**DEL AMO SUPERFUND SITE**  
**FEASIBILITY STUDY MEETING**  
**MAY 13, 2005**

**Location:** Holiday Inn Torrance  
19800 S. Vermont Avenue  
Torrance, CA 90502  
(310) 781-9100

**Attendees:**  
- George Landreth (Shell)  
- John Dudley (URS)  
- Jude Francis (URS)  
- Patrick Gobb (NewFields)  
- Dante Rodriguez (US EPA)  
- Frank Gonzales (DTSC)  
- Safouh Sayed (DTSC)

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<th>Agenda Item</th>
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<td>12:00-1:00</td>
<td>Lunch – The Ginger Café (Holiday Inn)</td>
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<td>1:00-1:15</td>
<td>Meeting Objectives and Agenda (George Landreth)</td>
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<td>1:15-1:30</td>
<td>Agency Expectations for FS (Dante and DTSC)</td>
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<td>1:30-1:45</td>
<td>Current Project Status (John Dudley)</td>
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<td></td>
<td>• Finalization of RI</td>
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<td>• Issuance of Risk Assessment</td>
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<td>• Introduction to Feasibility Study</td>
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<td>1:45-3:30</td>
<td>Feasibility Study Discussion (Group - Led by Jude)</td>
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<td>• Proposed Structure</td>
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<td>• Incorporation of Risk Assessment Results</td>
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<td>• Remedial Action Objectives and General Response Actions</td>
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<td>• Screening of Technologies</td>
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<td>• Identification of Applicable Remedial Alternatives</td>
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<td>• Detailed Evaluation of Remedial Alternatives</td>
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<td>• Integration of FS Evaluations</td>
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<td>3:30-4:00</td>
<td>FS Section Example - NAPL Source Area 12 - Jude</td>
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<td>4:00</td>
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DEL AMO SOIL AND NAPL FEASIBILITY STUDY

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EXECUTIVE SUMMARY

1.0 Introduction
   1.1 Purpose and Scope of Feasibility Study
   1.2 Site History
   1.3 Site Description
       Discuss current development and identification of parcels
   1.4 FS Report Organization

2.0 Site Investigation, Characterization, and Risk Assessment
   2.1 Geology and Hydrogeology
   2.2 Summary of Site Investigations
   2.3 Nature and Extent of Contamination
       2.3.1 Surface and Shallow Soil
       2.3.2 Deep Soil (>15 ft bgs)
       2.3.3 Soil Gas
       2.3.4 Indoor Air
       2.3.5 Groundwater and Non Aqueous Phase Liquid (NAPL)
   2.4 Summary of Risk Assessment
       2.4.1 Conceptual Site Model
       2.4.2 Commercial Worker
           2.4.2.1 Outdoor pathway
           2.4.2.2 Indoor Air
       2.4.3 Hypothetical Resident
       2.4.4 Trench Worker

3.0 Remedial Action Objectives and General Response Actions
   3.1 General Objectives
       3.1.1 Soil and Soil Vapor
           The objectives will be framed keeping in mind that the site is already fully
developed and that ICs will be used to restrict future residential
development and mitigate other potential exposures.
       3.1.2 NAPL and Groundwater
           Primary objective relates to enhancement of EPA’s selected groundwater
remedy
3.2 Parcels for FS Evaluation
  3.2.1 General
  This section will identify the decision-making environment
  - Risk Drivers
  - Data uncertainty (hot spot distribution, sampling limitations, elevated
detects, background, risk driven solely by incomplete data, spatial
weaknesses)
  3.2.2 Parcel by Parcel Uncertainty
  This section will identify the parcels, the completed risk pathway(s) (or
none if appropriate), and receptor(s) and presented as a table. This will be
a comprehensive summary that will allow the balance of the FS to be
focused on the parcels with identified elevated exposures.
  3.2.3 Parcel by Parcel Design Constraints Summary
  Present as a table only for parcels with identified elevated risk

3.3 Remedial Action Objectives
3.4 General Response Actions
  3.4.1 Soil and Soil vapor
  3.4.2 NAPL and Groundwater Contamination Source Areas
3.5 Applicable or Relevant and Appropriate Requirements
  Include discussion of TI Waiver Zone

