Department of Energy
Office of Legacy Management

March 31, 2009

Mr. Carl Spreng
Rocky Flats Cleanup Agreement Project Coordinator
Colorado Department of Public Health and Environment
4300 Cherry Creek Drive South
Denver, CO 80246-1530

SUBJECT: Screening Level Evaluation of Additives Proposed for Use in Solar Ponds Plume Treatment System Phase II and III Upgrades

REFERENCE: Rocky Flats Legacy Management Contact Record 2009-01

Dear Mr. Spreng:

This correspondence is to transmit the enclosed subject evaluation in accordance with Contact Record 2009-01.

The evaluation provides information about several potential carbon sources for metering into the inert substrate. We believe that any of the carbon sources evaluated would work, but we have not yet finalized an initial source. We expect to finish evaluating the logistics involved in purchasing, transporting, handling, monitoring, and storing the potential carbon sources in the next few weeks. Any feedback you have regarding the enclosed evaluation will be considered in the selection of the carbon source. The design of the upgrade components affords us the capability to use any of the evaluated carbon sources.

At present, we do not plan to perform the sodium bromide tracer test before the construction and initial operation of the Phase II and III upgrades. Note that the subject evaluation recommends using this particular tracer chemical during the inactive season for the Preble's meadow jumping mouse. When and if the tracer test is to be performed, we will also consider alternative tracer chemicals, as well as the possible timing of the tracer test.

If you have any questions regarding the information in this correspondence or the enclosure, please contact me at (720) 377-9682 or Rick DiSalvo at (720) 377-9674.

Sincerely,

Scott R. Surovchak
LM Site Manager

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Enclosure

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SCREENING LEVEL ECOLOGICAL RISK EVALUATION FOR PROPOSED ADDITIVES—ROCKY FLATS SOLAR PONDS PLUME TREATMENT SYSTEM UPGRADES

INTRODUCTION

This evaluation was conducted to determine if chemical additives proposed for use in the Solar Ponds Plume Treatment System (SPPTS) upgrades are likely to pose any significant risk to ecological receptors. Small concentrations of these additives in the SPPTS effluent may be expected to reach groundwater at the SPPTS Discharge Gallery and surface water in South Walnut Creek downgradient of the Discharge Gallery via groundwater baseflow.

Ecological receptors include the anticipated terrestrial and aquatic species in the riparian area where the SPPTS Discharge Gallery is located and along South Walnut Creek downgradient of the Discharge Gallery. This area is habitat for the Preble's meadow jumping mouse, a riparian species that is listed as "threatened" in Colorado under the Endangered Species Act and, thus, is a primary ecological receptor of concern at the site. A full discussion of ecological receptors of concern is included as Appendix A, "Comprehensive Risk Assessment," of the *Rocky Flats Resource Conservation and Recovery Act Facility Investigation–Remedial Investigation/Corrective Measures Study-Feasibility Study Report for the Rocky Flats Environmental Technology Site*.

This evaluation consists of a toxicity assessment of the proposed chemical additives and an exposure assessment for the Preble's meadow jumping mouse.

BACKGROUND

As approved in Rocky Flats Legacy Management Agreement (RFLMA) Contact Record 2008-07, the installation of a collection sump, a solar-powered pumping system, and upgrades to existing effluent piping was completed at the SPPTS in October 2008. The upgrade is called the "SPPTS Phase I" upgrade. The Phase I upgrade has successfully captured additional nitrate- and uranium-contaminated groundwater for treatment. RFLMA Contact Record 2009-01 documents the plans for the Phase II and Phase III upgrades to treat the higher flow rates and higher contamination levels resulting from Phase I. The results from Phase II and III will inform a final Phase IV upgrade configuration.

The Phase II upgrade components include a cell with reactive media consisting of zero valent iron (ZVI) to remove uranium contamination. The effluent from the ZVI treatment is the influent to the Phase III upgrade components. Phase III is a pilot scale treatment, including cells for an inert media (plastic rings) and an organic media (possibly walnut shells) designed to remove nitrate contamination by denitrifying bacteria. At least one type of inert media will be used in Phase III, and a second type of inert media may or may not be used. The water treated in the Phase II and III upgrade system will flow as influent to the current SPPTS treatment cells.

Sodium citrate will be metered into an appropriate location in the Phase II uranium treatment process as a chelating agent for dissolved iron in the effluent, to prevent scaling. The sodium citrate is also expected to be utilized by the nitrate treatment bacteria.

In the Phase III pilot scale system, a carbon source and nutrient will be metered into the water for the bacteria denitrification process. One proposed carbon source is a dilute ethanol aqueous solution (on the order of 15 percent ethanol), which may be a beer brewery waste product or a distilled product in aqueous solution. Another proposed carbon source is a commercially available carbon source, MicroC glycerin, made by Environmental Operating Solutions Inc. MicroC glycerin is made from a byproduct of biodiesel fuel. A small amount of phosphate (at a phosphate-to-carbon ratio of 1:100) will also be added to promote bacterial growth. The carbon source and phosphate will be metered into the water at an appropriate location in the system upstream of the inorganic media. Phase III may also include adding vegetable oil as a carbon source to impregnate or coat the organic media.

