INTERSTATE COOPERATION ITRC TECHNOLOGY REGULATORY

TECHNICAL/REGULATORY GUIDELINES

COST AND PERFORMANCE REPORTING FOR *IN SITU* BIOREMEDIATION TECHNOLOGIES

-FINAL-

December 1997

Prepared by
The Interstate Technology and Regulatory Cooperation Work Group
***In Situ* Bioremediation Technical Task Team**
in partnership with the
Bioremediation Consortium of the Remediation Technology Development Forum

ABOUT ITRC

Established in 1995, the Interstate Technology & Regulatory Council (ITRC) is a state-led, national coalition of personnel from the environmental regulatory agencies of some 40 states and the District of Columbia; three federal agencies; tribes; and public and industry stakeholders. The organization is devoted to reducing barriers to, and speeding interstate deployment of, better, more cost-effective, innovative environmental techniques. ITRC operates as a committee of the Environmental Research Institute of the States (ERIS), a Section 501(c)(3) public charity that supports the Environmental Council of the States (ECOS) through its educational and research activities aimed at improving the environment in the United States and providing a forum for state environmental policy makers. More information about ITRC and its available products and services can be found on the Internet at **www.itrcweb.org.**

DISCLAIMER

This document is designed to help regulators and others develop a consistent approach to their evaluation, regulatory approval, and deployment of specific technologies at specific sites. Although the information in this document is believed to be reliable and accurate, this document and all material set forth herein are provided without warranties of any kind, either express or implied, including but not limited to warranties of the accuracy or completeness of information contained in the document. The technical implications of any information or guidance contained in this document may vary widely based on the specific facts involved and should not be used as a substitute for consultation with professional and competent advisors. Although this document attempts to address what the authors believe to be all relevant points, it is not intended to be an exhaustive treatise on the subject. Interested readers should do their own research, and a list of references may be provided as a starting point. This document does not necessarily address all applicable heath and safety risks and precautions with respect to particular materials, conditions, or procedures in specific applications of any technology. Consequently, ITRC recommends also consulting applicable standards, laws, regulations, suppliers of materials, and material safety data sheets for information concerning safety and health risks and precautions and compliance with then-applicable laws and regulations. The use of this document and the materials set forth herein is at the user's own risk. ECOS, ERIS, and ITRC shall not be liable for any direct, indirect, incidental, special, consequential, or punitive damages arising out of the use of any information, apparatus, method, or process discussed in this document. This document may be revised or withdrawn at any time without prior notice.

ECOS, ERIS, and ITRC do not endorse the use of, nor do they attempt to determine the merits of, any specific technology or technology provider through publication of this guidance document or any other ITRC document. The type of work described in this document should be performed by trained professionals, and federal, state, and municipal laws should be consulted. ECOS, ERIS, and ITRC shall not be liable in the event of any conflict between this guidance document and such laws, regulations, and/or ordinances. Mention of trade names or commercial products does not constitute endorsement or recommendation of use by ECOS, ERIS, or ITRC.

COST AND PERFORMANCE REPORTING FOR

IN SITU BIOREMEDIATION

TECHNOLOGIES

-FINAL-

December 1997

Prepared by
The Interstate Technology and Regulatory Cooperation
Work Group
***In Situ* Bioremediation Technical Task Team**
in partnership with the
Bioremediation Consortium of the Remediation Technology
Development Forum

ACKNOWLEDGMENTS

The members of the Interstate Technology Cooperation Work Group (ITRC) *In Situ* Bioremediation Work Team, Cost and Performance Subgroup wish to acknowledge the individuals, organizations and agencies that contributed to this Technology Overview document.

The *Cost and Performance of In Situ Bioremediation Technologies* effort, as part of the broader ITRC effort, is funded primarily by the United States Department of Energy. Additional funding has been provided by the United States Department of Defense and the United States Environmental Protection Agency. Administrative support for state grants is provided by the Western Governors' Association and the Southern States Energy Board.

