Using Mass Discharge Techniques to Demonstrate Natural Attenuation (#0937)

HUNTSMAN

CDM Smith

senversa

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Introducing

Graham Smith is a principal level environmental professional providing specialist remediation advice to various large multidisciplinary projects across Australia. A recognised industry leader in the field, Graham manages and delivers complex environmental projects covering a wide range of environmental regulatory issues and environmental remediation cleanup programs.

Overview

Objective

Background

Site Context & Issue

What did we find?

Conclusions

Learnings

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Background –operational history

Clean-up of a complex and diverse chemical manufacturing facility, Australia (former Major Hazardous Facility)

Source of impact ...every day activities eg.

1. Constant small drips and weeps,
2. washing of chemicals down drains

Major releases were cleaned up immediately during operations

Minor releases are the issue over 70+ years of operations.

Background –extent of impacts

Three major source areas contributing to a mixed solvent groundwater contaminant plume extending over approx. 25 hectares (62 acres).

Plume contaminant mass is dominated by

- *Benzene (50%)*
- *Acetone (9%)*
- *Cumene (8%)*
- *Chlorinated Phenols (8%)*
- *Phenol (8%)*
- *Ethyl Benzene (6%)*

Background –three source areas

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Treatment Approach – treatment train

Treatment train approach:

<u>Source Areas:</u>

- Soil vapor extraction and cryogenic treatment (x9 tonnes in 6-months)
- Bio-augmented microbial treatment in source areas to enhance natural attenuation

<u>Plumes</u>

- Demonstration of natural attenuation

Treatment – microbial source treatment

Microbial respiration – sulphate reduction and some methanogenesis, is occurring at different stages across the site.

Treatment – microbial source treatment

Temperature increases within the plume, presence of volatile fatty acids and DNA from microbial communities

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Natural Attenuation –lines of evidence

Natural attenuation demonstrated via the following lines of evidence:

- Statistical trends
- Center of mass
- Mass flux

Findings

- Retracting plume
- Contaminant concentrations are stable / decreasing through the center of the benzene plume

Mann –Kendall Trend Analysis (Benzene 2016)

Retracting plume

Treatment Approach – center of mass

Center of mass calculations were used to;

- Determine the mass and center of mass of the shallow contaminant plume.
- Assessment of the fate and transport of contaminant mass degradation overtime across the Site

Method developed and explained by Ricker (2008), Mohr and Naude (2017)
Software package Surfer ™ (Golden Software, Golden, Colorado USA)

Treatment Approach – center of mass

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Mass flux and mass discharge

Mass Flux and discharge estimation

- to better understand source zone behaviour and the ongoing attenuation processes.

Modelling was based upon ITRC (2010) use and measurement of mass flux and mass discharge.

Treatment Approach – lines of evidence

Figure ES-3. Use of multiple well transects to measure mass discharge and mass flux.
(Adapted from Einarson and Mackay 2001.)

$JA_{i,j}$ = Individual mass flux measurement at Transect A

M_{dA} = Mass discharge at Transect A (total of all $JA_{i,j}$ estimates)

Benzene Impact in Groundwater (2016)

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Estimated Benzene mass discharge from the Site

Lines of evidence – Mass Discharge

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Benzene discharge over time

YEAR	MASS ATTENUATION (kg/day)	MASS ATTENUATION (tonnes/year)
2009	3.1	1.13
2010	6.5	2.37
2011	2.5	0.91
2012	3.0	1.10
2013	2.0	0.73
2014	1.5	0.55
2015	1.0	0.37
2016	0.4	0.13
Total mass discharge (2009 to 2016)		7.29

Conclusion

In summary, clean-up of a complex and diverse chemical manufacturing facility involved;

<u>Source area treatment</u>

- SVE/Cyrogenic treatment, followed by enhanced natural attenuation

<u>Plume treatment</u>

- Demonstration of natural attenuation
  - Physical properties
  - Statistical trends
  - Center of mass
  - Mass flux and mass discharge

Conclusion

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Conclusion

Source Area (Active treatment)

- Est. 9 tonnes (6 months)
- Energy intensive approach

Natural attenuation

- Est. 7 tonnes (7 years)
- Est. 94% reduction (6 years)
- Sustainable approach

Data indicates, mass reduction via natural attenuation is significant

Learnings

- Importance of multiple lines of evidence
- Modelling is only as good as the data set
- Modelling is only as good as the assumptions (beware the bias)
- Real world data (pump tests, lab results)
- Benefits of nested wells (vertical characterisation)
- What influences the approach? (time, risk (modelled or measured?), commercial, the pollution outrage!!)

Changing tomorrow today

Questions?

Should you have any questions please contact Graham at email: graham.smith@wsp.com

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