
EHC Placement Evaluation for Field Applications

EHC[®] is an integrated treatment material containing controlled-release organic carbon, fine-grained zerovalent iron (ZVI), and other additives for treatment of contaminated groundwater. Typically, in-situ EHC zones are created using injection placement methods, such as a direct push technique (DPT). Based on previous experience, distribution of the injected EHC depends on site conditions and injection equipment used. Therefore, confirmatory core evaluation is often performed to verify the radius of influence (ROI) and uniformity of EHC-amended zones.

Given below are several core examination methods that could be used as part of this evaluation. Ideally, both lateral and vertical substrate distribution would be evaluated using discrete depth samples in cores collected at different distances from the injection point. The cores collected in the vicinity of the EHC injections should be compared to those outside of the perceived ROI.

ZVI Presence

Because of the presence of ZVI in EHC, the amended zone should be enriched in reduced iron, both particulate ZVI and ferrous iron. In addition to distinct layers of dark colored EHC itself, visual inspection of cores may show a dark discoloration in sections influenced by EHC. It should be noted that red/brownish discoloration indicative of oxidized iron is not typically observed in EHC cores, even after prolonged exposure to air, likely due to the presence of the organic substrate (**Figure 1**).

The presence of ZVI particles can also be detected using a magnet. A wet magnetic separation, as described in Attachment A, can be used as a qualitative method to determine ZVI presence in a core sample or as a semi-quantitative method to determine the ZVI content. In our controlled tests, we obtained a method detection limit of about 0.1% per soil mass. The procedure is designed for use with simple equipment in a field laboratory. Method calibration is recommended in the field with site soils (i.e.; mixing a known amount of EHC to background soil and then detecting it using the magnetic separation method).

Laboratory Analyses

If selected core samples could be sent for laboratory analyses, then TOC could be analyzed in soil. Note that a typical laboratory determination of soil iron is based on a strong acid digestion, and as such is not useful for EHC evaluation due to interference from structural native iron present in soil minerals. If the coring equipment is capable of collecting pore water samples, then these samples could be analyzed for indication parameters described in the Attachment B.

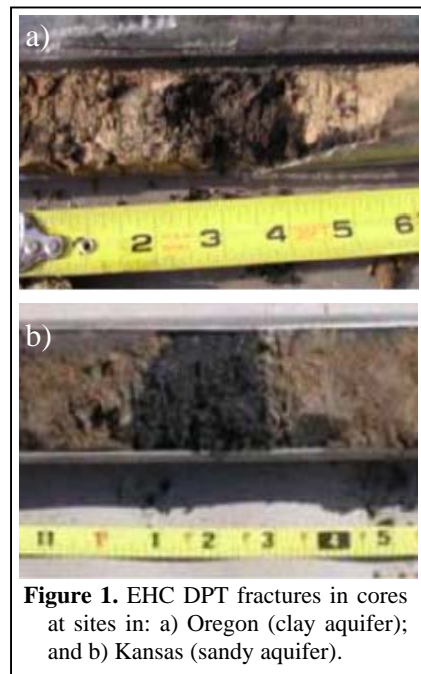


Figure 1. EHC DPT fractures in cores at sites in: a) Oregon (clay aquifer); and b) Kansas (sandy aquifer).

Attachment A -Magnetic Separation Method for ZVI Content Determination in EHC Amended Soil

- 1) Collect about 100 g of amended core material. Take a sub-sample of about 10 g, record its wet weight (*S1*), dry it in an oven, and record its dry weight (*S2*). The objective here is to calculate soil moisture content.
- 2) Weigh about 50 g of wet soil sample record its weight (*A*) and suspend it in about 300 mL of tap water in a transparent plastic cap. Tape a magnet to the bottom of the cap.
- 3) Stir the suspension, allow to settle and decant most of the water containing suspended fine soil particles and floating debris.
- 4) Add more water and repeat the procedure until the suspension is clear. ZVI and the soil sand fraction will be retained at the bottom. The objective here is to remove most soil fines adhering to the ZVI while not washing away the ZVI particles.
- 5) Remove magnet from the bottom of the cup and tape it to the side of the cup. Fill it with water, stir the suspension and tip the cup towards the opposite end of the magnet location. ZVI particles will be retained at the cup wall influenced by magnet while sand will be collected at the other end. Use a stirring stick and a squirt bottle filled with water to carefully remove and wash away the sand, while taking care not to disturb the retained ZVI particles. The objective here is to separate all iron particles from the sand. Repeat this procedure to separate any soil particles trapped with ZVI.
- 6) Remove magnet from the cup, using a squirt bottle wash the ZVI particles into a pre-weighed metal weighing boat. Use a magnet to remove excess water, dry it completely in an oven or on a hot plate, weigh and record the weight (*B*).
- 7) Calculate the iron fraction per dry weight soil using

$$\% \text{ Iron} = \frac{\text{WeightDryExtractedIron}(B)}{\text{InitialWetSampleWeight}(A) \frac{\text{DrySubSampleWeight}(S2)}{\text{WetSubSampleWeight}(S1)}} \times 100$$

- 8) Necessary Equipment:
 - a) Scale accurate to 0.1 gram
 - b) Magnet (e.g. a hardware store rectangular shape 1 in. x 2 in. ceramic magnet)
 - c) Transparent plastic cups (about 400 mL)
 - d) Drying oven or propane cook stove
 - e) Squirt bottle
 - f) Plastic spoon for mixing
 - g) Standard safety equipment (gloves, eye protections, etc.)