4.0 Screening of Technologies
4.1 Institutional and Engineering Controls
4.2 Remedial Technologies for Vadose Zone
  4.2.1 Non-VOCs in shallow soil
  4.2.2 VOCs in shallow soil
  4.2.3 VOCs in deep soil
4.3 Remedial Technologies for NAPL and Groundwater Source Areas

5.0 Identification of Applicable Remedial Alternatives

Note: In the introduction portion of each of the following sub-sections, reference will be
made back to Section 3.0 that would reiterate additional assessment activities that
will be performed during the RD phase to further assess the potential exposure
due to uncertainties identified during the Risk Assessment.
5.1 Parcel-by-Parcel Exposure Management Alternatives
This list of EAPCs will be consistent with the final risk assessment submitted to the EPA.

5.1.1 EAPCs with Commercial worker risk, CR>5x10^-5

EAPC 2 Commercial Worker Receptor
- Outdoor Shallow Soil

EAPC 4 Commercial Worker Receptor
- Indoor Air – Soil/Soil Gas

EAPC 5 Commercial Worker Receptor
- Indoor Air – Soil/Soil Gas

EAPC 16 Commercial Worker Receptor
- Outdoor Shallow Soil
- Indoor Air – Soil/Soil Gas

EAPC 17 Commercial Worker Receptor
- Indoor Air – Soil/Soil Gas

EAPC 19 Commercial Worker Receptor
- Indoor Air – Soil/Soil Gas

EAPC 21 Commercial Worker Receptor
- Indoor Air – Soil/Soil Gas

EAPC 23 Commercial Worker Receptor
- Indoor Air – Soil/Soil Gas

5.1.2 EAPCs with 5x10^-5 > CR > 1x10^-6

5.1.3 Other EAPCs (those addressed by ICs including residential risk RR>10^-6, RR<10^-6, No data)

5.2 NAPL and Groundwater Contamination Source Area Alternatives
Due to the similarities between many of these source areas, the text description of the alternatives will make efforts to avoid repetition.

5.2.1 Source Area #1
5.2.2 Source Area #2
5.2.3 Source Area #3
5.2.4 Source Area #4
5.2.5 Source Area #5
5.2.6 Source Area #6
5.2.7 Source Area #7
5.2.8 Source Area #8
5.2.9 Source Area #9
5.2.10 Source Area #11
5.2.11 Source Area #12
6.0 Detailed Evaluation of Remedial Alternatives

6.1 Description of CERCLA nine criteria

1-Overall Protection of Human Health and Environment
2-Compliance with ARARs
3-Long-Term Effectiveness and Permanence
4-Reduction in Toxicity, Mobility, and Volume Through Treatment
5-Short-Term Effectiveness
6-Implementability
7-Cost
8-State Acceptance
9-Community Acceptance

6.2 Parcel Groups (similar risk management design constraints)

6.2.1 Group 1 Parcels (EAPCs with CR>5x10^{-5} - Outdoor shallow soil)
   6.2.1.1 9-criteria analysis
   6.2.1.2 Comparative Analysis of Alternatives

6.2.2 Group 2 Parcels (EAPCs with CR>5x10^{-5} - Indoor air)
   6.2.2.1 9-criteria analysis
   6.2.2.2 Comparative Analysis of Alternatives

6.2.3 Group 3 Parcels (EAPCs with 5x10^{-5}>CR>10^{-6} – Outdoor shallow soil)
   6.2.3.1 9-criteria analysis
   6.2.3.2 Comparative Analysis of Alternatives

6.2.4 Group 4 Parcels (EAPCs with 5x10^{-5}>CR>10^{-6} – Indoor air)
   6.2.4.1 9-criteria analysis
   6.2.4.2 Comparative Analysis of Alternatives

6.2.5 Group 5 Parcels (Other EAPCs addressed by ICs)
   6.2.5.1 9-criteria analysis
   6.2.5.2 Comparative Analysis of Alternatives

6.3 NAPL and Groundwater Contamination Source Areas

Due to the similarities between many of these source areas, the text description of the evaluation will make efforts to avoid repetition.