The work team wishes to recognize the efforts of team members: Paul Hadley and Bal Lee (California Environmental Protection Agency); Jeff Kelley (Nebraska Department of Environmental Quality); William Mason (Oregon Department of Environmental Protection); and Randy Farr (Kansas Department of Public Health and the Environment).

The Cost and Performance Subteam appreciates the efforts of those agency representatives who made time in their schedules to thoughtfully respond to the concurrence questionnaire: Commissioner Robert C. Shinn (New Jersey Department of Environmental Protection); Deputy Director Dale Claypoole (California Environmental Protection Agency State Water Resources Control Board); Executive Officer Roger Briggs (California Environmental Protection Agency Central Coast Regional Water Quality Control Board); Permit Section Manager Edwin C. Bakowski (Illinois Environmental Protection Agency, Bureau of Land); Deputy Secretary L. Hall Bohlinger (Louisiana Department of Environmental Quality); and, Bureau Director Larry Knoche (Kansas Department of Health and Environment Bureau of Environmental Remediation). The Subteam would also like to recognize the efforts of their colleagues in state environmental agencies throughout the country.

The Work Team recognizes with special thanks those individuals of the Bioremediation Consortium of the Remediation Technologies Development Forum (RTDF) for their partnership with the ITRC during the development and review of this document. Their experience, talents and commitment to researching and objectively evaluating the soundness of new *in situ* technologies confirms the credibility of the following report.

EXECUTIVE SUMMARY

The Interstate Technology and Regulatory Cooperation (ITRC) Work Group, established in 1995, is a state-led partnership between state environmental regulatory agencies, federal agencies, tribal, public and industry stakeholders. The purpose of the ITRC is to improve environmental cleanup by encouraging the use of innovative environmental technologies, while reducing regulatory paperwork and overall costs. States are collaborating to develop and facilitate the use of standardized processes for the performance verification of new technologies. The *In situ* Bioremediation Team of the ITRC initiated a project to define a standardized method to compare cost and performance information from *in situ* bioremediation technologies. Ongoing demonstration projects being conducted at Dover Air Force Base in Delaware by the Remedial Technologies Development Forum (RTDF) were chosen to provide sample information for the reporting format.

This report describes a reporting methodology to obtain comparable information regarding the costs and performance associated with different types of technologies. Information gathered may then be compared in an equivalent manner to help determine which remediation technologies are the most effective for given site projects. Example information provided in this document is from a series of demonstrations by the Remediation Technologies Development Forum (RTDF), Bioremediation Consortium at Dover Air Force Base in Dover, Delaware.

Based on the level of concurrence from state agencies which regularly have oversight of proposed *in situ* bioremediation alternatives, the Cost and Performance Subteam of the *In Situ* Bioremediation Work Team of the Interstate Technology and Regulatory Cooperation Work Group recommends the use of the Cost and Performance Reporting for *In Situ* Bioremediation Technologies described herein. The Reporting format will provide standardized information with sufficient detail to adequately evaluate the relative effectiveness of insitu bioremediation remedies compared to other classes of remediation alternatives in given projects.

TABLE OF CONTENTS

APPENDICES

COST AND PERFORMANCE REPORTING FOR *IN SITU* BIOREMEDIATION TECHNOLOGIES

1.0 INTRODUCTION

The Interstate Technology and Regulatory Cooperation (ITRC) Work Group, established in 1995, is a state-led partnership between state environmental regulatory agencies, federal agencies, tribal, public and industry stakeholders. The purpose of the ITRC is to improve environmental cleanup by encouraging the use of innovative environmental technologies, while reducing regulatory paperwork and overall costs. States are collaborating to develop and facilitate the use of standardized processes for the performance verification of new technologies. The In-situ Bioremediation Team of the ITRC initiated a project to define a standardized method to compare cost and performance information from *in situ* bioremediation technologies. Ongoing demonstration projects being conducted at Dover Air Force Base in Delaware by the Remedial Technologies Development Forum (RTDF) were chosen to provide sample information for the Reporting format.

