UIC Class V Well Variances for Remediation of Contaminated Sites and Their Case Studies, Florida Department of Environmental Protection (DEP)

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Abstract: In Florida, innovative technologies of the 1990s and today present a key to cleanup of contaminated groundwater sites where previously no technology existed to realistically provide such remediation. The Florida Department of Environmental Protection (DEP) has approved a number of variances for Underground Injection Control (UIC), Class V injection/remediation wells for groundwater cleanup. Variances are necessary to allow an injection that produces one or more temporary exceedences of state primary or secondary drinking water standards. Remediation technologies attempted thus far include the injection of oxidizing/reducing agents, alcohols, and/or nutrients to control dissolved oxygen (DO) concentrations and the resulting contaminant breakdown. Direct push technology is commonly utilized for inexpensive and rapid site characterization and for enacting treatment at contaminated drycleaners, using a variety of shallow injection methods. Pilot tests demonstrate success in the cleanup of Dense Nonaqueous Phase Liquids (DNAPL) solvents, which prove particularly difficult due to contaminant solubility limitations, and intricate geological characteristics. Using advanced technologies, petroleum contaminated sites have demonstrated cleanups that have resulted in site restoration. Several sites demonstrate the unexpected mobilization rather than breakdown of contaminants in the ground water, and also mobilization into the vadose zone. This situation would require injection which increases DO levels to promote further contaminant breakdown, with the use of soil vapor extraction or air sparging in the vadose zone.

Since 1997, approximately 40 variances have been approved by DEP for the allowance of injection of a solution that creates a violation of groundwater primary or secondary standards at a contaminated site/facility. It is not DEP's position to certify a particular consultant or product or process they are proposing. DEP wants to ensure that a proposed product or method is environmentally and technically acceptable, reasonable, and feasible. The onus is on the manufacturer/developer/user to comply with regulations during activation of their product at the approved site.

Obtaining a variance initially requires a petition submittal which includes the following: 1) the rule from which the variance is requested; 2) explanation of the type of action requested for approval; 3) the reason why the variance serves the purpose of the underlying statute; 4) reason why the variance would serve the purposes of the underlying statute; 5) list of specific facts that would justify a variance for the petitioner; and 6) list of specific facts that demonstrate substantial hardship or a violation of principles of fairness. It should be stated how the injection has the potential to be beneficial to the aquifer, despite producing a violation of standards. It should also clarify how the target aquifer at the subject location is already significantly contaminated, making it unusable in its current condition.

While a variance is approved to a particular petitioner for use of a specific product for injection, these variances may be granted for site specific or statewide use. Prior to allowing an injection at a prospective site, a department-approved aquifer Remedial Action Plan (RAP), as described in rule 62-528.630, Florida Administrative Code (F.A.C), must be approved. The RAP will contain a zone of discharge (ZOD), with the required size for the

zone, commonly 100 feet, and duration of the ZOD, commonly one year. Site specific conditions, method of injection, and substance to be injected will determine size of ZOD and period of violation allowance. The RAP is considered DEP enforceable, and with it no permit is required. A sampling plan, within the RAP, complete with a post injection sampling for a one year period must also be provided and approved.

Strategies and **Case Studies** Remediation using biological augmentation to reduce dissolved oxygen concentrations and create in-situ anoxic conditions for reductive dechlorination (RD) is included in several projects, past and pending. Anoxic conditions enhance the activation of indigenous anaerobic bacteria, which will remove Cl^- ions and replace them with hydrogen, breaking down halogens into less toxic molecules. The variance granted to HSA, Inc., using molasses injection, entails such a RD plan. The 280 day project has parameter exceedences which include chloride, color, pH and TDS. A similar RD project has been proposed by Parsons Engineering Science, Inc. At a Cape Canaveral pilot study, Parsons is using vegetable (soybean) oil, which will act as an electron donor. Thirty six injection points will distribute 1,800 gallons of oil into the shallow aquifer. Parameters for variance that will be in violation include color and TRPH.

The first Florida DEP variance for injection, issued in 1997, was for the Oxy-Cat® process, which used H_2O_2 with a $FeSO_4$–based proprietary catalyst for an abandoned gas station remediation. Moderate levels of BTEX contaminants were present within a 40-foot diameter plume. One 600-gallon injection of the solutions was completed in 1997 and a second in 1998, with a "no further action" issued in July 1999.

