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DE&S
Duke Engineering & Services

9111 Research Boulevard
Austin, TX 78758

| Post-it . ax Note 7671 | Date 11/20/97 | # of pages ▶ 10 |
|---|---|---|
| To Ms. Kate Landman | From John Londergan | |
| Co./Dept. | Co. | |
| Phone # | Phone # 512.425.2006 | |
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512 425-2000
Fax 512 425-2099

November 19, 1997

Hold until orig. rec'd.

Dr. Luanne Williams
North Carolina Department of Health and Human Services
Occupational and Environmental Epidemiology Section
P.O. Box 29601
Raleigh, North Carolina 27626-0601

RE: Information Needed to Do Risk Assessment For a Proposed Partitioning Interwell Tracer Test at Site 88, Building HP 25, Camp Lejeune, North Carolina

Dear Dr. Williams:

Please find attached the response referenced above. To provide some project background information, I have included the executive summary from the work plan as well. If there are any questions or if more information is required, please call me.

Sincerely,

John T. Londergan
Senior Hydrogeologist

cc: Ms. Laura Yeh, Naval Facilities Engineering Service Center
Ms. Amy Axon, North Carolina DEHNR
Ms. Kate Landman, Naval Facilities Engineering Command
Mr. Mick Senus, AC/S EMD Camp Lejeune
Mr. Fred Holzmer, Duke Engineering and Services

# EXECUTIVE SUMMARY

Site 88 (Building HP25) is the location of the base central dry cleaning operation. Dry cleaning operations have been conducted there since 1940's using first Varsol and then tetrachloroethene (PCE) as dry cleaning fluids. Environmental investigations have detected the presence of both compounds in the subsurface. In particular, free-phase PCE, a dense nonaqueous phase liquid (DNAPL), has accumulated in two shallow wells installed adjacent to the facility during August of 1997.

The Naval Facilities Engineering Service Center (NFESC), in collaboration with the U.S. Environmental Protection Agency (EPA) National Risk Management Research Laboratory (NRMRL), is investigating the surfactant-enhanced aquifer remediation (SEAR) technology for the remediation of sites contaminated with DNAPL. This work is being conducted under the DOD's Environmental Security Technology Certification Program (ESTCP). The purpose is to perform additional validation of SEAR in order to promote its commercialization for the rapid cleanup of DNAPL sites owned by the government and industry. Based on the results of recently completed DNAPL investigations, Site 88 has been identified as a suitable site to conduct a demonstration of SEAR technology. In addition to subsurface treatment by surfactants, this demonstration will include procedures to recover surfactant from the effluent stream for reuse.

To investigate the ability of SEAR technology to remediate the site, the quantity of contamination present both before and after the surfactant flood must be measured. Because soil cores cannot be relied upon to provide reliable DNAPL saturations over large zones, the volume and extent of the DNAPL contamination at the demonstration area will be determined by conducting partitioning interwell tracer tests (PITTs). The SEAR demonstration will involve a pre-surfactant flood PITT, a surfactant flood, and a post-surfactant flood PITT.

The PITT was developed by Dr. Gary A. Pope of the University of Texas Department of Petroleum and Geosystems Engineering. Application of PITT technology to the environmental field was developed in conjunction with Dr. Richard Jackson of Duke Engineering and Services (DE&S). PITTs involve the injection of a suite of tracers in one or more wells and the subsequent extraction from one or more other wells in a well field. Analysis of the test results allow the detection and estimation of the volume of DNAPL present in the aquifer between the injection and extraction wells.

Duke Engineering and Services (DE&S), has been retained by the Navy to:

- conduct preliminary field work in support of a PITT;
- select the tracers to be used in the PITT;
- design the PITT; and
- conduct the pre and post-surfactant flood PITTs in the ESTCP demonstration area.

The results of the pre-surfactant flood PITT will be used in the design of a surfactant flood to be conducted during the summer of 1998. This work plan details the activities to be undertaken to perform the pre-surfactant flood PITT. The PITT is scheduled for the months of January and February, 1998.

