**Attachment A**

**List of Authorized Amendments**

**Note:** Highligted have been approved on 2007 WDR

***1. Chemical Oxidants (Final):***

* Fenton’s reagent (hydrogen peroxide, ferrous iron catalyst, and pH buffer)
* Hydrogen Peroxide
* Ozone
* Potassium or Sodium Permanganate
* Sodium Percarbonate
* Sodium Persulfate
1. ***Chemical Oxidant Activators (Final):***
	* Calcium Hydroxide
	* Chelating Agents (ferric EDTA, ferric citrate, sodium citrate, sodium malonate, sodium

 phytate)

* + Ferric Iron (Ferric Chloride)
	+ Silica and Silicates (Silicic Acid, Sodium Silicate, Silica Gel)
	+ Sodium Hydroxide
1. ***Aerobic Bioremediation Enhancement Compounds (Final):***
* Calcium Oxide/Peroxide
* Calcium Oxy-hydroxide
* Magnesium (Oxide/Hydroxide/Peroxide)

***4. Anaerobic Degradation Enhancement Compounds:***

* Calcium Sulfate (gypsum)
* Carageenan
* Cheese Whey
* Complex organic materials (starch, wood chips, soy, yeast extract, grain milling products)
* Complex Sugars
* Corn Syrup
* Emulsified Vegetable Oil
* Ethanol
* Glucose
* Glycerol esters of fatty acids and polylactates
* Glycerol Polylactate/Tripolylactate
* Glycerol, Xylitol, Sorbitol
* Guar
* Lactose
* Lecithin
* Magnesium sulfate
* Milk Whey
* Methanol
* Molasses
* Organic Acids (Acetate, Lactate, Propionate, Benzoate, and Oleate)
* Potassium Sulfate
* Propanol
* Sorbitol Cysteinate/Cysteine
* Sodium Sulfate

***5. Reduction Degradation Enhancement Compounds:***

* Ferrous Carbonate
* Ferrous Chloride
* Ferrous Gluconate
* Ferrous Lactate
* Ferrous Sulfate
* Hematite
* Greigite
* Mackinawite
* Magnetite
* Pyrite
* Sodium Sulfide
* Sodium Dithionite
* Zero-Valent Iron

***6. Metals Precipitation / Stabilization*** **(Final):**

* Calcium Phosphate
* Calcium Polysulfide
* Ferrous Sulfate
* Sodium Tripolyphosphate (STPP)

***7. Surfactants/Co-solvents (Final):***

* Benzenesulfonic acid
* Dioctyl Sodium Sulfocuccinate
* D-limonene
* Ethoxylated Castor Oils Surfactants
* Ethoxylated Cocamides Surfactants
* Ethoxylated Coco Fatty Acid Surfactants
* Ethoxylated Octylphenolic Surfactants
* Sorbitan Oleate

***8. Bioaugmentation Organisms:***

* Dehalococcoides Sp.
* Dehalobactor Sp.

***9. Tracer Study Compounds (Final):***

The tracer compounds shall be highly contrasting and not reactive with current contaminants

to be treated. The tracers may be chloride-, bromide-, or fluoride-based salts, or similar

materials as approved by the Executive Officer.

* Calcium Bromide
* Calcium Chloride
* Eosin Dyes
* Fluoride Salts
* Iodide
* Potassium Bromide
* Potassium Iodide
* Rhodamine Dyes
* Sodium Bromide
* Sodium Chloride
* Sodium Fluorescein

***10. Buffer Solutions and pH Adjusters (Final):***

Buffer solutions, such as calcium carbonate and sodium bicarbonate, can create groundwater pH conditions favorable to degradation of groundwater pollutants.

* Calcium Carbonate
* Calcium Magnesium Carbonate
* Potassium Bicarbonate
* Sodium (carbonate/bicarbonate)

**Additional Language to added to the permit:**

**Section 6 Language:**

Surfactants are classified by ionic charge of the hydrophilic group in aqueous solution. As

such, they are divided into ionic and nonionic. Sodium lauryl sulfate is an example of

anionic surfactant while pH-dependent amines are cationic. The most important criteria for

surfactants and co-solvents used in in-situ remediation are low toxicity and biodegradability.

The addition of electrolytes and co-solvents helps to improve contaminant mass recovery

and prevent formation of gels in the subsurface. Many long-chain alcohols exhibit some

surfactant properties. Co-solvents are mostly alcohol-based solutions, such as fatty alcohol.

Some of the commonly used electrolytes include sodium chloride and calcium chloride.

Most food grade surfactants can be applied as approved by the Executive Officer.

***Multiple Amendments:***

This category includes discharge of reducing agents or oxidizing agents, or both applied concurrently, or over time as in an approved RAP. Examples include:

(a) Establishing a reducing zone immediately downgradient of an oxidizing zone to reduce hexavalent chromium that may be produced under oxidizing conditions.

(b) Providing a slowly degradable carbon source along with polysulfides to precipitate sulfates as metal sulfides.

***7. Bioaugmentation Organisms:***

Other bacterial genomes with commercial names can be applied as approved by the EO.

Add language into permit: Not GMO or human/animal pathogens.