6.3.1 Source Area #1
6.3.2 Source Area #2
6.3.3 Source Area #3
6.3.4 Source Area #4
6.3.5 Source Area #5
6.3.6 Source Area #6
6.3.7 Source Area #7
6.3.8 Source Area #8
6.3.9 Source Area #9
6.3.10 Source Area #11
6.3.11 Source Area #12

7.0 Integration of FS Evaluations

7.1 Overall Remedial Strategy Recommendation
7.2 Specific Parcel by Parcel recommended measures
7.3 Specific NAPL Recommendations
Site Background

- Site is fully developed with active facilities or office buildings on all but 2 of the 65 parcels
- Site lithology predominantly low permeability heterogeneous silts with interbedded sandy zones
- Water table 40 to 50 feet bgs
NAPL Nature and Extent

- NAPL generally at residual concentrations
  - not mobile
  - two areas show accumulation SA#3, #12
- NAPL smeared due to rising water table
  - trapped in heterogeneous, low permeability formation
- Significant fraction of hydrocarbon source areas below or in close proximity to buildings
- NAPL is composed of Benzene, Ethylbenzene
  - Biodegradeable in dissolved and vapor phases

List of NAPL Source Areas

<table>
<thead>
<tr>
<th>SOURCE AREA TYPE</th>
<th>SOURCE AREA NO.</th>
<th>PRIMARY CONTAMINANTS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accumulation</td>
<td>3</td>
<td>Benzene</td>
<td>LNAPL observed in one or more wells (MW-20)</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>BTEX, Styrene</td>
<td>LNAPL observed in one or more wells</td>
</tr>
<tr>
<td>Residual NAPL</td>
<td>6</td>
<td>Benzene, Ethylbenzene</td>
<td>Residual LNAPL based on Jar testing or Dean-Stark testing</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Benzene</td>
<td>Residual LNAPL based on Jar testing or Dean-Stark testing</td>
</tr>
<tr>
<td>Presence inferred</td>
<td>4</td>
<td>Benzene, Cyclohexane</td>
<td>Presence of LNAPL based on concentration of dissolved contamination in groundwater</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>Benzene, Ethylbenzene</td>
<td>Presence of LNAPL based on concentration of dissolved contamination in groundwater</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>Benzene, Ethylbenzene</td>
<td>Presence of LNAPL based on concentration of dissolved contamination in groundwater</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Benzene, Toluene</td>
<td>Presence of LNAPL based on concentration of dissolved contamination in groundwater</td>
</tr>
<tr>
<td>Other source areas</td>
<td>2</td>
<td>TCE, PCE</td>
<td>Potential offsite contamination sources to the West</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Cyclohexane</td>
<td>NAPL unlikely (Evaluate in FS as soil contamination area)</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>BTEX, Styrene</td>
<td>NAPL unlikely (Evaluate in FS as soil contamination area)</td>
</tr>
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</table>
Groundwater

- Site-wide groundwater ROD, 1999
- TI Waiver Zone (tracks benzene plume)
  - Stable site-wide plume
- Plumes around each source area are generally at steady state concentrations
- Risk assessment – Vapor migration pathway
  - No exposure from NAPL
- Long term groundwater protection is overall objective

LNAPL Risk Analysis : Overview
Ref: API LNAPL Guide 2.0, 2005
Aggressive Technologies for NAPL

- Thermal technologies
  - Electric Resistance Heating
  - Thermal Conduction Heating (ISTD)
  - Steam Injection
- In-situ Chemical Oxidation
  - Fenton's ($\text{H}_2\text{O}_2$+Fe), Peroxone, Persulfate
  - Permanganate (Cl-solvent DNAPL)
- Surfactant Flushing

Cape Canaveral Demonstration
1998-2001

- Aggressive technologies demonstrated side-by-side on a DNAPL source area
  - ERH, ISCO and Steam Injection (each 75'x50' plot)
- Heavily investigated source area
- Mixed results
  - Serious problems with NAPL migration horizontally and vertically
  - Actual mass removal is uncertain
  - Dissolved phase concentrations not significantly decreased
Expert Panel Reports on NAPL