**Products Applied to Ground Water or Soil**
**Containing No Microorganisms**
**Information To Do Risk Assessment**

**Required General Information**

1. Ms. Amy Axon
North Carolina DEHNR, Ground Water Section
Underground Injection Control Program
2728 Capitol Blvd.
Raleigh, NC 27626
~~tel. 919-733-2801 ext. 349~~ ← 919-715-6165

2. Central Dry Cleaning Facility for Camp Lejeune, North Carolina
Mr. Mick Senus
AC/S EMD
Bldg. HP 67
Virginia Dare Road
Camp Lejeune, NC 28542
tel. 910-451-5068

3. Mr. John T. Londergan
Duke Engineering and Services
9111 Research Blvd.
Austin, Texas 78758
tel. 512-425-2028

4. The partitioning interwell tracer test (PITT) will be conducted at Site 88, the location of the base central dry cleaning operations. There are no active water supply wells located within a one mile radius of this site. The nearest active water supply well is HP-642 which is located approximately 1.5 miles east of the site.

5. As of November 17, 1997 there was up to 2.8 feet of tetrachloroethene accumulation in wells located adjacent to the dry-cleaning facility at Site 88. Contaminant levels of up to 26,000 part per million (ppm) tetrachloroethene, 180 ppm trichloroethene, 46 ppm cis-1,2-dichloroethene, and 4.8 ppm vinyl chloride have been detected in soil

samples collected from the surficial aquifer (8-18 ft BLS). . Varsol, a mineral spirits product produced by Exxon, is another contaminant present in the soils and groundwater. The Varsol contamination is found at the water table. Soil samples collected from this interval have been analyzed for diesel and gasoline range organics. Analyses for diesel range organics have detected up to 590 mg/kg. Analyses for gasoline range organics have detected up to 4,200 mg/kg.

6. The New River, located approximately 3,000 feet west of the site, is the nearest surface water. The location of the site in relation to the New River is shown on attached Figure 1.

7. The dry-cleaning facility, Building HP25, is located in the area of contamination. Barracks are located approximately 200 feet away.

**Required Product/Process Specific Information**

Duke Engineering and Services will request that the manufacturers of the products contact Dr. Luanne Williams representing the State of North Carolina for responses to items 1, 2, 3, 8, and 9 of this section. Below, we have included some information from the recently submitted PITT work plan pertaining to these items.

**Item 1.**

All products to be injected, with the exception of calcium chloride, will be purchased from Sigma Aldrich Industries.

Sigma-Aldrich Fine Chemicals
3050 Spruce Street
St. Louis, MO 63103
Contact person: Ms. Tracy Langenberg
Contact phone number: 1-800-325-3010 ext. 2385

The calcium chloride will be purchase from

Acros Organics N.V. (Fisher Scientific)
Janssen Pharmaceuticalaan 3a

2440 Geel, Belgium
Contact Person: Ms. Lisa Reutzel
Contact phone number: 1-412-490-8927

**Item 2.**

**Active Ingredients in Injectates**

| Injectate | Active Ingredients | Purpose |
|---|---|---|
| 4-Methyl-2-Pentanol | 4-Methyl-2-Pentanol | partitioning tracer |
| Bromide | Sodium Bromide | conservative or non-partitioning tracer |
| 1-Propanol | Propyl alcohol or 1-Propanol | nonconservative or partitioning tracer |
| 1-Hexanol | Hexyl alcohol, n-Hexanol or 1-Hexanol | partitioning tracer |
| 2,4-Dimethyl-3-pentanol | Diisopropylcarbinol or 2,4-Dimethyl-3-pentanol | partitioning tracer |
| 1-Heptanol | Heptyl alcohol, n-Heptanol or 1-Heptanol | partitioning tracer |
| 2-Ethyl-1-hexanol | 2-Ethyl-1-hexanol | partitioning tracer |
| calcium chloride | calcium chloride | prevents mobilization of fine clay particles in the aquifer |