In-situ bioremediation (ISB) generally includes a broad spectrum of remediation methods which depend on the activities of microorganisms and other natural processes to degrade contaminants. In-situ bioremediation of fuel-related hydrocarbon compounds has been recognized for a number of years and has gained considerable acceptance within the regulatory community. ITRC regulatory members have noted the lack of a valid method to compare cost and performance of ISB technologies with other classes of remediation alternatives.

This report describes a reporting methodology to obtain comparable information regarding the cost and performance associated with different types of technologies. Information gathered may then be compared in an equivalent manner to help determine which remediation technologies are the most effective for given site projects. Example information provided in this document is from a series of demonstrations by the Remediation Technologies Development Forum (RTDF), Bioremediation Consortium at Dover Air Force Base in Dover, Delaware.

2.0 DEVELOPING THE REPORTING FORMAT

The ITRC Work Group identified the collection of consistent cost and performance data on environmental technologies, particularly remediation technologies, as a high priority on its agenda. As an initial step, the *In Situ* Bioremediation Work Team prepared the Reporting Format for *In Situ* Bioremediation Technologies set forth in this report. While preparing the format, input was obtained from 15 states which participate in the ISB Work Team, the ITRC Management Team, and the consortium members of the RTDF.

Based on input from these sources, the need to collect data to demonstrate cost and performance was balanced with the need to collect scientific data to demonstrate technology effectiveness with minimal additional operating costs. The format evolved to provide information on important process

variables influencing an *in situ* bioremediation process in such a way as to characterize the performance of the technology and to capture the costs associated with those variables to the greatest extent practicable.

In 1996, the Federal Remediation Round Table prepared guidance on collecting cost and performance data for remediation projects. The ISB Work Team recognized that the level of detail in the Round Table document was inadequate for characterizing the cost and performance of an *in situ* bioremediation project. Therefore, the Work Team identified parameters necessary to document the costs and performance of a general class of *in situ* bioremediation technologies. Reporting according to these parameters is not meant to be prescriptive or inflexible, e.g., analytical and field methods used to obtain information can vary between sites based on the operators' preferences and the states' oversight agencies' requirements. The format designed by the Cost and Performance Subteam follows.

3.0 REPORTING FORMAT

Site staff gathers appropriate date, and reports it in the following format:

SITE IDENTIFICATION
Project (City, State)

TECHNOLOGY
Common Name (Vendor Name as appropriate)

PROJECT DESCRIPTION
Short description describing purpose of demonstration, contaminants of concern, methods employed, and beginning and end dates of each phase of the demonstration. Include special conditions expected or necessary, and reference documentation as appropriate.

Site Background
Previous use of site (include SIC Code)

Waste Management Practice
e.g., spill, pollution prevention, etc

SITE CHARACTERISTICS
Media Treated
Note *in situ* media of interest

Contaminants Treated
As from project description.

Scale of Project
e.g., number of wells, depth, height, width of area to be treated

TREATMENT SYSTEM

Primary Treatment Technology (or method)
Common Name (Vendor Name as appropriate)

Supplemental Treatment Technology
Common Name (Vendor Name as appropriate)

RESULTS

Period of treatment
The period of treatment gives the evaluator a sense of the time that this remedial method took to reach its regulatory goal.

Pounds of Chemicals Degraded
Removal can be benchmarked against other technologies (e.g., Pump and Treat, etc).

Unitized Costs and Total Cost
Costs can be evaluated against other technologies which reach the same regulatory endpoint.

CHARACTERISTICS AFFECTING BIOREMEDIATION TREATMENT

Water Quality Characteristics
pH
Dissolved Oxygen
Reduction Potential
Anion Concentration
Cation Concentration

Presence and Concentration of Target Compounds
PCE
TCE
cis-DCE
trans-DCE
1,1-DCE
Vinyl Chloride

Presence and Concentration of Gases
Methane
Ethene
Ethane
Propane

Presence and Concentration of Other Organics
Total Organic Carbon
Substrate (e.g., Sodium Lactate)
Substrate (e.g., Yeast Extract)

