

Phytoremediation of Cyanides at MGP Sites

Description: To examine the feasibility of using engineered wetlands to treat cyanide and hydrocarbon-impacted groundwater at an MGP site.

Status: Project completed.

BENEFITS

This cyanide remediation approach utilizes the fact that MGP impacted sites are often located near bodies of water and in lowlands where natural wetlands exist. It harnesses two naturally occurring processes for the treatment of the metal cyanide complexes: photodecomposition and phytoremediation/biodegradation. Natural sunlight decomposes the metal-cyanide complexes to form free cyanide, which is then rapidly biodegraded by the bacteria and plants within the wetlands that utilize the free cyanide as a source of organic nitrogen. The process is very rapid, prohibiting the accumulation of toxic concentrations of free cyanide in the water as well as its eventual release to the atmosphere.

BACKGROUND

Cyanide is one of the potentially toxic substances encountered at MGP sites. The forms of cyanide that are present are dominated by the iron-cyanide complexes such as ferric ferrocyanide. A previous study by NYSEARCH (Characterization of Cyanides

at Manufactured Gas Plant Sites and Development of Analytical Methods for Their Detection) identified specific cyanide compounds at MGP sites. The treatment of these forms of cyanide requires capital intensive remedial technologies.

NYSEARCH, in conjunction with Gas Technology Institute, and Alcoa, Inc. previously demonstrated that the cyanide compounds present at MGP sites can be removed from impacted soils by taking advantage of the natural cyanide cycle in the environment (Phytoremediation of Cyanide at Manufactured Gas Plant Sites). Specifically, it was demonstrated that willow plants are capable of taking up dissolved free and iron cyanide, using the organic nitrogen in the cyanide molecule for the production of amino acids. Additional work was done by Alcoa to further investigate the use of natural processes for the treatment of these metal cyanide complexes. This work consisted of the construction and operation of a pilot-scale wetland in Alcoa, Tennessee, that was used to

treat cyanide-impacted groundwater. Targeted cyanide fate and transport laboratory studies were also conducted at Clarkson University. The data from these laboratory and field studies were used to develop and calibrate a process model that predicts the fate and transport of dissolved-phase cyanide compounds in an engineered wetland. That effort has led to this field investigation of using an engineered wetland as a more cost-effective treatment for cyanide-impacted groundwater and/or surface water.

TECHNICAL APPROACH

As part of this project, NYSEARCH retained ENSR (formerly RETEC) to evaluate the feasibility of using an engineered wetland for the treatment of cyanide-impacted surface water and/or groundwater at an MGP site in upstate New York. To perform this evaluation, site-specific data was reviewed and the volume and quality of groundwater that will require treatment was estimated. Currently,

plans at the site include the installation of a DNAPL/groundwater interception trench, from which the ground-water will be pumped to the wetland (Figure 1). The flow rate of groundwater to the wetland will be based upon the volume of water that must be removed from the collection trench to maintain a hydraulic gradient from the surrounding area to the collection trench. At the same time, the discharge requirements for the treated groundwater will also be determined based upon the surface water quality standards in the State of New York for cyanide.

Using this information as input into a wetlands process model, the model will be used to determine the optimal size of the wetland that is necessary to treat the cyanide-impacted groundwater and to permit its discharge into the local creek. The wetlands process model includes the primary fate and transport processes for cyanide compounds, such as sorption, photodecomposition, and biodegradation, and was developed and calibrated using a combination of laboratory test data and the monitoring results from pilot-scale wetlands that was constructed and operated on cyanide-impacted groundwater at the ALCOA aluminum facility site in Tennessee.

A preliminary cost estimate was also developed for the full-scale treatment system. This preliminary design and cost estimate will provide the basis for assessing the feasibility of using this alternative technology for treating cyanide-impacted groundwater at this MGP site. This evaluation protocol, i.e., development of model inputs and data generation using the process model, will be documented to permit its use for similar, site-specific evaluations of this alternative treatment technology at other MGP sites in New York.

PROJECT STATUS

The design basis memorandum, or DBM, has been developed for the wetland. The DBM defines the overall constraints that must be met by the wetland and the critical assumptions necessary to complete the design and economic analysis of the full scale treatment system. The DBM and the wetlands process model will be used to develop the full scale design of the engineered wetlands at the selected MGP site. A constructability review was conducted to determine if any changes to the design are necessary due to site-specific constraints. After these site-specific considerations were incorporated into the DBM, a design of the full scale system was completed and the preliminary economics for

construction was prepared. On the basis of this information, the feasibility of using this alternative treatment approach will be assessed.

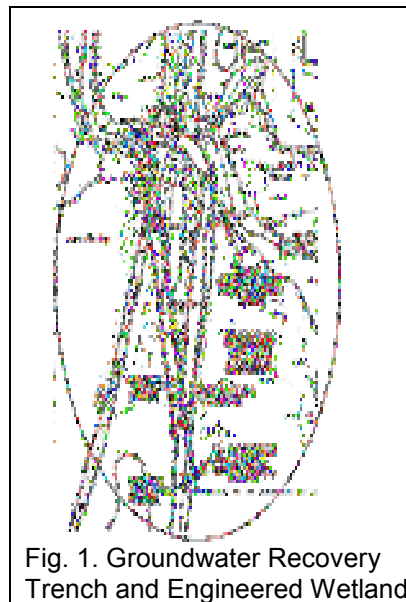


Fig. 1. Groundwater Recovery Trench and Engineered Wetland

FOR ADDITIONAL INFORMATION

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