DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

RCRA Corrective Action
Environmental Indicator (EI) RCRAInfo Code (CA750)
Migration of Contaminated Groundwater Under Control

Facility Name: Bristol-Myers Squibb Company (BMS) Worldwide Medicines
Facility Address: 1 Squibb Drive, New Brunswick, Middlesex County, New Jersey
Facility EPA ID#: NJD011550092

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 EIs 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 objectives of the RCRA Corrective Action program, the EIs 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 groundwater 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 Determination status codes should remain in the RCRAInfo national database ONLY as long as they remain true (i.e., RCRAInfo status codes must be changed when the regulatory authorities become aware of contrary information).

Facility Information

The Bristol-Myers Squibb (BMS) site consists of approximately 96 acres in New Brunswick, Middlesex County, New Jersey. The main property is bordered by U.S. Route 1 to the south, Georges Road to the north, Rutgers University and residential properties to the east, and the inactive Raritan River Railroad corridor to the west. This site also includes a small parcel of land located immediately west of the railroad tracks and adjacent to the northwest corner of the main facility property. This parcel, referred to as the West Annex, is bordered by industrial and residential properties.

Approximately 90 acres of the property have been developed and are covered by impervious surfaces consisting of warehouses, office buildings, parking lots, and roads. Undeveloped areas are limited to the West Annex and Squibb Park, a recreational/ornamental area on the southeast portion of the main property. Site surface topography is generally flat, with a gradual decline in elevation to the northwest. Two surface water bodies are located in the vicinity of the BMS site: a tributary of the Raritan River known as Mile Run Creek that flows northwest within the inactive railroad right-of-way along the west of the main BMS property, and an unnamed tributary to Weston's Mill Pond that flows southeast along the eastern border of the main BMS property. Three small, isolated forested wetland areas are located within the West Annex.

The site was purchased by E.R. Squibb and Sons, Inc. (Squibb) in 1905, and has been used for pharmaceutical manufacturing, research, and development since 1907. Current operations, conducted in more than 40 buildings on the property, include pharmaceutical research and development, quality control/quality assurance, administrative and technical support for worldwide manufacturing, and global engineering. BMS does not currently manufacture pharmaceutical products at this site for sale to the public.

In 1982, Squibb sold a portion of the site adjacent to Georges Road to Cell Products (an independent pharmaceutical company). Cell Products filed for bankruptcy protection in 1986, and Squibb reacquired the Cell Products property in 1987. However, the property transfer triggered investigation and/or cleanup of the Cell Products site under New Jersey's Environmental Cleanup Responsibility Act (ECRA), now known as the Industrial Site Recovery Act (ISRA), case number 87895. In 1989, Squibb was purchased by the Bristol-Meyers Company, and the corporations merged to create Bristol-Meyers Squibb, Inc. This merger triggered ECRA investigation and/or cleanup for the rest of the BMS property under case number 89657 (Refs. 2 and 3).

Contaminants detected in soil at the BMS site include trichloroethene (TCE) and tetrachloroethene (PCE); various semi-volatile organic compounds (SVOCs); arsenic, lead, and mercury; polychlorinated biphenyls (PCBs); and dieldrin. BMS excavated a significant amount of soil containing contaminant concentrations above New Jersey Non-Residential Direct Contact Soil Cleanup Criteria (NRDCSCC) and sent the bulk wastes for off-site disposal. Caps have been installed over most remaining areas of soil contamination, and BMS proposes to file a site-wide deed notice restricting future land use at the property. This proposed final remedy has been approved by New Jersey Department of Environmental Protection (NJDEP) (Refs. 2 and 3). Additional delineation and cleanup activities are ongoing to address soil contamination above NRDCSCC at six Areas of Environmental Concern (AECs 4, 6, 26, 44, 51, and 56).

Numerous volatile organic compounds (VOCs) and arsenic have been intermittently detected in groundwater samples collected across the western half of the site (Ref. 1). As an Interim Remedial Measure, BMS installed a groundwater extraction system on the West Annex in 1994 to provide hydraulic containment of contamination on the western side of the site. This system conveys groundwater to an on-site treatment facility for treatment prior to being discharged to the Middlesex County Utilities Authority sanitary sewer system or reused in on-site cooling towers. Certain groundwater impacts are also being managed under a Monitored Natural Attenuation (MNA) program approved by NJDEP. A Groundwater Classification Exception Area (CEA) was approved by NJDEP in 2003 (Ref. 2). On-site groundwater concentrations are currently monitored semi-annually for VOCs, ethyl ether, and arsenic. In

2009, BMS initiated a series of vapor intrusion remedial investigations at the site and adjacent properties. Continued vapor intrusion monitoring is ongoing (Ref. 4).