HYDROGEOLOGIC CHARACTERISTICS

Aquifer Properties
% sand, using ASTM Method D-422 Sieve Analysis
% silt, using ASTM Method D-422 Hydrometer
% clay, using ASTM Method D-422 Hydrometer
% Organic Carbon (f^{oc})
Hydraulic Gradient (m/m)
Hydraulic Conductivity (cm/s)
Porosity (%)
Areal Extent of Contaminants (m^2)
Saturated Thickness (m)

ESTIMATES OF CONTAMINANT TRANSPORT CHARACTERISTICS

Pumping (Natural Conditions)
Velocity, cm/day (Tracer tests)
Volume of Aquifer to be treated, m^3 (Engineer Calculation)
Flux of Ground water, m^3/day (Engineer Calculation)
Flux of Contaminant, g/day (Engineer Calculation)

Bioremediation Treatment System Characteristics
Hydraulics
Injection Rate, m^3
Extraction Rate, m^3

COST

Cost Metric Value (dollars) unit
Cost/kg solvent destroyed
Cost/cubic meter of aquifer treated
Cost/1000 gallons of water treated
Cost/gallon per minute of water flowing through treatment region

Performance Metric
Weight of contaminant removed per year (lbs or kg)

4.0 SAMPLE REPORT

Information in the following example has been provided strictly as a test of the utility and usefulness of the Reporting Format, and should not be construed as a formal evaluation of the Dover Project. A description of the applicable Dover project is provided here to establish context for the example Cost and Performance Report.

The Remedial Technologies Development Forum (RTDF) Bioremediation Consortium includes representatives from various companies, the US Environmental Protection Agency (EPA), the US Department of Defense (DoD), and the U.S. Department of Energy (DOE). These members share a common interest in the development of *in situ* bioremediation technologies for the degradation of

chlorinated solvents in soils and ground water. During the spring of 1995, agreements were negotiated with the EPA, the Air Force, and DOE to facilitate collaboration between the public and private sectors to plan research projects at Dover Air Force Base (Dover AFB) in Dover, Delaware (hereafter referred to as "Dover" or "Dover projects").

The Dover projects focus on three *in situ* bioremediation processes: Intrinsic bioremediation (for treatment of the bulk of a plume), cometabolic bioventing, (for treatment in the vadose zone), and enhanced anaerobic biodegradation (for treatment of more concentrated areas of the plume). Part of the RTDF agreement called for joint participation in research, development, demonstration and evaluation necessary to achieve public and regulatory acceptance of these *in situ* processes. As a test of this Cost and Performance Reporting Format, RTDF was asked to input data collected during their demonstration of Accelerated Anaerobic Biodegradation at Dover.

4.1 Sample Project Description: Enhanced Anaerobic Biodegradation

Enhanced anaerobic biodegradation is the process where supplemental nutrients are used to optimize the destruction rates and control the degradation kinetics of chlorinated solvents.

Pilot Project Description:

In June 1996 an enhanced *in situ* anaerobic pilot system was installed at Dover AFB. Manipulation of process variables includes the injection of substrate, nutrients, inorganic chemical agents and other environmental amendments. There will also be studies on the most effective method of delivery of nutritional additions to the aquifer to facilitate the rate of anaerobic dechlorination. Currently, the pilot consists of an extraction well in a down gradient portion of the plume from which drawn ground water is mixed with nutrient and substrate amendments. The blend is then piped to an upgradient injection well where the contaminated ground water and amendments are injected back into the aquifer.

The main goal of the pilot is to demonstrate microbial degradation of ground water contaminated with PCE, TCE, and daughter products (i.e., DCE, VC, and ethene). Other objectives include: (1) demonstration that degradation of PCE and/or TCE can be stimulated in the deep portion of the aquifer; (2) confirmation that degradation will proceed through biogenic intermediates to nontoxic end products (*e.g.*, ethylene, Cl^-, and CO_2); (3) development of operation and cost data for a full-scale system; and (4) documentation of methodologies for implementing the technology at other sites.

