DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

9/27/01

RCRA Corrective Action
Environmental Indicator (EI) RCRIS Code (CA750)

Migration of Contaminated Groundwater Under Control

Facility Name: **Bristol-Myers Squibb Company**
Facility Address: **State Road #3, Km 77.5, Humacao, Puerto Rico**
Facility EPA ID #: **PRD090021056**

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.

SWMUs identified at Bristol-Myers Squibb Manufacturing Company (BMSMC) to date are described below. Figure 1 identifies the locations of each SWMU. Past investigations reveal that only three SWMUs are of concern for contributing to groundwater contamination. These include the Brule Incinerator (SWMU 1), the Former Tank Farm Area (SWMU 8), and the Bubbling Area-Building 5 (SWMU 25). Therefore, these are the only SWMUs, with the current analytical data, that will be addressed in this document.

SWMU 1, Brule Incinerator: The Brule Incinerator was located to the west of the Trane Incinerator in the Hazardous Waste Management Facility (HWMF). The unit sits on a concrete pad that has a containment dike and is enclosed by a trench. The incinerator is fed with kerosene at a rate of 230 gallons per hour in order to burn up to 800 gallons per hour of cold wastes. Cold waste is defined as a dilute, aqueous solvent mixture, with a low heating value and less than 100 parts per million of any toxic constituent. No evidence of releases have been found originating from the Brule Incinerator. However, during the closure of the Brule incinerator in October 1997, an oil-like material was discovered underneath the pad. Sampling of this oil-like substance indicated that it is mostly diesel fuel. The Brule incinerator used fuel oil and then switched to kerosene during its operation. Squibb has recently conducted Field Investigation/Delineation for characterizing the extent of the contaminant plume found beneath the concrete pad of the former Brule incinerator as part of the RFI process.

SWMU 2, Garver-Davis Incinerator: The Garver-Davis Incinerator began operation in 1970 and had a capacity of 11,500-gallons per day of cold wastes. The unit sat on top of a concrete pad but had no containment dikes or trenches. No evidence of releases were found around the Garver-Davis Incinerator. The incinerator was closed in 1992, and its closure certification was approved by EPA and the Puerto Rico Environmental Quality Board on August 24, 1993.

SWMU 3, Trane Incinerator: The Trane Incinerator is a liquid incinerator that began operation in 1979; it is located west of Building 30 and operates as a Resource Conservation and Recovery Act (RCRA) Interim status facility. The incinerator's capacity is 17,280 gallons per day, and it operates at approximately 950° F. The Trane Incinerator receives salty, cold, and hot wastes. The incinerator also receives additional hazardous wastes that have been contained after a spill in any area of the plant. A trench encircles the perimeter of the concrete pad where the incinerator is located so that spilled material is collected and returned to the incinerator.

SWMU 4, Caloric 1 Incinerator: This unit is located to the north of the control room, in the HWMF. The unit started operating in January 1990 and is still being used to incinerate cold wastes. There are future plans to expand the incinerator's use to include other wastes. The unit sits on a concrete floor, encircled with a trench to control releases around the unit. Quench tanks, venturi scrubbers, and a packed bed tower are used to help reduce air pollutants. No evidence of releases has been observed around the Caloric 1 Incinerator.

SWMU 5, Caloric 2 Incinerator: This unit is located to the south of the control room, in the HWMF. The incinerator sits on a concrete floor and has a trench around it. Air pollution is controlled using a quench tank, a venturi scrubber, and a packed bed tower. The unit began operation in 1994, but is not currently in operation. When operation resumes, it is expected to be used to incinerate hot, salty, and cold wastes.

SWMU 6, Tank Area-HWMF: The tank area began operations in 1970 and contains six hazardous waste tanks, a batch still, and a filter pit. The tank area is located northwest of the Trane Incinerator and receives waste from all areas of the plant, including spills from containment structures. The tanks are constructed of stainless steel and stand vertically within a diked area. The tanks are inspected daily for leaks and are subjected annually to shell thickness measurements and tightness testing. The entire tank area is underlain by a concrete pad, with a containment wall about 2 feet high. The concrete overlies compacted backfill, which overlies impermeable clay.

SWMU 7, Empty Drum Management Area: This unit began operations in 1990 and is located to the north of the tanks area at the HWMF. Empty, dirty drums are taken from production facilities, delivered to the Empty Drum Management Area, washed, compacted, and prepared for recycling. This unit typically manages 500 to 1,000 drums in a month.

