DOCUMENTATION OF ENVIRONMENTAL INDICATOR DETERMINATION

Interim Final 2/5/99

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

Migration of Contaminated Groundwater Under Control

Facility Name:	Union Carbide Corporation – Technical Center
Facility Address :	3200-3300 Kanawha Turnpike South Charleston, West Virginia 25303
Facility EPA ID#:	WVD060682291

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

The following discussion provides a brief background and overview of information collected to date regarding known or reasonably suspected releases to groundwater.

The Union Carbide Corporation (UCC) Technical Center, also referred to as the Facility, is located in South Charleston, West Virginia (Figure 1). The property encompasses approximately 681 acres. Approximately 125 acres are developed. As shown in Figure 1, the Facility is located adjacent to I-64, and approximately 4,000 feet south of the Kanawha River. The Technical Center provides research and development and process engineering for UCC and leases building space for other entities. The Facility includes major laboratory buildings, pilot plant areas, waste packaging and storage facilities, office buildings, and shops.

RCRA Corrective Action activities are currently being performed as part of a Facility Lead Agreement with EPA Region III, which was signed on December 15, 1999. Several investigations pertinent to this Groundwater Environmental Indicator (GWEI) determination have been conducted at the Facility, as summarized in the paragraphs below. A detailed history of facility operations and previous investigations is presented in the report entitled RCRA Facility Investigation (RFI), South Charleston Technical Center, South Charleston, West Virginia (CH2M HILL, January, 2005).

Previous Investigations

Several investigations were conducted at the Facility between 1989 and 2005 that defined the nature and extent of groundwater contamination. Monitoring wells were installed and sampled during each successive investigation, which not only continued to build an understanding of the nature and extent of contamination, but also provided temporal data for existing monitoring points. Figure 2 shows the locations of all of the monitoring wells installed at the Facility during the investigations described below.

RCRA Facility Assessment (Kearney, 1989). *A RCRA Facility Assessment (RFA) was conducted in 1989 in accordance with a RCRA Corrective Action permit issued to UCC by EPA Region III in 1985. Sixty-two solid waste management units (SWMUs) were identified as part of this RFA. Twenty-five piezometers, and five monitoring wells (MW-1 through MW-5, shown on Figure 2), were installed during the RFA to provide an initial characterization of the groundwater quality at the Facility. Subsequent groundwater investigations were conducted in 1990 and 1992 during which wells MW-6 through MW-22 (Figure 2) were installed to further*

characterize groundwater at the Facility. Groundwater data collected from these wells was evaluated in the investigation summarized below.

Category A SWMU RFI (Key, 2001). *An RFI focusing on the Category A SWMUs was conducted 2001. The Category A RFI consisted of an historical activity review, which eliminated two High Priority SWMUs from further consideration, and field investigation activities for the remaining four High Priority SWMUs. Soil, groundwater, surface water, and waste material were sampled during the Category A RFI. Based on this RFI, and the results of the 1989 RFA, constituents of interest in groundwater were reported to be bis(2-chloroisopropyl)ether, benzene, di-n-octylphthalate, arsenic, barium, lead, and chromium. Further, the data suggested the groundwater contamination originated in the Upper Ward and Lower Ward landfills, and was located primarily within the Upper Freeport Sandstone bedrock unit. The RFI Report recommended installation of monitoring wells in the Upper Freeport Sandstone to the northwest (downgradient) of monitoring wells MW-20, MW-21, and MW-22, shown on Figure 2, to determine the downgradient extent of contamination relative to the property boundary.*

Following the recommendations made in the RFI Report, three Upper Freeport monitoring wells (wells MW-23 through MW-25, shown in Figure 2) were installed in late 2001. Three additional Upper Freeport monitoring wells (wells MW-26 through MW-28, shown in Figure 2) were installed in mid-2002 based on the analytical results from wells MW-23 through MW-25 and regulatory agency input. Most of these wells contained constituents of interest, but the concentrations declined in the downgradient direction and only bis(2-chloroisopropyl)ether, bis-2(ethylhexyl)phthalate, and barium were present at concentrations above the EPA Region III Risk-Based Concentration (RBC) or Maximum Contaminant Level (MCL). Further, the sporadic nature of the detections and concentrations of bis-2(ethylhexyl)phthalate suggests its presence may be attributable to its common occurrence in plastics (e.g., PVC wells) and/or to its common occurrence as a laboratory contaminant.