4.2 Sample Data: Reporting Format

SITE:

Dover AFB, DE

TECHNOLOGY:

Enhanced *In Situ* Anaerobic Biodegradation of Chlorinated Solvents in Ground Water

PROJECT DESCRIPTION:

An enhanced anaerobic biodegradation pilot is being conducted *in situ* at Dover AFB, Delaware. The purpose of the pilot is to demonstrate that the degradation of perchloroethylene (PCE) and trichloroethylene (TCE) through biogenic intermediates to non-

toxic end products can be stimulated within the aquifer. The pilot consists of a six well (3 inj./3 ext.) recirculation cell (approx. 12 m x 18 m x 3m) with an amendment injection building. Sodium lactate and yeast extract are being injected into the ground water as substrate and diammonium phosphate injected as a nutrient. After 4.5 months of operation, one drum of 60% sodium lactate with 1288 grams of yeast extract has been added along with 9 kg of diammonium phosphate. Anaerobic conditions are beginning to be established a short distance from the injection wells; no evidence of dechlorination of compounds has been documented to date. On January 20, 1997, the sodium lactate addition rate was doubled. Time to complete this remediation will be determined at the end of the pilot.

Site Background

Aircraft operation and maintenance that used chlorinated solvents for cleaning purposes. (SIC Code 581).

Waste Management Practice

Spill.

SITE CHARACTERISTICS

Media Treated

Aquifer matrix and ground water (*in situ*)

Contaminants Treated

Perchloroethylene (PCE), Trichloroethylene (TCE); and degradation by-products.

Scale of Project

The hydraulic recirculation cell consisted of three extraction wells and three injection wells. The wells formed a rectangular cell 12 m wide by 18 m long. The screened interval of all wells was from approximately 12 m to 15 m below the ground surface. The total ground water recirculation rate averaged 3.8 gallons per minute.

TREATMENT SYSTEM

Primary Treatment Technology

Enhanced Anaerobic Biodegradation

Supplemental Treatment Technology

Injection/extraction facilities

RESULTS

See summary for current results. *(At the time of this report, no final results are available for discussion).*

CHARACTERISTICS AFFECTING BIOREMEDIATION TREATMENT

For the purposes of the ITRC report, this "example" section is presented as tables. The group has found that identifying and tracking these parameters for comparison of cost and performance of technologies is most effectively presented as a table, rather than in descriptive format.

Water Quality Characteristics

Parameter	EPA Test Method	Avg.	Before Treatment Low Value	Before Treatment High Value	# of Samp.	Avg.	After Treatment Low Value	After Treatment High Value	# of Samp.	Diff of Averages
Field Measured										
pH	Field 150.1	5.1	4.9	5.58	5					
Dissolved Oxygen, mg/L	Field	0.84	0.2	1	5					
Redox Potential, mV	Field	106	-411	370	5					
Anions										
Cl^-, mg/L	325.3	21	19	24	12					
Br^-, mg/L	Std.4110.B	<0.5	<0.5	<0.5	12					
SO_4^{-2}, mg/L	375.4	1.9	<0.5	5.7	12					
NO_3^{-2}, mg/L	353.2	7.9	0.9	11	12					
S^{-2}, mg/L	376.2	0	0	0	5					
PO_4^{-3}, mg/L	365.1	<0.5	<0.5	<0.5	12					
Cations										
Fe^{+2},mg/L	200.7	0.1	0.01	0.12	4					
NH_4^+, mg/L	350.2	ND	ND	ND	4					

Presence and Concentration of Target Compounds

* - detection limit

Parameter	EPA Test Method	Avg.	Before Treatment Low Value	Before Treatment High Value	# of Samp.	Avg.	After Treatment Low Value	After Treatment High Value	# of Samp	Diff of Averages
PCE, ug/L	624	12.5	5*	40	16					
TCE, ug/L	624	2112	42	10000	16					
cDCE, ug/L	624	531	22	4700	16					
TransDCE, ug/L	624	5.6	5*	25*	16					
1,1-DCE,ug/L	624	5.2	5*	25*	16					
VC, ug/L	624	10.25	5*	49	16					

