



Department of Environmental Protection

Jeb Bush
Governor

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

Colleen M. Castille
Secretary

May 25, 2005

Bor-Jier (Benjamin) Shiau, Ph.D., P.E.
Director of Surfactant Technology
Surbec Environmental, LLC
3111 Broce Drive
Norman, Oklahoma 73072

Re: **Integrated Surfactant-Enhanced Subsurface Remediation (SESR)**

Dear Dr. Shiau:

The Bureau of Petroleum Storage Systems hereby reaffirms and updates its acceptance of the Integrated Surfactant-Enhanced Subsurface Remediation (SESR) method for in situ remediation of petroleum and other suitable contaminants in groundwater and soil.

This letter supersedes the original June 16, 2004 acceptance and contains two major revisions. The first is a correction to an erroneous indication that a temporary, injection zone of discharge must be permitted by variance for the two surfactants that are used. The correction is that no variance at all is involved, and that the zone of discharge is permitted by Rule 62-522.300(2)(c), Florida Administrative Code (F.A.C.), for all the chemical species associated with the fluid to be injected, including the two surfactants. The second revision considers Standard Method SM 5540-C for measuring the concentration of anionic surfactants in groundwater samples.

SESR is surfactant flushing that is used in combination with subsequent abiotic polishing for the removal and destruction of subsurface free product and dissolved contaminants, hence the integrated process. The method is flexible in that it is capable of using different types and mixtures of surfactants for flushing, and different types of chemical oxidants for the subsequent polishing step. It is also flexible in that it is capable of operating at a high surfactant concentration, in which the surfactant can be recovered and reused, or at a low surfactant concentration in a "once-through" manner, in which the surfactant is discarded as part of the effluent sent to a wastewater treatment plant or other appropriate means of disposal.

For its submittal to this Bureau, for regulatory evaluation as an Innovative Technology, Surbec Environmental LLC has chosen to provide information about the low surfactant concentration mode, using a mixture of two specific anionic surfactants, and low concentration chemical oxidation polishing with Fenton's reagent. The two surfactants are sodium dioctyl sulfosuccinate and a linear alkyl diphenyl oxide sulfonate, to which a small amount of sodium chloride is added to adjust surfactant phase behavior. The Fenton reaction chemicals are a low concentration hydrogen peroxide, and ferrous sulfate, with sulfuric acid used to adjust the pH.

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Even though some information about the SESR method is already available from the United States Patent Office, the specific concentrations of the surfactants and the Fenton reagents to be used in Florida are proprietary. Therefore, the Bureau of Petroleum Storage Systems, in this letter, will limit its discussion to only the information that is currently available to the public. Enclosure 1 is a voucher for the confidential disclosure of proprietary SESR concentrations, submitted by Surbec Environmental LLC to the Bureau of Petroleum Storage Systems for in situ aquifer remediation projects in Florida.

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, 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 jurisdiction.

For injection-type, in situ groundwater remediation via direct injection of SESR into an aquifer, there are underground injection control (UIC) regulations in Florida that must be observed, and for that reason the bulk of the regulatory requirements discussed herein will be directed to that topic.

The Bureau recognizes SESR as a viable product and method 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) Rule 62-522.300(2)(c), F.A.C., is observed with respect to the sodium dioctyl sulfosuccinate surfactant, the linear alkyl diphenyl oxide sulfonate-type surfactant, iron, sulfate, sodium, pH, and total dissolved solids; and (c) a site-specific Remedial Action Plan is submitted pursuant to Chapter 62-770, F.A.C., and approved by the Department for each site where the use of SESR is proposed. Some major regulatory considerations that apply to SESR are discussed in Enclosure 2.

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 and safety. 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 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 are advised to include a copy of this letter in the appendix of the plans they submit, and call attention to it in the text of their document. In this way, technical reviewers throughout the

Benjamin Shiau, Ph.D., P.E.
May 25, 2005
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state will be informed that you have contacted the Department of Environmental Protection to inquire about the acceptability of SESR. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as Enclosure 3.

The Department reserves the right to revoke its acceptance of a product or process if it has been falsely represented. Also, 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 a Remedial Action Plan. You may contact Rick Ruscito at (850) 877-1133, extension 29 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

enc: (1) Proprietary Concentrations Voucher
(2) Regulatory Information
(3) Supplemental Information

c: T. Conrardy - FDEP MS 4530/Tallahassee

History:

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5/25/05



ENCLOSURE 1

SESR Voucher
May 25, 2005

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Twin Towers Office Building
2600 Blair Stone Road
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May 25, 2005

Bor-Jier (Benjamin) Shiau, Ph.D., P.E.
Director of Surfactant Technology
Surbec Environmental, LLC
3111 Broce Drive
Norman, Oklahoma 73072

**Re: Proprietary Concentrations Voucher for
Integrated Surfactant-Enhanced Subsurface Remediation (SESR)**

Dear Dr. Shiau:

The Bureau of Petroleum Storage Systems hereby acknowledges receipt of a confidential disclosure dated February 17, 2004, submitted by Surbec Environmental LLC, regarding the proprietary concentrations of surfactants and reagents used by the remediation method known as Integrated Surfactant-Enhanced Subsurface Remediation (SESR) for the cleanup of petroleum in groundwater and soil pursuant to Chapter 62-770, Florida Administrative Code (F.A.C.). While neither the ingredients nor their concentrations have changed, this voucher supersedes the original that was issued on June 16, 2004, in order to correct an erroneous indication that a temporary, injection zone of discharge must be permitted by variance for the two surfactants that are used. The correction: No variance at all is involved, and the temporary, injection zone of discharge is permitted by Rule 62-522.300(c), F.A.C., for all the chemicals and species associated with the fluid to be injected, including the two surfactants.

