United States Environmental Protection Agency Statement of Basis For Corrective Action At Solid Waste Management Unit #01/12 (Mustard Gas Burial Ground) Naval Surface Warfare Center, Crane, Indiana

Introduction

This Statement of Basis (SB) was prepared to satisfy requirements of the Resource Conservation and Recovery Act (RCRA) Corrective Action Process. This process is designed to identify sites that are known to be, or may be, hazardous to human health and the environment, and to propose and implement remedies for correcting unacceptable environmental conditions. This introduction describes the site to which this SB applies, the environmental conditions at the site, and the action that is proposed to ensure future protection of human health and the environment.

Facility Name and Description

This SB applies to the Mustard Gas Burial Ground (MGBG), located on a remote ridge top in the southeastern area of the Naval Surface Warfare Center (NSWC) Crane (Figure 1). NSWC Crane is located in a rural, sparsely populated south central region of Indiana, USA. Most of NSWC Crane is forested, and the surrounding area is wooded or farm land.

NSWC Crane manufactures, renovates, and tests equipment, shipboard weapons systems, and ordnance for the U.S. Navy. More detailed physical and operational descriptions of NSWC Crane and SWMU 01 are provided in Section 1.0 of the RCRA Facility Investigation (RFI) report (TtNUS, 2004) and in the text below.

The MGBG is listed as Solid Waste Management Unit (SWMU) 01/12 in the site's RCRA permit. It is commonly referred to as SWMU 01 or the MGBG (Figure 2).

Purpose of Document

This Statement of Basis:

- is a mechanism and basis for gathering public comments for selection of a remedy to correct unacceptable groundwater conditions that exist at the MGBG.
- describes MGBG contaminants and the proposed RCRA Corrective Action remedy at the NSWC Crane. It also explains the rationale for selecting this remedy from among other possible remedies.
- describes all remedies evaluated in the process of selecting the proposed remedy.

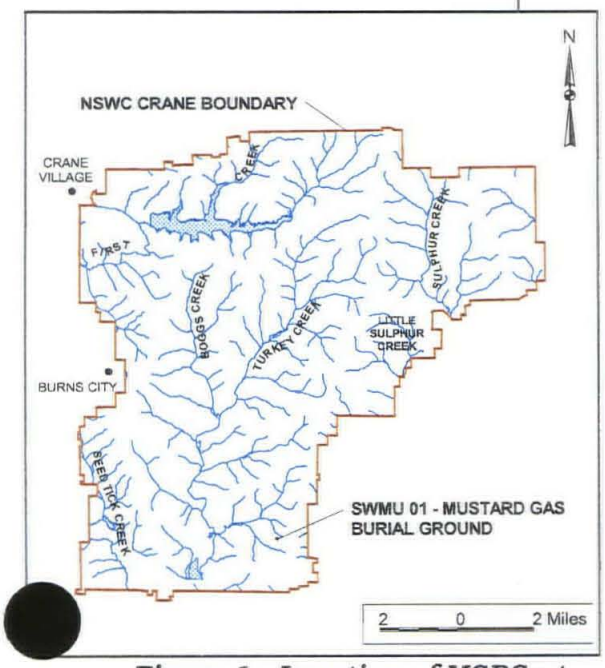

Figure 1: Location of MGBG at NSWC Crane

Figure 2: Mustard Gas Burial Ground

Importance of Public Comment

The "public" includes the general public, the owner or operator of NSWC Crane, and other parties (e.g., public interest groups, other regulatory agencies). Because of a slight potential for exposure of the public to MGBG groundwater contaminants, the public may have an interest in understanding the environmental conditions at the MGBG and the relationship of the proposed or alternate remedies to correcting the environmentally unacceptable conditions.

