **discharge** into **surface water** bodies?

   ☒ If yes - continue after identifying potentially affected surface water bodies.

   ☐ If no - skip to #7 (and enter a "YE" status code in #8, if #7 = yes) after providing an explanation and/or referencing documentation supporting that groundwater "contamination" does not enter surface water bodies.

   ☐ If unknown - skip to #8 and enter "IN" status code.

Rationale and Reference(s):

Historical groundwater flow patterns indicated by potentiometric surface maps suggest that shallow water table groundwater discharges primarily to Gravelly Run with a portion in the extreme northern part of the site discharging directly to the James River. Groundwater in the deep aquifer discharges only to the James River. Analytical data collected from seeps along Gravelly Run during the Phase II RFI and 2004 groundwater sampling event indicate that site-related contaminants were discharging at that time.

Migration of Contaminated Groundwater Under Control
Environmental Indicator (EI) RCRIS code (CA750)

5. Is the **discharge** of "contaminated" groundwater into surface water likely to be **"insignificant"** (i.e., the maximum concentration[3] of each contaminant discharging into surface water is less than 10 times their appropriate groundwater "level," and there are no other conditions (e.g., the nature, and number, of discharging contaminants, or environmental setting), which significantly increase the potential for unacceptable impacts to surface water, sediments, or eco-systems at these concentrations)?

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☐ If yes - skip to #7 (and enter "YE" status code in #8 if #7 = yes), after documenting:
1) the maximum known or reasonably suspected concentration[3] of key contaminants discharged above their groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and
2) provide a statement of professional judgment/explanation (or reference documentation) supporting that the discharge of groundwater contaminants into the surface water is not anticipated to have unacceptable impacts to the receiving surface water, sediments, or eco-system.

☒ If no - (the discharge of "contaminated" groundwater into surface water is potentially significant) - continue after documenting:
1) the maximum known or reasonably suspected concentration[3] of each contaminant discharged above its groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and
2) for any contaminants discharging into surface water in concentrations[3] greater than 100 times their appropriate groundwater "levels," the estimated total amount (mass in kg/yr) of each of these contaminants that are being discharged (loaded) into the surface water body (at the time of the determination), and identify if there is evidence that the amount of discharging contaminants is increasing.

☐ If unknown - enter "IN" status code in #8.

Rationale and Reference(s):

An assessment of whether the current discharge of contaminants via groundwater results in unacceptable impacts to the receiving surface water, sediments, or eco-system was made by estimating contaminant mass loading to Gravelly Run using data from the 2016 Groundwater Sampling Event. A mass loading assessment to the James River was not conducted because historical data indicate contaminant impacts to the deep aquifer near the Site boundaries are not a concern.
The maximum observed concentrations of tetrachloroethene, trichloroethene, vinyl chloride, arsenic and sodium exceed their respective groundwater levels by a multiple of greater than 100 times in the shallow water table aquifer monitoring wells representative of groundwater that discharges to Gravelly Run. Using data from the June 2016 groundwater sampling event, the estimated mass flux rate for compounds with maximum concentrations greater than 100 x the RSL being discharged to Gravelly Run was estimated and the result of this estimate on an annualized basis is summarized in the following table:

Parameter	Flow Tube and Flux Plane Section*	Estimated Flux Rate (mg/sec)	Estimated Annual Flux (kg/yr)
Tetrachloroethene	3	9.09E-03	0.29
Trichloroethene	2	4.28E-05	16.9
	3	5.35E-01	
Vinyl Chloride	3	3.61E-01	11.38
Arsenic	2	1.45E-03	8.59
	3	2.50E-01	
	4	2.15E-02	
Sodium	1	1.30E+02	14,971
	2	9.37E+00	
	3	2.61E+02	
	4	7.43E+01	

*Section 1 represents monitoring well MW-03S and MW-04S; section 2 represents monitoring well MW-36S; section 3 represents monitoring wells MW-18S and MW-19S; section 4 represents monitoring wells MW-21S and MW-22S.