Surface water sampling has identified TCE, PCE, vinyl chloride (VC), and arsenic in surface water above the New Jersey Surface Water Quality Criteria (SWQC). Previously completed surface water remedial activities have included removal of impacted sediments, improvement of the site stormwater management system, and construction/operation of the extraction trench and groundwater extraction system described in the paragraph above. According to the ISRA Semi-annual Progress Report from June 2013 (Ref. 4), these actions have effectively reduced the volume of shallow groundwater discharging to Mile Run Creek.

References:

1. Hydraulic Assessment Report. Prepared by Blasland, Bouck, & Lee. Dated October 2000.

2. Revised Baseline Ecological Evaluation. Prepared by Blasland, Bouck, & Lee. Dated February 2006.

3. Initial Receptor Evaluation. Prepared by BMS. Dated February 25, 2011.

4. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated June 2013.

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?

 _X_ 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.

<u>Summary of Site-Specific Areas of Environmental Concern:</u>

Soil-Based Areas of Environmental Concern

Investigative activities have been ongoing at the site under the ECRA/ISRA program since 1987. During these investigations, BMS identified a total of 67 AECs. Potential soil contamination is the primary concern at 65 of the identified areas (AECs 1 through 64, and AEC 67). With NJDEP approval, BMS has determined that no further action is needed for 38 of the soil-based AECs. BMS and NJDEP have also determined that engineering and institutional controls will be sufficient to address residual contamination at 21 of the remaining soil-based AECs. These controls include capping, implementation of a formal Soil Management Process, and establishment of a site-wide deed notice to restrict future property usage to industrial/commercial activities. Continued corrective actions (investigation and/or cleanup) are needed for contaminated soil at only six AECs, as shown in the table below.

A map showing the locations of all 67 AECs was not identified in the available file material. However, because most of the remaining AECs are associated with a building or other physical structure, the site map provided as Attachment 2 can be used as a reference (Ref. 1). A marked-up version of this map is attached to this EI report.

AEC	AEC Description and General Location (if Known)	Current Status
4	Building 69 (south-central portion of site)	Investigation is complete; NJDEP approved a remedial action work plan for a vegetated soil cover; BMS has purchased the railroad right-of-way and is currently securing required permits to implement remedial action.
6	Building 81 (south-central portion of site)	Investigation is complete; NJDEP approved a remedial action work plan for a vegetated soil cover; BMS has purchased the railroad right-of-way and is currently securing required permits to implement remedial action.
26	Ecological Evaluation (site-wide)	Storm water system repaired and sediments removed from manhole; NJDEP approved no further investigation for surface water, but sediment investigation is ongoing; the *Habitat Characterization Report*, presenting results of the site-specific ecological evaluation, is complete.
44	Electric Trench on Fir Street (future trench location at center of site)	Additional soil sampling is needed for depths greater than 5 feet; sampling in progress; results to be reported in October 2013 Semi-Annual Progress Report.
51	Reinjection Well Pipeline	Additional soil sampling is needed to assess arsenic contamination at levels of potential concern; sampling in progress; results to be reported in October 2013 Semi-Annual Progress Report.
56	Building 109 Glassware (southern portion of site)	No further investigation proposed for arsenic and lead contamination in soil; area will be included in site-wide deed notice; additional delineation planned for PAHs and vanadium.

Because they focus on soil contamination, corrective actions associated with these six AECs are beyond the scope of the CA750 determination and will not be discussed further in this EI.

Groundwater-Based Areas of Environmental Concern

Potentially contaminated groundwater at the BMS site is being addressed as AEC 65. Three distinct source areas have been identified for groundwater contamination at the site. Attachment 3 has been marked up to show the location of each of the following groundwater contamination areas:

- Area 1 (Ethyl Ether Operations Area) – This area of historic groundwater contamination is associated with a former tank farm and adjacent solvent recovery process area in the vicinity of Building 42 and the on-site cooling towers (on the northern side of the site). Historical operations in this area involved use of oxygenated organic compounds (OOCs) including n-butanol, isopropanol, acetone, ethanol, isobutanol, isopropanol, methanol, and ethyl ether.

- Area 2 (Building 83/105 Area) – This area of groundwater contamination is located on the eastern side of the site, near on-site Buildings 83 and 105 and adjacent to the neighboring Parker-Hannifin facility. Contaminants in this area historically included chlorinated VOCs including 1,1,2,2-tetrachloroethane, 1,2-dichloroethane (DCA), chloroform, PCE, and TCE. These chlorinated solvents were ultimately attributed to an off-site source at the upgradient Parker-Hannifin facility (Ref. 2), as described further in Question No. 2. Area 2 also includes benzene contamination in well RS-25.

- Area 3 (Building 53/65 Area) – This area of groundwater contamination focuses on the former tank farm between Buildings 53 and 65 on the western side of the site. Available file material indicates that the tanks were used for solvent storage and that there was an open well in this area which could have served as a preferential pathway for contaminant migration to groundwater. Constituents of concern (COCs) identified in this area include TCE, PCE, chloroform, methylene chloride, VC, and other chlorinated VOCs.

