Soil Mix Permeable Reactive Barrier Using Inorgano- Organo Bentonite

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Main Points

- **Contaminated land & Groundwater Remediation**
- **PRB for Groundwater Remediation**
- **Inorgano-organo Bentonite for Water Treatment**
- **Laboratory Results**
- **SMiRT Project (The Field Trial)**
- **Results & Conclusions**

Motivation to current research

1GM Monday November 24 2014 | THE TIMES

Million homes on brownfield sites could save countryside

Ben Webster Environment Editor

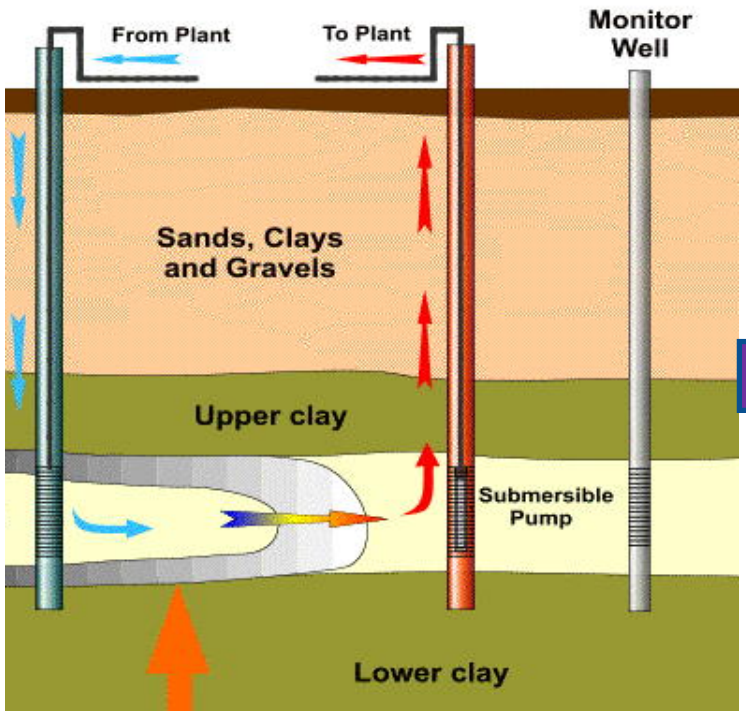
The number of new homes which could be built on brownfield land is being grossly underestimated by the government, which is allowing developers to target open countryside instead, according to the Campaign to Protect Rural England.

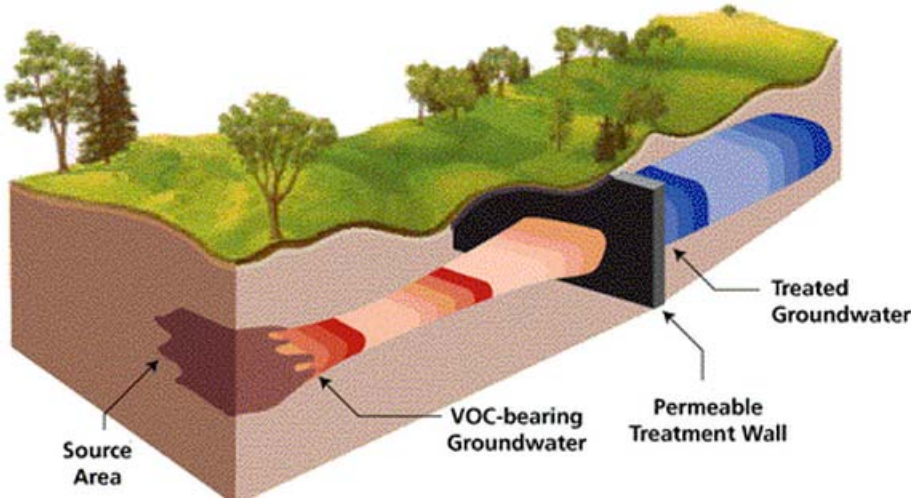
from the government to allocate land for housing have identified sites for up to 700,000 new homes in the countryside, including 200,000 in protected green belt land around cities, according to CPRE. It says that there is enough brownfield land to meet the entire housing need for at least four years without touching any countryside.