Presence and Concentration of Gases

Parameter	**EPA Test Method**	**Avg.**	**Before Treatment** Low Value	High Value	**# of Samp.**	**Avg.**	**After Treatment** Low Value	High Value	**# of Samp.**	**Diff of Averages**
Methane, ug/L	Modif. 8015	74	3.9	140	10					
Ethene, ug/L	Modif. 8015	2	1	5.7	10					
Ethane, ug/L	Modif. 8015	1	1	1	4					
Propane, ug/L	Modif. 8015	1	1	1	4					

Presence and Concentration of Other Organics

Parameter	**EPA Test Method**	**Avg.**	**Before Treatment** Low Value	High Value	**# of Samp.**	**Avg.**	**After Treatment** Low Value	High Value	**# of Samp.**	**Difference of Averages**
Total Organic Carbon, mg/L	415.1	3.37	1.76	4.76	20					
Substrate, mg/L Substrate, mg/L	Std.4110B 415.1	100 1	Sodium Lactate Yeast Extract							

HYDROGEOLOGIC CHARACTERISTICS

For the purposes of the ITRC report, this "example" section is presented as tables. The group has found that identifying and tracking these parameters for comparison of cost and performance of technologies is most effectively presented as a table, rather than in descriptive format.

Aquifer Properties

Parameter	**Average**	**Low Value**	**High Value**	**# of Samp.**	**Measurement Procedure**
% sand	92.5	90	95	2	ASTM D-422 Sieve Analy.
% silt	4	3	5	2	ASTM D-422 Hydrometer
% clay	3.5	2	5	2	ASTM D-422 Hydrometer
% organic carbon, (f^{oc})	0.00014	0.0000936	0.000192	2	
Hydraulic Gradient (m/m)	0.002				Well differential
Hydraulic Conductivity (cm/s)	2.00E-02				Pump tests
Porosity (%)	35				Estimated with tracer test
Areal Extent of Contam. (m^2)	220				Transport time engineered cell
Saturated thickness (m)	3				Target Pilot Study thickness

CONTAMINANT TRANSPORT CHARACTERISTICS

Parameter	**Natural Conditions**	**Pumping Conditions**	**Method of Identification**
Velocity, cm/day	5	30	Tracer tests
Volume of Aquifer to be treated, m^3	660		Engineer calculation
Flux of GW, m^3/day	1.2	3.6	Engineer calculation
Flux of contaminant, g/day	3	9	Engineer calculation

Bioremediation Treatment System Characteristics

Parameter	**Avg. Daily**	**Low Value**	**High Value**	**# of Samp.**	**Total Volume or Mass**
Hydraulics					
Injection Rate, m^3	20.2				
Extraction Rate, m^3	20.2				

Injected Compounds

Added Compounds	**Total Carbon (kg)**	**Total Mass (kg)**	**Pumping Duration** (days/week)
Substrate Sodium Lactate	1.8	5.6	3.75
Nutrient Ammon. Phosphate	-	0.4	2.75
Sodium Bromide	-	2.7	2.75

COSTS

Capital Investment		**Operating Costs through 11/30/96**	
Item	Cost	Item	Cost
Design and Construction	$82,000.00	Direct Labor	$74,096.00
Site Preparation	$5,742.00	Materials – Substrate	$771.00
Structures	$39,818.00	Materials – Nutrients	$230.00
Process Equipment and Appurtenances	$24,067.00	Materials – Supplies	$2,272.00
Non-Process Equipment		Utilities	
Utility Infrastructure Hookup (elec., water, sewer, gas)	$50,716.00	Laboratory Analysis	$75,196.00
Installation Labor	$8,600.00	Sampling	$2,018.00
Monitoring Wells	$78,306.00	Shipping	$5,061.00
Dedicated Pumps	$18,224.00	Overhead	$975.00
Other Equipment	$5,690.00	Demobilization	
Injection Wells	$30,400.00	Waste Disposal	
Extraction Wells	$24,000.00	Injection Well Maintenance	$4,343.00
Dismantle/Demobilize		Extraction Well Maintenance	
TOTAL CAPITAL	$367,563.00	**TOTAL OPERATING**	$164,962.00
	Present worth, determined with 7% (suggested) discount rate, 30-year operating period		$2,414,576