SWMU 8, Former Underground Tank Farm Area: Operations at the Former Tank Farm Area began in 1970. The Former Tank Farm Area consisted of 26 underground tanks constructed of stainless-steel and having capacities in the range of 10,000 to 23,000 gallons. The tanks held waste solvents for reclamation (mostly methylene chloride, methanol, methyl isobutyl ketone (MIBK), isopropanol, and acetone), raw materials, and kerosene. The Former Tank Farm Area was divided into two, separated by interrelated tank systems: System I contained 20 tanks and System II contained six tanks. The area had no secondary containment or leak detection system. Solvent concentrations became elevated in soils and groundwater. Four extraction wells, installed to remove the solvent contamination, were later removed from use. All of the underground storage tanks and associated piping were removed, decontaminated, dismantled, and scrapped. In 1985, it was discovered that chemicals may have leaked from tanks into the surrounding soil. Further study of the situation confirmed the presence of volatile organic compounds in the soil and groundwater. Remediation activities to date have included tank and soil removal as well as follow-up investigation to determine the nature and extent of contamination. Based on the results of the Corrective Measure Study (CMS) so far, the corrective measure alternatives that are proposed to be implemented are thermal Desorption, Pump and Treat, Excavation, Bioslurping, Multi-Phase Extraction, Monitored Natural Attenuation (MNA), and In-situ Chemical Oxidation.

SWMU 9, Solvent Recovery Columns: This area consists of five columns for solvent recovery and four waste storage tanks; this unit is located across the street from, and to the east of, Building 1. The columns are used for the recovery of methanol, acetone, and methylene chloride. Chemicals used to feed the process consist of spent methanol contaminated with water, methylene chloride, and dissolved and suspended, colored, organic solids. The acetone recovery process is fed with spent acetone from the Amphotericin process that is contaminated with water and dissolved and suspended, colored, organic solids.

SWMU 10, Biological Waste Treatment Plant (WTP): This unit is located south of Building 29, to the west of the HWMF. The biological waste treatment plant has a capacity of 500,000 gallons per day. The system consists equalization tanks, aeration tanks, and clarifiers. This unit started operations in 1970 and is still in use. No release control measures are in place at this unit. Wastes managed at this unit consists of non-hazardous waste such as equipment, floor wash water, air pollution control liquids, steam condensate, and certain mother liquors. Biotreated wastewater is discharged to the Humacao Regional Wastewater Treatment Plant for further treatment and then discharged into the Caribbean Sea. Past investigations found no evidence of releases at the unit.

SWMU 11, Dewatering Building: This unit is located in the HWMF to the east of the biological treatment plant. The unit has been operating since 1981 and is still in use. The unit consists of sludge pumping facilities, sludge dewatering, a pressure filter package, a sludge conditioning tank, a filtrate tank, precoat system, and a sludge dumpster. This area is located in a 72-foot-long by 73-foot-wide by 4.5-foot-high diked area. Biosludge is dewatered using a filter press and is disposed at a municipal landfill as nonhazardous waste. Past investigations found no evidence of releases at the unit.

SWMU 12, Hazardous Waste Storage Area–Outside of Building 29-South: This area began operation in 1986 and consists of about 26 to 30 drums of 30 gallons each and two hazardous waste storage tanks. Sources of wastes for this area include spent cakes, spent mother liquors, solvent distillation residuals, and equipment washes. The drums sit on plastic pallets on a concrete floor under a roof. Releases are controlled through the use of a sump area, which collects the waste in case any spill occurs and pumps it to hazardous waste storage tanks. This unit is active but the waste storage tanks are not currently in use. Past investigations found no evidence of releases at the unit.

SWMU 13, Epichlorohydrin Management Tanks: This active unit has been in operation since 1986 and is located on the east side of Building 29. The unit consists of two vertical waste storage tanks. Both tanks are within the same concrete containment dike, which is about 15 feet wide by 40 feet long by 6 inches high. The vault is backfilled with rocks and is equipped with a fume detection system. The tanks are within a concrete containment dike, with a drain in the floor that leads to the emergency spill tank. Past investigations found no evidence of releases at the unit.

SWMU 14, Hazardous Waste Storage Tanks-Building 29: This active unit has been in operation since 1986 and is located inside of Building 29, north of the raw materials tank farm. This unit contains process vessels, virgin material tanks, product storage tanks, waste tanks, and waste recovery units. All of the waste management units are contained within the building. The floors are constructed of concrete and contain drains that lead to the biological WTP. Drains can be diverted to the HWMF in the event of a spill. This unit processes hot wastes, cold wastes, and wastewater. No evidence of releases has been observed at the unit.