More than 400,000 homes could be

containing hundreds of homes ea
Brownfield sites are often suitable
ten homes or less and it can be proh
tively expensive for small building c
panies to prepare the detailed sub
sions needed to obtain planning
mission for them. They may also
to cleaned up and sites may
several different owners with r
ive covenants in place.

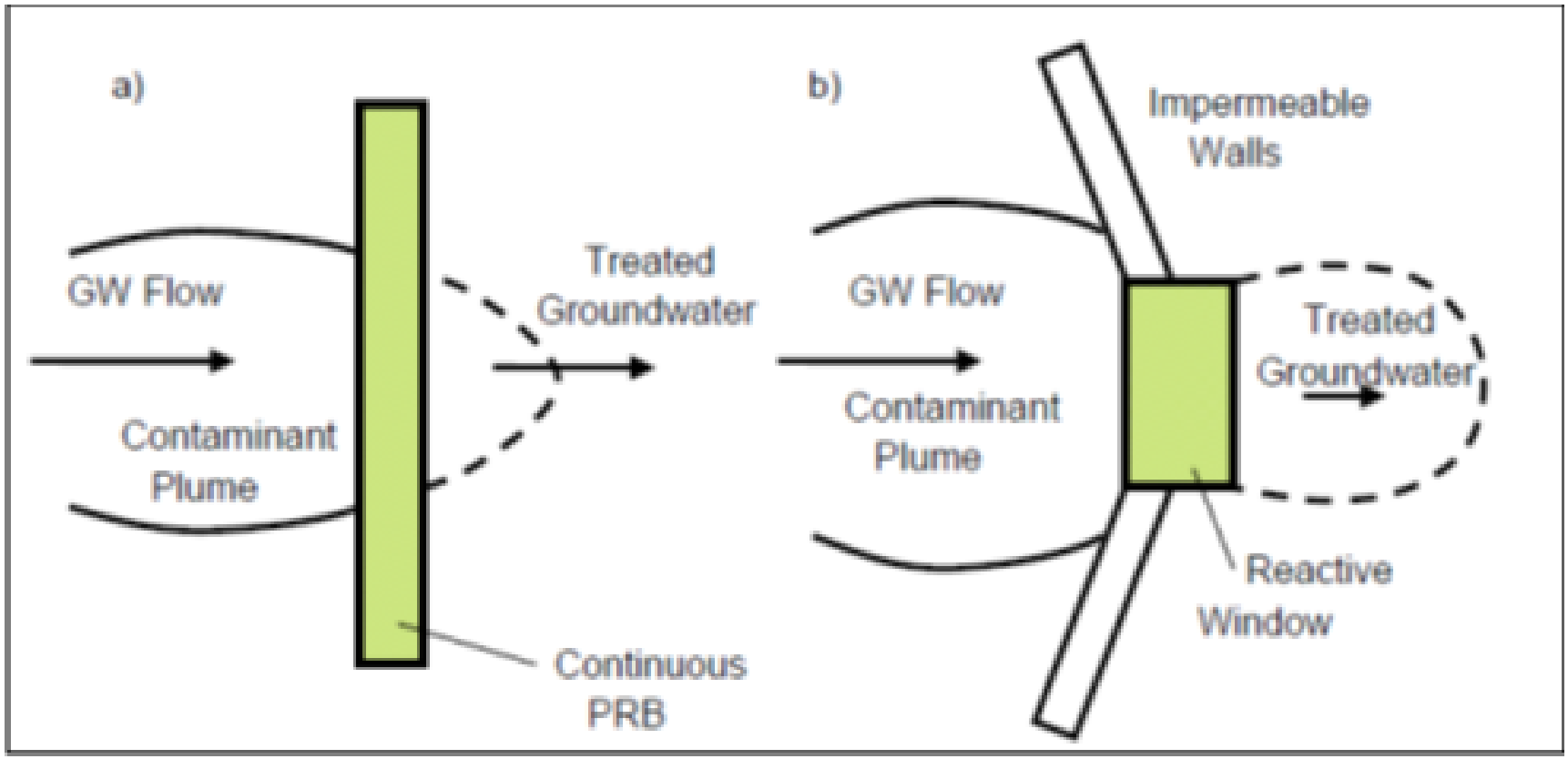
Myth of Permeable Reactive Barrier:





