

Entrix, Inc.
515 Post Oak Blvd., Suite 400
Houston, Texas 77027
(713) 960-9733

February 2, 1994

Mr. Mike Grimm
Amoco Production Company
501 West Lake Boulevard
Houston, TX 77079

Re: Proposal for Groundwater Remediation Pilot Study,
and Cost Estimate
South Sprint, Texas
ENTRIX Proposal No. 0146704

Dear Mike:

ENTRIX, Inc. appreciates the opportunity to present this proposal to assist Amoco Production Company (Amoco) in conducting a pilot study, and subsequent design and installation, of a groundwater remediation system, at the Amoco South Sprint facility. This proposal has been prepared at your request and outlines the scope of work and estimated costs involved.

Background

Previous studies conducted at the South Sprint site by Amoco and others have identified free-phase and dissolved-phase hydrocarbons [as Total Petroleum Hydrocarbons (TPH) and benzene, toluene, ethylbenzene, and xylenes (BTEX)] in groundwater. A preliminary evaluation of available site data and treatment options indicates that the following remediation system may be the most practical for the South Sprint facility:

- Recovery of free-phase hydrocarbons with a system of groundwater recovery wells; and
- Installation of a system of air sparging and soil venting wells for the removal of dissolved-phase hydrocarbons from the groundwater and vadose zone.

Air sparging and soil venting, an in-situ remediation method, can reduce groundwater remediation time by enhancing volatilization of hydrocarbons in the groundwater and by promoting biological degradation of residual hydrocarbons through an increase in oxygen levels in the subsurface soils. Vadose zone and capillary fringe soils can also be remediated. Cost savings can be realized by minimizing the volume of groundwater that must be pumped and treated, and by reducing remediation time. Available information regarding site soils suggests that permeabilities are ideal for an effective air sparging system and soil vapor extraction (SVE) system, limited only by the high static groundwater levels.

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At the request of Amoco, ENTRIX has evaluated the available data and recommends the following scope of work be performed.

Scope of Work

Before a groundwater remediation system can be designed and installed at the South Sprint facility, ENTRIX first recommends the collection of proposed treatment system performance data through the installation and testing of a pilot system. Following an evaluation of the results from this first phase, a final design can be completed and the system installed.

Phase 1—Pilot Study

ENTRIX proposes that a pilot study be conducted to confirm the feasibility of air sparging/SVE technology at the South Sprint facility, and to obtain data for the conceptual design of a remediation system. Based on a small area and consistent geology, a single pilot study location should be adequate for design purposes. ENTRIX will recommend a linear array of six wells (one soil vent, one air sparging, and four monitor wells) spaced approximately 10 feet apart. This array was selected based on previous investigations at sites similar to the South Sprint site in which a radius of influence for the SVE system exceeded 60 feet. Existing monitor wells may be utilized as additional monitor points, if possible, to verify the radial influence of both the air sparging and SVE systems. However, it is expected that the screened interval in existing wells may not be appropriate for the pilot test. The pilot study wells will be used in the full-scale remediation system if compatible with the final design.

The goals of the pilot study are to:

- Confirm whether air flow can be sustained in the saturated and unsaturated zones, and if so, determine the optimum flows and pressures;
- Determine the radius of influence of soil venting alone, air sparging alone, and soil venting in combination with air sparging;
- Estimate the rate of BTEX removal achievable with air sparging and venting, over a 24-hour period;
24 to 36 hr
- Confirm the presence of bacteria with an affinity for degrading hydrocarbons, and measure nutrient availability, to evaluate whether conditions are conducive to biodegradation;
- Establish design criteria for the remediation system based on the results of the pilot study, including the number, spacing, size, and approximate location of soil venting and air sparging wells.

The details of the proposed scope of work are outlined in the following task descriptions.

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TASK 1—INSTALLATION OF TEST WELLS

For the purposes of this proposal it is assumed that six new wells will be installed. Based on prior conversations, Amoco will install as many of the wells as possible prior to the pilot study mobilization:

- One air sparging well, 1¼-inch-diameter, with two feet of 60 mesh screen, placed at approximately 20 to 25 feet below the ground surface. Galvanized steel riser in five-foot sections will be connected with galvanized couplings. Teflon tape will be used at each joint to prevent air loss during sparging operations.
- One soil vent well, and four monitor wells, each completed approximately five feet down into the aquifer, with 10 feet of screen at the base, and three to five feet of screen above the static water level. ^{1½"} Two-inch-diameter Schedule 40 PVC will be used for these wells. The SVE well will require Teflon tape to prevent air loss during SVE testing.

Wells will be installed by Amoco personnel and soil samples ^{will} should be collected during drilling activities for ~~bioassay~~ ^{BTEX} (if no bioassay data has been collected in the past).

TASK 2—PILOT TEST

To perform the pilot study test, ENTRIX will install the appropriate equipment and connections on each well, including air compressors/blowers, flow meters/regulators, pressure gauges, and sampling ports to measure test parameters. Amoco will furnish electrical generators, air compressors, and vacuum blowers.

^{Amoco} ENTRIX will first conduct preliminary testing of the soil vent system alone at various flow rates, and then the air sparging alone at various flow rates. The system will be monitored for air pressure (or vacuum), water level, and visual observations of bubbling in the groundwater to determine the radius of influence. Field approximations will be used to determine the optimum combination of wells and flow rates. (The optimum will be that combination which is expected to result in the most cost-effective remediation system, considering both capital and operating costs.) Flow rates on the vent wells and air sparging wells, pressures on each monitor well, and volatile organic concentrations (using an organic vapor monitor) will be used to monitor each combination of flow rates and test wells. The independent air sparging/SVE testing is expected to require approximately one day.