SWMU 15, MIBK Recovery Unit: This active unit has been in operation since 1980 and is located across the street from, and to the east, of Building 1. The MIBK recovery unit consists of a batch still and six aboveground storage tanks (AST). The batch still tank is a horizontal evaporator, with a capacity of about 11,000 gallons. The still operates in three stages, with the storage tanks holding the products for each stage. The waste that enters the system consists of spent solvent contaminated with wastewater, methanol, isopropanol, and colored, dissolved, and suspended organic solids. The bottoms of the process are pumped to the HWMF for incineration. No evidence of releases has been observed during past site visits.

SWMU 16, Storage Tanks–Outside Building 1: This active unit has been in operation since 1983 and is located outside the southwestern corner of Building 1. The unit consists of two waste tanks placed in a diked area that is 16 feet long by 14 feet wide by 30 inches high. Sources for hazardous waste for this unit includes mother liquors, wash water, and product recovery residuals. No evidence of releases has been observed during past site visits.

SWMU 17, Hazardous Waste Storage Area-Building 1: This active unit has been in operation since 1970 and is located inside of Building 1. This area contains process vessels, virgin material tanks, product storage tanks, and vertical, 500-gallon waste tanks. About 50 30-gallon drums are located on pallets placed on concrete floors that have drains that lead to the biological waste treatment plant. However, any hazardous material can be diverted to the HWMF in the event of a spill. Each tank is in a 12 foot long by 12 foot wide by 12 inch high diked area. Wastes managed in this area consist of Cooper Oxalate, solvent used in the intermediate process of Aztreonam Non-Sterile Alfa, salty waste, and process wastewater. No evidence of releases has been observed during past site visits.

SWMU 18, Storage Tanks-Building 2: This unit has been active since 1984 and is located outside of Building 2, on the northern side. This area consists of four stainless-steel storage tanks; one storage tank is located within an individual diked area, and the other three are located in another diked area that is equipped with a system to pump the waste to the tank in case of a spill. Wastes managed at the site include methanol, methylene chloride, dimethyl formamide (DMF), and acetone from spent mother liquors, wash water, bio-waste, and product recovery residuals. No evidence of releases has been observed during past site visits.

SWMU 19, Hazardous Waste Storage Area–Inside of Building 2: This unit has been in operation since 1990 and is located on the southern interior side of Building 2. The building contains process vessels, virgin material tanks, product storage tanks, one waste tank, and a container storage area. The floors are concrete and have drains that lead to the biological WTP. However, any hazardous material can be diverted to the HWMF in case of a spill. No evidence of releases has been observed during past site visits.

SWMU 20, Storage Tanks-Building 5: This active unit has been in operation since 1988. The unit consists of four stainless-steel storage tanks–one on the interior of Building 5 and three on the eastern exterior of Building 5. Each tank sits within its own diked area. The only waste managed at this unit includes methylene chloride originating from spent mother liquors, solvent distillation residuals, and equipment washes. No evidence of releases has been observed during past site visits.

SWMU 21, Storage Tanks-Building 3: This unit was put into operation in 1970 and is still being used. Three ASTs are located within the building and are contained in their own 6-square-foot by 9-inch-high diked area. The floors are concrete and contain drains that lead to the biological WTP. However, hazardous material can be diverted to the HWMF in the event of a spill. Wastes that are managed in this area include mother liquors, acetone, methanol, and methylene chloride, which originate from spent mother liquors and product distillate. No evidence of releases has been observed during past site visits.

SWMU 22, Underground Storage Tanks (UST) -Building 3: This unit was placed into operation in 1970 and is still active. This unit is located outside, on the northern side of Building 3. This unit consists of three USTs and one AST, all made of stainless steel. The tanks sit within a concrete vault, which is used as a secondary containment. Wastes managed in this area include biowaste and nonhazardous process wastewater. No evidence of releases has been observed during past site visits.

SWMU 23, Storage Tank-Building 17 and 18: This active unit has been in operation since 1983 and consists of a 565-gallon fiberglass UST that is located between Buildings 17 and 18. Buildings 17 and 18 generate laboratory wastes that are stored in the tank, such as acetone, methanol, isopropanol, mother liquors, and methylene chloride, that are generated during quality control research and development operations. No evidence of releases has been observed during past site visits.

SWMU 24, Storage Tanks-Building 8: This unit has been active since 1987. The unit is located outside of Building 8 and consists of two tanks: one AST and one UST. The AST is located within an individual dike, and the UST is enclosed within a concrete vault. The unit manages nonhazardous wastewater and steam condensate. No evidence of releases has been observed during past site visits.

