

# A Citizen's Guide to In Situ Chemical Reduction



## What Is In Situ Chemical Reduction?

In situ chemical reduction, or "ISCR," uses chemicals called "reducing agents" to help change contaminants into less toxic or less mobile forms. It is described as "in situ" because it is conducted in place, without having to excavate soil or pump groundwater above ground for cleanup. ISCR can clean up several types of contaminants dissolved in groundwater. It can also be used to clean up contaminants known as "dense non-aqueous phase liquids" or "DNAPLs," which do not dissolve easily in groundwater and can be a source of contamination for a long time. ISCR is most often used to clean up the metal chromium and the industrial solvent trichloroethene, or "TCE," which is a DNAPL.

## How Does It Work?

When reducing agents are added to contaminated soil and groundwater, a chemical reaction occurs that changes contaminants into other forms. For example, a very toxic form of chromium called "hexavalent chromium," or "chrome 6," can be changed to chrome 3 when reducing agents are injected into contaminated groundwater. Chrome 3 is a much less toxic form of the metal. Chrome 3 is also less mobile because it does not dissolve as easily in water.

Common reducing agents include zero valent metals, which are metals in their pure form. The most common metal used in ISCR is zero valent iron, or "ZVI." ZVI must be ground up into small granules for use in ISCR. In some cases, micro- or nano-scale (extremely small)

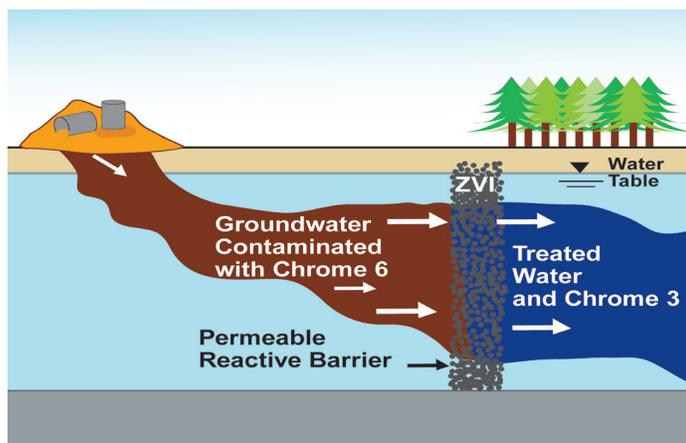


Illustration of the treatment of contaminated water with a PRB made of ZVI.

particles are used. The smaller particle size increases the amount of iron available to react with contaminants. Other common reducing agents include polysulfides, sodium dithionite, ferrous iron, and bimetallic materials, which are made up of two different metals. The most common bimetallic material used in ISCR is iron coated with a thin layer of palladium or silver.

There are two ways of bringing reducing agents into contact with contaminated soil and groundwater: direct injection and construction of a permeable reactive barrier, or "PRB."

**Direct injection** involves mixing the reducing agent with water (or sometimes vegetable oil) to create a slurry, which is pumped down holes drilled directly into the contaminated soil and groundwater. This method is often used to treat highly contaminated source areas, including DNAPLs. Nano-scale ZVI is usually used when injecting iron underground, but micro-scale ZVI also is used.

A **PRB** is a wall built below ground, usually by digging a trench and filling it with a reducing agent. Iron filings, which are larger granules of ZVI, are commonly used. Because the wall is permeable, groundwater flows through the PRB allowing contaminants to react with the reducing agent; treated water flows out the other side. A PRB is used to treat contaminants dissolved in groundwater. It will only treat the water that flows through it. (See *A Citizen's Guide to Permeable Reactive Barriers* [EPA 542-12-015].)

## How Long Will It Take?

ISCR may take as little as a few months to clean up a source area using direct injection, and PRBs may take several years. The actual cleanup time will depend on several factors that vary from site to site. For example, ISCR will take longer where:

- The source area is large, or contaminants are trapped in hard-to-reach areas like fractures or clay.
- The soil or rock does not allow the reducing agent to spread quickly and evenly or reach contaminants easily.
- Groundwater flow is slow.