In 1994, BMS installed a groundwater extraction system as an interim remedial measure to provide hydraulic control for groundwater contamination associated with the two former tank farms (Areas 1 and 3). This system conveys groundwater to an on-site treatment facility for treatment. Initially, treated groundwater was re-injected into the shallow aquifer upgradient of the pumping center under a New Jersey Pollutant Discharge Elimination System (NJPDES) permit. However, the re-injection of treated groundwater was discontinued in 2000. Currently, the majority of treated groundwater is beneficially reused in the on-site cooling towers. A small portion of the treated effluent is discharged to the Middlesex County Utilities Authority sanitary sewer system. Groundwater impacts associated with Buildings 83 and 105 (Area 2) are managed under an MNA program approved by NJDEP in 2003.

Vapor Intrusion Concerns

The potential for vapor intrusion at and around the BMS site is being evaluated as AEC 66. Up to six phases of vapor intrusion investigation have been implemented at 28 on-site buildings and two off-site locations since 2009. Continued vapor intrusion monitoring is proposed for eight on-site buildings. No further action has been approved by NJDEP for one of the off-site locations. Although soil gas concentrations measured at the other off-site property exceeded relevant soil gas screening levels, measured indoor air concentrations were less than their respective indoor air screening levels. BMS is currently in discussions with the property owner with regard to potential next steps on that property.

Because vapor intrusion concerns are beyond the scope of the CA750 determination, these issues will not be discussed further in this EI.

References:

1. Buildings 83/105 Groundwater Remedial Investigation Report. Prepared by Blasland, Bouck, & Lee. Dated January 1998.

2. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated June 2013.

2. 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?

_X_ 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:

Hydrogeologic Background

Groundwater underlying the site occurs in two main hydrogeologic units: overburden and bedrock. The overburden layer varies in thickness and is unconfined and semi-saturated, with depth to water varying from 4 to 10 feet below ground surface (bgs). In some areas (e.g., the western portion of the site where overburden is thinnest), overburden groundwater may be non-existent. The BMS site straddles a natural drainage divide located in the approximate center of the site, between Buildings 102 and 105, just west of Fir Street. As shown on Attachment 4 (Ref. 5), overburden groundwater west of the divide flows northwest toward Georges Road and Mile Run Creek, and appears to be only marginally affected by pumping of the extraction system. Overburden groundwater east of the divide flows toward Westons Mill Pond (located approximately 0.5 miles off site to the east) and is independent of the extraction system. Overburden wells are screened between 6 and 25 feet bgs.

Groundwater flow in bedrock occurs via secondary porosity through fractures or joints. Bedrock groundwater occurs under leaky, confined conditions within the upper 50-150 feet of competent rock, and is confined at depths greater than 150 feet. This bedrock consists mostly of mudstone and siltstone, with minor amounts of shale. Bedrock groundwater flow is highly complex due to the numerous fractures and joint sets with varying densities. The groundwater divide is observed in both the shallow (30-60 feet bgs) and intermediate (65-85 feet bgs) bedrock zones. Groundwater flow in the deep bedrock (> 90 feet bgs) is consistent with regional groundwater flow toward the Raritan River, located approximately one mile northeast of the site (Refs. 2 and 3). As shown on Attachments 5 though 7 (Ref. 5), bedrock groundwater west of the divide is significantly affected by ongoing operation of the extraction system. In all three bedrock zones, flow converges on the pumping wells located in the West Annex. A moderate radial flow pattern is observed in the intermediate and deep bedrock zones, with groundwater being pulled back toward the West Annex from off-site areas. Significant seasonal variations in groundwater flow direction do not appear to occur at this site.

Vertical hydraulic gradients observed under non-pumping conditions depict an upward hydraulic gradient on the west side of the hydraulic divide observed at the BMS site. Under pumping conditions, vertical

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[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).

hydraulic gradients are induced to converge toward the intermediate bedrock depth interval of the West Annex (Ref. 2).

Current Contamination Levels

On-site groundwater concentrations are currently monitored semi-annually for VOCs, ethyl ether, and arsenic. The most recent on-site groundwater sampling event for which data are available at this time was conducted in December 2012. A total of 39 wells monitoring the overburden aquifer and various depths of bedrock groundwater were sampled during this event. A number of constituents were detected above New Jersey Groundwater Quality Standards (NJGWQS) during this sampling event. The maximum detected concentrations for these constituents are presented in Table 1 below. The highest concentration of each constituent (regardless of groundwater unit) is bolded.