SWMU 25, Bubbling Area-Building 5: BMSMC currently is conducting a corrective measures study (CMS) at this unit, which has been active since 1993. In a 1997 RCRA Facility Investigation (RFI), underground process waste piping adjacent to the northeastern corner of Building 5 was identified as the source of contamination for the Bubbling Area. The unit includes the maintenance storage shed; the nitrogen tank; hot, cold, and biowaste abandoned underground pipelines; abandoned waste sumps; and new waste holding tanks. The area is partially paved. The area was investigated in response to an observed bubbling gas in a small rainwater puddle located nearby. Analysis of the water indicated the presence of MIBK, methylene chloride, isopropanol, ethanol, acetone, and another constituent that could be xylene. Xylene has not been used in the building since the 1970s, but the other compounds currently are used in Building 5. Remediation activities to date have included investigation to determine the nature and extent of contamination and the Corrective Measure Study (CMS). Based on the results of the Corrective Measure Study (CMS), the corrective measure alternatives that are proposed to be impemented are thermal Desorption, Pump and Treat, Excavation, Bioslurping, Multi-Phase Extraction, Monitored Natural Attenuation (MNA), and In-situ Chemical Oxidation.

BACKGROUND

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).

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 and Reference(s):

BMSMC is a pharmaceutical company that manufactures drugs for human consumption. BMSMC is a wholly owned subsidiary of E.R. Squibb and Sons, a publicly held corporation incorporated in Princeton, New Jersey. BMSMC is located on State Road #3, Km 77.5, Humacao, Puerto Rico, which is about 2 miles west of the east coast of the Caribbean Sea. BMSMC began operating in 1970 and for tax purposes, consisted of several different companies: Ersana, Renasa, and Squibb. The primary products manufactured at BMSMC are the antibiotics Cephradine, 7ADCA, Mycostatin, and Amphotericin; the steroid Triamcinolone; and the antihypertensive Capoten. Various solvents and other chemicals are used in the manufacturing process. Spent solvents are purified by distillation at BMSMC, or by another company, and then reused. Hazardous and nonhazardous wastes are separated at their origin. Nonhazardous wastes are sent to the biological treatment plant, where 99 percent biological oxygen demand removal occurs before being discharged to the Humacao WTP. Only liquid hazardous wastes are stored at the BMSMC plant. All liquid hazardous wastes generated from a particular production building will be combined at that building and conveyed to the hazardous tank storage system for subsequent incineration treatment.

The structures associated with the three SWMUs of concern on the BMSMC property have been removed (EPA 2000). The Brule incinerator (SWMU-1) was demolished in 1997. At the former UST (SWMU-8), the contents of the storage tanks were removed and the tanks and associated piping were excavated by the end of 1989. In a 1997 RFI, underground process waste piping, adjacent to the northeastern corner of Building 5, was identified as the source of contamination for the Bubbling Gas Area (SWMU-25). The piping was removed from service and partially excavated.

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[1] "Contamination" and "contaminated" describe 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 resources and its beneficial uses).

Waste releases to soils around the three SWMUs of concern have been determined to be the source of groundwater contamination. Recently, Anderson Mulholland & Associates, Inc. (AMAI), conducted soil sampling at the three SWMUs of concern to characterize the extent of contamination remaining at the site, because soil contamination likely acts as a source for groundwater contamination. Surface and subsurface soil samples were evaluated for migration to groundwater pathways by comparison of analytical results to EPA soil screening levels (SSL). Soil samples collected at the former tank farm in February and November 2000 and in January 2001 revealed xylenes, MIBK, methylene chloride, and acetone at levels that exceed SSLs (AMAI 2001a, 2001b, 2001c). High concentrations of xylene from 5 to 10 feet below ground surface indicate the presence of residual, light, nonaqueous-phase liquid (LNAPL) in the zone of water table fluctuation, between the saturated and unsaturated zones. While concentrations of MIBK, methylene chloride, and acetone were above migration to groundwater SSLs, the mass and level of contamination did not indicate the presence of residual LNAPL or dense, nonaqeous-phase liquid (DNAPL). Soil samples collected at the Building 5 area in February 2000 revealed detections of xylene, MIBK, acetone, methanol, benzene, ethylbenzene, and toluene at concentrations above migration to groundwater SSLs (AMAI 2000a). Xylene, MIBK, and acetone were detected at the highest concentrations and frequencies. Methanol, benzene, toluene, and ethylbenzene were detected in exceedance of their respective SSLs, but at a lesser frequency and within the boundary of the existing xylene, MIBK, and acetone plumes. In soil sampling conducted at the Brule incinerator in March and February 2000, ethylbenzene was the only constituent of concern to exceed its SSL (13,000 milligrams per kilogram [mg/kg]). Ethylbenzene was detected in Boring B-4A at a concentration of 25,750 mg/kg (AMAI 2000b).