5.0 CONCURRENCE SURVEY

The ISB/Cost and Performance Subteam circulated the Reporting Format to ITRC states. States were asked to review the Format, and respond to the Subteam with their level of concurrence. The levels identified were:

- We agree that the document is appropriate and commit to ask operators to collect cost and performance information for *in situ* bioremediation demonstrations according to the format of the document to the maximum extent feasible.
- We agree that the document is appropriate; however, there is an organizational, policy, or statutory conflict. The conflict is *[respondents are asked to describe the conflict]*
- We agree conceptually with the document, and will use it and evaluate it in a test mode.
- We do not agree the document is appropriate for the following reason(s): *[respondents are asked to describe inadequacies of the document]*

5.1 Cost and Performance Response Summary

In July 1997, the ISB/Cost and Performance Subteam circulated a request to review the *Cost and Performance Reporting for In Situ Bioremediation Technologies* for level of concurrence to ITRC member states. Six responses from five states were returned; California sent two responses from the state and regional Water Quality Control Boards.

Of the five state agencies, three responded with the highest degree of concurrence, stating an intention to use the format as written to the maximum extent feasible. Both of the other two state agencies recognized the value of collecting the cost and performance information described; Illinois

stated such information is already requested, and Louisiana indicated they will evaluate the described format in a test mode.

Additional comments and information were also provided by respondents. California's Central Coast Regional Water Quality Control Board requested that the format be revised to indicate length of the project, rather than only an "end date." New Jersey indicated that the format provided in the document will allow case managers with perhaps limited experience with *in situ* bioremediation technologies to have a higher degree of assurance using this method, since it has been developed and peer reviewed by regulators from several states. Illinois provided a copy of their Reporting Procedures to demonstrate what information they request as a matter of course.

5.2 Responding State Agencies

Response to the request for concurrence was provided by: California Environmental Protection Agency State Water Resources Control Board; California Environmental Protection Agency Central Coast Regional Water Quality Control Board; Illinois Environmental Protection Agency, Bureau of Land; Kansas Department of Health and Environment Bureau of Environmental Remediation; Louisiana Department of Environmental Quality; and New Jersey Department of Environmental Protection.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the level of concurrence from state agencies which regularly have oversight of proposed *in situ* bioremediation alternatives, the Cost and Performance Subteam of the *In Situ* Bioremediation Work Team of the Interstate Technology and Regulatory Cooperation Work Group recommends the use of the Cost and Performance Reporting for *In Situ* Bioremediation Technologies described herein. The Reporting format will provide standardized information with sufficient detail to adequately evaluate the relative effectiveness of insitu bioremediation remedies compared to other classes of remediation alternatives in given projects.

APPENDIX A

Acronyms

ACRONYMS

CERCLA	Comprehensive Environmental Response, Compensation and Liability Act of 1980
DCE	Dichloroethylene
DoD	Department of Defense
DOE	Department of Energy
Dover AFB	Dover Air Force Base
EPA	Environmental Protection Agency
ISB	*In situ* bioremediation
ITRC	Interstate Technology and Regulatory Cooperation
PCE	Perchloroethylene
RCRA	Resource Conservation and Recovery Act
RTDF	Remedial Technologies Development Forum
SIC	Standard Industrial Code
TCE	Trichloroethylene
VC	Vinyl Chloride

APPENDIX B

ITRC Work Team Contacts
ITRC Fact Sheet
Product Information
User Survey

ITRC CONTACTS

Paul Hadley
ITRC *In Situ* Bioremediation Technical Task Team Leader
California Environmental Protection Agency
Department of Toxic Substances Control
PO Box 806
Sacramento, CA 95814
Tel: (916) 324-3823
Fax: (916) 327-4494

Steve R. Hill
Coleman Research Corporation
2995 North Cole Road
Suite 260
Boise, ID 83704
Tel: (208) 375-2909
Fax: (208) 375-5506