



Department of Environmental Protection

Jeb Bush
Governor

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

David B. Struhs
Secretary

July 15, 2003

Mr. Scott Inwood
University of Waterloo
Technology Transfer and Licensing Office
Office of Research
Needles Hall, Room 3005
Waterloo, Ontario, Canada N2L 3G1

Re: **Waterloo Emitter™**

Dear Mr. Inwood:

The Bureau of Petroleum Storage Systems hereby accepts the Waterloo Emitter™ as an innovative remediation technology. It is a device that is capable of passively diffusing into groundwater a variety of fluids (both gases and liquids) for in situ aquifer remediation of petroleum contaminants. Since it is not limited to the diffusion of any particular fluid or combination of fluids, it has the capability of serving to remediate non-petroleum contaminants as well.

This "in-the-well" device is a pressurized coil of polymeric tubing that contains the fluid to be diffused for the purpose of in situ aquifer remediation. A few examples of the fluids that the emitter is capable of diffusing, as indicated in the literature you provided are oxygen, hydrogen, propane, toluene, carbon dioxide, and sulfur hexafluoride.

Although this acceptance applies only to the jurisdiction of this bureau, other bureaus within the Department of Environmental Protection, or other state agencies and local governments may choose to recognize it if their needs and regulations are similar. There are no objections to the use of the Waterloo Emitter for the cleanup of petroleum contamination pursuant to Chapter 62-770, F.A.C., which is the jurisdiction of this bureau, provided such use is in accordance with an approved site-specific Remedial Action Plan. This bureau, however, is not responsible for applications beyond its jurisdiction. Enclosure 1 cites Florida environmental regulations that apply when the Waterloo Emitter is used for in situ aquifer remediation.

While the Department of Environmental Protection does not provide endorsement of specific or brand name remediation products or processes, it does recognize a 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 letter of acceptance be construed as certification of product performance. Additionally, the Department emphasizes a distinction between its regulatory "acceptance"

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 in the Florida Administrative Code.

Those who prepare Remedial Action Plans are advised to 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 environmental acceptability of this product. To aid those who prepare Remedial Action Plans, as well as those who review them, supplemental information about the Waterloo Emitter is provided in enclosure 2.

The Department reserves the right to revoke its acceptance of any product or process if it has been falsely represented. Additionally, Department acceptance of a 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 me at (850) 245-8911 if there are any questions.

Sincerely,

Rick Ruscito, P.E.
Bureau of Petroleum Storage Systems

c: T. Conrardy - FDEP/Tallahassee

ENVIRONMENTAL REGULATIONS AND CONSIDERATIONS

Note. Because the Waterloo Emitter is designed to introduce a variety of fluids into an aquifer for remediation purposes, it is not a chemical-specific process. And because it is not practical for the Bureau of Petroleum Storage Systems to address in an acceptance letter every conceivable chemical that could be introduced by the emitter, the regulatory considerations are discussed below only in general. The onus shall be on the user of the emitter to explain, in a site-specific Remedial Action Plan, how the specific fluid [i.e. chemical(s)] chosen to remediate the site meet all applicable and appropriate regulations.

Additionally, although the introduction of a fluid into an aquifer by the Waterloo Emitter is more of a diffusion process than an injection, the Bureau of Petroleum Storage Systems believes that underground injection control regulations should apply. Even though the fluid introduced by the emitter is not an injection in a conventional sense, it still relies on a pressure or concentration gradient to force a remediation fluid into an aquifer.

From a regulatory standpoint, there is also another aspect of the emitter that is common to underground injection control. Attention must be paid to the composition of the remediation fluid to be injected, and its potential for undesirable toxicological effects on the groundwater. Regardless of whether the introduction of a fluid into an aquifer for remediation purposes is a forceful pressurized injection, or a gentle diffusion via the Waterloo Emitter, the most important aspect from a regulatory standpoint is the chemical composition of the fluid. There is a need to make sure that the remediation fluid itself does not create a groundwater contamination problem or unwanted environmental and toxicological effects.