Proposed Remedy

The proposed Corrective Action remedy is to continue monitoring groundwater conditions at the MGBG and implement land use controls at the site. This remedy will ensure that controls are in effect to prevent human exposure to site contaminants. With these controls in place exposure potential is extremely low. The additional data will improve estimates of how fast contaminant concentrations are decreasing in the MGBG groundwater. These refined estimates will ensure that land use controls remain in place until contaminant concentrations reach acceptable levels.

This remedy was selected for the following reasons:

- An unacceptable human health risk currently exists for anyone who would be exposed to MGBG groundwater, but the risk can be controlled under the proposed remedy.
- The proposed remedy will serve to cost-effectively protect human health and the environment while gathering data to confirm improving site conditions through natural attenuation of contamination.
- The proposed remedy may provide additional time for new technologies to be developed that could lead to more aggressive, yet still cost-effective remedies than those already considered.

Descriptions of the NSWC Crane MGBG site conditions, the remedies considered prior to selecting the proposed remedy, and the proposed remedy are provided in the sections that follow.

Facility Background

Description of NSWC Crane Mustard Gas Burial Ground

The MGBG (Figure 2) was originally a 2-acre area surrounded by a fence. This area was used between the end of World War II and 1956 for disposal of hazardous materials (USACE WES, 1991). Disposal was in the form of shallow burials (pits), typically within 6 feet of the ground surface. Evidence gathered to date indicates that these burials occurred in a small area within the 2-acre site. The smaller area is approximately 0.2 acres in size and is called the Primary Burial Area (PBA). Three types of hazards or possible hazards were originally identified at the site. They were:

- Mustard gas bombs (without explosives).
- Thorium nitrate powder (used in pyrotechnic flares; weakly radioactive).
- Small quantities of unspecified chemical laboratory wastes.

The closest NSWC Crane property boundary is approximately one mile east of the MGBG. The MGBG geology is fractured bedrock with limited groundwater flow potential. This type of geology limits the success of treating the groundwater to remove contaminants because it is difficult to pump treatment chemicals into, or out of the bedrock. The primary groundwater flow direction is northwest toward the interior of the NSWC Crane and away from the nearest NSWC Crane property boundary.

Soil Investigations Conducted at the MGBG Site

Two excavations (in 1974 and 1980) were undertaken to remove buried hazards at the MGBG (TtNUS, 2004). Field testing for mustard gas and soil screening for radiation were performed. In addition, laboratory radiation analyses were reported to have been conducted. Some mustard gas and radioactive thorium were found during the excavations. By 1980, the radioactive material and mustard gas had been removed and properly disposed off site.

After the excavations, the risk of exposure to mustard agent was determined to be extremely small. In addition, the site was cleared for unrestricted use with regard to radioactive contamination (U.S. Navy, 1980). Further details regarding the excavations are presented in the MGBG RFI report, Section 1.3.3 (TtNUS, 2004).

Groundwater-Related Environmental Investigations

In the early 1980s chlorinated solvent contamination was detected in groundwater northwest and west of the MGBG (Figure 3). The groundwater contaminant plume extended several hundred feet to the northwest of the MGBG with concentrations of total solvent (industrial cleaning chemicals) concentrations in the

