



GOV. BUSH
Governor

Department of Environmental Protection

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

December 16, 2003

Mr. David J. Levy, P.G.
Southeast Remediation Technology, Inc.
321 Northlake Boulevard, Suite 210
North Palm Beach, Florida 33408

Re: **Levuk Method**

Dear Mr. Levy:

The Bureau of Petroleum Storage Systems hereby accepts the Levuk Method as a process for in situ and ex situ bioremediation of petroleum and other suitable contaminants in groundwater and soil. The process is a closed-loop re-injection-type system that combines groundwater recovery, soil washing, air sparging and bioremediation in a synergistic fashion. The process does not rely on a single bioaugmentation product, thereby allowing the user the freedom to select any commercially available bioremediation product that is appropriate for the contaminants and conditions at a given cleanup site.

This acceptance applies only to the regulatory jurisdiction and the remediation needs of the Bureau of Petroleum Storage Systems, which is primarily the cleanup of subsurface petroleum contamination pursuant to Chapter 62-770, Florida Administrative Code (F.A.C.). Other government agencies and local governments may choose to recognize this acceptance if their needs and regulations are similar. This bureau, however, is not responsible for applications beyond its own jurisdiction.

For vadose remediation at sites where conditions are such that the Levuk process will not cause contaminants or applied remediation products to leach into the underlying groundwater, there are no special concerns beyond those that would normally need to be addressed in preparing a Remedial Action Plan and conducting a soil cleanup in accordance with the requirements of Chapter 62-770, F.A.C. However, if any ingredients of the products applied for such a cleanup are themselves considered to be soil contaminants, then their residual concentrations in the soil upon completion of a cleanup project shall not exceed their respective soil cleanup target levels set forth in Chapter 62-777, F.A.C.

For ex situ groundwater treatment, in which an aboveground treatment system produces effluent meeting the petroleum cleanup criteria referenced by Chapter 62-770, F.A.C., and the drinking water standards of Chapter 62-550, F.A.C., for disposal via recharge gallery or NPDES permit, there are no special concerns. But for in situ groundwater remediation, via direct injection of remediation products and fluids into an aquifer by the Levuk process, there are underground injection control regulations that must be observed. Since in situ aquifer remediation via injection is likely to be the most common application of this process, and because it deliberately relies on leaching to accomplish washing of contaminants to the underlying groundwater for subsequent capture, the bulk of the regulatory requirements discussed herein will be directed to that topic. (As a side note, the bureau would like to point out to readers that leaching will not be the only remediation process at work here, because some degree of in situ biodegradation of contaminants is

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likely to occur as they travel downward to the water table in a carrier fluid that is rich in oxygen and nutrients.)

The bureau recognizes the Levuk Method as a viable process for the remediation of petroleum contaminated sites in Florida. There are no objections to its use provided: (a) the considerations of this letter are taken into account; (b) a Remedial Action Plan is approved by the Department; and (c) applicable and appropriate underground injection control regulations are observed. For the Levuk Method, the major environmental and regulatory considerations are set forth in enclosure 1.

While the Department of Environmental Protection does not provide endorsement of specific or brand name remediation products or processes, it does recognize the need to determine their acceptability from an environmental standpoint with respect to applicable rules and regulations, and the interests of public health, safety and welfare. Vendors must then market the products and processes on their own merits regarding performance, cost and safety in comparison to competing alternatives in the marketplace. In no way, however, shall this regulatory acceptance letter be construed as Department certification of product or process performance. Additionally, the Department emphasizes a distinction between its regulatory "acceptance" letters and an approval. Products and processes are accepted but they are not approved.

Also, it is not a requirement that a particular remediation product or process have an official acceptance letter in order for it to be proposed in a site-specific Remedial Action Plan. The plan, however, must contain sufficient information about the product or process to show that it meets all applicable and appropriate rules and regulations, especially those of the Florida Administrative Code pertaining to underground injection control.

Those who prepare Remedial Action Plans may include a copy of this letter in the appendix of plans they submit, and call attention to it in the text of their document. In this way, technical reviewers throughout the state will be informed that you have contacted the Department of Environmental Protection to inquire about the Levuk Method's environmental acceptability. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure 2.