A tracer test may be conducted to determine if the existing SPPTS treatment cells reactive medium (ZVI mixed with wood chips and ZVI mixed with pea gravel) is being bypassed through the presence of preferential flow pathways. Sodium bromide is proposed as the tracer.

Effluent from the SPPTS is discharged to the groundwater at the Discharge Gallery, and becomes part of the groundwater contribution to baseflow in North Walnut Creek downgradient of the Discharge Gallery. Water quality standards for on-site surface water have been established under RFLMA, and groundwater is also evaluated based on RFLMA surface water quality standards and other criteria. The RFLMA standards are based on the water quality standards promulgated by the Colorado Water Quality Control Commission (WQCC).

None of the proposed additives have RFLMA or promulgated WQCC statewide or North Walnut Creek–specific water quality standards. However, the basic WQCC surface water standards also state that surface waters shall be free from substances attributable to human-caused point source or nonpoint source discharge in amounts, concentrations, or combinations that would be detrimental to beneficial uses or are toxic to humans, plants, animals, or aquatic life. See 5 Code of Colorado Regulations, 1002-31, sec. 31.11.

TOXICITY ASSESSMENT

The proposed chemical additives for use in the treatment system—brewery waste or aqueous solutions containing ethanol, vegetable oil, glycerin, phosphate, and sodium citrate—are considered nontoxic and are not expected to have any deleterious effects on ecological receptors; no toxicological benchmarks are available for these constituents.

Brewery waste, or ethanol or glycerin, and vegetable oil are a food source for bacteria; therefore, most of these materials will likely be consumed in the denitrification process, and only minor amounts would be present in the treatment system effluent. Vegetable oil is, of course, a common cooking ingredient. Sodium citrate is a common food additive and water softener. Brewery waste is composed of a variety of constituents, including ethanol and minor amounts of essential nutrients such as calcium, phosphorus, and iron (Nguyen and Ogle 2000). Studies conducted at Cantho University, Vietnam, used brewery wastes in various proportions as feed material for ducks (Nguyen and Ogle 2000). While a diet composed of 100 percent brewery waste was not optimum for duck growth, it certainly was not toxic.

Glycerin (also called "glycerol") is widely used in foods and beverages as a sweetener and is common in pharmaceutical and personal care products, such as soap. The U.S. Food and Drug Administration classifies it as a caloric macronutrient. According to the material safety data sheet for MicroC glycerin (MSDS 2009), the specific product considered for use at the SPPTS, it is biodegradable in soil and water, does not bioaccumulate, and has no known chronic health effects. Based on the small amounts expected to be used at the SPPTS, no adverse ecological effects are expected on aquatic or terrestrial receptors.

Phosphate is expected to be added in small amounts to the carbon source. Phosphate is a common component of fertilizers, animal wastes, and domestic sewage (Dunne and Leopold 1978). Storm water runoff in urban areas commonly has phosphorus in the concentration range of 0.1 to 1.5 milligrams per liter (mg/L) (Dunne and Leopold 1978). Data for sodium phosphate and other related compounds indicate that they are commonly used as fungicides, herbicides, and microbiocides (Kegley et al. 2009b). These compounds are *not* known to be one or more of the following: a highly acute toxicant, a known or probable carcinogen, a known groundwater pollutant, or a known reproductive or developmental toxicant (Kegley et al. 2009b). Based on the information outlined above and on the very small amounts expected for use at the SPPTS, no adverse ecological effects are expected on aquatic or terrestrial receptors.

Generally, concentrations of chemicals in water that are recognized to pose a risk to human health or the environment will have a promulgated standard based on concentrations that are protective of the water's use category. The proposed chemical additives do not have promulgated WQCC standards, nor are they included as candidate contaminants for regulation by the U.S. Environmental Protection Agency, indicating that exposure to minor amounts of these chemicals would not pose a recognized significant risk. One issue with respect to surface water quality associated with the discharge of biodegradable materials, such as glycerin and ethanol, is that the receiving water may become depleted of oxygen, which can harm the aquatic ecosystem (Dunne and Leopold 1978). Another issue is whether vegetable oil concentrations in the effluent might create visible oil sheen on the surface water. For economic and operation reasons, the additives will be metered to provide just enough of the chemicals to meet the requirements for water softening and denitrification. Ideally, all of the carbon source and nutrients will be completely consumed. The expected concentrations of the additives in the effluent, if any, are expected to be very dilute and are not likely to pose an oxygen depletion risk or cause visible oil sheen.

Sodium bromide is proposed for use as a tracer. By definition, tracers are nonreactive and highly mobile in aqueous systems. If flow through the treatment system occurs in a manner favorable for maximizing biotreatment (a piston-type flow), an injected tracer should exit the treatment system at the same concentration as the injectate after the passage of 1 pore volume. A sodium bromide concentration of approximately 200 mg/L is anticipated for use in the proposed tracer tests.