Once the optimum combination has been selected, a continuous soil venting and air sparging test will be conducted for approximately 24³⁶ hours. To monitor the effectiveness of the system, gas samples from the soil vent discharge will be measured, and groundwater samples from the monitor wells will be collected at regular intervals during the test and analyzed for BTEX at an off-site laboratory.

TASK 3—DATA ANALYSIS AND REPORT

Following completion of the field work, the data will be analyzed to determine the radius of influence of the sparging and venting wells and the effectiveness of the system in removing BTEX. Plots will be made of the applied vacuum versus distance from the soil vent well. BTEX concentrations in groundwater and soil vent offgases will be plotted against time to assist in estimates of the effectiveness and time required for remediation. BTEX concentrations in the gas samples will also be used to calculate total expected emissions for determination of state air emissions compliance.

A report will be prepared which summarizes the results of the pilot study, including analytical data, radius of influence determinations, and conceptual design criteria (approximate number and size of soil vent and air sparging wells, well spacing, anticipated flow rates, and basic equipment requirements) for the full-scale remediation system.

TASK 4—PRELIMINARY DESIGN AND COST ESTIMATE

Upon successful completion of the pilot study, ENTRIX will prepare a preliminary design. The design criteria established from the pilot study will be used as the basis for the design, including appropriate number, location, and spacing of groundwater recovery, air sparging, and soil vent wells, and the size and specification of associated equipment such as pumps, blowers, and treatment system components.

Using the preliminary design, ENTRIX will prepare an estimate of the capital and operating costs for the proposed system. This estimate will be developed to an expected accuracy of ± 15 percent. The preliminary design and cost estimate will be provided to Amoco in report format for Amoco review and approval.

Schedule

It is expected that the pilot study schedule is largely contingent upon approval by governmental agencies.

Estimated Costs

The total cost for the pilot study and associated reporting is estimated to be \$5,830. A summary of the estimated costs is included as Table 1. The assumptions used for the estimate include:

- One trip to South Sprint;
- A majority of the wells have been installed prior to arriving at the site;
- A single optimum configuration for the 24-hour soil vent/air sparging test can be determined (if not, additional testing may be recommended), and;
- A report documenting the procedures and results will be drafted for review by Amoco. A brief discussion on conceptual design for the final

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remediation system, and estimated equipment and installation costs will be included.

A budgetary estimate of the costs for detail design, equipment, and installation will be presented to Amoco upon completion of the pilot study.

The proposed scope of work will be performed on a time-and-materials basis (in accordance with Attachment A), not to exceed the estimated cost without prior approval from Amoco.

Project Team

ENTRIX proposes the following key Project Team members:

Todd M. Williams, P.E., P.G., will serve as Project Director. He will be responsible for overall project guidance.

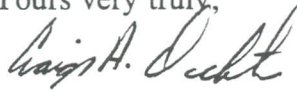
Craig A. Docktor will serve as Project Manager/Geologist. He will perform field activities including oversight of pilot study.

Other qualified ENTRIX staff will be used on an as-needed basis.

ENTRIX is prepared to initiate work as soon as possible after receiving approval from Amoco. To indicate approval, please sign and return one original copy to my attention.

We look forward to assisting you with this challenging assignment. Please call if you have any questions.

Yours very truly,

 FOR

Todd M. Williams, P.E., P.G.
Principal Consultant



Craig A. Docktor, P.G.
Project Geologist

CAD/pmp

Enclosures

Approved by:

Name: _____

Title: _____

Date: _____

ATTACHMENT A
Soil Vapor Extraction Pilot Study
Amoco - South Sprint

1. Soil Vapor Extraction Pilot Study

A. Labor

Project Geologist	- 24 hours	\$85 / hr	\$2,040
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Total Estimated Labor Costs

\$2,040

B. Expenses

Per Diem	- 2 days	\$90 /day	\$180
Van Rental	- 2 days	\$50 /day	\$100
Vacuum Blower (a)	- 2 days	\$0 /day	\$0
Generator (a)	- 2 days	\$0 /sam	\$0
Compressor (a)	- 2 days	\$0 /sam	\$0
OVM (a)	- 2 days	\$0 /day	\$0
Flow Meters, Gauges, and Fittings	- 2 days	\$75 /day	\$150

Total Estimated Expenses

\$430

2. Data Review, Reporting, and Recommendations

A. Labor

Project Geologist	- 10 hrs x	\$85 / hr	\$850
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B. Expenses

CADD	- 2 hrs x	\$85 / hr	\$170
Word Processing	- 1 hrs x	\$50 / hr	\$50
Computers	- 4 hrs x	\$15 / hr	\$60

Data Review, Reporting and Recommendations

\$1,130

3. Preliminary Design and Cost Estimates

A. Labor

Principal Consultant	- 3 hrs x	\$140 / hr	\$420
Project Geologist	- 16 hrs x	\$85 / hr	\$1,360

B. Expenses

CADD	- 4 hrs x	\$85 / hr	\$340
Word Processing	- 1 hrs x	\$50 / hr	\$50
Computers	- 4 hrs x	\$15 / hr	\$60

Preliminary Design and Cost Estimates

\$2,230

Total Estimated Costs

\$5,830

(a) - Equipment rental will be ordered by, and billed directly to Amoco.

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Yours very truly,

Craig A. Docktor FOR

Todd M. Williams, P.E., P.G.
Principal Consultant

Craig A. Docktor

Craig A. Docktor, P.G.
Project Geologist

CAD/pmp

Enclosures

Approved by:

Name: *R. E. Kacian*

Title: *Env. Services Supervisor*

Date: *2-8-94*