The Department reserves the right to revoke its acceptance of a product or process if it has been falsely represented. Additionally, Department acceptance of any product or process does not imply it has been deemed applicable for all cleanup situations, or that it is preferred over other treatment or cleanup techniques in any particular case. A site-specific evaluation of applicability and cost-effectiveness must be considered for any product or process, whether conventional or innovative, and adequate site-specific design details must be provided in Remedial Action Plans proposing the product or process. You may contact Rick Ruscito by telephone at (850) 877-1133, extension 29, or at the letterhead address, Mail Station 4590, if there are any questions.

Sincerely,

Rick Ruscito, P.E.
Ecology and Environment, Inc.
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

Rebecca S. Lockenbach
FDEP Section Leader
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

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c: T. Conrardy - FDEP, Tallahassee/MS 4530

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ENCLOSURE 1

ENVIRONMENTAL AND REGULATORY INFORMATION

For the Levuk Method, the major environmental and regulatory concerns are listed below.

- a. Groundwater cleanup standards: The onus shall be on users of the Levuk Method to ensure that all applicable groundwater contaminant standards will be met at the time of project completion, for the contaminants of concern, any residuals associated with the ingredients of commercial remediation products used during the Levuk process, and any byproducts produced as a result of chemical or biochemical reactions involving those ingredients. The following chapters of the Florida Administrative Code are cited: Chapter 62-550, F.A.C., for primary and secondary water quality standards; Chapter 62-520, F.A.C. for groundwater classes and standards; Chapter 62-522, F.A.C., for groundwater permitting and monitoring requirements; Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-777, F.A.C., for cleanup target levels.

A noteworthy aspect of the minimum criteria set forth in Chapter 62-520, F.A.C., is that it requires groundwater to be free from substances that are harmful to plants, animals, and organisms, and free from substances that are carcinogenic, mutagenic, teratogenic or toxic to human beings. In effect, these "free from" requirements form a catchall. They close what would otherwise be a loophole in the regulations by preventing injection of a potentially harmful product in the event that any of its ingredients is not regulated as a specific primary or secondary drinking water contaminant.

- b. Closed-loop re-injection: Rule 62-522.300(2)(c), F.A.C., effective August 27, 2001, directly applies to the Levuk Method, which is a closed-loop, re-injection-type aquifer remediation process. This rule allows a temporary zone of discharge for such a process, for the primary standards for groundwater and for the prime constituents of the reagents used to remediate a site's contaminants, and for the secondary standards for groundwater. In order for users of the Levuk process to comply with this rule, a Department-approved Remedial Action Plan must address the duration and size of the zone of discharge, and provide for groundwater monitoring of ingredients of commercial remediation products and any site contaminants in the re-injected fluid that do not meet their respective primary or secondary drinking water parameters.

For most commercial bioremediation products used by the Levuk process, the Bureau of Petroleum Storage Systems anticipates that the temporary zone of discharge will be permitted by rule 62-522.300(2)(c), F.A.C., and not by a zone of discharge variance. A variance allowing a zone of discharge, however, will be necessary in cases where a chemical species present in a remediation product used by the Levuk process causes the re-injected fluid to exceed a minimum groundwater criterion, or the chemical species is not a prime constituent of the reagents needed to remediate the contaminants at a site, and that species causes the re-injected fluid to exceed a primary groundwater standard. More information about this topic can be found in the Bureau of Petroleum Systems' guidance document "BPSS-10, In Situ Chemical Additives" at web page www.dep.state.fl.us/waste/categories/pcp/pages/active.htm.