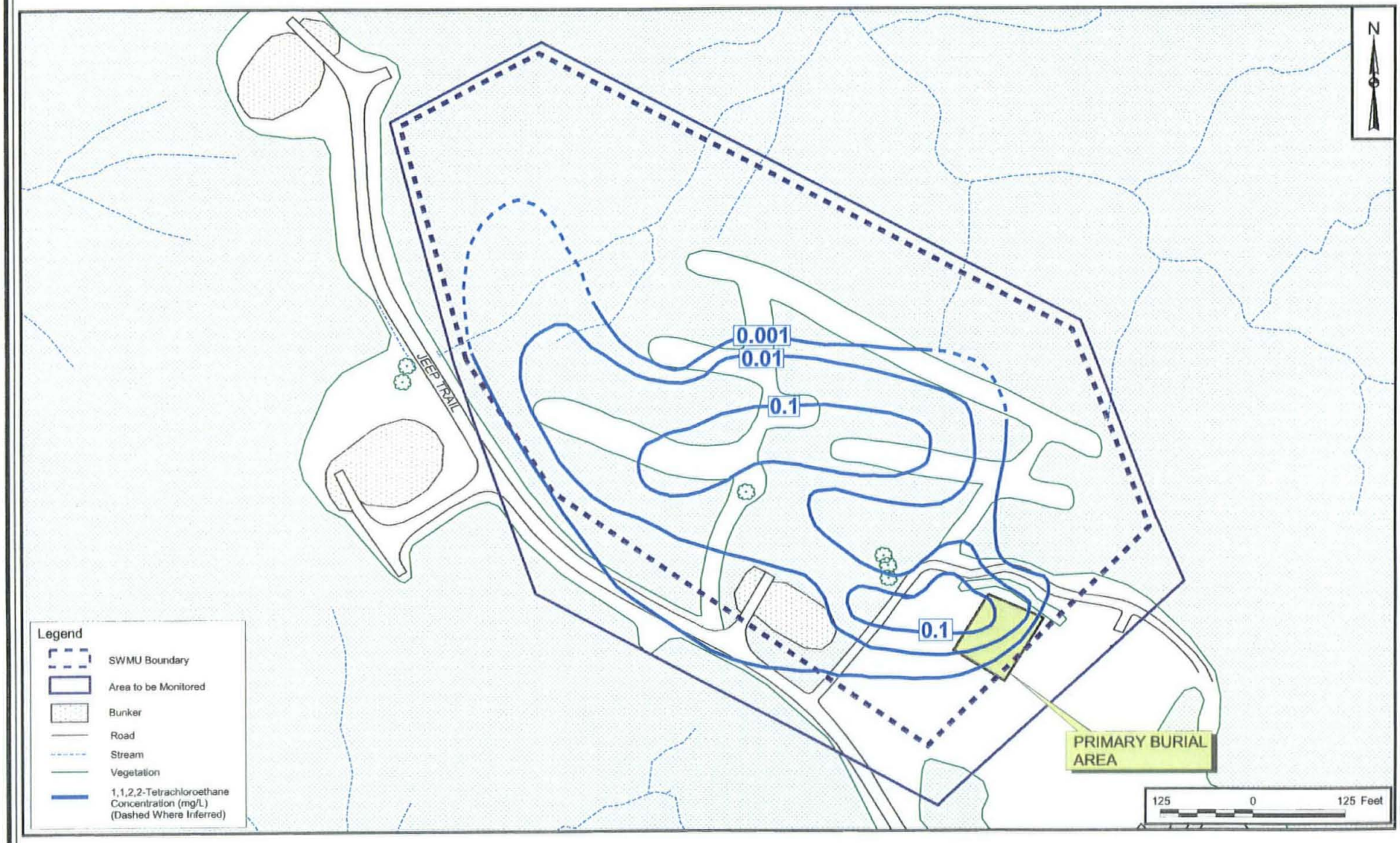

Figure 3 Proposed MGBG Groundwater Monitoring Area

hundreds of milligrams per liter (mg/L) near the source area. One mg/L is effectively the same as one part out of one million parts. For example, one drop out of 10 gallons of water is equal to about one part per million. In 1993, a magnetometer survey for buried metal was conducted. This survey identified two buried metal objects just south of the PBA.

RFI Phase III investigations were conducted in 2001 and 2002 (TtNUS, 2004). During this time, new monitoring wells were installed to more completely define the extent of the groundwater solvent plume (Figure 4). A total of 34 wells have been installed.