- a. Groundwater cleanup standards: The onus shall be on users of the Waterloo Emitter 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 substances introduced to an aquifer by the emitter, and any by-products produced as a result of chemical or biochemical reactions involving those substances. 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. These chapters are currently available at web page www.dep.state.fl.us, in a blue-colored sidebar under the heading of "Rules".

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 the Bureau of Petroleum Storage Systems for in situ, injection-type aquifer remediation constitutes the granting of a Class V injection well permit.
- c. Groundwater injection standards: For injection-type in situ aquifer remediation, pursuant to the underground injection control regulations in Chapter 62-528, F.A.C., the composition of an injected fluid must meet the drinking water standards set forth in Chapter 62-550, F.A.C., the general minimum groundwater criteria described in Chapter 62-520, F.A.C., and the minimum groundwater criteria for specific chemicals set forth in Chapter 62-777, F.A.C.

For situations where the Waterloo Emitter will be used to diffuse into the aquifer a fluid in the liquid state, the chemical composition of the fluid can be compared to the groundwater standards cited in the foregoing paragraph in order to determine whether the fluid meets underground injection control requirements. This should be a relatively straightforward comparison since underground injection control standards in the Florida Administrative Code are expressed in terms of contaminant concentrations in a liquid (e.g. in milligrams per liter). Examples of liquid "injections" using the Waterloo Emitter would be the introduction of hydrogen peroxide or toluene.

However, for situations where the Waterloo Emitter will be used to diffuse into the aquifer a fluid in the gaseous state, the comparison of the composition of the "injected" fluid to injection standards is not as straightforward. There are no injection standards for the introduction of gases to an aquifer. Therefore, in order to meet the intent of underground injection regulations to protect groundwater, the Bureau of Petroleum Storage Systems suggests that -- when the Waterloo Emitter is used to dissolve a gas other than air or diatomic oxygen into an aquifer -- the potential for the gas to cause an exceedance of a groundwater standard be considered.

For example, if an emitter is used to dissolve gaseous ammonia into an aquifer, and the resulting concentration of ammonia in the aquifer will be less than the maximum 2.8 milligrams per liter allowed by Chapter 62-777, F.A.C., then there are no problems in regard to underground injection control regulations. However, if the concentration in the aquifer will exceed the 2.8-milligram per liter limit, then a variance for a temporary zone of discharge for the ammonia must be granted prior to the introduction of the ammonia. A similar approach can be taken for other gases, like butane, that may be introduced to an aquifer for remediation purposes.

- d. Zone of discharge variances: Substances introduced into an aquifer, or degradation products and by-products of those substances that do not meet the minimum groundwater criteria for specific contaminants listed in Chapter 62-777, F.A.C., must obtain a variance from Rule 62-522.300(3), F.A.C., for a temporary zone of discharge, within

which the minimum criteria may be temporarily exceeded for the beneficial purpose of remediating a contaminated aquifer. Instructions for petitioning for a temporary zone of discharge variance can currently be found at web page www.dep.state.fl.us/waste/categories/pcp/pages/innovative.htm.

Additionally, since the Waterloo Emitter is capable of introducing a variety of fluids into an aquifer, there may be situations where a particular substance to be introduced is of environmental or toxicological concern, but not regulated as a specific groundwater contaminant. Such a situation falls into the general category of minimum groundwater criteria in Chapter 62-520, F.A.C. When this happens, it will be necessary to develop minimum groundwater criteria for the substance(s) of concern, and then petition for a variance from Rule 62-522.300(3), F.A.C., for a zone of discharge, within which the developed minimum criteria may be temporarily exceeded.

- e. Rule 62-522.300(2)(c), F.A.C.: In situations where the Waterloo Emitter will be used to introduce into an aquifer a fluid for which the prime constituents of the reagents needed to perform the remediation do not meet the primary or secondary drinking water standards of Chapter 62-550, F.A.C., it is not required that a variance for a temporary zone of discharge be obtained, but rather the approved site-specific Remedial Action Plan address the following, in order to obtain a temporary zone of discharge by rule rather than by variance: (a) identification of the "injected" chemical species in the reagents that do not meet their primary and secondary drinking water standards; (b) the time and duration of the temporary zone of discharge; and (c) monitoring of the groundwater for the chemical species that will not initially meet their primary or secondary standards, or their natural-occurring background concentrations in the groundwater at a site, whichever is less stringent. Chapter 62-522, F.A.C., which contains rule 62-522.300(2)(c), F.A.C., is currently available at web page www.dep.state.fl.us, in a blue-colored sidebar under the heading of "Rules".
- f. 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 existing wells as Waterloo Emitter wells. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used as a Waterloo Emitter well. 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 by the emitter, 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 emitter well.
- g. Underground injection control inventory: Remedial Action Plans prescribing 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 3.