Using an electronic interface probe and a bottom-loading bailer, AMAI conducted investigations to determine whether free-phase LNAPL and DNAPL were present beneath the former tank farm area. DNAPL was not detected at the former tank farm (AMAI 2001b). In March 2000, LNAPL was detected at a maximum thickness of 0.02 foot in Monitoring Well MW-3. However, four subsequent measurements taken from the well did not reveal a thickness of LNAPL. A similar investigation was conducted at the Building 5 area in 2000. Because methylene chloride was not a COC at the Building 5 area, only LNAPL measurements were attempted. No LNAPL was detected during the March 2000 sampling event; however, a 0.025-foot thickness of LNAPL was measured at Monitoring Well A-1 in June 2000 (AMAI 2000a). AMAI outlined additional work to be performed to evaluate the nature and extent of the LNAPL in its July 2000 CMS Report for the Building 5 area.

An ongoing study provides quarterly progress reports indicating dissolved concentrations of contaminants in groundwater around each SWMU. Groundwater was recently sampled in the area surrounding the Brule Incinerator in December 2000 (AMAI 2001a). Groundwater data from the December 2000 groundwater sampling event at the Brule incinerator are provided as Attachment A. Samples were collected at the Bubbling Gas Area and the Former Tank Farm Area in March 2001. Historical data summaries for these two SWMUs, including data from the March 2001 sampling event, are provided as Attachment B. Concentrations of several contaminants have been found in groundwater samples, exceeding maximum contaminant levels (MCL) and risk-based concentrations (RBC). The most recent sampling event did not identify any volatile organic compounds in excess of their respective MCLs at monitoring wells around the Brule Incinerator. Other compounds were identified at trace levels, but none indicated the presence of a contaminated groundwater plume.

March 2001 groundwater sampling results for the Bubbling Gas Area identified several COCs above their respective MCLs or RBCs. The COCs identified in the area included acetone, ethylbenzene, MIBK, toluene, xylenes, and methanol. MCLs or RBCs for one or more of the COCs identified were exceeded in Wells A-1R, A-2R, B-1, E-1, and G-1. The highest concentrations for each contaminant are shown in Table 1.

TABLE 1

MAXIMUM CONTAMINANT CONCENTRATIONS DETECTED IN MARCH 2001 AT THE BUBBLING GAS AREA

BRISTOL-MEYERS SQUIBB COMPANY, HUMACAO, PUERTO RICO

Contaminant	Maximum Concentration (µg/L)	Maximum Containment Level or Risk-Based Concentration (µg/L)	Well Identification Number
Acetone	1,860,000	610*	A-1R
Ethylbenzene	29,000	730	A-2R
Methyl Isobutyl Ketone	1,420,000	140*	A-1R
Toluene	6,000	1,000	A-2R
Xylenes	102,000	10,000	A-2R
Methanol	Not Sampled**	18,000*	--

µg/L = Micrograms per liter
= Risk-based concentration
** = The previous sampling event in December 2000 yielded a concentration of 7,280,000 µg/L in Well A-1R.

March 2001 groundwater sampling results for the Former Tank Farm Area identified several COCs above their respective MCLs or RBCs. The COCs identified in the area included: MIBK (4-Methyl-2-pentanone) and methylene chloride. MIBK was detected at a concentration of 190 micrograms per liter (µg/L) (RBC of 140) in Monitoring Well (MW) 3. Methylene chloride also exceeded its RBC of 140 µg/L in MW 3, with a concentration of 3,170 µg/L.

It should be noted that, in analytical results for samples collected from these SWMUs, some nondetects are listed at reporting limits above their respective RBCs or MCLs. In analytical results from the Brule Incinerator area, chloroethane, chloromethane and 1,1,2,2-tetrachloroethane were listed as nondetect at reporting limits above their respective RBCs or MCLs. No detections of these compounds were reported in the historical data for the Brule Incinerator area, and these compounds were never listed as COCs for the SWMU. These compounds were analyzed as part of a "catch all" Appendix IX analytical list and may therefore be disregarded. With regard to analytical results from the DST farm and Building 5 areas, original reporting limits were established in 1993 with the intent of identifying the presence of COCs rather than determining precise levels. Greater confidence should be placed on reporting limits established after 1997, when more information was known about the location and makeup of the COC plumes and more emphasis was placed on delineating them.

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 and Reference(s):

The migration of contaminated groundwater is expected to remain stable (i.e., the contaminated groundwater is expected to remain within vertical and horizontal dimensions of the "existing area of contaminated groundwater"[2]) based on the physical data and hydrogeologic setting as it is understood and described below. The expectation of no further migration of groundwater contamination is also based on the knowledge that the primary sources of contamination have been or will be further addressed through interim and final remedial actions (discussed in the response to Question 7) that should significantly reduce contaminant concentrations in groundwater traveling to the head of the groundwater plume.

