(사)한국토양환경학회 1998년
춘계학술발표회 논문집 6/5

Groundwater Monitoring Network Design by Employing CPT Rig and BAT Sampling Techniques

김창균*, David Lockington and William Clarke*

포항산업과학연구원 수질환경연구팀

* *Department of Civil Engineering, University of Queensland, Brisbane, Queensland, 4072, Australia*

Abstracts

This study was conducted to delineate plume occurred in hazardous waste disposal site. At first, CPT (Cone Penetrometer Test) rig and HydroPunch were used to collect depth-discrete groundwater samples in concerned area. However, it was not capable of sampling the groundwater due to the cone refusal where the residual clay are layered at nominal depth through the aquifer. Alternatively, a number of temporary wells were installed after each of locations was penetrated using a modified steel cone functioned by CPT rig. The samples taken from those of wells were characterized by GCMS and GCFID, which revealed that sulfolane and thiolane were mainly presented. Subsequent analyses performed for the samples taken from permanent nest piezometers consistently demonstrated that possible plume boundary can be presented in the study area where contaminants were found as low as detection limit or levels of not-detectable.

Introduction

Groundwater contaminated by leachate from hazardous waste disposal site can pose health risks to individuals supplied with water from affected wells. Delineation of contaminant plumes can be costly because of the expense involved in observation well drilling and groundwater sampling and analyses. Proper contamination assessment must be made at affected sites before remediation can be initiated. An investigation was begun characterising a ground water plume containing unknown organic contaminants leached through the interceptor trench installed in a site in Brisbane, Australia. At the time of this work, 19 monitoring wells had been placed on site to evaluate the stratigraphy and to delineate the concentrations of unknown organic contaminants in ground

water.

This paper provides an examples of how screening data can be interpreted in a detailed manner to produce an understanding of organic contaminants distribution in groundwater.

Field Methods

Cone Penetrometer Test

The CPT logging was conducted in cooperation with Douglas Partner on 28 to 29 November 1995 to evaluate hydrogeological setting in the study area as located in Figure 1.

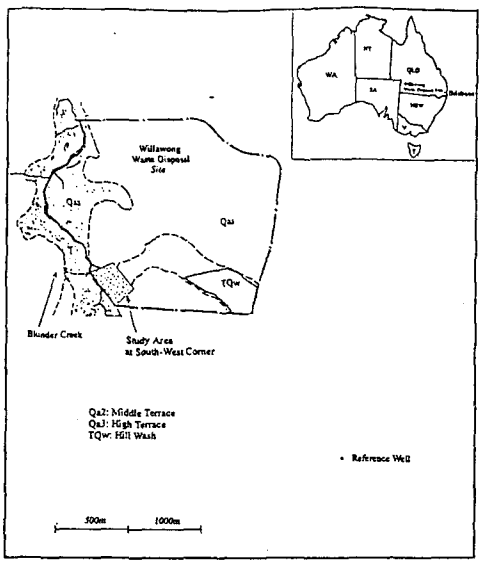

Figure 1 Site locations of CPT test in the study area

This study was concentrated in obtaining information about the nature and the distribution of alluvium formations in the study area. It was also performed conductivity measurement through all CPT test location during the test. The locations are on two parallel lines along Blunder Creek and each point is 50 m nominal distance. The ratio of sleeve friction to point resistance was represented the soil type and the conductivity was used to delineate potential contaminants plume.

Construction of Temporary PVC Piezometers

It was undertaken to delineate boundary of plume in the study area. Cone technology can be used for the purpose of detection of contaminant plumes in conjunction with HydroPunch (QED Environmental Systems inc., Ann Arbor, Michigan). A number of people have used the combination of these techniques in obtaining groundwater samples for preliminary plume definition of organic contaminants (Torstensson, 1984; Smolley and Kappmeyer, 1991; Mines et

al., 1993; Zemo et al., 1994; Appleyard, 1995).

The HydroPunch is a concealed screen arrangement, which is connected with push rod and then forced to a desired depth using the CPT rig. However, the probe cannot be pushed through cobbles or thick sequences of coarse, gravelly material. It also has common sampling difficulties including refusal of the cone, loss of sample due to leaking check valves, and long period of sampling time because of extremely low hydraulic conductivity of the target soil formation eg. clays.

Due to HydroPunch and CPT rig limitation to get groundwater sample from nominal depth, the other sampling technique has been considered to define the zone of plume.using CPT rig in combination with modified push rods connected with the cone (Figure 2). The push rod (30 mm OD x 1 m L) was forced into nominal soil depth. The rod was successfully pushed down until it reaches to a nominal depth in the aquifer. After the rod was retrieved, UPVC (33 mm OD and 29 mm ID) was introduced into the hole.

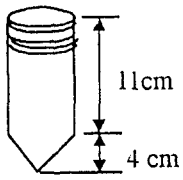

Figure 2 The cone used for penetration of soil

After installation of 19 temporary wells, groundwater samples were taken using foot valve (1.6 cm ID, 2.4 cm OD, and 7.3 cm L, Watera, USA).

Permanent Nested Piezometers

Subsequent groundwater samples were obtained using Bladder pump from permanent nest piezometers, which have been installed in the study area based on the temporary monitoring well observance.

Results and Discussion

CPT results represented that the study area is consisted of alluvium overlaid by weathered rock formations as presented in Figure 3. The clayey silt bounds the impermeable layer at the bottom of aquifer, while sandy layer forms possible permeable pathway for groundwater and solute transport.