The most significant groundwater contamination at BMS is located in Area 3, around and downgradient of Buildings 53 and 65. Groundwater in Area 1 wells (highlighted in green in Table 1) indicated continued exceedances of the NJGWQS for arsenic and ethyl ether. As shown in the table, groundwater contamination in Areas 1 and 3 increases with depth. The highest contaminant concentrations were reported in either intermediate or deep groundwater wells. When the CEA was first proposed for overburden and bedrock groundwater at this site in 2000, data indicated that groundwater contamination attenuated rapidly with depth (Ref. 2). Based on the changing vertical footprint of contamination in these areas, it is possible that the West Annex groundwater extraction system may be drawing contamination into deeper bedrock groundwater intervals. It should also be noted that, although the observed levels of certain VOCs (TCE, dichloroethene [DCE], VC) are high enough in the deeper Area 3 wells to suggest the presence of dense nonaqueous phase liquid (DNAPL), no free product has been reported in any of the wells at BMS. Furthermore, investigations conducted in 1995 failed to identify DNAPL in a topographical trough on the bedrock surface in the vicinity of the potential Area 3 source at Building 53 (Ref. 1). Unless and until the influence of the groundwater extraction well system is ruled out as the cause of contaminant increases at depth, or until actual DNAPL is observed in a BMS well, no further evaluation of potential DNAPL presence in the subsurface is warranted.

The only exceedance reported in Area 2 groundwater in December 2012 was the benzene detection in overburden well RS-25 (highlighted in orange in Table 1). The detection of benzene at 3.1 µg/L is lower than the historic maximum of 5 µg/L of benzene in this well. Three chlorinated VOCs (TCE, 1,2-DCA, and 1,1,2,2-tetrachloroethane [1,1,2,2-PCA]) also exceeded their respective NJGWQS in Area 2 overburden well RS-19R when it was last sampled in May 2012. Investigations conducted in the vicinity of Buildings 83, 99, and 105 between 1992 and 1999 did not identify significant VOC concentrations in soil. During a review of environmental conditions at neighboring facilities, BMS determined that overburden groundwater coming onto the site from the upgradient Parker-Hannifin site contained chlorinated solvents at concentrations up to two or three orders of magnitude higher than those observed in on-site overburden wells. Based on this finding, chlorinated solvents in Area 2 groundwater have been attributed to off-site activities, as summarized in the ISRA Semi-Annual Progress Report dated June 2013 (Ref. 5). This argument has been accepted by NJDEP (Ref. 4). Accordingly, chlorinated solvent contamination in Area 2 groundwater will not be considered further in this EI determination.

With only one exception (benzene in well RS-25), groundwater reported above NJGWQS is located beneath the western portion of the property and follows flow patterns observed west of the hydraulic divide.

Table 1: Maximum Groundwater Exceedances, December 2012

Constituent	GWQS (µg/L)	Max. Conc. (µg/L)	Well	Area
Overburden Aquifer				
Arsenic	3	39.9	MW-12R	3
Benzene	1	3.1	RS-25	2
1,1,2,2-TCA	1	2.4	MW-12R	3
1,1-DCE	1	1.5	SR-1	3
1,2-DCA	2	3.5	SR-1	3
PCE	1	1.3	MW-12R	3
TCE	1	35	MW-12R	3
VC	1	24	SR-1	3
Shallow Bedrock Aquifer				
Arsenic	3	76	CW-9	1
Benzene	1	1.2 J	DWR-A1	3
1,1-DCE	1	7.5 J	DWR-A1	3
1,2-DCA	2	31	DW-1R	3
cis-1,2-DCE	70	1,400	DWR-A1	3
Ethyl Ether	1,000	2,400	CW-9	1
TCE	1	17	DWR-A2	3
VC	1	1,800	DWR-A2	3
Intermediate Bedrock Aquifer				
Arsenic	3	**154**	CW-10	1
Benzene	1	18 J	DWR-B3	3
1,1,2,2-TCA	1	300	DWR-B3	3
1,1-DCA	50	86	DWR-B3	3
1,1-DCE	1	100	DWR-B3	3
1,2-DCA	2	44 J	DWR-B3	3
cis-1,2-DCE	70	19,000	DWR-B3	3
Ethyl Ether	1,000	3,400 D	DWR-B1	1
PCE	1	38 J	DWR-B3	3
Trans-1,2-DCE	100	**760**	DWR-B3	3
TCE	1	5,500	DWR-B3	3
VC	1	**9,900**	DWR-B3	3
Deep Bedrock Aquifer				
Arsenic	3	40.1	DW-9	3
Benzene	1	**42 J**	DW-9	3
1,1,1-TCA	30	**120**	DW-9	3
1,1,2,2-TCA	1	**780**	DWR-C2	3
1,1,2-TCA	3	**27 J**	DW-9	3
1,1-DCA	50	**190**	DW-9	3
1,1-DCE	1	**360**	DW-9	3
1,2-DCA	2	**330**	DW-9	3
Chloroform	70	**75 J**	DW-9	3
cis-1,2-DCE	70	**22,000**	DW-9	3
Ethyl Ether	1,000	**3,600**	DW-9	1
Trans-1,2-DCE	100	490	DW-9	3
PCE	1	**120**	DW-7	3
TCE	1	**21,000**	DW-7	3
VC	1	6,900	DW-9	3

Source: Ref. 4
Bolded values represent the highest detection of each constituent, regardless of groundwater unit.
J – Estimated concentration; D - the listed concentration is derived from analysis of a diluted sample

References:

1. Phase II DNAPL Investigation Report on DNAPL Well Installations and Sampling in the Vicinity of Building No. 53. Prepared by RECON Environmental Corp. Dated March 23, 1995.