Groundwater is not pumped out from the aquifer
The soil is not transported for treatment and disposal.

Myth of Permeable Reactive Barrier:



(Snow & Jones 1999)

- Bentonite consumption has been driven largely by foundry, oil drilling and iron ore pelletising markets

- Clay formed by the alteration of volcanic ash,

- However, bentonite is clay consisting essentially of **smectite** minerals (usually **montmorillonite**) regardless of occurrence or origin.

- **Have good properties to work as adsorbent for contaminants**

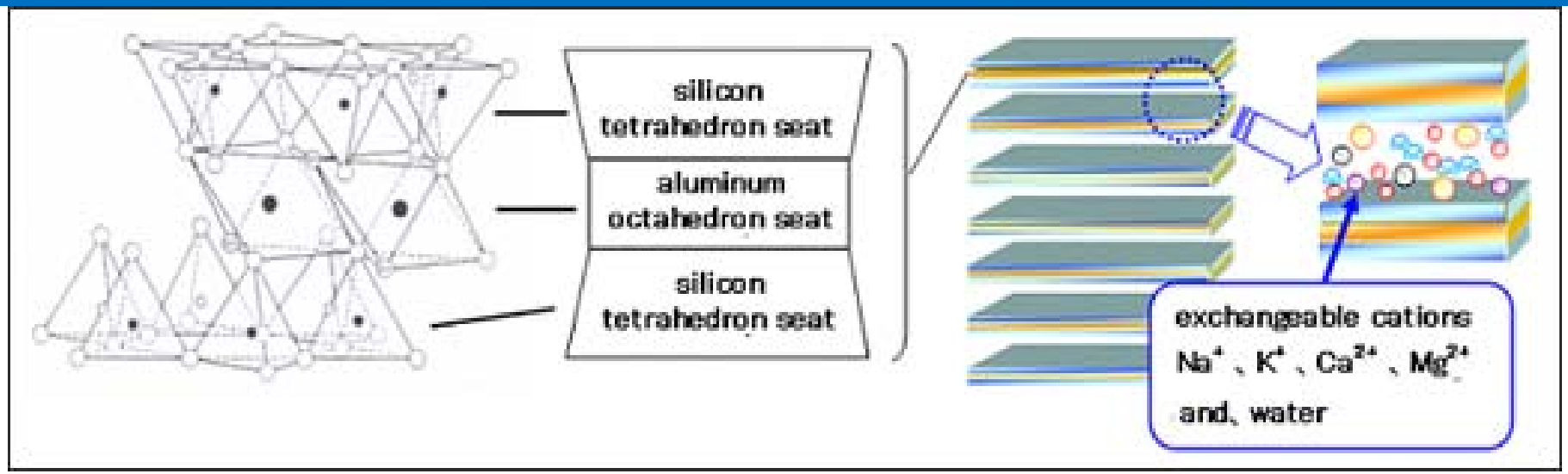
Why Modified Bentonite

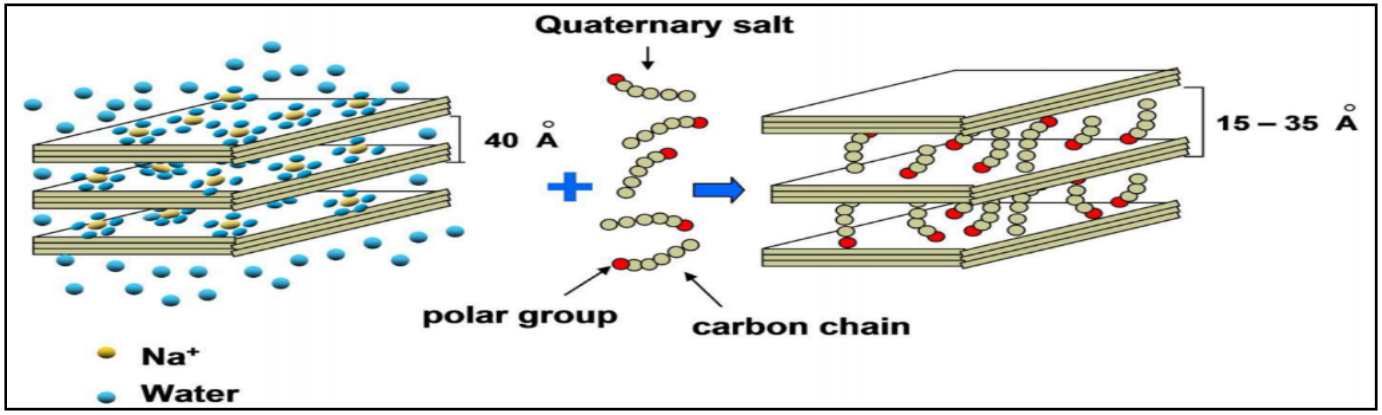
Adsorbent	Price ($ US/ kg)
Bentonite	~ 0.05
Granular activated carbon	1.54- 2.93
Smectite organoclay	0.98
Microscale zero valant irong	2.2- 3.74
Granular iron	0.88

(Carvalho et al. 2012)

- **Global bentonite production was estimated at 16m tonnes in 2015. (USGS)**

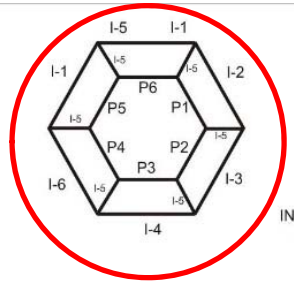
Modified Bentonite

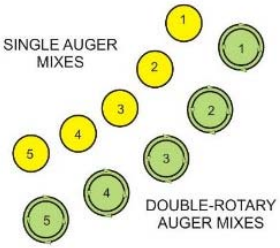




$$\left[H_3C - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{N}}}} - CH_3 \right]^{+} Cl^{-}$$