- "DNAPL Remediation Challenge", EPA 600-R03-143, Dec 2003
- Adverse impacts of source reduction
  - Expansion of NAPL source zone due to mobilization
  - Undesirable changes in NAPL distribution (architecture)
  - Undesirable changes in physical, chemical and microbiological environment
  - "This study did not demonstrate that ERH technology was likely to be a cost effective approach for DNAPL source depletion at this site", Page 26

- "Strategies for Monitoring the Performance of Source Zone Remedies", ITRC Aug 2004
  - "Treatment by ISCO of sites highly contaminated with DNAPL might not be a cost-effective alternative", Page B-14

Ongoing NAPL Research

- Relating to "NAPL Source Zone Treatment"
- Colorado School of Mines
  - Tom Sale, Dave McWhorter, T. Illangasekare et al.

- Quote (http://cesep.mines.edu/projects/AFCEE.htm)
  - "...limited reductions in risk or site care requirements provides little basis for pursuing costly source zone remedies. Without measurable benefit there is no basis for investment."
"As the curves demonstrate, the downstream effects of various remediation strategies may range from no effect ("base case") to instant and complete cleanup ("type C") to some intermediate behavior. As one can deduce from the curves, if the downstream effluent behavior of a particular cleanup strategy results in little or no benefit (e.g. "type B" as compared to drinking water MCLs or other standards), the cost of that strategy may not be justified."

Ref: llmangustara, 2005; Colorado School of Mines  http://cesep.mines.edu/projects/AFCEE.htm

Three LNAPL guidance documents

- RTDF: led by EPA with industry collaboration
  - "LNAPL Decision Framework", EPA 542-R04-11, March 2005
- API: LNAPL Interactive Guide 2.0 (2005)
  - Interactive manual with software and tutorials
- All three programs are generally consistent
SA#12 Site Plan with Historic facilities
Remedial Action Objective

- LNAPL objective
  - “Where practicable and where measurable benefits would result, contain or remove LNAPL to prevent migration to or contact with groundwater”

- Examples of measurable benefits/remediation metrics
  - significant mass reduction or significant reduction in dissolved phase concentrations
    - aquifer restoration in reasonable timeframes (say 30 to 100 years)
    - > 95% mass removal from source area needed to reduce dissolved concentrations in reasonable timeframe
  - significant decrease in long term site care requirements over a reasonable timeframe

Remedial Alternatives

- No Action
- Institutional Controls + Mon. Natural Attenuation + Long Term Monitoring
- Active Remedial Alternatives
  - Electric Resistance Heating + SVE
  - In-situ Chemical Oxidation + SVE
  - Hydraulic Extraction + SVE

- Uncertainty with source area extent
Conceptual Design

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<tr>
<th>ALT</th>
<th>NAME</th>
<th>DESIGN ELEMENTS</th>
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<tbody>
<tr>
<td>3</td>
<td>Electric Resistance</td>
<td>150 electric heating + SVE wells, 44 perimeter SVE wells, 2000 scfm flow, aboveground treatment with thermal oxidizer, Need to control heating rate to limit benzene vapor rate.</td>
</tr>
<tr>
<td></td>
<td>Heating + SVE</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>In-situ Chemical</td>
<td>230 injection points at 15-foot spacing. Permeate process, SVE wells at 50-foot spacing, 8-10 million gallons of chemical injected. Uncertainty in performance due to permeability limitations and natural oxidant demand.</td>
</tr>
<tr>
<td></td>
<td>Oxidation + SVE</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Hydraulic Extraction</td>
<td>50 combined HE-SVE wells at 50-foot spacing, above ground treatment: Liquid-advanced oxidation, air stripping, LPGAC, vapor - thermal oxidizer.</td>
</tr>
<tr>
<td></td>
<td>+ SVE</td>
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</table>
Partial source removal is not a significant benefit

- Only able to remove a fraction of the NAPL/hydrocarbon mass in source area
- No significant change in dissolved phase concentrations
- Aquifer restoration times still in thousands of years
- No significant benefit due to this remediation.