- h. Avoidance of migration: Although it is unlikely that the Waterloo Emitter will cause unwanted migration of a groundwater contamination plume, the Bureau of Petroleum Storage Systems believes it is still worthwhile to provide a reminder about migration. For in situ injection-type aquifer remediation projects, the introduction of fluids shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the injected fluid or the contaminants of concern in the aquifer results, pursuant to Rule 62-528.630(3), F.A.C.
- 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.

SUPPLEMENTAL INFORMATION

- a. Description: The Waterloo Emitter is made from coils of either ¼-inch diameter Low Density Polyethylene (LDPE) or silicone diffusive tubing. The LDPE diffusive tubing has a maximum operating pressure of 90 pounds per square inch (psi), and the silicone diffusive tubing has a maximum operating pressure of 25 psi. Two emitter sizes are currently available. The nominal 4-inch diameter model has an overall outside diameter of 3.88 inches and an overall length of 54 inches (of which 48 inches is functional emitter length). If the diffusive tubing in the 4-inch model were to be uncoiled, its length would be approximately 85 feet. The nominal 8-inch diameter model has an actual overall outside diameter of 6.0 inches and an overall length of 54 inches (of which 48 inches is functional emitter length). If the diffusive tubing in the 8-inch model were to be uncoiled, its length would be approximately 150 feet.
- b. Approvals and Underground Injection Control (UIC) notification: 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 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 Environmental Protection Agency and the Department delegates 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.

- c. More about UIC notification: In situations where the emitter will be used to diffuse air (79% diatomic nitrogen, 21% diatomic oxygen) or pure diatomic oxygen into an aquifer, the bureau suggests a little common sense with respect to UIC notification. Air and oxygen are relatively innocuous, and there appears to be no reason to develop groundwater standards for them from a toxicological standpoint. For this reason, the Bureau of Petroleum Storage Systems does not believe it necessary to file a UIC notification, as discussed in paragraph *b* above, when air and diatomic oxygen are diffused into an aquifer using the Waterloo Emitter. However, notification should be provided to the Underground Injection Control Section when other less inert gases, such as ozone, propane, butane and ammonia to name a few, are diffused into an aquifer. For the introduction of a gas into an aquifer, the UIC Section can be notified about the amount over the life of the remediation project in different ways. If the volume of gas at a specific temperature and pressure is a convenient way of expressing the amount, then this is acceptable. Another way of notifying the UIC Section of the total amount of gas to be introduced into the aquifer over the life

of a cleanup project at a remediation site is to provide the total mass of the gas.

- d. Safety: For the Waterloo Emitter, like any other product or process used for the remediation of petroleum-contaminated sites, the Bureau of Petroleum Storage Systems expects appropriate safety practices to be observed. Depending on the type of fluid being diffused by the emitter, the safety concerns may include but may not necessarily be limited to the following: safe handling of chemicals and gases; compatibility of chemicals if more than one type of fluid will be diffused; safety and appropriate protection for personnel at the site; the safety of passersby; potential fire hazards if flammable fluids will be handled by the emitter; and National Electrical Code considerations for equipment items at the wellhead and aboveground if flammable substances will be handled.
- e. Primary use: The Bureau of Petroleum Storage Systems agrees with an indication in the Waterloo Emitter literature that the bulk of the applications for this device will be for diffusion of oxygen into aquifers for the purpose of bioremediation. In those cases, the safety concerns would be similar, and no more severe than those for other oxygen diffusing devices that the bureau has accepted to date.
- f. Web site: For more information and details about the Waterloo Emitter, please visit web site www.WaterlooEmitter.com.

**Florida Department of
Memorandum 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
Page Two
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 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.

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- 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.