- c. Injection well permit: The issuance of a site-specific Remedial Action Plan Approval Order by either the Bureau of Petroleum Storage Systems or the Bureau of Waste Cleanup, for injection-type aquifer remediation via the Levuk Method, constitutes the granting of a Class V injection well permit.
- d. Utilization of wells: If a remediation site happens to have an abundance of monitoring wells, then the Department has no objection to the use of some wells as Levuk Method injection points. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used as Levuk Method injection points. This will avoid premature conclusions that the entire site meets cleanup goals. By making sure that designated tracking wells are not also used for treatment, there will be more assurance that the treatment process has permeated the entire site and that it did not remain localized to the area immediately surrounding each injection well.
- e. Groundwater monitoring:
 - 1. Active remediation monitoring of petroleum: During the period of active remediation, groundwater shall be monitored for petroleum contaminants of concern in accordance with the requirements set forth in Section 62-770.700, F.A.C. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
 - 2. Post remediation monitoring of petroleum: During the period of post active remediation, groundwater monitoring for petroleum contaminants of concern shall be conducted in accordance with the requirements set forth in Section 62-770.750, F.A.C. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
 - 3. Monitoring for underground injection control purposes: Pursuant to rule 62-522.300(2)(c), F.A.C., groundwater monitoring of the primary and secondary drinking parameters set forth in Chapter 62-550, F.A.C., that are not met by the injected fluid must be addressed in a Department-approved Remedial Action Plan. Additionally, if an injected fluid does not meet the minimum groundwater criteria of Chapters 62-520 and 62-777, F.A.C., then groundwater monitoring must be conducted for the specific parameters associated with the necessary temporary zone of discharge variance that permits the injection of such a fluid.
- f. Underground injection control inventory: Remedial Action Plans proposing in situ injection-type aquifer remediation shall include information pursuant to Rule 62-528.630(2)(c)1 through 6, F.A.C., for the inventory purposes of underground injection control. Per Rule 62-528.630(2)(c), F.A.C., aquifer remediation projects involving injection wells may be authorized under the provisions of a Remedial Action Plan, provided the construction, operation, and monitoring requirements of Chapter 62-528, F.A.C., are met. A memorandum outlining the inventory information about injection-type aquifer remediation projects to be transmitted by Department reviewers to the Underground Injection Control Section is provided as enclosure 3.
- g. Avoidance of migration: For in situ injection-type aquifer remediation projects, operation of the Levuk process shall be performed in such a way that no undesirable migration of either the ingredients of the commercial

remediation products used or the contaminants of concern in the aquifer results, pursuant to Rule 62-528.630(3), F.A.C.

- h. Operating parameters: Section 62-770.700, F.A.C., sets forth frequency requirements for the measurement of bioremediation operating parameters such as dissolved oxygen levels, rates of nutrient addition, temperature, etc. It also includes an option for reduction in the frequency or discontinuation of some measurements in situations when appropriate.
- i. Abandonment of wells: Upon issuance of a petroleum Site Rehabilitation Completion Order, or a declaration of "No Further Action", injection wells shall be abandoned pursuant to Section 62-528.645, F.A.C. The Underground Injection Control Section of the Department shall be notified so that Levuk Method injection wells can be removed from the inventory-tracking list.
- j. Shallow galleries: The Bureau of Petroleum Storage Systems believes there may be situations where notification to the Underground Injection Control Section of the Division of Water Resource Management is not necessary, because the Levuk process is not injecting a remediation fluid, but rather dispersing the fluid via shallow galleries for a soil washing effect that flushes contaminants to the water table, for subsequent collection by a groundwater recovery system. A word of caution is hereby provided to users of the process that this should not be construed as carte blanche to use any remediation product or chemical of choice, without regard to its toxicological impact on the groundwater at a remediation site. The toxicological effects of chemicals on groundwater are irrespective of the method by which they are introduced to an aquifer. The minimum groundwater criteria of chapters 62-520 and 62-777, F.A.C., still apply. While notification does not have to be given to the Underground Injection Control Section when a Remedial Action Plan proposing in situ soil washing via shallow galleries is approved, the bureau would like to provide a reminder that such a Remedial Action Plan should still provide for groundwater monitoring of any chemical species in the soil washing fluid that are of toxicological concern, and those that exceed a primary or secondary drinking water standard, or a minimum groundwater criterion.
- k. Intentions of Southeast Remediation Technology Incorporated: Even though a variety of commercial remediation products can be used by the Levuk process, Southeast Remediation Technology Incorporated, as a prudent measure, has indicated a preference at this time to use only those products already accepted by the Bureau of Petroleum Storage Systems, and to follow the Department's requirements when using them. The bureau appreciates this prudent approach. It should be noted, though, that there is no requirement that a product first be accepted in order to propose its use in a site-specific Remedial Action Plan, provided it meets all applicable and appropriate rules and regulations. This note is provided to help dispel a common misconception that product acceptance is a requirement.

ENCLOSURE 2

SUPPLEMENTAL INFORMATION

The information below, compiled from several sources, may be helpful to reviewers of Remedial Action Plans proposing bioremediation.

- a. Department of Environmental Protection reviewers of in situ injection-type aquifer remediation plans, regardless of whether in Tallahassee or district offices, must fill in the blanks on the enclosure 3 memorandum, whose subject is "Proposed Injection Well(s) for In Situ Aquifer Remediation at a Petroleum Remedial Action Site". The completed form must be submitted to the Underground Injection Control Section at 2600 Blair Stone Road, Tallahassee, Florida, 32399-2400.