2. Hydraulic Assessment Report. Prepared by Blasland, Bouck, & Lee. Dated October 2000.

3. Revised Baseline Ecological Evaluation. Prepared by Blasland, Bouck, & Lee. Dated February 2006.

4. RCRA GPRA 2020 Corrective Action Report for E.R. Squibb & Sons, Inc. Data input by Jay Nickerson, NJDEP Case Manager. Report run on March 20, 2013.

5. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated June 2013.

3. 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)?

_X_ 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:

Stabilization in the Source Areas

As stated previously, BMS has implemented two corrective action programs for contaminated groundwater. The groundwater extraction system removes contaminant mass from the subsurface and maintains hydraulic control within Groundwater Areas 1 and 3. As shown in the 2012 Annual Groundwater Trend Analysis Report (Ref. 6), groundwater quality in these areas remains stable or is improving over time, except in well DW-7 which exhibits period fluctuations in contaminant concentrations. MNA is being used to address contamination in Area 2, with groundwater quality remaining stable or improving over time (Ref. 6).

Table 2 below identifies the highest groundwater contaminant concentrations reported above NJGWQS in non-pumping wells in December 2012. Table 2 also includes well-specific historic maximum concentrations for the identified constituents of concern. Pumping wells have not been included in this evaluation, as contaminant concentrations in such wells represent contamination being pulled back from surrounding areas. As such, contaminant concentrations in these wells would be expected to fluctuate until the treatment program is complete.

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[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.

Table 2: Current Maximums in Non-Pumping Wells and Historic Ranges for Those Wells

Constituent	GWQS (µg/L)	Dec 2012 Max. Conc. (µg/L)	Well	Historic Max in Well Since May 1999 (µg/L)
Overburden Aquifer				
Arsenic	3	39.9	MW-12R	1,130
Benzene	1	3.1	RS-25	5
1,1,2,2-TCA	1	2.4	MW-12R	130
PCE	1	1.3	MW-12R	11
TCE	1	35	MW-12R	480
Shallow Bedrock Aquifer				
Arsenic	3	76	CW-9	339
1,2-DCA	2	31	DW-1R	85
Ethyl Ether	1,000	2,400	CW-9	19,000
TCE	1	2.7	DW-1R	330
VC	1	20	DW-5	35
Intermediate Bedrock Aquifer				
Arsenic	3	154	CW-10	266
Benzene	1	6.1 J	CW-10	0.6
1,2-DCA	2	2.9 J	CW-10	11
Ethyl Ether	1,000	1,800	CW-10	2,200 *
VC	1	16	CW-10	52
Deep Bedrock Aquifer				
Arsenic	3	40.1	DW-9	624
Benzene	1	42 J	DW-9	24
1,1,1-TCA	30	120	DW-9	380
1,1,2,2-TCA	1	250	DW-9	650
1,1,2-TCA	3	27 J	DW-9	ND *
1,1-DCA	50	190	DW-9	820
1,1-DCE	1	360	DW-9	700
1,2-DCA	2	330	DW-9	540
Chloroform	70	75 J	DW-9	70
cis-1,2-DCE	70	22,000	DW-9	46,000
Ethyl Ether	1,000	3,600	DW-9	13,000
Trans-1,2-DCE	100	490	DW-9	1,500
PCE	1	120	DW-7	570
TCE	1	21,000	DW-7	94,000
VC	1	6,900	DW-9	24,000

* Limited range of data available for comparison
Sources: Refs. 3, 5, and 7
J – Estimated concentration; ND – Non-Detect

As shown in Table 2, only three constituents (benzene, chloroform, and 1,1,2-TCA; highlighted in yellow) fell outside their historic concentration ranges. Most of the outliers were reported in deep bedrock well DW-9, which is situated near the West Annex extraction well network. Based on its location amid several extraction wells, these increasing concentrations may be attributable simply to ongoing operation of the groundwater pump and treat system. Contamination will continue to be pulled toward the West Annex from Areas 1 and 3, and wells in this area may report significant fluctuations in contaminant concentrations until the treatment program is complete. The only other outlier was identified in intermediate bedrock well CW-10, located west of Building 42 and well within the site and CEA boundaries. This well will continue to be monitored on a semi-annual basis.