Figure 4: Installation of Well 01T05

Twenty-one soil cores were removed, generally to a depth of 10 feet across the 2-acre MGBG. In some areas, like the PBA, the soil depth was no greater than 7 feet before hitting bedrock. The highest number of soil borings was in the PBA which was the suspected contaminant source area. Fifty-nine (59) soil samples were analyzed from the soil cores. Surface water and sediment samples were also collected from drainage gullies leading away from the MGBG. Two metal objects identified during the 1993 magnetometer survey were excavated and found to be non-ordnance related metal debris, including an old fence post and two perforated metal plates (Figure 5).

Based on the site history and the available data, the PBA was identified as the solvent contaminant source area. This was further supported with groundwater and soil analyses performed during a Corrective Measures Study (CMS) conducted at the site (TtNUS, 2005). During the CMS, excavations were conducted to try to locate high solvent concentrations in soil that could be the source of the groundwater contamination. Figure 3 shows the location of the PBA and the current extent of the groundwater solvent plume, as represented by the solvent 1,1,2,2-tetrachloroethane.

Figure 5: Looking West Over Excavated Metal (foreground)

Summary of MGBG Risks

After conducting the RFI, the MGBG boundary was expanded to approximately 12 acres to more accurately reflect the area of contaminated groundwater. This new SWMU boundary is shown on Figure 3. The solvent plume extends approximately 800 feet northwest of the PBA.

Groundwater is the only environmental medium th presents an unacceptable risk. This unacceptable ris could be experienced by children or adults if they were to live at the MGBG and use the groundwater for drinking and other domestic uses. Risk to a construction worker could also occur if, for example, the worker would excavate into the groundwater and become exposed in that manner.

The possible risks are an increased frequency of cancer and non-cancer health problems as compared to use of uncontaminated groundwater. In particular, the cancer-related risks were estimated to exceed the 1E-6 to 1E-4 risk range established by the U.S. Environmental Protection Agency (U.S. EPA) as acceptable. A 1E-6 risk corresponds to one additional person out of a million people developing cancer beyond what is normally expected. The 1E-4 risk corresponds to one person out of 10,000 people developing cancer beyond the normal cancer risk. The non-cancer-related hazard estimates for the construction worker, the future child resident, and the future adult resident for the groundwater exposure pathway were greater than unity (1.0) for the MGBG. A non-cancer risk greater than 1.0 is considered to be unacceptable. The degree of risk would be proportional to the frequen and duration of exposures to the groundwater. A futu site resident would have the greatest frequency and duration of exposure and hence, the greatest risk. The RFI report (TtNUS, 2004) explains the risk exposure assumptions in detail.

The solvent chemicals responsible for the majority of risk are:

- 1,1,1,2-Tetrachloroethane (1,1,1,2-PCA)
- 1,1,2,2-Tetrachloroethane (1,1,2,2-PCA)
- 1,1-Dichloroethene (1,1-DCE)
- 1,2-Dichloroethane (1,2-DCA)
- Chloroform
- cis-1,2-Dichloroethene (cis-1,2-DCE)
- Tetrachloroethene (PCE)
- Trichloroethene (TCE)

Some of these organic chemicals are frequently used to remove grease from equipment and may also be laboratory chemicals. Some of the chemicals are breakdown products of parent organic chemicals. For example, microbes are known to break down PCE and TCE into cis-1,2,-DCE. Because the breakdown products are present, it is clear that the primary solvent contaminants have been degrading without any form of engineered groundwater treatment.

In addition to human health risks from exposure to solvents in groundwater, much less potential for risk would come from exposure to the following chemical contaminants in MGBG groundwater:

- Arsenic
- bis(2-ethylhexyl)phthalate (BEHP)
- Heptachlor
- Hexachloroethane
- Manganese

The arsenic and manganese are naturally occurring metals that could also originate from industrial processes. The available evidence, however, suggests that the elevated levels of arsenic and manganese could be coming from the native soil and bedrock. The remaining three contaminants were detected infrequently at only very slightly unacceptable levels. Their concentrations would likely be reduced by the proposed remedy.

