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EXCHANGE PLACE

BOSTON, MASSACHUSETTS 02109

TELEPHONE (617) 570-1000

TELECOPIER (617) 523-1231

TELEX 94-0840

CABLE GOODPROCT, BOSTON

SUSAN M. COOKE  
(617) 570-1380

October 23, 1990

**BY HAND**

RuthAnn Sherman, Esquire  
U.S. Environmental Protection Agency  
Region I, RCS-2207  
J.F. Kennedy Federal Building  
Boston, Massachusetts 02203

Re: Silresim Superfund Site/DNAPL Investigation

Dear RuthAnn:

Enclosed, as we discussed, please find a copy of the technical memorandum prepared by John Cherry and Guy Patrick on EPA's currently proposed program for investigating DNAPL contamination in the shallow groundwater at the Silresim Superfund Site. I have enclosed additional copies of that memorandum for distribution to Leslie McVickar, EPA technical staff and management, and CDM.

In light of EPA's current policy of evaluating and weighing the risk of investigatory actions at a Superfund site, we are confident that the recommendations of these leading experts in the field will receive serious consideration at the highest levels in the Region's Superfund program. As set forth in their memorandum, drilling in the shallow zone should only be undertaken if an initial investigation outside the area confirms that there is a suitable layer or "bottom" in the contaminated area. Such an approach was discussed at the October 11 EPA meeting attended by Messrs. Cherry and Patrick, and we trust that the CDM contract to carry out the investigation can be implemented in a manner that is consistent with that approach.

We are of course ready to respond to any questions EPA or its consultants might have regarding the enclosed memorandum.

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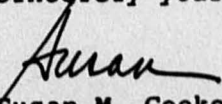
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RuthAnn Sherman, Esquire  
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We look forward to EPA's response to the enclosed material.

Sincerely yours,

  
Susan M. Cooke  
On Behalf of the Silresim Trustees

SMC:dp  
Encl.

cc  
(w/encl.): J. Cherry  
G. Patrick  
J. Rogers  
G. Mayberry  
J. Guerin  
J. Horowitz

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COMMENTS ON DNAPL INVESTIGATORY  
PROGRAM AT THE SILRESIM SUPERFUND SITE

I. INTRODUCTION

The following discussion sets forth our comments and recommendations regarding the soil boring and monitoring program described in EPA Contract No. 68-W9-0045. This contract covers the investigation of dense nonaqueous phase liquid ("DNAPL") groundwater contamination in the shallow zone at the Silresim Superfund Site. In technical discussions with EPA and its consultants on October 11, 1990, we discussed how that investigation would be modified so as to proceed in phases and thereby minimize the environmental damage that could otherwise result. Under the modified program, the first phase of soil borings would be conducted outside the shallow zone area that has been found to be contaminated with DNAPL (the "DNAPL contaminated area").

During the October meeting, there was also a consensus among the technical personnel that borings should not be drilled or monitoring wells installed in the DNAPL contaminated area if there was a real risk that such action would exacerbate environmental contamination at the site. As we discussed at the meeting, this could occur if there is not a good confining layer or bottom below the shallow zone of contamination. As described more fully below, the existing data indicate that such a bottom does not exist. If this is confirmed in borings taken outside the DNAPL contaminated area, then the work described in the above-referenced contract should not be carried out and the only remedial measures that should be considered in that area are ones which will not require drilling.

II. EXISTING CONDITIONS

A. Shallow Contaminated Zone

Numerous borings and monitoring wells in the overburden suggest that there is a major zone of shallow contaminated overburden to depths of about 15 feet, which is sometimes referred to hereafter as "the shallow contaminated zone". This zone has a water table generally at a depth of 6 to 10 feet below ground surface and a land surface area of approximately one acre. Two of the monitoring wells in this zone have yielded free-product DNAPL. Additional evidence of DNAPL contamination is derived from soil collected at two boreholes that penetrated below the water table. Core logs for these boreholes state that there was visual evidence of black oily liquid, which would be indicative of the presence of DNAPL.

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We conclude, therefore, that the shallow contaminated zone has free-product DNAPL in some areas. Such DNAPL may exist as puddles or pools lying on top of continuous or discontinuous layers of low permeability geologic material such as silt or clay layers or lenses. If these lenses or layers actually exist, they would most likely be at a depth of 10 to 15 feet.

B. Deep Contaminated Zone

In addition to chlorinated solvent contamination in the shallow groundwater, there exists deep groundwater contamination at the Silresim Site. The existence of deep contamination is indicated by one deep (bedrock) well (MW309-3) that has yielded free-product DNAPL and two other deep wells that show high concentrations of dissolved-phase solvents. The amount of DNAPL that exists in the deep zone is not known nor will it ever be known with much accuracy.