Stabilization at the Site Perimeter

As stated previously, a CEA was established for the BMS site in 2003 to identify the extent of groundwater expected to contain contamination above relevant NJGWQS. Attachment 8 shows the areal extent of the CEA (Ref. 2). The CEA covers all but the northernmost edges of the entire site west of Building 107, and includes the West Annex and Groundwater Areas 1, 2, and 3. The CEA also extends approximately 300 feet off site to the northwest to two monitoring well clusters located in the cemetery across Georges Road (Ref. 4). Vertically, this CEA extends into the deep bedrock zone at an approximate depth of 254 feet bgs (Ref. 1).

Wells MW-12R and MW-21R are the most downgradient overburden wells on the western (contaminated) side of the property. A network of 15 monitoring wells has also been installed in shallow, intermediate, and deep bedrock around the perimeter of the BMS site. These wells are monitored to ensure that the contaminant plumes do not migrate beyond the established CEA boundaries. Wells comprising this downgradient monitoring network are highlighted on the attached, marked-up version of Attachment 9 (Ref. 7). The overburden wells are monitored semi-annually, and the bedrock wells are sampled each May. Each sample is analyzed for VOCs, oxygenated organic compounds including ethyl ether, and arsenic. Table 3 provides a summary of exceedances observed in these wells during the most recent round of sampling for which data are currently available (May or October 2012).

Table 3: Exceedances in Perimeter Wells

Constituent	GWQS (µg/L)	Detected Conc. (µg/L)	Well	Historic Max in Well Since May 1999 (µg/L)
Overburden Aquifer				
Arsenic	3	39.9	MW-12R	1,130
1,1,2,2-TCA	1	2.4	MW-12R	130
PCE	1	1.3	MW-12R	11
TCE	1	35	MW-12R	480
		1.1	MW-21R	3.6
Shallow Bedrock Aquifer				
Arsenic	3	5	DW-15	5
Intermediate Bedrock Aquifer				
Arsenic	3	4.4	MWN-13	4.7
		17	DW-14	38.1
		4.4	CW-22	391
TCE	1	3.6	DW-14	4.4
Deep Bedrock Aquifer				
Arsenic	3	3.8	DW-8	9.9
		8.6	DWC-12	17.3
		5.8	MWN-12A	37.4
		5.2	MWN-13A	11.9

Source: Refs. 5 and 7

The most downgradient wells at BMS still report exceedances for a few constituents. Nevertheless, as shown in Table 3, current concentrations are within historic well-specific maximums. Most also indicate stabilization only marginally greater than the relevant NJGWQS (i.e., within an order of magnitude). Only arsenic and TCE concentrations in overburden well MW-12R continue to exceed NJGWQS by more than an order of magnitude. However, well MW-12R is located approximately 700 feet upgradient of the northwestern CEA boundary. It is expected that levels of arsenic and TCE would continue to decline as they migrate from Groundwater Areas 1 and 3, such that concentrations at the CEA boundary are close to or below NJGWQS. Based on this analysis, it appears that groundwater contamination beneath the western portion of the property is stable and/or decreasing over time, even if still marginally above NJGWQS in certain wells.

Benzene in well RS-25 is the only area of groundwater contamination subject to flow on the eastern side of the hydraulic divide. The recent detection of benzene at 3.1 µg/L is only slightly greater than the NJGWQS of 1 µg/L and lower than the historic maximum of 5 µg/L in this well. Although this well is located near the eastern property boundary, overburden groundwater flow in this area is to the southeast. It is expected that benzene concentrations would decline below the NJGWQS via natural attenuation before travelling approximately 2,000 feet to the nearest downgradient property boundary. Accordingly, groundwater contamination beneath the eastern portion of the site is sufficiently stabilized for purposes of this EI determination.

References:

1. Hydraulic Assessment Report. Prepared by Blasland, Bouck, & Lee. Dated October 2000.

2. Revised Baseline Ecological Evaluation. Prepared by Blasland, Bouck, & Lee. Dated February 2006.

3. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated October 2009.

4. Initial Receptor Evaluation. Prepared by BMS. Dated February 25, 2011.

5. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated October 2011.

6. 2012 Annual Groundwater Trend Analysis Results Report. Prepared by Arcadis U.S., Inc. Dated October 2012.

7. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated June 2013.

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

_X_ 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:

As shown on the attached figures, two surface water bodies are present in the immediate vicinity of the BMS site. Mile Run Creek is located on the west side of the BMS property and extends off site to the northwest. The unnamed tributary is located along the northeastern boundary of the BMS site. Both surface water bodies are classified as fresh water non-trout (FW2-NT) features. Isolated wetlands are also present in the West Annex area.