SESR is surfactant flushing followed by abiotic polishing for the removal and destruction of subsurface free product and dissolved contaminants. It is a flexible process in that the type of surfactants used can be mixed and varied, and that the chemical oxidants used for the polishing step can be varied too. But for its submittal to the Bureau of Petroleum Storage Systems, for regulatory evaluation as an Innovative Technology for subsurface remediation in Florida, Surbec Environmental LLC has chosen a mixture of two specific, anionic surfactants to be used in low concentrations for flushing, and Fenton's reagents to be used in low concentration as a chemical oxidation polishing step. The two surfactants are sodium dioctyl sulfosuccinate and a linear alkyl diphenyl oxide sulfonate-type surfactant, to which a small amount of sodium chloride is added to adjust surfactant phase behavior. The Fenton reaction chemicals are low concentration hydrogen peroxide, ferrous sulfate, and sulfuric acid that are used to adjust the pH. Having reviewed the confidential disclosure, the Bureau hereby vouches for the concentrations.

Without divulging any more than is absolutely necessary, we provide information to potential users of the SESR method, and reviewers of plans proposing it, in order for them to comply with Florida's underground injection control regulations.

Temporary, injection zone of discharge by rule. For the substances that Surbec Environmental LLC will inject, a temporary zone of discharge is permitted by Rule 62-522.300(2)(c), F.A.C. for sodium, which is a state primary drinking water contaminant in Florida; and the following secondary drinking water chemical species and parameters: the sodium dioctyl sulfosuccinate surfactant, the linear alkyl diphenyl oxide sulfonate-type surfactant, iron, sulfate, pH, and total dissolved solids. In order to obtain a temporary zone of discharge for these seven (7) chemical species and parameters pursuant to that rule, a Department-approved Remedial Action Plan must: (a) identify each of the seven parameters; (b) specify the zone of discharge size and duration that is needed; and (c) propose groundwater monitoring for each.

For underground injection control purposes, aquifer remediation plans proposing SESR must provide the volume and composition of the fluid to be injected. Since the exact concentrations of the ingredients are proprietary, it will suffice to indicate only the volume of the SESR fluids to be injected, and provide a footnote indicating that a one-time confidential disclosure regarding the proprietary concentrations of the constituents has been submitted to the Department in exchange for this voucher. Reference should be made to the original February 17, 2004 disclosure and to this voucher. Remediation plan reviewers for petroleum-contaminated site applications involving SESR may contact Rick Ruscito at (850) 877-1133, extension 29.

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

ENCLOSURE 2

REGULATORY CONSIDERATIONS

- a. Groundwater cleanup standards: The onus shall be on users of SESR to ensure that all applicable groundwater contaminant standards will be met at the time of project completion, for petroleum, other contaminants that may be present, any residuals associated with the ingredients of SESR, 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, and minimum criteria; 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., also for minimum groundwater criteria.

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. 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 remediation via injection of SESR fluids into an aquifer, constitutes the granting of a Class V injection well permit.
- c. Zone of discharge: For in situ aquifer remediation, the composition of an injected fluid must meet the primary and secondary drinking water standards set forth in Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapter 62-520, F.A.C., pursuant to underground injection control Rule 62-528.600(2)(d), F.A.C. For fluids that do not meet this requirement, a temporary injection zone of discharge must be permitted either by Rule 62-522.300(2)(c), F.A.C., or by variance, or by a combination of the two, depending on the chemical species involved. In the case of SESR, the zone of discharge is permitted entirely by rule; no variance is necessary.

The indication above that a zone of discharge is permitted by rule for all SESR parameters is a correction to the original June 16, 2004 SESR acceptance letter, which erroneously indicated that a zone of discharge for its two surfactants could only be obtained by way of a variance. Clarification: The Department's Underground Injection Control Program issued a determination on April 7, 2005, in regard to variance petition number OGC 05-0356 for another injection-type aquifer remediation product that also contains a surfactant. It was determined that the surfactant is a prime constituent of the reagents needed to remediate site contaminants, and as such, was permitted a temporary injection zone of discharge by Rule 62-522.300(2)(c), F.A.C. Permission for a zone of discharge by way of a variance was not necessary.