Two aquifers lie beneath BMSMC in Humacao, Puerto Rico. An extensive lower aquifer, located in the weathered bedrock of the intrusive San Lorenzo batholith, is upwardly confined by 250 to 265 feet of dense clay. Production wells at BMSMC tap this lower aquifer. Above the thick clay confining unit, lie about 17 feet of fill, fine fluvial soils, sand, and clay. An unconfined, upper aquifer is located in these sandy deposits. Groundwater within the upper aquifer flows along a shallow gradient to the southeast and demonstrates seasonally variable water levels between 4.5 and 10 feet bgs. Locally, sediment transmissivity values have been measured at 600 to 2,000 square feet per day, with a specific yield of only 0.02 (EPA 2000). These values are one to two orders of magnitude below those typical of good production aquifers. Because of the thin, discontinuous nature of the upper aquifer, its relatively poor rate

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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 or tested in the future for a physical verification 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.

of production, and its proximity to the surface, BMSMC currently does not use water from the upper aquifer for any purpose, nor does BMSMC plan to tap the upper aquifer water source in the future. Regardless, the Commonwealth of Puerto Rico classifies the upper aquifer beneath the BMSMC facility as SGI water. SGI water is groundwater that serves or may serve as a source of drinking water or as a source of water for irrigation or other agricultural use. In accordance with this classification, BMSMC has established a remediation goal of restoring impacted groundwater to a level suitable as an SGI water (AMAI 2000a, 2001b).

AMAI collected data at the three BMSMC SWMUs of concern to evaluate groundwater contaminant concentrations, migration, and biodegradation. According to AMAI (2001b), COCs present in groundwater at BMSMC above applicable MCLs or RBCs are capable of in situ biodegradation under both aerobic and anaerobic conditions. Data collected during 2000 indicate that a variety of anaerobic degradation processes are occurring at BMSMC, including denitrification, manganese reduction, iron reduction, sulfate reduction, and methanogenesis. Field parameters, including dissolved oxygen, oxidation-reduction potential, temperature, and pH also support the evidence that intrinsic bioremediation of dissolved COCs is occurring at the BMSMC Site. In addition, groundwater samples for phospholipid fatty acid (PLFA) and volatile fatty acid (VFA) analysis were collected from select monitoring wells at the Brule Incinerator and Former Tank Farm. PLFA and VFA levels were high in wells within the dissolved COC contaminant plumes at the two SWMUs and low or not detected in wells near the border or outside of the plumes. This data suggests that a microbial community is active within the SWMU plumes, where COCs act as a food source, supporting the evidence that biologically mediated degradation is occurring in areas of elevated dissolved COC concentrations (AMAI 2000a, 2001b).

In addition to suitable biochemical conditions and the presence of microorganisms documenting the occurrence of natural attenuation (NA) within the dissolved COC plumes in groundwater, BMSMC also has significant historical data documenting the stabilization of dissolved COC plumes in groundwater at the three SWMUs. During the September 2000 sampling event, monitoring wells at the Brule Incinerator detected only one COC, benzene (8.9 µg/L), at a concentration above its MCL (5.0 µg/L). The subsequent sampling events however detected no COCs above their respective MCLs or RBCs, indicating that dissolved contaminants in groundwater were being effectively reduced at the SWMU. Historical groundwater data from the Former Tank Farm and Building 5 areas also indicate stabilization of the respective dissolved COC groundwater plumes (see Attachment B). With the exception of xylene detections below MCLs in Monitoring Well MW-15/DP-1 at the Former Tank Farm Area and in Monitoring Wells S-29R and S-30 at the Building 5 area, downgradient monitoring wells showed estimated (J-flagged) or no detections in the last four, quarterly, groundwater monitoring events.

Figures 2, 3, and 4 present positive groundwater detections at the three SWMUs of concern. Contours represent the approximate isoconcentration lines for a contaminant MCLs or RBCs. Contours are shown only for contaminants in exceedance of their respective MCLs or RBCs. Data presented are the most recent groundwater data provided for each of the three SWMUs of concern. March 2001 data are available for the Former Tank Farm Area and Building 5 Area, and December 2000 data area available for the Brule Incinerator Area.