As stated previously, shallow groundwater in the vicinity of Mile Run Creek is influenced primarily by the groundwater extraction system. However, the Revised Baseline Ecological Evaluation indicates that a minor component of overburden and/or shallow bedrock groundwater flow in this area may naturally discharge to Mile Run Creek (Ref. 1). Shallow groundwater may also reach Mile Run Creek via: (1) infiltration into storm sewer piping (i.e., through joints, cracks, and manholes) and subsequent discharge into the creek at Outfall 003DS, southwest of Buildings 45 and 49; or (2) flow through porous bedding materials around the storm sewer piping (Ref. 2). Accordingly, groundwater contamination observed in the western portion of the site has several potential pathways to surface water.

Shallow groundwater contamination in the vicinity of the unnamed tributary is limited to benzene at well RS-25. However, groundwater beneath the eastern portion of the site flows parallel to the unnamed tributary (Ref. 3). Consequently, contaminated groundwater would only enter the tributary system as a result of dispersion perpendicular to the direction of flow.

References:

1. Revised Baseline Ecological Evaluation. Prepared by Blasland, Bouck, & Lee. Dated February 2006.

2. Memo from Greg Braun, Arcadis, to Robert Weiss, Arcadis, re: Mile Run and Storm Sewer Sampling Results for the BMS Facility. (Provided as Attachment 10 to the October 2012 ISRA Semi-Annual Progress Report.) Dated July 29, 2011.

3. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated June 2013.

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 ecosystems at these concentrations)?

_X_ 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 ecosystem.

___ 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:

Elevated levels of VOCs and arsenic were first identified in Mile Run Creek in the mid-1980s. To prevent direct discharges of shallow groundwater to the creek, BMS installed an extraction trench along the western property boundary between Building 46 and the creek. The trench is approximately 400 feet long by 5 feet wide by 10-12 feet deep. Groundwater captured by the extraction trench is directed to a sump for collection before being pumped to the on-site groundwater treatment facility (Ref. 2).

In November 1991, BMS identified numerous locations where groundwater was infiltrating the on-site storm sewer system and subsequently discharging to the creek at Outfall 003DS. To minimize groundwater discharges to Mile Run Creek via the sewer system, BMS implemented a system-wide repair program between November 1992 and July 1995. This program included repair or replacement of piping, pressure grouting of compromised joints, coating and waterproofing of manholes and catch basins, and installation of resin impregnated fabric inversion liners. Surface water sampling collected after the repairs indicated that the sewer system had been satisfactorily rehabilitated, and no further action was recommended to address potential groundwater to surface water pathways associated with the sewer system (Ref. 1).

In 2007 and 2010, BMS collected surface water samples from Mile Run Creek and upgradient drainage ditches. Sample locations and analytical results from this investigation are shown on Attachment 10 (Ref.

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

1). Four constituents (TCE, PCE, VC, and arsenic) were detected in the creek samples at concentrations above NJDEP freshwater surface water quality criteria (SWQC) for human health. However, as shown in Table 4 below, SWQC exceedances reported upstream of the outfall in 2007 and 2010 were generally higher than those observed at downstream sampling points.

Table 4: SWQC Exceedances in Mile Run Creek

Constituent	SWQC (µg/L)	Max Upstream Conc. (µg/L)	Max Downstream Conc. (µg/L)
PCE	0.34	9.9	ND
TCE	1.0	4.2	3.3
VC	0.082	0.55 J	ND
Arsenic	0.017	71.5	4.7 J

Source: Ref. 1
J – Estimated concentration; ND – Non-Detect

It is important to note that most of the upstream surface water sampling locations are also upgradient of shallow groundwater contamination plumes on the western side of the BMS site. Furthermore, it is possible that chlorinated solvent contamination originates in groundwater migrating into Mile Run Creek from the adjacent Parker-Hannifin site.

Based on these findings, it appears that any contribution to Mile Run Creek surface water contamination from groundwater at BMS is insignificant. Accordingly, NJDEP determined that no further action was needed for surface water under AEC 26, including on-site drainage ditches leading to Mile Run Creek (Ref. 2). In a Notice of Deficiency (NOD) letter dated May 27, 2009, NJDEP also indicated that no further action was needed for the unnamed tributary or wetlands (Ref. 1). Groundwater-related impacts to surface water are, therefore, considered insignificant for purposes of this EI determination.

References:

1. Memo from Greg Braun, Arcadis, to Robert Weiss, BMS, re: Mile Run and Storm Sewer Sampling Results for the BMS Facility. (Provided as Attachment 10 to the October 2012 ISRA Semi-Annual Progress Report.) Dated July 29, 2011.

2. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated June 2013.

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 ecosystems 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 ecosystems), 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 specialist, including an ecologist) adequately protective of receiving surface water, sediments, and ecosystems, 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 ecosystem.

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

<u>Rationale</u>:

This question is not applicable. See the response to Question 5.

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[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.

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?"

_X_ 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:

As a condition of the approved CEA, BMS must continue monitoring groundwater for VOCs, ethyl ether, and arsenic. Wells and sampling frequencies comprising the current monitoring program are identified in Table 5. Wells used only for development of groundwater potentiometric surface maps are also identified on the table.