**Item 3.**

**Biological Effects of Some Partitioning Tracers**

| Toxicity Threshold* (cell multiplication inhibition test) | 1-Hexanol mg/L | 1-Heptanol mg/L |
|---|---|---|
| bacteria (Pseudomonas putida) | 62 | 67 |
| algae (Microcystis aeruginosa) | 12 | 3.5 |
| green algae (Scenedesmus quadricauda) | 30 | 17 |
| protozoa (Uronema parduczi Chatton-L woff) | 75 | 31 |

*Verschueren, K. 1983. "Handbook of Environmental Data on Organic Chemicals", Van Nostrand Reinhold, New York.

**Item 4.** Based on numerical simulations conducted using a three-dimensional multi-phase simulation code known as UTCHEM, it is anticipated that about 93% of the injected tracers will be recovered after 40 days of pumping.

**Item 5.** The final tracer concentrations will be approximately 1-5 mg/L.

**Item 6.** The PITT will be conducted in a well field constructed during the course of this project. Under the current conceptualization, the well field will consist of three injection wells and six extraction wells arranged in a pattern known as a line-drive geometry. The injection wells and extraction wells will be spaced 15 feet apart, while neighboring injection and extraction wells will be spaced 10 ft apart. A hydraulic control well will be installed at each end of the line of three injection wells to help contain the injected fluids and maximize injectate recovery. Figure 9 from the project work plan, attached, is a schematic of the proposed well pattern.

At no time will the product concentrations in the groundwater exceed the injected concentrations. The concentrations and quantities of injectates to be used during the Site 88 PITT are provided in the table below.

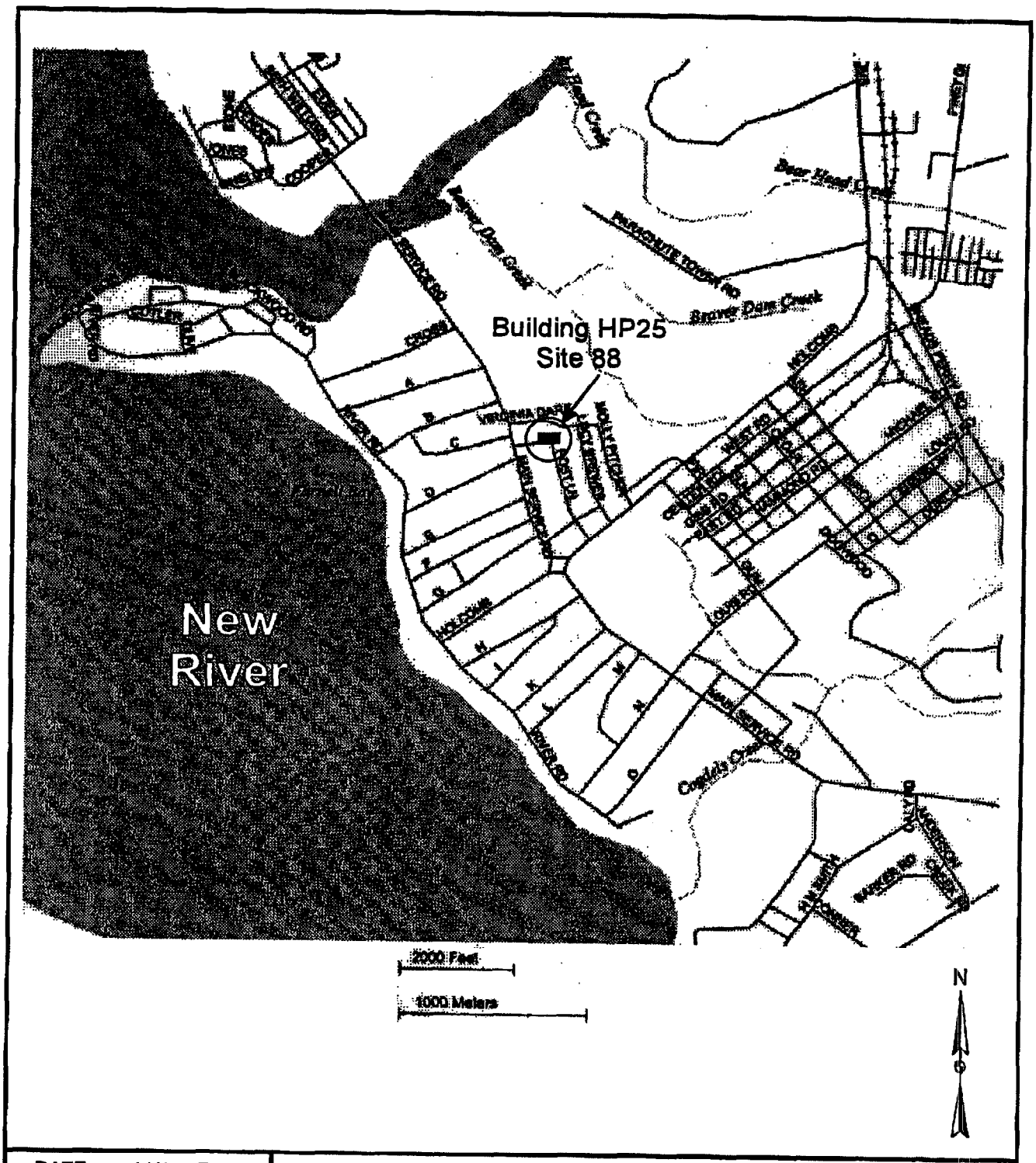
**Concentrations and Quantities of Injectates to be Used for Site 88 PITT**