http://www-g.eng.cam.ac.uk/smirt/





INDIVIDUAL TRIPLE AUGER MIXES

28
29
30
31

INDIVIDUAL ALLU MASS STABILISATION MIXES

27 26 25
6 5 4
7 8 9
12 11 10
15 14 13
24 23 22
18 17 16
1 20 19

HEXAGON WITH INSTALLED WELLS

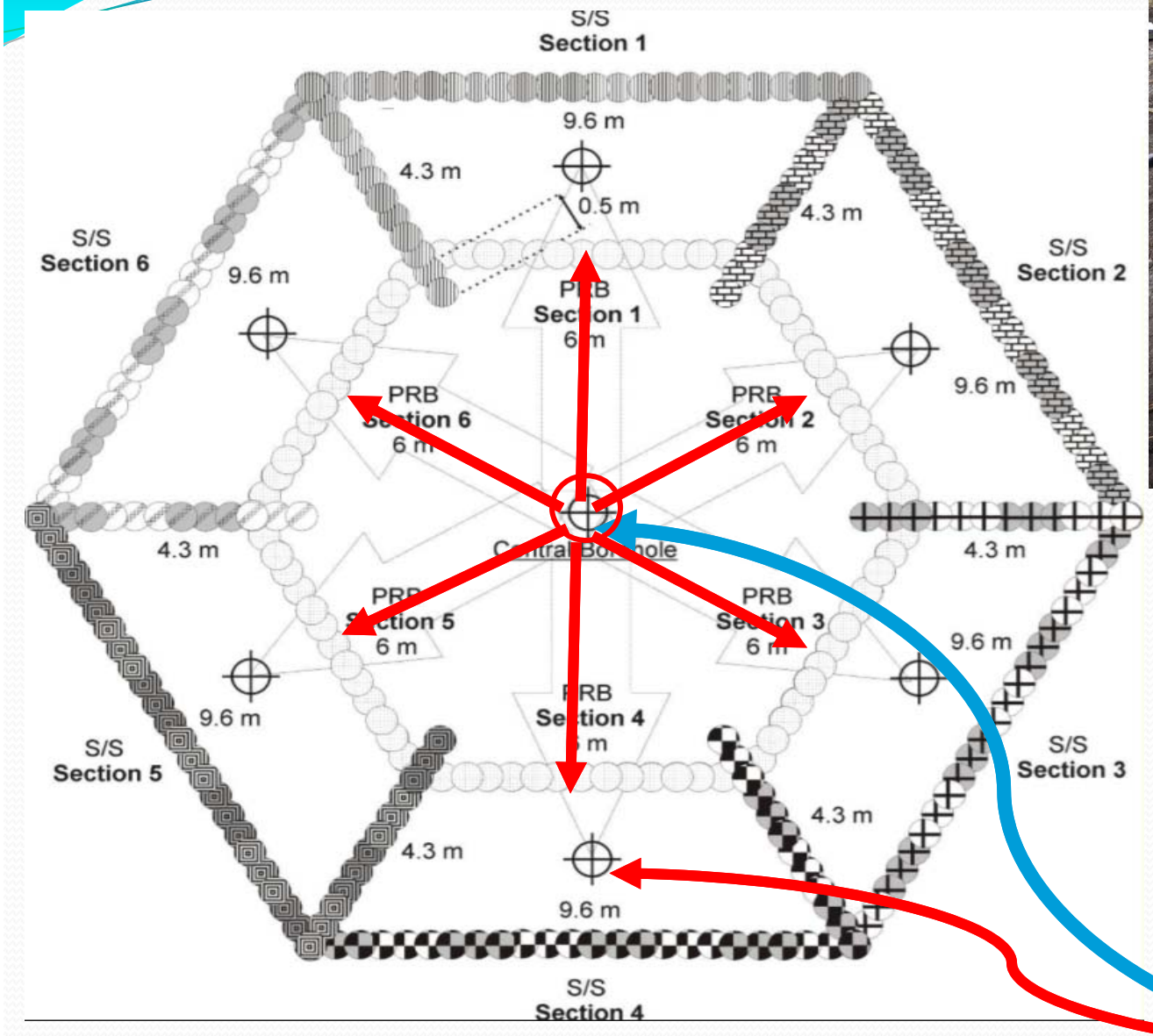
Soil Mix Remediation Technology Project

No.	Composition	Ratio
1	Zeolite- OC – IOB2	23:23:56
2	IOB 1	Pure
3	IOB 2	Pure
4	IOB 3	Pure
5	OC- IOB 2	25:75
6	Zeolite Gr-IOB2	15:85