Phase I Groundwater Evaluation*: In July 2003, two additional groundwater monitoring wells (MW-29 and MW-30, shown in Figure 2) were installed into the Upper Freeport to assess whether any groundwater contaminant migration may occur radially from the Upper and Lower Ward, shown in Figure1, prior to converging north toward I-64. The data collected from these wells, as well as from a monitoring well located north of I-64 (BW-2, shown in Figure 2), supported the original supposition that contaminated groundwater migrated in the general downgradient direction toward I-64, and did not migrate radially away from the Upper and Lower Ward landfills.*

RCRA Facility Investigation for Solid Waste Management Units (CH2M HILL, 2005). *Based on the results of the RFA, Category A RFI, and the Phase I Groundwater Evaluation, an additional RFI was conducted to gather sufficient information to evaluate potential human health and environmental risks associated with SWMUs for which initial investigation, or further investigation, was deemed necessary. Two of the goals of this RFI were to provide analytical data to support preparation of the GWEI, and to further define the downgradient extent of groundwater contamination.*

A historical data evaluation conducted as part of the RFI Workplan development recommended 55 of the Low Priority SWMUs for no further action, and 11 SWMUs for further action. Groundwater associated with the 11 SWMUs, which are shown in Figure 2, was evaluated as part of this RFI. In addition, two bedrock groundwater monitoring wells (MW-31 and MW-32, shown in Figure 2) were installed in the Upper Freeport north of I-64 to determine the downgradient extent of groundwater contamination, primarily bis(2-chloroisopropy)ether. During the RFI, the on-site and off-site wells were sampled and surface water and sediment samples were also collected from Ward's Branch.

The results of the RFI concluded that limited, isolated, groundwater is present in the overburden at the Facility, and confirmed contamination in bedrock groundwater exists as a result of constituents present in the Upper and Lower Ward landfills. Further, groundwater data from MW-31 and MW-32 indicated that the downgradient extent of the groundwater contamination attributed to the Upper and Lower Ward landfills had been delineated.

Definition of Environmental Indicators (for the RCRA Corrective Action)

EIs 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 Determination 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 providing or 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)

As summarized above, several iterations of groundwater investigation activities occurred at the Technical Center from 1989 to 2005 to define the nature and extent of groundwater contamination. Specifically, groundwater investigations conducted between 2001 and 2005 have determined that an area of groundwater contamination exists at the Facility which originated in the Upper and Lower Ward landfills and extends in the downgradient direction towards Route I-64. Figure 2 shows the approximate area of groundwater contamination at the Facility.

For the purposes of preparing this GWEI determination, groundwater analytical results from historical sampling events were evaluated, with emphasis on the most recent events, conducted in 2004 and 2005. During 2004 and 2005, groundwater was analyzed for Volatile Organic Compounds (VOCs), Semi-Volatile Organic Compounds (SVOCs), and barium. The analysis conducted in 2004 and 2005 included:

- *SVOCs and barium in July 2004;*
- *VOCs, SVOCs, and barium in October 2004 and February 2005; and*
- *VOCs in June 2005.*

Based on a review of the 2004 and 2005 groundwater data, VOCs, SVOCs, and barium are present in groundwater at concentrations that exceed applicable groundwater criteria (MCLs or RBCs). Tables 1 through 3 below show, by constituent type, the maximum concentration detected for each constituent present above the applicable criteria during the 2004 and 2005 sampling events.

Table 1 shows that only two VOCs, 1,4-dioxane and benzene, were present above regulatory criteria. However, the June 2005 sampling showed that these two constituents were not present in the most downgradient wells (MW-31 and MW-32) at the Facility. In February 2005, several wells located in and near the Lower and Upper Ward Landfills, and surface water from Upper Ward Landfill, were sampled to determine the potential source of the 1,4-dioxane in the Ward Hollow groundwater monitoring wells. None of the wells from potential UCC source areas (Upper and Lower Ward Landfill) upgradient of Ward Hollow stream showed detectable concentrations of the 1,4-dioxane constituent. The conclusion is that the 1,4-dioxane in the groundwater at the Technical Center is not from the Upper and Lower Ward former landfills, but is likely from an off-site (non UCC) source.

Table 2 shows that the only SVOCs present above regulatory criteria were bis(2-chloroisopropyl)ether and bis(2-ethylhexyl)phthalate. Bis(2-chloroisopropyl)ether has never been detected in the two most downgradient wells. Bis(2-ethylhexyl)phthalate was detected at a level slightly above the EPA Region III RBC in February 2005, and has been detected only sporadically during previous sampling events. As shown in Table 3, barium was detected above its regulatory criterion in groundwater during the February 2005 sampling event. However, barium was not detected at the two most downgradient well locations.

Based on the current understanding of the extent of groundwater contamination associated with the Facility, there are no drinking water or production wells affected, or with the potential to become affected, by contaminated groundwater at the Facility. Potable water for Charleston and South Charleston is provided by the West Virginia-American Water Company. The Kanawha River is located over 4,000 feet from the northern border of the Facility, as is further described in response to Question 3 below.

The conclusion from this evaluation of the 2004 and 2005 data, is that groundwater at the Facility is contaminated with VOCs, SVOCs, and barium at concentrations that exceed applicable groundwater criteria (MCLs or RBCs). The groundwater contamination emanates from the Upper and Lower Ward landfills, extends downgradient toward MW-27 and MW-28 (near I-64), as shown in Figure 2, and is generally confined to the Upper Freeport Sandstone.