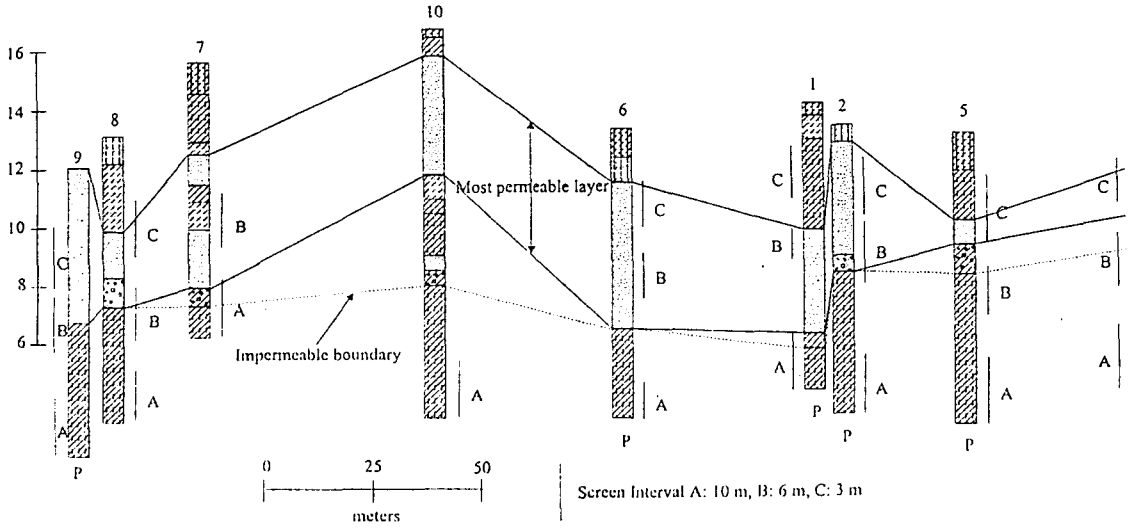

Figure 3 Soil stratification in the study area

The conductivity results revealed that middle depths of aquifer are heavily contaminated as showing 200 to 250 mS/cm of conductivity. It may indicate that some of dense contaminants are presented in the study area.

Subsequent analyses of groundwater samples taken from temporary bores reports that sulfolane and thiolane predominantly present in the study area as high as 27 and 11 ppm, respectively. In contrast, the contaminants were not detected at all or observed below detection limit. Those locations possibly are composed of boundary of plume.

Based on this result, depth-variant nest piezometers were installed at 11 locations in the study area. These three different depths of monitoring wells would provide density variable plume, especially for sulfolane and thiolane (e.g. 1.23 and 0.98 g/cm3) as shown in Figure 4.

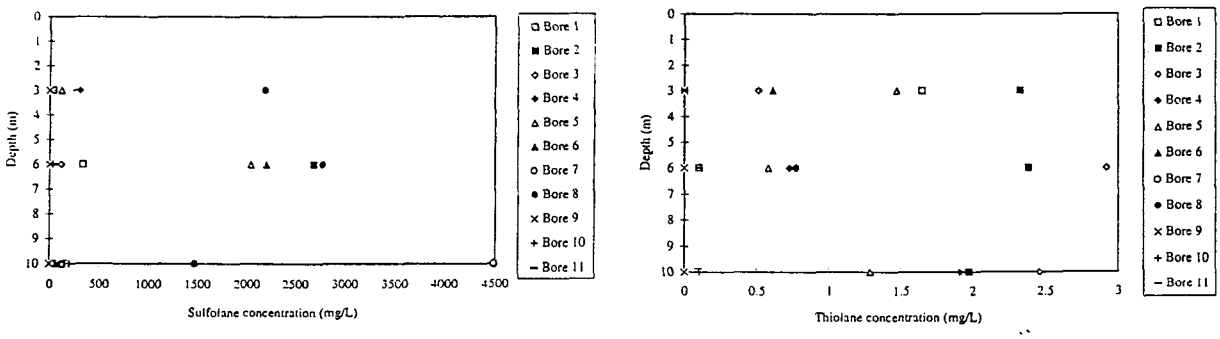

Figure 4 Spatial distribution of sulfolane and thiolane in the study area

Conclusion

As a result, depth-derived conductivity measurements imply possible presence of contaminant plume, which is evidently demonstrated by investigation of depth variant sample analyses. Temporary sampling works also provide confident plume dimension, which consequently installed permanent monitoring wells. The boundary of plume are well consistent with the results obtained from both temporary and permanent groundwater monitoring wells

References

1. Appleyard S.J.(1995). Investigation of ground water contamination by fenamiphos and atrazine in a residential area: source and distribution of contamination. *Ground Water Monitoring Review* **15**(4) 110-113

2. Mines B.S., Davidson J.L., Bloomquist D. and Stauffer T.B.(1993). Sampling of VOCs with the BAT ground water sampling system. *Ground Water Monitoring Review* **13**(1) 115-120

3. Smolley M. and Kappmeyer J.C. (1991). Cone penetrometer tests and HydroPunch sampling: A screening technique for plume definition. *Ground Water Monitoring Review* **11**(2) 101-106

4. Torstensson, B.A. (1984). A new system for ground water monitoring. *Ground Water Monitoring Review* **4** (4) 131-138

5. Zemo D.A., Pierce Y.G. and Gallinatti J.D. (1994). Cone penetrometer testing and discrete-depth ground water sampling techniques: A cost-effective method of site characterisation in a multiple-aquifer setting. *Ground Water Monitoring Review* **14**(4) 176-182