The following two hypotheses can explain how the deep zone became contaminated: (1) leakage of DNAPL downward through natural geologic pathways from the shallow overburden zone to the deep zone and (2) leakage of DNAPL downward from the shallow zone to the deep zone by way of boreholes drilled for cores or monitoring wells through shallow DNAPL puddles or pools. The preponderance of the field data strongly supports the second hypothesis over the first.

If DNAPL reached the deep zone by way of boreholes, this downward DNAPL flow must have occurred since 1980 during drilling or installation of wells. There is no reason to believe that such downward DNAPL leakage occurs today or that it will occur in the future, except under circumstances that could arise if new borings or wells are placed through the shallow zone or if the conditions of DNAPL equilibrium in the shallow zone are disturbed adversely in some other way by remedial actions in the shallow zone.

If a risk assessment shows that the deep DNAPL causes unacceptable risk to off-site receptors, the only remedial action available to minimize such risk would be a deep zone pump-and-treat program for cutoff of the plume. Should more DNAPL be added to this deep zone because of shallow drilling, the pump and treat program would take longer to complete.

III. PROPOSED SHALLOW SOIL BORING AND MONITORING PROGRAM

At the October 11 meeting EPA distributed an information sheet that proposed to conduct a "shallow investigation at the Silresim Site designed to provide information regarding an apparent shallow confining layer or contaminant-retarding zone. This further information will be used to define

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contaminant behavior above this confining layer and design a remedial program."

#### IV. RECOMMENDATION

##### A. Overview

We recommend that this investigation be conducted in a manner that poses no significant risk of causing DNAPL in the shallow zone to flow down new boreholes to the deeper zone. The fact that we now recognize that previous drilling most likely was the cause of the existing deep contamination is good reason to avoid drilling any more holes through the shallow DNAPL zone or, at a minimum, to take exceptional precautions not to repeat such unfortunate events. To do so would increase the risk that deep contamination may eventually pose to receptors and to the resultant cost of remediation.

##### B. Risk of DNAPL Movement to Deeper Zones Caused by Drilling

Should drilling proceed in the DNAPL contaminated area using the methods proposed by EPA when a suitable "bottom" or confining layer has not been previously identified, then additional DNAPL is likely to migrate vertically downward into the deeper aquifer zone. Our review of stratigraphic data available for the Silresim Site shows no evidence of a suitable confining layer in the shallow zone. Relatively little information is available at the present time for the deep zone, and we cannot predict the impacts of additional DNAPL migration into that zone as a result of a shallow drilling program.

A work plan has been approved by EPA to drill five to six additional deep boreholes outside the DNAPL contaminated area to evaluate conditions at depth. It is expected that this program will provide additional information for assessing the extent of DNAPL and dissolved contamination in the deep zone. However, unless this program is implemented prior to conducting a shallow program in the DNAPL contaminated area, the impacts of a shallow program on the deep zone will not be addressed. Therefore, if EPA decides to drill within the DNAPL contaminated area, this drilling should be delayed until the deep zone is evaluated further.

##### C. DNAPL Remediation

A suitable confining layer within the shallow zone will minimize risks imposed by unproven DNAPL remediation technologies such as surfactants and steam injection. These technologies, while promising for in situ DNAPL extraction, require a suitable "bottom" or confining layer to ensure that

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DNAPL can be collected and removed if it is mobilized downward. At the Silresim Site, the bottom condition can best be determined by initially drilling outside the DNAPL area. If a suitable bottom is not identified outside the shallow contamination zone, then alternative methods of investigation and/or remediation should be pursued.

Remediation options discussed at the October 11 meeting included soil venting (in situ vacuum extraction) with dewatering, as well as possible capping or containment of the source area until a proven and effective technology is identified or until a bottom can be created by hydrodynamic force or other means. Although the length of time to achieve a cleanup is unknown and may be slow, the primary advantage of soil venting is that it does not require drilling through DNAPL puddles or pools in order to proceed with a pilot vacuum extraction operation. That is to say, the risk of mobilizing DNAPL downward can be minimized, if not eliminated, by pursuing application of this technology. It is our understanding that Goldberg Zoino & Associates, Inc. is currently evaluating soil venting in bench-scale tests as part of the Feasibility Study for the Silresim Site. Issues regarding effectiveness and cleanup times may be resolved by their efforts.

In summary, a proven and environmentally safe in situ technology for rapid removal of DNAPL from the shallow zone does not exist at the present time. Moreover, implementation of vacuum extraction for slow removal of DNAPL would not require drilling through the shallow zone. Consequently, a decision to drill through the shallow zone is not sensible or justified at this time. A proposed protocol for collecting borehole samples outside the DNAPL contaminated area is presented below.