| Tracer | Injected Concentrations mg/L | Quantity (lbs) to be injected |
|---|---|---|
| 4-Methyl-2-Pentanol | 1,000 | 55 |
| Bromide | 1,000 | 66 |
| 1-Propanol | 1,000 | 55 |
| 1-Hexanol | 800 | 44 |
| 2,4-Dimethyl-3-pentanol | 800 | 44 |
| 1-Heptanol | 800 | 44 |
| 2-Ethyl-1-hexanol | 500 | 28 |
| calcium chloride* | 1000 | 1,120 |

* Quantity listed reflects the total amount required for the entire demonstration and not just the period of tracer injection.

**Item 7.** It is not anticipated that any of the injectate will discharge to the New River, the nearest surface water body. The location of the site in relation to the New River is shown on attached Figure 1.

**Items 8& 9.** The product manufacturers will provide responses to these items.

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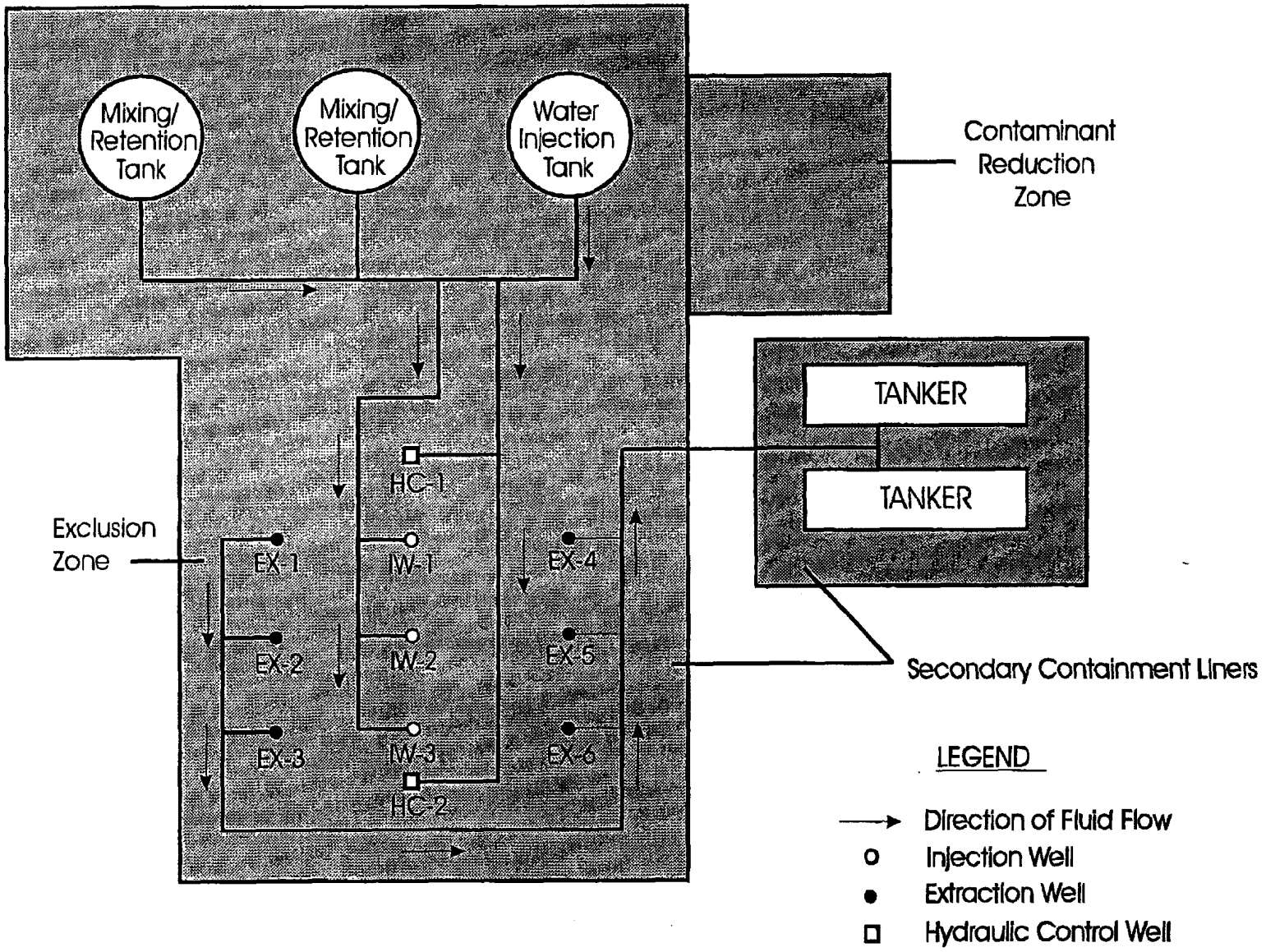
## Site Location Map
## Camp Lejeune, North Carolina

(Modified from 1997 Delorme, Street Atlas USA)

Figure 1




| | |
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| DATE: 10/07/97 | **Schematic of General Test Configuration** |
| WID#: TDN 301 99999 | |
| FILE: TDN301.CDR | |
| DE&S Duke Engineering & Services | Figure 9 |

**Item 10.** The volume and extent of DNAPL contamination at the demonstration area will be determined by conducting a PITT. The PITT involves the injection of a suite of tracers in one or more wells and subsequent extraction from other wells in a well field. Conservative (i.e., non-partitioning) tracers pass unretarded through the DNAPL zone, whereas the partitioning tracers are retarded due to their partitioning into and out of the DNAPL. The arrival times and concentrations of the tracers at the extraction wells are used to measure the volume and distribution of DNAPL in the interwell zone.

## Reference

Jin, M., M. Delshad, V. Dwarakanath, D.C. McKinney, G.A. Pope, K. Sepehrnoori, C. Tilburg, and R.E. Jackson: ÒPartitioning Tracer Test for Detection, Estimation and Remediation Performance Assessment of Subsurface Nonaqueous-phase Liquids,Ó Water Resources Research, 31 (5), pp.1201, 1995.

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