The Cogen V® process was successfully used at a former gas station, where two 60-foot plumes contained total VOCs in groundwater measured in the 6-800 range. After a soil and tank excavation took place in 1998, 14 hand-augured holes were drilled in 1999, and injected with 275 gallons of solutions, and then backfilled. By 2000, all PAHs and NAPs levels were BDL, and only ethylbenzene remained, at 1.6 ug/L.

At drycleaner sites, use of various injectates in groundwater has focused on DNAPL contamination, where complete remediation has never been accomplished. The presence DNAPL remains an imperative concern to the public, where vulnerable drinking water supplies could jeopardize public health if exposure to DNAPL contamination occurs. Case study documented herein will focus on use of: 1) hydrogen peroxide, (H_2O_2); 2) hydrogen release compound (HRC); 3) potassium permanganate, ($KMnO_4$), using alcohol flooding to address contamination.

The use of H_2O_2 has been attempted for remediation at Florida Drycleaner Solvent Cleanup Program (DSCP) sites, with at least partial success in cases. Complex flow patterns in aquifers and inability to locate a DNAPL source may obscure remediation at some sites. At the Swift Cleaners site, PCE and TCE concentrations to greater than 22,000 ug/L were measured at 43 foot bls, with concentrations decreasing upward at depths of 28, 32 and 38 feet. Three injection periods using 176 injection points at four discrete depths using Oxy-Cat® took place in September 2000. Analysis of multiple groundwater points took place at baseline, and after the second and final injections. Results were very inconsistent, with

some points decreasing contaminant levels in half after one of two injection episodes, and then increasing fourfold after the final. A full-scale project will be completed by publication time, extending injection points further outward into the migrating plume, and definition of the 300-foot plume extending from the site may be better controlled.

HRC™, by Regenesis, has documented success at the Beaches site in Jacksonville, FL, where one injection of 22,000 lbs. of HRC has reduced PCE to bdl at almost all of over 30 sampling points. TCE is similarly breaking down, and to a lesser degree DCE. The DCE is breaking down to vinyl chloride, which is not reducing. Air sparging or ORC may be attempted next to reduce the vinyl chloride. Contemporary Cleaners at Orlando has undergone a HRC™ injection that was effective in the shallow zone. A deeper injection was completed in April 2000 to address deeper contamination. Results will be documented by publication of this document.

The use of alcohol flooding is a process that was initiated in the petroleum industry to enhance petroleum recovery, and has also been a focus of DNAPL capture (Brandes and Farley, 1993). The DSCP, together with LFR Levine-Fricke, Inc. consultants and the University of Florida, conducted an alcohol flushing at a DNAPL site pilot study in Jacksonville, FL in 1998, as the first DSCP remediation project. Approximately 9,000 gallons of ethanol was injected into three wells with target depths at 25-30 feet BLS. Recovery of product from surrounding recovery wells took place for the ensuing eight days, with the capture of approximately 17 liters of PCE. The success of multiphase DNAPL recovery at this site by alcohol flooding has led to a recent variance that includes both ethanol flooding, and the addition of $KMnO_4$ to breakdown the DNAPL that has been solubilized. This co-oxidation methodology has led to fieldwork designs that are being finalized for the project at the time of this publication.

Rule Amendment: There is no cost for a variance, but the efforts to obtain one are quite laborious for DEP and contractors acting as petitioners, commonly requiring more than 90 days to complete. Recent developments by the DEP Division of Water Resource Management and Office of General Counsel include a draft of amendments to rules 62-522, F.A.C., Ground Water Permitting and Monitoring, and 62-528, F.A.C., Underground Injection Control (UIC), for Class V, Group 4 UIC wells. This amendment will allow a remediation product to be injected into the subsurface, granting a zone of discharge for primary and secondary drinking water standards at sites of remediation, without a variance requirement. A site RAP will be required as before, which contains a ZOD, with the duration usually between 30 days and two years, depending the nature of the site and the process being utilized.

The minimum criteria rule for groundwater will still apply, which means that certain standards not in the primary or secondary standards rule must be met. This rule states that groundwater must be “free from” substances in concentrations which are harmful to plants, animals, organisms indigenous to the soil, or that are carcinogenic, mutagenic, teratogenic or toxic to human beings. This is essentially a catchall that prevents indiscriminate injection of a potentially harmful substance into an aquifer in the event that the substance is not specifically regulated as a primary or secondary drinking water contaminant.