Soil Mix Remediation Technology Project

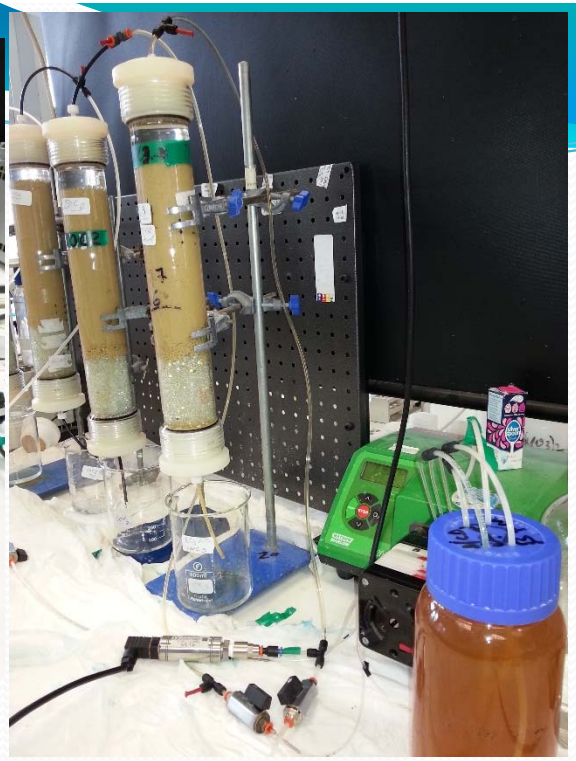
- Very little spoil, reduces off-site disposal problems
- Relatively fast, enables rapid redevelopment of sites
- Can deal with mixed contaminants & be used on sites of any size