It should be noted that, in analytical results for samples collected from these SWMUs, some nondetects are listed at reporting limits above their respective RBCs or MCLs. In analytical results from the Brule Incinerator, chloroethane, chloromethane, and 1,1,2,2-tetrachloroethane were listed as nondetect at reporting limits above their respective RBCs or MCLs. No detections of these compounds were reported in the historical data for the Brule Incinerator, and these compounds were never listed as COCs for the SWMU. These compounds were analyzed as part of a "catch all" Appendix IX analytical list, and may therefore be disregarded. With regard to analytical results from the DST farm and Building 5 areas, original reporting limits were established in 1993 with the intent of identifying the presence of COCs, rather than determining their precise levels. Greater confidence should be placed on reporting limits established after 1997, when more information was known about the location and makeup of the COC plumes and emphasis was switched to delineating them.

The hydraulic conductivity of water-bearing materials from the Building 5 area was determined using sieve analysis, and rising-head slug tests (ENSR 1997). Sieve analysis revealed a hydraulic conductivitiy between 1.8×10^{-2} centimeters per second (cm/sec) and 9.0×10^{-3} cm/sec. Rising-head slug tests, analyzed using the Hvorslev Method, produced hydraulic conductivitiy results between 9.07×10^{-3} cm/sec and 5.44×10^{-2} cm/sec, and an average hydraulic conductivity result of 3.00×10^{-2} cm/sec for four permanent monitoirng wells in the area.

ENSR Consulting and Engineering (1997) determined the hydraulic conductivity of the upper aquifer beneath the Building 5 area using sieve analyses, and rising-head slug tests. Sieve analyses revealed a hydraulic conductivitiy between 1.8×10^{-2} centimeters per second (cm/sec) and 9.0×10^{-3} cm/sec. Rising-head slug tests, analyzed using the Hvorslev Method, produced hydraulic conductivitiy results between 9.07×10^{-3} cm/sec and 5.44×10^{-2} cm/sec, and an average hydraulic conductivity result of 3.00×10^{-2} cm/sec for four permanent monitoring wells in the area. The water table gradient, based on water level measurements from 11 temporary piezometers in the Building 5 area, ranged from 0.022 to 0.0085 (ENSR 1997). The median range of hydraulic conductivities and of gradients produces a flow velocity of 0.0019 cm/sec or 595 meters (1,952 feet) per year. From release, the contamination plume beneath the Building 5 Area has traveled no more than 500 feet,the plume beneath the Former Tank Farm area has traveled no more than 380 feet, and the plume beneath the Brule Incinerator area has traveled no more than 110 feet. Comparison of plume movement to groundwater movement over the same period of time further supports the idea of plume stabilization.

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

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

_X_ 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):

The surface water body nearest BMSMC is Frontera Creek, which runs south along the northeastern corner of the property. Frontera Creek lies at least 300 feet downgradient of all SWMUs listed for the BMSMC property. Groundwater in the upper aquifer beneath BMSMC travels to the southeast.

No sediment or surface water sampling has been conducted at Frontera Creek to date; however, it is reasonable to assume that no contamination has migrated from the BMSMC property into Frontera Creek. Groundwater contamination associated with the Former Underground Tank Farm, Building 5, and the Brule Incinerator has shown to be stable and contained within the boundry of the plume, and the hydraulic gradient in these areas is shallow.

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)?

____ 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 <u>key</u> 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 judgement/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 <u>each</u> 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):

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

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):

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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 and Reference(s):

A monitoring well network has been established to monitor groundwater migration and to verify that the contaminant plume remains stable. Groundwater samples are currently collected quarterly and analyzed for COCs and natural attenuation parameters.

BMSMC has proposed corrective measures for the Former Tank Farm Area (AMAI 2001b), consisting of a phased approach to remediation of source areas. Phase I of remediation will consist of excavation and on-site treatment of soil source areas within the System 2 area of the tank farm. Phase II is proposed as a final corrective measure, consisting of either excavation and on-site treatment of source area soils or in situ treatment using air sparging. Monitored natural attenuation (MNA) is proposed as a remedial measure for contaminated groundwater at the former tank farm areas. BMSMC will conduct performance monitoring to evaluate the effectiveness of the above corrective measures. Monitoring wells to be used in performance monitoring include Wells MW-3, MW-5, and MW-7, within the plume; Wells MW-13 and MW-14, side-gradient of the plume; Well MW-16, upgradient of the plume; and Well MW-15, downgradient of the plume. Quarterly sampling began in March 2000 and will continue until December 2001. Semiannual sampling will continue from that point until 5 years following completion of the phased source area remediation.