D. Shallow Borehole Drilling Protocol

1. Continuous Soil Cores

Prior to initiating a boring or cone penetration testing ("CPT") program within the DNAPL area, a detailed understanding of stratigraphic conditions in the upper 15 to 20 feet of soils is required. This information is necessary to determine whether a suitable "confining" layer is present that: (a) is capable of containing a perched DNAPL layer and (b) is of sufficient thickness such that drilling or sampling methods used to define DNAPL thickness will not "damage" or penetrate the layer, thereby allowing DNAPL to migrate to greater depths. As discussed at the October 11 meeting with EPA, it is prudent to perform any stratigraphic investigation outside the affected DNAPL area first. Methods discussed at that meeting included a CPT program and continuous soil coring. Our concerns with the

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proposed CPT program are:

- potential inability to define confining layers less than about 2 inches thick,
- potential problems with grouting the CPT holes in a short enough period of time to prevent downward migration of DNAPL, and
- current protocols, which do not include continuous coring at or adjacent to the CPT hole, and thus do not permit an accurate correlation of CPT results with known detailed stratigraphic conditions.

Given the uncertainties of the CPT methodologies, we recommend, as a follow-up to our meeting, that CPT testing be dropped entirely from the investigation program. As an alternative, we recommend that continuous cores first be drilled outside the DNAPL area to depths of about 15-20 feet. In order to provide continuous cores that are likely to be least disturbed, we suggest using either the University of Waterloo manually operated piston core barrel, which takes 5 foot long cores in aluminum tubes, or a 5 foot long by four inch diameter CME (Central Mining Equipment) split core barrel or its equivalent. The Waterloo barrel is used without a drilling rig, while the CME barrel can be used with conventional hollow-stem equipment.

We recommend that 5 to 6 boreholes be drilled outside the DNAPL area, and that the cores be carefully inspected to identify all features relevant to DNAPL transport. It would be prudent to space the holes such that the areal dimensions of any clay or silt lenses could be estimated, or the results could be used to infer continuity among even thin (one inch thick or less) clay beds.

## 2. Data Evaluation and Drilling Criterion

Following data acquisition, we recommend a technical group meeting to evaluate the data and determine whether it would be appropriate, in light of risk considerations, to proceed with a drilling/coring program inside the DNAPL contaminated area. In the latter case, the attendees could also determine the safest technique for such drilling. Before commencement of drilling, we suggest that a criterion be established which specifies the minimal requirements for a confining layer. We also recommend that drilling only be carried out if a continuous confining layer of at least two feet in thickness is identified outside the DNAPL area.

If EPA decides to proceed with drilling inside the DNAPL area, great caution should be exercised and methods should be

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used to identify potential DNAPL puddles or residual concentrations within soils at any depth. Our current understanding of existing conditions leads us to conclude that DNAPL may be encountered at various depths from ground surface to 15 to 20 feet below the surface. Should a possible DNAPL puddle be encountered, we recommend that drilling cease and that no sampling occur below the suspected DNAPL zone since continuous sampling below the DNAPL zone may open a pathway through the confining layer, allowing DNAPL to penetrate downward prior to grouting. Therefore, drilling methods should be utilized that detect DNAPL as drilling proceeds so that it can be stopped immediately.

To our knowledge, the use of dense drilling mud has never been shown to prevent downward migration of DNAPL during coring. Further, in order to collect soil cores, the drilling mud will not be physically present at the base of the corehole during core removal. The potential will therefore exist, over some time period, for DNAPL to penetrate downward to the bottom of the corehole even if dense mud is used. Thus, we cannot support the proposed use of that technique to prevent DNAPL migration. As stated above, we instead recommend that drilling cease as soon as DNAPL is suspected. It would of course be prudent to implement a laboratory or bench-scale test using the proposed field methods to demonstrate whether or not DNAPL mobilization will occur.

E. Summary of Recommendations

In summary, we recommend that the following protocol be adopted for the shallow DNAPL investigation:

1. Continuously core five to six boreholes to depths of 15 to 20 feet outside the DNAPL area.
2. Following data acquisition, a meeting of the technical representatives to evaluate the borehole data and determine whether to proceed with drilling inside the DNAPL area.
3. If drilling inside the DNAPL area is not appropriate, proceed with an evaluation, and possible pilot testing, of in situ venting as a remedial option.
4. If drilling inside the DNAPL area is appropriate, then efforts should be made to identify better methods of investigation than those proposed by EPA. A variety of drilling and sampling technologies should be considered. The most appropriate technology for cautious vertical exploration should then be selected

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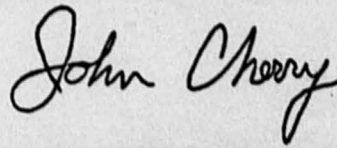
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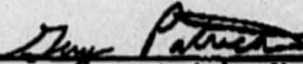
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for use inside the DNAPL area so as not to penetrate  
any DNAPL confining layer that is encountered.



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John Cherry, Ph.D.  
Professor, University of  
Waterloo  
Centre for Ground-Water  
Research



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Guy C. Patrick, M. Sc.  
Golder Associates Inc.

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