- 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 for the application of SESR. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply SESR fluids. 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. Additives: If, in the future, either Surbec Environmental LLC or a user of SESR decides to augment it with additional chemicals, then the injection of such additional chemicals into an aquifer must also be in accordance with the underground injection control requirements of Chapter 62-528, F.A.C., which require that substances injected meet the drinking water standards set forth Chapter 62-550, F.A.C., and the minimum groundwater criteria of Chapter 62-520, F.A.C. Additionally, minimum groundwater criteria for specific chemicals are listed in Chapter 62-777, F.A.C.
- f. Groundwater monitoring:
 - 1. Active remediation petroleum monitoring: During the period of active remediation, groundwater shall be monitored in accordance with the requirements set forth in Section 62-770.700, F.A.C.
 - 2. Post remediation petroleum monitoring: At least one (1) year of quarterly post remediation groundwater monitoring shall be conducted at a minimum of two (2) wells, one located in the area of maximum petroleum contamination, the other downgradient of the area of maximum petroleum contamination, pursuant to Section 62-770.750, F.A.C.
 - 3. Underground injection control monitoring: For injection fluid parameters that do not meet primary and secondary standards, and minimum groundwater criteria, groundwater monitoring is required by Rule 62-522.300(2)(c), F.A.C. In the case of SESR, those parameters and their standards are as follows: sodium, 160 mg/L; iron, 0.3 mg/L; sulfate, 250 mg/L; pH, range 6.5 to 8.5; total dissolved solids, 500 mg/L; and foaming agents, 0.5 mg/L.

Foaming agents (i.e. surfactants) are regulated as a group by the secondary drinking water standards of Chapter 62-550, F.A.C. Standard Method SM 5540 can be used for the measurement of them in drinking water samples. The Department, having reviewed SM 5540, believes it may be a viable method for measuring the concentration of the sodium dioctyl sulfosuccinate surfactant and the linear alkyl diphenyl oxide sulfonate-type surfactant in groundwater samples from SESR remediation sites. Method SM 5540-C applies to anionic surfactants, the class of surfactants to which these two belong. The method can distinguish between anionic, cationic, and nonionic surfactant classes, but no further.
- g. Underground injection control inventory: Remedial Action Plans proposing injection-type, in situ 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 plans to be transmitted by Department reviewers to the Underground Injection Control Section is provided as Enclosure 4. Only reviewers within the Department, including its district offices, may approve in situ injection-type remediation plans in which the approval constitutes a Class V injection permit; local programs are not authorized to grant such approvals.

h. Operation:

1. Avoidance of migration: For injection-type, in situ aquifer remediation projects, injection of SESR fluids shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the fluids' constituents or the petroleum contaminants in the aquifer results, pursuant to Rule 62-528.630(3), F.A.C.
 2. Underground injection control operating permit: Although an operating permit is not required for aquifer remediation wells pursuant to Rule 62-528.640(1)(b), and 62-528.640(1)(c), F.A.C., since no movement of the petroleum contamination plume is expected to accompany the SESR treatment process, the Department requests that the information items listed in Rule 62-528.640(1)(b), F.A.C., be considered and included in Remedial Action Plan proposals as a matter of good and thorough design practice. Briefly summarized, they are: quality of water in the aquifer; quality of the injected fluid; existing and potential uses of the affected aquifer; and well construction details.
- 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 the injection wells can be removed from the inventory-tracking list.

ENCLOSURE 3

SUPPLEMENTAL INFORMATION

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

- a. Department of Environmental Protection reviewers of injection-type, in situ aquifer remediation plans, regardless of whether in Tallahassee or district offices, must fill in the blanks on the Enclosure 4 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 reviewers within the Department and its district offices may approve injection-type, in situ remediation plans in which the approval constitutes the issuance of a Class V injection permit; local programs are not authorized to grant such approvals. Reason: Although an arrangement between the Environmental Protection Agency and the Department delegated 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 innovative technologies and bioremediation, per rule 62-770.700(2), 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. Dosage and application rate: The Bureau of Petroleum Storage Systems recommends that users consult Surbec Environmental, LLC when determining a site-specific dosage and application rate for SESR.
- d. Degradation products: Carbon dioxide and water are the ultimate products of petroleum hydrocarbon destruction by chemical oxidation.
- e. Process economics: Surbec Environmental LLC indicates that economics will play a role in deciding whether to use the SESR method at high surfactant concentrations, which requires the use of additional equipment to recover and re-inject the surfactant, or to use a low surfactant concentration in a "once-through" manner, which discards the spent surfactant as part of the effluent to a wastewater treatment plant or other appropriate method of disposal.
- f. Actual field use: A brief 1-page summary of a an actual field application of SESR at a petroleum-contaminated site appears at web page www.surbec-art.com. The briefing indicates that one pore volume of low concentration surfactant (1%) was injected over a 2-month period, and that it reduced the gasoline free product layer from an initial thickness of approximately 3 feet to a non-detectable level. During the fresh water injection phase of the flushing, the concentration of benzene in the groundwater decreased by 50 - 95%. At the time the briefing was placed on the web page, the polishing step to complete the remediation of dissolved groundwater contaminants had not yet begun.

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): _____

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, which 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.