[3] As measured in groundwater prior to entry to the groundwater-surface water/sediment interaction (e.g., hyporheic) zone.

Migration of Contaminated Groundwater Under Control
Environmental Indicator (EI) RCRIS code (CA750)

6. Can the **discharge** of "contaminated" groundwater into surface water be shown to be "**currently acceptable**" (i.e., not cause impacts to surface water, sediments or eco-systems that should not be allowed to continue until a final remedy decision can be made and implemented[4])?

☒ If yes - continue after either:
1) identifying the Final Remedy decision incorporating these conditions, or other site-specific criteria (developed for the protection of the site's surface water, sediments, and eco-systems), and referencing supporting documentation demonstrating that these criteria are not exceeded by the discharging groundwater;
OR
2) providing or referencing an interim-assessment[5], appropriate to the potential for impact that shows the discharge of groundwater contaminants into the surface water is (in the opinion of a trained specialists, including ecologist) adequately protective of receiving surface water, sediments, and eco-systems, until such time when a full assessment and final remedy decision can be made. Factors which should be considered in the interim-assessment (where appropriate to help identify the impact associated with discharging groundwater) include: surface water body size, flow, use/classification/habitats and contaminant loading limits, other sources of surface water/sediment contamination, surface water and sediment sample results and comparisons to available and appropriate surface water and sediment "levels," as well as any other factors, such as effects on ecological receptors (e.g., via bio-assays/benthic surveys or site-specific ecological Risk Assessments), that the overseeing regulatory agency would deem appropriate for making the EI determination.

☐ If no - (the discharge of "contaminated" groundwater can not be shown to be "**currently acceptable**") - skip to #8 and enter "NO" status code, after documenting the currently unacceptable impacts to the surface water body, sediments, and/or eco-systems.

☐ If unknown - skip to 8 and enter "IN" status code.

Rationale and Reference(s):

Gravelly Run flows through a portion of the Site and receives discharge of non-contact cooling water from AdvanSix operations from NPDES Permitted Outfall 001 and 002 at a permitted rate of 100 mgd to 150 mgd. It also receives groundwater discharge impacted by COCs from the shallow water table aquifer. Gravelly Run eventually empties into the James River a short distance downstream of Facility boundaries. Although Gravelly run extends upstream from the site and the point where discharge from Outfall 001 and 002 joins its base flow, base flow volume from upstream is insignificant for purposes of estimating contaminant loading.

The James River receives ground water from the deep aquifer via subaqueous outcrops. For the reason stated above in Section 5, contaminant mass loading via discharge from the deep aquifer is not a concern and was not estimated.

Flow Sections representing groundwater flow paths terminating in a flux plane positioned perpendicular to the groundwater flow direction and parallel to the receiving surface water body were used to estimate groundwater discharge and contaminant loading. Contaminant loading as mass flux to Gravelly Run for reported VOCs, SVOCs and dissolved metals was estimated for the discharge from the shallow water table aquifer. Estimates are based on analytical data and groundwater elevation data collected during the June 2016 sampling event.
The results of mass loading calculations and estimated concentrations of contaminants in Gravelly Run were evaluated by an ecologic risk assessor to assess the ecologic risk. Modeled concentrations are below available benchmarks and therefore, concentrations of suspected contaminants are not expected to have unacceptable impacts to Gravelly Run surface water.

Water quality benchmarks were selected from the following sources in the order presented:

1) Virginia Department of Environmental Quality (VADEQ) Freshwater Chronic Criteria for Surface Water (9VAC25-260-140)
2) USEPA Region Nationally Recommended Water Quality Criteria (USEPA, 2016)

3) USEPA Region III BTAG Freshwater Screening Benchmarks for Freshwater (USEPA, 2005).