The estimated risks described above are based on maximum observed contaminant concentrations and conservative exposure scenarios that deliberately overestimate the degree of risk in order to be protective of human health and the environment. Table ES-1 of the RFI report (TtNUS, 2004) presents a more detailed summary of these risks.

The greatest risk to human health would be associated with the use of groundwater from within and immediately downgradient of the PBA. Less risk would be experienced if groundwater from other areas of the MGBG were used. The PBA spans approximately 0.2 acres and is much smaller than the current 12-acre MGBG. The MGBG is within the NSWC Crane boundary and there are currently no domestic/ residential users of MGBG groundwater. There is little possibility of solvent-contaminated groundwater leaving NSWC Crane because the predominant direction of horizontal groundwater movement has been essentially entirely northwest from the Primary Burial Area toward the interior of NSWC Crane. The groundwater data also show that vertical movement of the solvent plume has been minimal. There are no known impacts to surface water from the contaminated groundwater. The foreseeable MGBG land use is expected to remain as it currently is for quite some time into the future, with limited access to the public. Because the MGBG is in a remote area of NSWC Crane, its use is even more limited than other operations at this facility.

All of the groundwater data collected to date show that the solvent plume has remained fairly "stable" (i.e., has not grown in size) in recent times. An apparent expansion was noted previously when wells were installed in the direction of groundwater (and past solvent) movement, however, those wells have shown that the solvent concentrations in groundwater decrease toward the northwestern edge of the plume and have remained relatively unchanged in the past several years. Fluctuations in solvent concentrations on the perimeter of the plume are minor. Over time, the solvent concentrations have decreased, therefore, the solvent plume and the MGBG contamination boundary are expected to shrink naturally. As pointed out in the CMS report, the rates of solvent concentration decreases, and the plume shrinkage rate, are very uncertain at this time. It is likely that the plume will break into smaller plumes within the current boundary as the concentrations decrease.

No unacceptable ecological risks were identified for the MGBG Site.

Scope of Corrective Action

All evidence collected between 1981 and the present indicate that the maximum concentrations of groundwater solvent chemicals have decreased to less than one one-hundredth (<1%) of their original levels that were measured in 1981. The decreases have occurred through natural mechanisms such as chemical or biochemical degradation, dilution, and dispersion. Ultimate elimination of contaminants

through active treatment or natural mechanisms is expected to eventually remove the risk that could occur from exposure to MGBG groundwater. This will eventually make the MGBG groundwater suitable for use.

The number of actions that could be taken at the MGBG to remove MGBG groundwater contaminants is limited because of underlying geologic conditions. These conditions limit the effectiveness of pumping treatments into the contaminated groundwater or pumping contaminated groundwater out of the ground for treatment.

Corrective actions that were potentially effective for use at the MGBG were evaluated when selecting the proposed remedy. The possible actions that could be taken to reduce the human health risks focused on solvents because those chemicals pose the greatest potential risks to identified receptors.

Corrective Action Alternatives Evaluation Process

Evaluation of corrective actions began with a relatively large number of possible technologies that might be applicable at the MGBG. However, the list of technologies was rapidly reduced to a "short list" of actions considered to be practical and cost-effective. These actions were evaluated in detail. All corrective actions that were considered are described in the CMS report (TtNUS, 2005). The "short-listed" actions that were evaluated in the greatest detail were:

Alternative No. 1 – No Action. The No Action alternative maintains the site as is and is retained to provide a baseline for comparison to other alternatives. This action is not an active action that would actively reduce contaminant concentrations.