Sodium bromide is considered to be toxic in sufficient quantities. According to the toxicological information in its material safety data sheet (Mallinckrodt Baker Inc. 2008), sodium bromide has a median lethal dose of 3,500 milligrams per kilogram for oral exposure in rats. This means that an oral dosage of 3,500 milligrams of sodium bromide per kilogram of a rat's body weight, when administered to a test population of rats, results in the death of 50 percent of the test population. In low dosages, sodium bromide has been used as an anticonvulsant drug (SedoNeural) in humans, though prolonged ingestion of small amounts can cause central nervous system depression. While less toxic drugs are now give to humans in place of sodium bromide, sodium bromide is still commonly used to prevent seizures in dogs (Setter, n.d.). Common starting dosages for dogs range from 20 to 40 milligrams per kilogram per day.

Tests were conducted, using algae, crustaceans, and fish, to assess the toxicity of sodium bromide on freshwater organisms (Canton et al. 1983). Acute toxicity varied from 44 to 5,600 mg/L bromium ion, depending on the test species. Long-term tests produced "no observed effect" concentrations ranging from 7.8 to 250 mg/L bromium ion. Similar ranges for sodium bromide toxicity are reported in the Pesticide Action Network database (Kegley et al. 2009a), with wide variations in responses even within similar species. The concentration proposed for tracer testing is within reported "no observable effect" concentration ranges and below many reported lethal concentrations (median lethal doses), though acute toxicity was observed in some species at fairly low concentrations.

The carbon source, nutrient and sodium citrate, is not considered further in this evaluation. Sodium bromide is carried through the exposure assessment.

EXPOSURE ASSESSMENT

As a worst-case scenario, it is assumed that a receptor is exposed to sodium bromide in water at the concentration with which it exits the treatment system—200 mg/L. It is assumed that the Preble's meadow jumping mouse is the main ecological receptor of concern. An average body weight for the Preble's meadow jumping mouse is 18 grams (USFWS 2002). Based on data compiled for deer mice (EPA 1993), a representative water ingestion rate is 0.2 grams per gram of body weight per day. For a mouse of average body weight, this results in a water ingestion rate of 3.6 grams (or 3.6 milliliters) per day and, in turn, a daily dosage of 0.72 milligrams of sodium bromide per day (or 400 milligrams of sodium bromide per kilogram of body weight per day), based on a sodium bromide concentration of 200 mg/L.

DISCUSSION

In a worst-case scenario, the Preble's meadow jumping mouse could be exposed to levels of sodium bromide in water that are approximately 1 order of magnitude below an oral median lethal dose for rats, but 1 order of magnitude above a therapeutic dosage for dogs. Concentrations would not likely be high enough to be acutely toxic; however, based on sodium bromide's effects on humans, the concentrations could produce adverse effects if exposures persisted over a significant period. Still, there are a number of factors that make this level of exposure unrealistic:

- *Dilution/Dispersion*. Although groundwater tracers are selected because of their nonreactive properties, some attenuation would probably occur between the point at which the tracer solution enters the groundwater and the point at which it exits (by discharge to surface water). Nitrate data indicate that samples collected at the surface water monitoring location (GS13) are about 75 percent lower in concentration than those collected where water exits the treatment system (SPOUT).
- *Preble's Meadow Jumping Mouse Home Range Size*. Field studies of the Preble's meadow jumping mouse indicate that it does not spend its entire time confined to riparian areas (USFWS 2002). Preble's meadow jumping mice regularly use uplands up to 100 meters outside of floodplain areas. Additionally, they are known to travel as much a 1 mile along a given stream in a single night (USFWS 2002). Therefore, any individual mouse would likely drink water from multiple sources during the course of a day, thereby reducing exposure to a single contaminant source.
- *Test Duration*. The injection of tracer solution is expected to take place for only 14 days. Therefore, any potential exposures to sodium bromide would be temporary. Concentrations of undiluted solution would probably not be considered acutely toxic (lethal based on short-term exposure). The short-term nature of the test would probably be insufficient to produce chronic (long-duration) effects. In addition, the Preble's meadow jumping mouse hibernates each year for 7 to 8 months, from September or October to May (USFWS 2002). If the test takes place during this timeframe, potential exposures can be largely eliminated.

CONCLUSION

It is unlikely that the chemical additives planned for use at the SPPTS will harm the Preble's meadow jumping mouse. Most of the materials used will be consumed by bacteria, and only limited quantities are likely to discharge to surface water. Under worst-case conditions, sodium bromide proposed for tracer testing could discharge to surface water at levels that could harm ecological receptors (i.e., the Preble's meadow jumping mouse) under conditions of constant, prolonged exposures. Those levels would not be expected to be acutely toxic. Because of the potential for contaminant dilution, the fairly large home range of the Preble's meadow jumping mouse, and the short duration of the tracer tests, actual exposures are likely to be low and to result in minimal, if any, adverse effects. Exposures can be essentially eliminated if testing is conducted during the Preble's meadow jumping mouse's hibernation period. While this evaluation focused predominantly on the Preble's meadow jumping mouse, some of the same lines of reasoning (e.g., probability of dilution, bacterial consumption of organic materials, short duration of tracer testing) support the conclusion that the proposed activities would not likely have a significant adverse impact on the aquatic ecosystem.

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