Lacking values from the sources above, the following sources were also considered:

4) USEPA Region IV Interim Draft Surface Water Screening Benchmarks (USEPA, 2015)
5) USEPA Region V Ecological Screening Levels (ESLs) for surface water (USEPA, 2003).
6) ORNL SCV - Oak Ridge National Laboratory Secondary Chronic Values (Suter & Tsao, 1996)
7) European Chemicals Agency (ECHA) chemical substances database – Probable No-Effects Concentrations (PNECs) for Freshwater (ECHA, 2016)

Seeps draining into Gravelly run from the Facility as well as surface water were sampled and analyzed. Those data confirm the modeled conclusions above. Three seep locations along Gravelly Run and one (1) surface water sample were collected and analyzed during the Phase II RFI to assess potential impacts on surface water quality. Three (3) seep samples were collected along Gravelly Run and six (6) surface water samples were collected from Gravelly Run during the 2004 groundwater sampling event.

[4] Note, because areas of inflowing groundwater can be critical habitats (e.g., nurseries or thermal refugia) for many species, appropriate specialist (e.g., ecologist) should be included in management decisions that could eliminate these areas by significantly altering or reversing groundwater flow pathways near surface water bodies.

[5] The understanding of the impacts of contaminated groundwater discharges into surface water bodies is a rapidly developing field and reviewers are encouraged to look to the latest guidance for the appropriate methods and scale of demonstration to be reasonably certain that discharges are not causing currently unacceptable impacts to the surface waters, sediments or eco-systems.

Migration of Contaminated Groundwater Under Control
Environmental Indicator (EI) RCRIS code (CA750)

7. Will groundwater **monitoring** / measurement data (and surface water/sediment/ecological data, as necessary) be collected in the future to verify that contaminated groundwater has remained within the horizontal (or vertical, as necessary) dimensions of the "existing area of contaminated groundwater?"

☒ If yes - continue after providing or citing documentation for planned activities or future sampling/measurement events. Specifically identify the well/measurement locations, which will be tested in the future to verify the expectation (identified in #3) that groundwater contamination will not be migrating horizontally (or vertically, as necessary) beyond the "existing area of groundwater contamination."

☐ If no - enter "NO" status code in #8.

☐ If unknown - enter "IN" status code in #8.

Rationale and Reference(s):

RCRA Corrective Action activities have been conducted since 1989 under an Administrative Order on Consent (Docket No. RCRA-III-019-CA). Recommendations set forth in the *Comprehensive Groundwater Sampling Event and SWMU 3 Delineation Report, Hopewell Facility, Hopewell, Virginia* (September 2016) for future activities following this Groundwater Environmental Indicator Determination include preparation of a Corrective Measures Study followed by EPA development of a Statement of Basis document. It is anticipated that corrective measures that will be selected for the SWMUs and other areas of concern at the Facility will include groundwater monitoring. The monitoring duration, frequency and wells to be monitored will be identified in future corrective measure O&M documents to be developed and submitted following construction completion of any necessary corrective measures.

Migration of Contaminated Groundwater Under Control
Environmental Indicator (EI) RCRIS code (CA750)

8. Check the appropriate RCRIS status codes for the Migration of Contaminated Groundwater Under Control EI (event code CA750), and obtain Supervisor (or appropriate Manager) signature and date on the EI determination below (attach appropriate supporting documentation as well as a map of the facility).

☒ YE - Yes, "Migration of Contaminated Groundwater Under Control" has been verified. Based on a review of the information contained in this EI determination, it has been determined that the "Migration of Contaminated Groundwater" is "Under Control" at the (insert facility and EPA ID #, located at (insert address). Specifically, this determination indicates that the migration of "contaminated" groundwater is under control, and that monitoring will be conducted to confirm that contaminated groundwater remains within the "existing area of contaminated groundwater" This determination will be re-evaluated when the Agency becomes aware of significant changes at the facility.

☐ NO - Unacceptable migration of contaminated groundwater is observed or expected.

☐ IN - More information is needed to make a determination.

Completed by Erich Weissbart Date 01/05/2017

Erich Weissbart
Project Manager

Supervisor

Date 01/11/2017

Luis Pizarro, Associate Director
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