Only the appropriate bureau chiefs and division directors within the Department and its district offices may sign in situ injection-type remediation plan approval orders that constitute the granting of a Class V injection permit. Local program staff may review such plans but are not authorized to sign the approval orders. Reason: Although an arrangement between the U.S. Environmental Protection Agency and the Department provides for the delegation of underground injection control authority to the Department, it does not allow the Department to delegate that authority any further. This includes delegation to the Department's contracted remediation review agencies such as those operated by the counties and other local governments.

- b. Pilot study: For bioremediation, per Section 62-770.700, F.A.C., a pilot study proposal shall be submitted for review, and a pilot test shall be performed prior to designing a treatment system. If conditions or the situation at a site do not warrant a pilot study, then a proposal explaining the rationale for the decision not to perform a pilot study shall be submitted for review.
- c. Bacteria: It is generally reported (on a total weight basis) that bacteria are approximately 70 to 80 percent water. On a dry weight basis, approximately 95 percent of the composition is represented by 5 elements: carbon, oxygen, nitrogen, hydrogen, and phosphorus. At a petroleum remediation site, it is intended that the source of carbon for the growth of bacteria will come from the petroleum hydrocarbons themselves. Natural-occurring organic carbon at a site can also serve as a carbon source for bacteria. Depending on site's specific conditions, the remaining four elements must either be available naturally, or added as macronutrients in order to stimulate bioremediation. Micronutrients must also be present for bacteria to grow.
- d. Degradation products: Carbon dioxide and water are the ultimate products of aerobic and most anaerobic biodegradations of hydrocarbons. In the case of methanogenesis, an anaerobic process, carbon dioxide and methane are produced. The intermediate products of aerobic degradation may include simple acids, alcohols, and fatty acids. Aerobic processes use oxygen as an electron acceptor to produce carbon dioxide and water.
- e. Parameters: The following parameters may be useful in determining the potential for bioremediation at a site, or whether bioremediation is already occurring. They were selected from a list that appears in the publication "In Situ Treatment Technology" by E. Nyer et al., Lewis Publishers, 1996. The parameters are dissolved oxygen; redox potential; pH; temperature; specific conductance; volatile organic compounds;

nitrate; nitrite; ammonia nitrogen; manganese (total and dissolved); iron (total, dissolved, and ferrous); sulfate; sulfide; and total organic carbon. Gaseous parameters include carbon dioxide, oxygen, nitrogen, and methane. Other parameters that may be helpful are chemical oxygen demand, biochemical oxygen demand, and total organic carbon. Those who prepare bioremediation plans and their reviewers should determine which parameters, if any, should be investigated on a site-specific basis.

- f. Dosage and application: Given that the Levuk Method can deliver a variety of remediation fluids and products, the Bureau of Petroleum Storage Systems suggests that users of the method consult Southeast Remediation Technology Incorporated to determine a dosage based on the specific remediation product to be applied, and the specific conditions of the site to be remediated. Similar advice is given for the method of application: deciding whether the remediation fluid should be delivered via injection well or shallow gallery will depend on the physical characteristics of the specific site, such as soil type, permeability, the depth interval at which the target contaminants are located, limitations on work space imposed by buildings and other structures at the site, etc.
- g. Levuk process operating parameters: Southeast Remediation Technology Incorporated provided information about Levuk Method operating parameters, which the Bureau of Petroleum Storage Systems would like to pass along. It should be kept in mind that the values below are provided as rule-of-thumb information only, and that they are not to be construed as absolute. Site-specific conditions will have an effect on operating parameter values, and adjustments should be made accordingly to suit the needs of the site. The parameters are given below.

Parameter	Value
Injection depth	Begin injection 1 to 3 feet above the layer of the contaminated soil.
Recovery well radius of influence	Expect at least 10 to 15 feet, depending on permeability of the soil.
Flow rate	0.5 to 150 gallons per minute, depending on aquifer characteristics. Optimum range: 5 to 50 gpm.
Injection pressure	0 to 3 pounds per square inch, depending on aquifer characteristics.
Temperature range	32 to 100 degrees Fahrenheit
pH	5 to 10 (buffer as necessary)
Dissolved oxygen	6 to 7 milligrams per liter in the fluid prior to injection, as a result of the aerator in the aboveground portion of the Levuk method's closed-loop re-injection-type process.