Alternative No. 2 – Natural Attenuation with Monitoring and Land Use Controls. This alternative includes two main components: (1) Land Use Controls (LUCs) and (2) Groundwater Monitoring throughout the 12-acre MGBG (Figure 3). Land use controls would restrict future site development and prohibit groundwater use. Land use controls would also include regular site inspections to verify that effective controls stay in place until it is appropriate to remove them. Groundwater monitoring would consist of periodically collecting and analyzing groundwater samples from monitoring wells located at the site. The analytical data would be used to evaluate site conditions, especially the contaminant concentrations. The controls and inspections would be implemented and enforced by NSWC Crane with oversight from the U.S. EPA Region 5. NSWC Crane would be responsible to periodically report on site conditions to the EPA. The objective of this corrective action would be to monitor and assure the public that acceptable solvent contaminant concentrations are eventually achieved through natural mechanisms while at the same time protecting the public and the environment by prohibiting groundwater use.

Alternative No. 3 – *In-Situ* Anaerobic Reductive Dechlorination with Land Use Controls and Monitoring. An aggressive treatment strategy was developed to reduce contaminant concentrations to acceptable levels in a very short time frame. The strategy involves aggressive treatment of the entire solvent contaminant plume to attain Media Cleanup Standards (MCSs) within 1 year. MCSs are chemical concentrations that must be achieved to ensure that the contaminants do not cause undue risk. Initial chemical injections would be followed by several repeat injections and monitoring over the next 15 years to make sure that the contaminant concentrations are acceptable and remain acceptable. Land use controls would also be implemented. NSWC Crane would implement this strategy with oversight by U.S. EPA Region 5. NSWC Crane would report periodically to the EPA concerning site conditions. The objective of this strategy would be to rapidly achieve acceptable solvent contaminant concentrations through active remediation while protecting human health and the environment. The main disadvantage of this alternative is that its success depends on precisely determining the locations where treatment needs to occur, which is a difficult and expensive task in a bedrock aquifer. Furthermore, following the treatment, the duration for the plume to reach MCSs would continue to be uncertain because of the nature of the aquifer (i.e., slow groundwater movement and tortuous water flow pathways). An additional disadvantage would be the extensive area over which trees would need to be cleared, and wildlife habitat destroyed, to make way for the chemical injection points.

Cost Evaluation

There would be no cost associated with implementing Alternative 1; Comparative estimated costs (in terms of what they are worth today) for Alternatives 2 and 3 are:

Cost Item	Alternative 2	Alternative 3
Present-Worth[1]	$350,000	$9,402,000

[1] The present value (or worth) of an investment is the total amount that a number of future payments is worth now, in today's dollars.

Consideration was given to factors such as the current concentrations and the time required to attain acceptable solvent concentrations (i.e., MCSs), both

with and without active treatment. Details of the uation process and the factors that were considered presented below, and in more detail in the CMS Report (TtNUS, 2004).

Other Considerations

Clean up standards tend to change over time and so does the availability of new technologies that are more effective than current technologies for cleaning up contaminants. Other factors, such as land use, may also change. Therefore, the details of cleanup such as the actual cleanup levels to be achieved and the time frames for achieving those levels will be determined during the design of the final remedy that is accepted by EPA and the public. These details will be incorporated into the Corrective Measures Implementation (CMI) work plan. This is where the design of the remedy and the measures by which it is judged to be effective will be described.

Evaluation of Proposed Remedy and Alternatives

The process used to evaluate the three alternative corrective actions is described below.

Remedy Evaluation Criteria

alternative corrective actions were evaluated using specific criteria set forth in the Office of Solid Waste and Emergency Response (OSWER) Guidance Document 9902.3-2A, RCRA Corrective Action Plan (EPA, 1995) as follows:

- Protection of human health and the environment
- Attainment of media cleanup standards
- Control of release sources
- Compliance with applicable standards for waste management

Other factors including:

- Long-term reliability and effectiveness
- Reduction in toxicity, mobility, or volume of wastes
- Short-term effectiveness
- Implementability
- Cost

In addition, the following criteria were evaluated.

- Potential for regulatory acceptance
- Potential for community acceptance

Details of these evaluations are provided in the CMS Report (TtNUS, 2005).