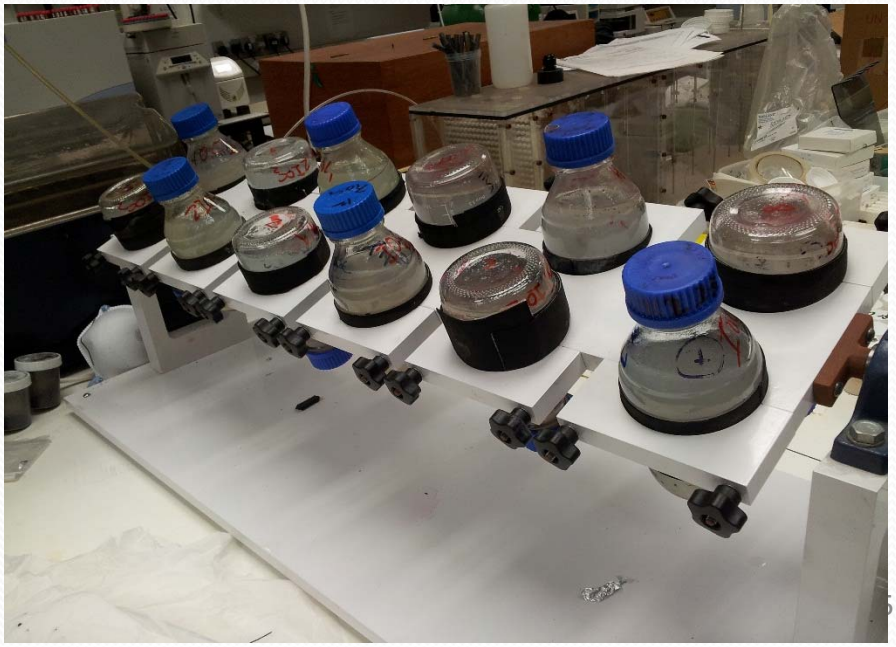
Pumping Work at SMiRT



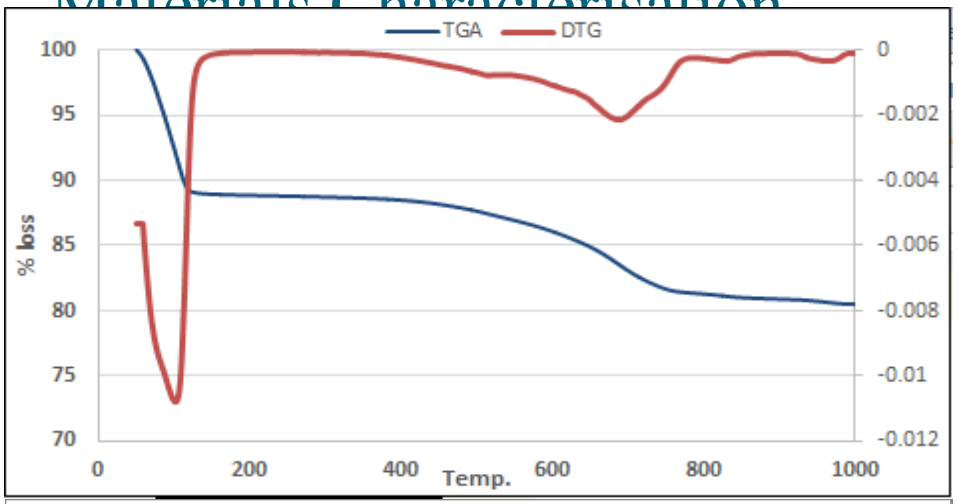
Pumping from external well