- h. Limitations: The Levuk Method is a bioremediation process for organic compounds. It is not intended for the remediation of elements such as metals.

Memorandum**Florida Department of
Environmental Protection**

TO: Richard Deuerling, Mail Station 3530
 Division of Water Facilities
 Underground Injection Control Section
 Florida Department of Environmental Protection
 2600 Blair Stone Road, Tallahassee, FL 32399-2400

FROM: _____ (Note 1.)

DATE: _____

SUBJ: **Proposed Injection Well(s) for In Situ Aquifer
 Remediation at a Petroleum Remedial Action Site**

Pursuant to Rule 62-528.630(2)(c), F.A.C, inventory information is hereby provided regarding the proposed construction of temporary injection well(s) for the purpose of in situ aquifer remediation at a petroleum-contaminated site.

Site name: _____
 Site address: _____
 City/County: _____
 Latitude/Longitude: _____
 FDEP Facility Number: _____

Site owner's name: _____
 Site owner's address: _____

Well contractor's name: _____ (Note 2.)
 Well contractor's address: _____

Brief description of the in situ injection-type aquifer remediation project:

Summary of major design considerations and features of the project:

Areal extent of contamination (square feet): _____
 Number of injection wells: _____
 Composition of injected fluid (Note 3)
 (ingredient, wt. %): _____

Injection volume per well (gallons): _____
 Single or multiple injection events: _____
 Injection volume total (all wells, all
 events): _____

Richard Deuerling
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Date: _____

Site name: _____
FDEP facility no.: _____

A site map showing the areal extent of the groundwater contamination plume, and the location and spacing of injection wells and associated monitoring wells is attached.

The following is a summary description of the affected aquifer:

Name of aquifer: _____
Depth to groundwater (feet): _____
Aquifer thickness (feet): _____

The injection well(s) features are summarized below, and/or a schematic of the injection well(s) is attached.

Direct-push or Conventional (*circle the appropriate well type*)
Diameter of well(s) (i.e., riser pipe & screen)(inches): ____
Total depth of well(s) (feet): _____
Screened interval: _____ to _____ feet below surface
Grouted interval: _____ to _____ feet below surface
Casing diameter, if applicable (inches): _____
Cased depth, if applic.: _____ to _____ feet below surface
Casing material, if applic.: _____

The in situ injection-type aquifer remediation plan for this petroleum contaminated site is intended to meet the groundwater petroleum cleanup criteria set forth in Chapter 62-770, F.A.C. Additionally, all other groundwater standards will be met at the time of project completion for any residuals associated with the ingredients of the injected remediation products, and any by-products or intermediates produced as a result of the chemical or biochemical transformation of those ingredients or the contaminating petroleum during their use. Applicable primary and secondary drinking water standards are set forth in Chapter 62-550, F.A.C., and additional groundwater quality criteria are set forth in Chapter 62-520, F.A.C.

The remediation plan estimates that site remediation will take _____ months. We will notify you if there are any modifications to the remediation strategy that will affect the injection well design or the chemical composition and volume of the injected remediation product(s).

The proposed remediation plan was approved on _____ by an enforceable approval order. A copy is attached. The remediation system installation is expected to commence within 60 days. Please call me at _____ if you require additional information.

Note 1. Local programs are not authorized to approve underground injections into aquifers. Reason: Per agreement with EPA, the FDEP cannot delegate this authority. Local programs, after reviewing a Remedial Action Plan or an injection proposal document, should follow the instructions in a March 16, 2000 memorandum to arrange for Department headquarters' execution of an approval order, and then complete this form. This form is primarily for use by state and local program technical reviewers, but petroleum remediation contractors may fill in all blanks except those labeled "FROM", "DATE", and "approval date", and "telephone number" blanks in the last paragraph. Those blanks should be completed only by a state or local program reviewer.

Note 2. If an injection well installation contractor has not yet been selected, then indicate the name and address of the project's general remediation contractor/consultant.

Note 3. Complete chemical analysis of injected fluid is required by Chapter 62-528, Florida Administrative Code. Proprietary formulations shall make confidential disclosure. Injected fluids must meet drinking water standards of Chapter 62-550, F.A.C., unless an exemption or variance has been granted.