Table 5: Groundwater Monitoring Program

Wells	Gauging Frequency	Sampling Frequency	Reporting Months
MW-19, MW-20, MW-21R*, MW-12R, DW-1R, DW-9, DW-7, DW-5, CW-1, CW-2, CW-9, CW-10, and RS-25	February May August November	May November	October April
RS-18, RS-19R, RS-22, CW-7, CW-8, MW-18, MWN-11, MWN-11A, DWC-11, RS-11R*, RS-12, CW-17, CW-18, CW-19, CW-20, CW-21, CW-22, DW-8, DW-14, DW-15, MWN-12, MWN-12A, DWC-12, MWN-13, MWN-13A, and DWC-13	February May August November	May	October
CW-3, CW-4, CW-5, CW-6, CW-11, CW-12, CW-13, CW-14, DW-10, DW-4, DW-6, MW-17, MW-2, MW-25, MW-4, MW-6, MW-7, MW-7B, RS-1, RS-15, RS-16, RS-17, RS-24, RS-26, RS-27, RS-4, RS-5, RS-6, RSD-1, and RSD-3	February May August November	Not sampled	Not sampled

Source: Ref. 2

In addition to routine monitoring, BMS continues ongoing evaluation of capture zone, transmissivity zones, and other hydrogeologic issues outlined in NJDEP's March 14, 2013 letter to the facility (Ref. 1). As always, this EI determination should be reevaluated if significant changes in site conditions are identified.

References:

1. Letter from Jay Nickerson, NJDEP, to Robert Weiss, BMS, re: Review of the October 2012 ISRA Semi-Annual Progress Report. Dated March 14, 2013.

2. ISRA Semi-Annual Progress Report. Prepared by Arcadis U.S., Inc. Dated June 2013.

8. Check the appropriate RCRAInfo 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).

_X_ 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 Bristol-Myers Squibb Company Worldwide Medicines site, EPA ID# NJD011550092, located at 1 Squibb Drive, New Brunswick, Middlesex County, New Jersey. 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: ______________________________ Date:____________________

Michele Benchouk
Lead Associate
Booz Allen Hamilton

Reviewed by: ______________________________ Date:____________________

Amy Brezin
Associate
Booz Allen Hamilton

Also reviewed by: ______________________________ Date:____________________

Alan Straus
Hazardous Waste Programs Branch
EPA Region 2

______________________________ Date:____________________

Philip D. Flax, Section Chief
Hazardous Waste Programs Branch
EPA Region 2

Approved by: Original signed by: Date: September 27, 2013

Adolph Everett, Chief
Hazardous Waste Programs Branch
EPA Region 2

Locations where references may be found:

References reviewed to prepare this EI determination are identified after each response. Reference materials are available at U.S. EPA, Region 2.

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Attachments

The following attachments have been provided to support this EI determination.

- Attachment 1 – Summary of Media Impacts Table
- Attachment 2 – Figure 1-2 (marked up) in the Groundwater Remedial Investigation Report for Buildings 83 and 105, dated January 1998
- Attachment 3 – Figure 3 (marked up) from the Receptor Evaluation Form, dated February 2001
- Attachment 4 – Figure 4-10 from the ISRA Semi-Annual Progress Report, dated June 2013
- Attachment 5 - Figure 4-11 from the ISRA Semi-Annual Progress Report, dated June 2013
- Attachment 6 - Figure 4-12 from the ISRA Semi-Annual Progress Report, dated June 2013
- Attachment 7 - Figure 4-13 from the ISRA Semi-Annual Progress Report, dated June 2013
- Attachment 8 - Figure 1-4 from the Revised Baseline Ecological Evaluation, dated February 2006
- Attachment 9 - Figure 4-1 (marked up) from the ISRA Semi-Annual Progress Report, dated June 2013
- Attachment 10 – Figure 1 from Attachment 10 to the October 2012 ISRA Semi-Annual Progress Report, dated July 29, 2011

Note: Attachments #2 to #10 available upon request.

Attachment 1: Summary of Media Impacts Table

AOC or SWMU	GW	AIR (Indoors)	SURFACE SOIL	SURFACE WATER	SEDIMENT	SUB SURFACE SOIL	AIR (Outdoors)	CORRECTIVE ACTION MEASURE	KEY CONTAMINANTS
AEC 65, Groundwater	Yes	No	No	No	No	No	No	A groundwater extraction system was installed on the West Annex in 1994 to provide hydraulic containment of contamination on the western side of the site (Areas 1 and 3). This system conveys groundwater to an on-site treatment facility for treatment prior to being reused in on-site cooling towers. Groundwater impacts in Area 2 are being managed under a Monitored Natural Attenuation (MNA) program approved by NJDEP in 2003. A groundwater Classification Exception Area (CEA) for impacted site groundwater was approved by NJDEP in 2003.	Volatile Organic Compounds, Ethyl Ether, Arsenic