

IEG Technical Briefing Note No. 17

Stacked Groundwater Circulation Well - (IEG stacked GCW)

The Groundwater Circulation Well (GCW) is applied to treat halogenated solvents, semi-VOCs (SVOCs), pesticides, and petroleum products and their constituents such as benzene, toluene, ethylbenzene, and xylene (BTEX). It has been applied to a wide range of soil types, from sandy clay to coarse sandy gravel. Groundwater Circulation Wells can be used in conjunction with other *in situ* process methods such as bioaugmentation, enhanced natural attenuation, bioventing, soil vapour extraction, reactive dehalogenation, *in situ* denitrification and chemical oxidation.

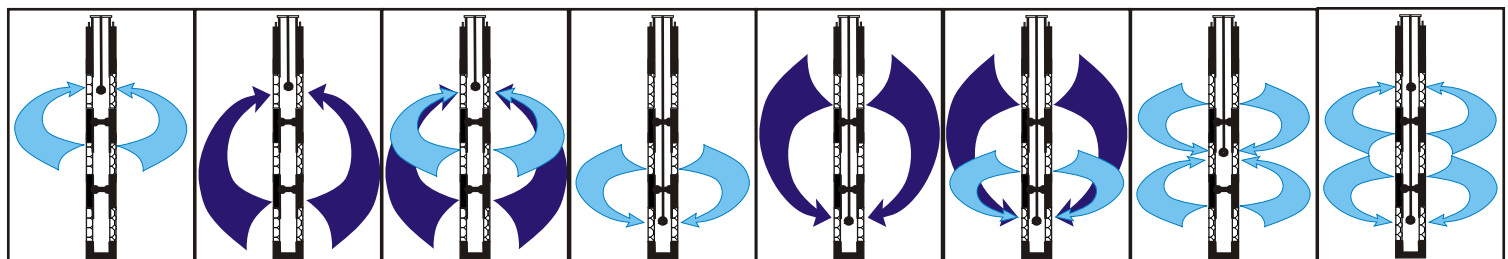
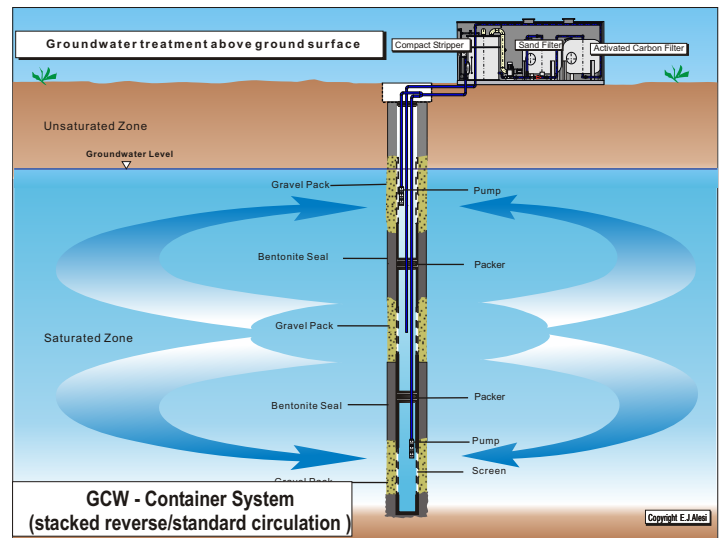
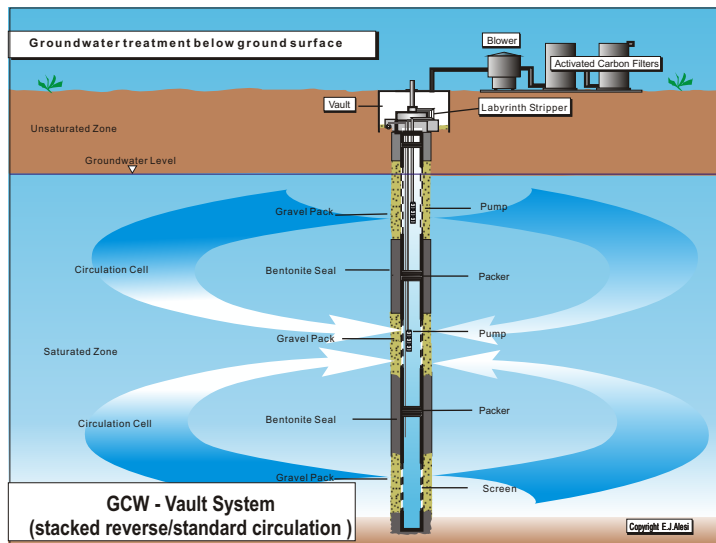
The pressure gradient between the two screen sections induces a circulation flow in the aquifer. The groundwater moves through the treatment zone both horizontally and vertically before entering the influent screen. Groundwater flows into the lower screen to compensate for the water removal from the upper section (Standard Circulation). The direction of flow can be reversed by reversing the direction of the pump (Reverse Circulation). Thus, a three-dimensional groundwater flow field pattern develops. These flow dynamics and the dimensions of the capture zone, circulation cell, and release zone, can be calculated using design aids based on numerical simulations of the groundwater hydraulics.

Groundwater treatment by air-stripping is applied to remove volatile constituents from the groundwater. The double-labyrinth stripper itself can be placed in a below-ground vault or installed as a mobile containerised compact stripper above ground. Negative pressure created by a blower is applied to the air-tight vault or container, where the stripping units are located and fresh air is pulled through the various stages of the labyrinth strippers. The volatile constituents are transferred into the gaseous phase according to the prevailing phase equilibrium and are removed with the off gas. The desorption process is repeated in a second labyrinth stripper located directly underneath the first one. The off-gas is treated sequentially by catalytic oxidation and then by GAC.

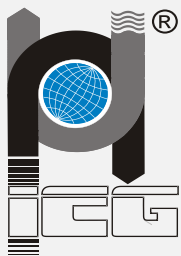
Under **standard circulation** mode, groundwater is pumped upward inside the remediation well as it enters a lower screen section and exits via an upper screen section. Groundwater flow inside the well can be induced via a submersible, in-well groundwater circulation pump. The use of a pump offers control of the air/water ratio which can be important in regulating the efficiency of stripping. The circulation cell flow path thus encompasses groundwater flowing from the upper part of aquifer to the lower part.

In a **reverse circulation** mode, the flow of groundwater within the well is downward via the aid of an in-well pump. Groundwater flows from the bottom of the aquifer in a toroidal upward pattern. In the reverse circulation mode, groundwater in the lower half of the aquifer moves away from the well while the water in the upper half of the aquifer moves toward the well.

Under **stacked circulation**, a GCW with 3 screen sections, separated by lip or inflatable packers, can be run in variable operation modes using a second submersible pump. According to the configuration of the two submersible pumps, extraction or re-injection can be established separately through the lower, the intermediate or the upper screen section or through two screen sections. The mode of operation can be adjusted dependent on the progress of remediation and the distribution of the contamination in the subsurface.



Different circulation modes



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