Rationale for Selecting Alternative 2 – The Proposed Remedy

Alternative 1 would not be sufficiently protective of human health and the environment because it would not prevent potential future exposure to contaminated groundwater. It also would not warn of potential migration of groundwater contaminants. This alternative, however, is always evaluated during a CMS to provide a point of reference for evaluating the cost-effectiveness of other alternatives.

Alternative 3 was not proposed as the remedy because its success is difficult to predict with adequate confidence. Furthermore, the uncertainties lessen its potential cost-effectiveness. The Navy also considered treating the most highly contaminated zone of the plume to expedite the decay of solvents, however, the same technical difficulties described above would apply, even if on a smaller scale. This alternative also would result in the removal of many healthy trees and would require periodic inspection and maintenance of the treatment system. Finally, active treatment will not be necessary if the organic solvents decay rapidly enough on their own. The proposed remedy (Alternative 2) is designed to verify more precisely the groundwater solvent decay rates while periodically allowing a reconsideration of the imposed remedy.

Alternative 2, the proposed remedy, would be much less costly than Alternative 3, but the time required to attain MCSs is currently uncertain. This proposed remedy incorporates continued groundwater sampling and analyses (monitoring) throughout the 12-acre MGBG. The additional data will be used to more accurately estimate the time that will be required to reduce solvent concentrations to acceptable levels through natural mechanisms. These mechanisms include chemical or biochemical breakdown as well as dilution and dispersion of the chemicals that lower their concentrations. The only way to obtain better estimates of these concentration decreases is by collecting data over time. Based on the observed chemical concentration changes at the MGBG to date, this process is expected to last several years. After collecting sufficient data, the degradation rates will be used to estimate the time necessary to attain acceptable levels. If this time is acceptable, the solvent concentrations will be allowed to decrease naturally. During this time, the concentrations will be continually monitored to ensure that they decrease to the target levels. If the projected decrease is not rapid enough, active measures to make the solvent concentrations decrease more rapidly may be necessary. Whether to implement more aggressive remedial measures will be decided by NSWC Crane and U.S. EPA Region 5 after future analysis of monitoring results.

Because the foreseeable land use will not change from the current use, and because risks are manageable through land use controls, Alternative 2 is deemed the most appropriate remedy. It will not require destruction of site woodlands as active treatments would and it will not expend resources unnecessarily. It will, however, still be protective of human health and the environment. A CMI work plan will describe in detail the remedy performance criteria and decision framework for concluding that the proposed remedy is effective, or not, within acceptable time frames. In addition, details of how the land use controls will be implemented will be described in that document.

Land Use Controls Objectives

While Alternative 2 is in effect, it will be necessary to protect human health by implementing LUCs. The LUC objectives will be:

- Prevent access to, or use of the groundwater within the boundary shown in Figure 3 until MCSs (cleanup goals) are met.
- Maintain the integrity of any current or future remedial system or monitoring system (monitoring wells).
- Prohibit the development and use of property for residential housing, elementary and secondary schools, child care facilities and playgrounds.
- Ensure that the boundary of the contaminant plume shown in Figure 3 does not change appreciably (i.e., increase in size) without making adjustment to the corrective action.

Administrative Record

The MGBG Administrative Record is a collection of documents associated with this site. It is available at the following location:

United States Environmental Protection Agency – Region 5
77 West Jackson Boulevard (DW-8J)
Chicago, IL 60604
(312) 886-7890
Between 8:00 AM and 4:00 PM
Monday – Friday
(excluding federal holidays)

References

EPA, 1991. Guidance on RCRA Corrective Action Decision Documents: The Statement of Basis and Response to Comments; memorandum from Don R. Clay (Assistant Administrator) to Regional Administrators for Regions I – X and Frank Covington, NEIC, dated 04/29/91, U.S. Environmental Protection Agency, Washington, D.C. 20460, OSWER Directive No. 9902.6

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