Similarly, BMSMC has proposed corrective measures for the Building 5 area (AMAI 2000a). AMAI has identified a number of technologies for remediation of soil, including excavation and in situ soil vapor extraction, bioventing, air sparging, and chemical oxidation. The most effective technology will be selected, following pre-design activities at the site. MNA is proposed as a remedial measure for contaminated groundwater at the Building 5 area. Predesign analysis and data acquisition includes quarterly groundwater sampling, which began in March 2000 and will continue until sufficient data have been gathered to determine the viability of MNA as a final remedy for groundwater. Monitoring wells to be used in quarterly groundwater monitoring include Well UP-1, upgradient of the plume; Wells A-1, A-2, B-1, and S-27R, within the plume; E-1, at the toe of the plume; and S-30, downgradient of the plume. Crossgradient Monitoring

Wells D-1 and S-29R will be sampled semiannually. Additional predesign analysis and data acquisition measures include a groundwater level investigation, numerical modeling, field tests, an in situ respiration test, a soil permeability test, and an air sparge test.

For the Brule Incinerator, BMSMC has proposed implementation of interim corrective measures intended to remove the source of the groundwater impact (AMAI 2000b). The primary interim corrective measure calls for the excavation of soil overlying the impacted groundwater. The second apsect of the interim corrective measure would be the implementation of a groundwater monitoring program designed to evaluate the viability of MNA as a final groundwater remedy. Groundwater monitoring began in March 2000 and will continue until sufficient data have been gathered. Groundwater is monitored on a quarterly basis at Well BR-1, upgradient of the plume; BR-2, within the plume; and BR-3, downgradient of the plume.

Surface water and sediment sampling will not be necessary. COC plumes are expected to remain stable, and the local hydraulic gradient is shallow. Additionally, source removal has eliminated the potential for contamination of overland flow.

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).

 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 **Bristol-Myers Squibb Company** facility , EPA ID # **PRD090021056** , located at **State Road #3, Km 77.5, Humacao, Puerto Rico**. 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 Original signed by Date 09/27/01
Sin-Kie Tjho, Project Manager
RCRA Program Branch
EPA Region 2

Supervisor Original signed by Michael Poetszch for Date 09/27/01
Sam Ezskwo, Acting Section Chief
RCRA Program Branch
EPA Region 2

Approved by Original signed by Date 09/27/01
Raymond Basso, Chief
RCRA Program Branch
EPA Region 2

Locations where References may be found:

U.S. Environmental Protection Agency - Region 2
RCRA File Room
290 Broadway - 15th Floor
New York, New York 10007

Contact telephone and e-mail numbers

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REFERENCES

Anderson, Mulholland and Associates, Inc. (AMAI). 2000a."CMS Report: Building 5 Area, Squibb Manufacturing, Inc., Humacao, Puerto Rico." July.

AMAI. 2001b. "Corrective Measure Study (CMS) Report, Former Tank Farm Area, Bristol-Myers Squibb Manufacturing Company, Humacao, Puerto Rico." March.

AMAI. 2001a. "RCRA Corrective Action Program (CAP) Quarterly Progress Report, Bristol-Myers Squibb Manufacturing Company, Humacao, Puerto Rico. Report No. 2." Reporting Period January 1 through March 31, 2001. April.

AMAI. 2000b. "Field Investigation/Delineation Report and Interim Corrective Measure Work Plan: Former Brule, Incinerator Area, Squibb Manufacturing, Inc., Humacao, Puerto Rico." July.

AMAI. 2001c. "RCRA Corrective Action Program (CAP) Quarterly Progress Report, Bristol-Myers Squibb Manufacturing Company, Humacao, Puerto Rico. Report No. 01." Reporting Period October 1 through December 31, 2000. January.

ENSR. Consulting and Engineering (ENSR). 1997. "RCRA Facility Investigation (RFI) Report, Bubbling Gas Study Area, Squibb Manufacturing Inc., Humacao, Puerto Rico." Document No. 6290-023-50. May.

U. S. Environmental Protection Agency (EPA), Region 2. 2001. "Summary of Groundwater Sampling Results for the Former Tank Farm Area and the Building 5 Area." Provided by Sin-Kie Tjho. June 25.

EPA, Region 2. 2000. "Final Permit, Bristol-Myers Squibb Manufacturing Co., Humacao, Puerto Rico. Volume 3 of 6." Permit not Included. September.

Attachment L:
Scope of Work for RCRA Facility Investigation

Attachment M:
Scope of Work for Corrective Measure Study

Attachment N:
Versar, Inc. 1987. "Revised Final Report, RCRA Facility Assessment, Squibb Manufacturing, Inc., Humacao, Puerto Rico." November 4.

Commonwealth of Puerto Rico Environmental Quality Board. 2000. Land Pollution Regulation Program, Hazardous Waste Division. "RCRA Facility Assessment (RFA) Update, Squibb Manufacturing, Inc., Humacao, Puerto Rico, PRD 090021056." March.

Attachment O:
Facility Description with Site Photographs, Maps, and Aerial Photographs

Attachments truncated, see facility file (MSS, 03/06/02)