Table 1
VOC - Constituents of Interest
Maximum Groundwater Concentrations Compared to Screening Criteria

Volatile Organic Compounds	Maximum Concentration (ug/L)	Sample Location	Sample Date	MCL or RBC (ug/L)	
1,4-Dioxane (1)	333	MW-23	2/8/05	6.1	RBC
Benzene	69.8	MW-1	6/15/05	5	MCL

(1) Also detected above groundwater criteria during the June 2005 sampling event.

Table 2
SVOC- Constituents of Interest
Maximum Groundwater Concentrations Compared to Criteria

Semi-Volatile Organic Compounds	Maximum Detection (ug/L)	Sample Location	Sample Date	MCL (ug/L)	
Bis (2-chloroisopropyl) ether	344	MW-21	2/8/05	0.26	MCL
Bis (2-ethylhexyl) phthalate	7.03	MW-32	2/8/05	6.0	RBC

Table 3
Metals – Constituent of Interest
Maximum Groundwater Concentrations Compared to Criteria

Metals	Maximum Detection (mg/L)	Sample Location	Sample Date	MCL (mg/L)	
Barium	55.1	MW-26	2/8/05	2	MCL

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):

Based on the available information about site geologic, hydrogeologic, and hydrologic conditions, the area of contaminated groundwater at the Facility is considered to be stabilized. This determination was made based on the following:

- *Groundwater is absent or localized in the overburden at the Facility*
- *Groundwater flow and the area and extent of groundwater contamination are well-defined*
- *Groundwater contaminant concentrations have been stable over the sampling period and contamination decreases significantly in the downgradient direction*

Groundwater is absent or localized in the overburden at the Facility

In general, groundwater is absent from the overburden, and is limited to the bedrock underlying the Facility. During the 2005 RFI, overburden groundwater was found only at SWMU 11, which is shown in Figure 2, and was likely more indicative of an isolated zone of saturated soil than areally extensive groundwater.

Groundwater flow and the area and extent of groundwater contamination are well-defined

The area and extent of groundwater contamination are well-delineated, based on the 2005 RFI and previous investigations. The groundwater contamination, which is found primarily in the Upper Freeport Sandstone, emanates from the Upper and Lower Ward landfills, and extends downgradient toward MW-27 and MW-28, as shown in Figure 2.

Groundwater contaminant concentrations have been stable over the sampling period and contamination decreases significantly in the downgradient direction

Based on the groundwater data collected in 2004 and 2005 described above, there were no VOCs or barium detected above regulatory criteria in the most downgradient wells (MW-31 and MW-32, shown on Figure 2). 1-4 dioxane was detected in MW-32 in the October 2004 sampling event, but was not detectable in the February 2005 and June 2005 sampling events. In February 2005, only one SVOC, bis(2-ethylhexyl)phthalate (MW-32), was detected at a concentration above groundwater criteria. Bis(2-chloroisopropy)ether, the primary constituent of interest in groundwater, has not been detected in either MW-31 or MW-32. In addition to having defined the downgradient extent of groundwater contamination, data from successive groundwater sampling events conducted since 2000 show that concentrations of detected constituents have remained relatively stable within the area of groundwater contamination, shown in Figure 2.

Because the most downgradient wells do not contain the primary constituents of interest attributed to the Facility, and because the constituent levels in the more upgradient wells have remained relatively stable over time, migration of contaminated groundwater at the Facility has been determined to be stabilized.

Footnotes:

[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 samples/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 location are permissible to incorporate formal remedy decisions (i.e., including public participation) allowing a limited area for natural attenuation.

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 Kanawha River, located over 4,000 feet from the northern border of the Technical Center, is likely the closest potential discharge point for groundwater within the Upper Freeport Sandstone. The most downgradient Facility wells (MW-31 and MW-32) have not shown the presence of contamination attributed to the Facility during the last two sampling events. Therefore, Facility-related contaminants are not currently discharging to the Kanawha River.

The piezometric surface of the Upper Freeport Sandstone is 70 to 120 feet below Ward’s Branch, which suggests that contaminated groundwater is not discharging to Ward’s Branch.

Therefore, based on the regional geologic and hydrogeologic information, contaminated groundwater from the Facility is not discharging to on-site or off-site surface water bodies.

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 reasonable suspected concentration[3] of key contaminants discharged above their groundwater "level," the value of the appropriate "level(s)," and if there is evidence that the concentrations are increasing; and 2) provide a statement of professional judgment/explanation (or reference documentation) supporting that the discharge of groundwater contaminants into the surface water is not anticipated to have unacceptable impacts to the receiving surface water, sediments, or eco-system.

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

____ If unknown – enter "IN" status code in #8.

Rationale and Reference(s):

Footnotes:
[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, us/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):

[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 tot he 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):

Evaluation of groundwater contamination will be part of future RFI activities as needed and, if necessary, future corrective action.

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 *The Union Carbide Corporation, Technical Center Facility*, EPA ID # *WVD060682291*, located at *3200-3300 Kanawha Turnpike, South Charleston, West Virginia 25303*. 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 (signature) /s/ Date 8/25/05

(print) _____

(title) _____

Supervisor (signature) /s/ Date 8/25/05

(print) _____

(title) _____

(EPA Region or State) _____

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