High risk from aggressive technologies

- Human health e.g. office workers/employees working at the site and neighboring areas
  - vapor intrusion, explosions, vapor emissions from stack
- Environment - potential for migration of otherwise immobile NAPL
- Presence of contaminants under or adjacent to contaminants make these options high in risk
- Community issues – Waste Pits experience
  - Community opposition can be expected to vapor treatment especially with aggressive technologies
Implementability challenges

- Implementability challenges at this fully developed site
- Implementability is rated poor to moderate for aggressive remedial measures
  - ERH
  - ISCO
- Implementability is rated moderate for
  - Hydraulic Extraction

Poor Cost Effectiveness

- SA#12 costs range from $12M-$18M
- Very High in Cost
  - $100-$300/cubic yard
  - $5M-$10M/acre
- Mass removal of 20% to 50%
  - Residual contamination below building footprint
  - Residual contamination in dissolved phase outside/downgradient of source area
Summary for Active Remedies

- Only partial source removal
  - Plume lifetime not significantly changed
  - Dissolved concentrations not changed significantly
- Elevated risk due to remedy implementation at a fully developed site
- Very high cost ($5-$10M/acre)
- Not cost effective, given that...
  - NAPL is not mobile (residual)
  - NAPL related vapor risk is not significant
- Long term site care requirements would be unchanged
  - Will continue to need ICs in the long run

Conclusion

- Institutional Controls + Monitored Natural Attenuation + Long Term Monitoring
  - Provides adequate protections to human health and environment
  - Less overall risk, more implementable
  - Nat Attenuation is vigorous, GW concentrations at steady state
  - Site is already in productive reuse
  - Vapor migration risks from vadose zone (soil) contamination addressed separately in FS
LNAPL Risk Analysis: Conceptual Overview

Free phase hydrocarbons or LNAPL have been identified at the Site

Examine each of the 4 pathways

Vapor Pathway

Are LNAPL vapors a potential concern?

Yes

Is the structure of concern occupied?

Yes

Proceed to the flowchart for guidance on determining chronic exposure risks from hydrocarbon vapors.

No

Proceed to the flowchart for guidance on determining explosive risks from hydrocarbon vapors.

No

Direct Contact Pathway

Is there a potential to directly contact LNAPL impacted soils, or evidence that LNAPL is approaching a surface water body?

Yes

Assess direct contact pathways (ingestion, dermal, inhalation of vapors and particulates).

No

LNAPL Migration Pathway

Is there an indication or potential for the LNAPL to be migrating?

Yes

Utilize investigation techniques and the tools provided in this guide and other references to understand the rate and limits of migration, and the options to arrest further migration.

No

Dissolved Phase Pathway

Are dissolved phase constituents in the groundwater a potential concern?

Yes

Utilize investigation techniques and tools in this guide and other references to determine the COCs, their concentrations over distance and time, potential pathways/receptors, and risk levels.

No

Human health and ecological risks from this pathway will not drive remedial actions. Examine remaining pathways

* If this pathway is determined to present a human health or ecological risk, then factor it, along with Regulatory Requirements, Business Considerations, and Stakeholder Issues, into the Project Objectives and Remedial Strategy and examine remaining pathways.
Enter Process

Immediate hazard under control

Organize Resources (Section 2.0)
(Develop Conceptual Model & Initiate Stakeholder Process)

Develop Long-Term Vision and Goal (Section 3.0)

Evaluate Risk & Technical Issues/Limitations

Determine LNAPL Distribution, Mobility and Recoverability
(Section 4.0)

Review Conceptual Model, Risks, Long-Term Vision and Goals
(Section 5.0)

Identify, Evaluate, and Select Management/Technology Options
(Section 6.0)

Define Endpoints/Develop Contingency Plan
(Section 7.0)

Implement and Monitor Performance (Section 8.0)

Evaluate Progress (Section 9.0)

Have Endpoints, Goal, and Vision been achieved?

No

Yes

Is Management Option on track to meet Endpoints, Goal and Vision?

No

Yes

Implement contingency plan or reevaluate long-term vision or management options

End Process

EPA LNAPL DECISION FRAMEWORK
MARCH 2005