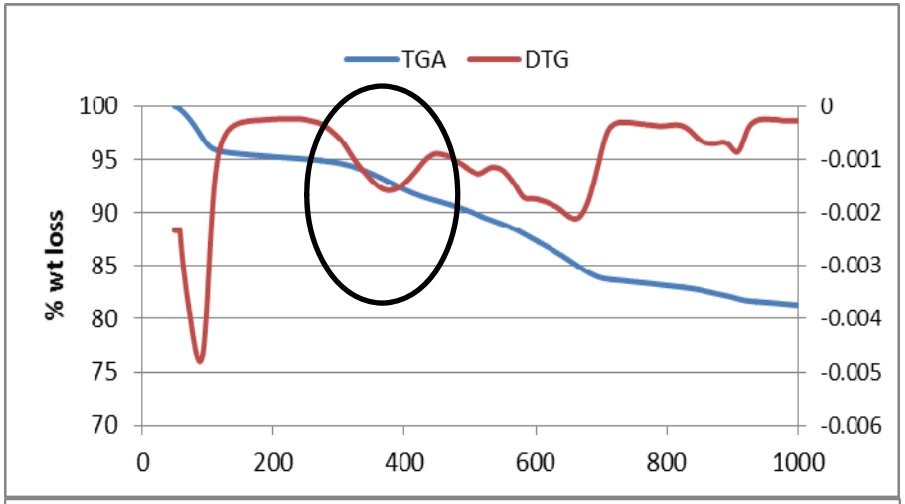

BD Plastipak
PHD|ULTRA
HARVARD
APPARATUS

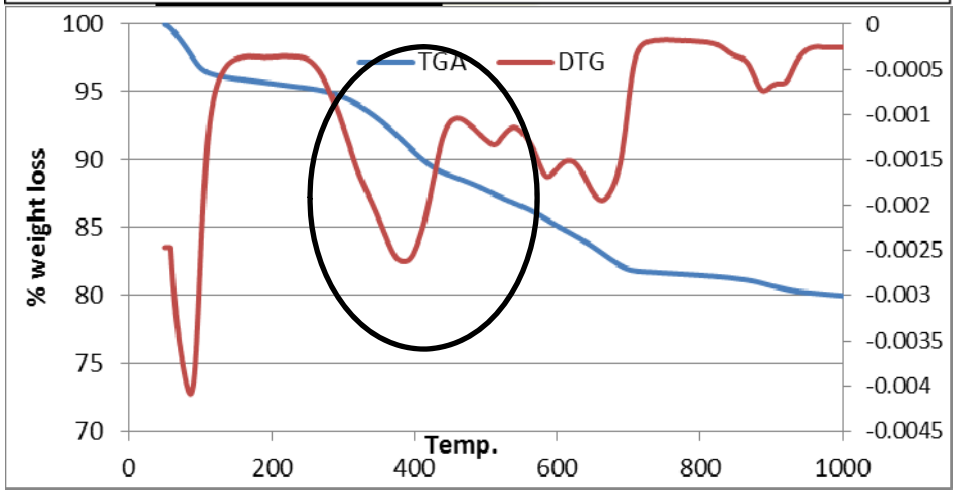


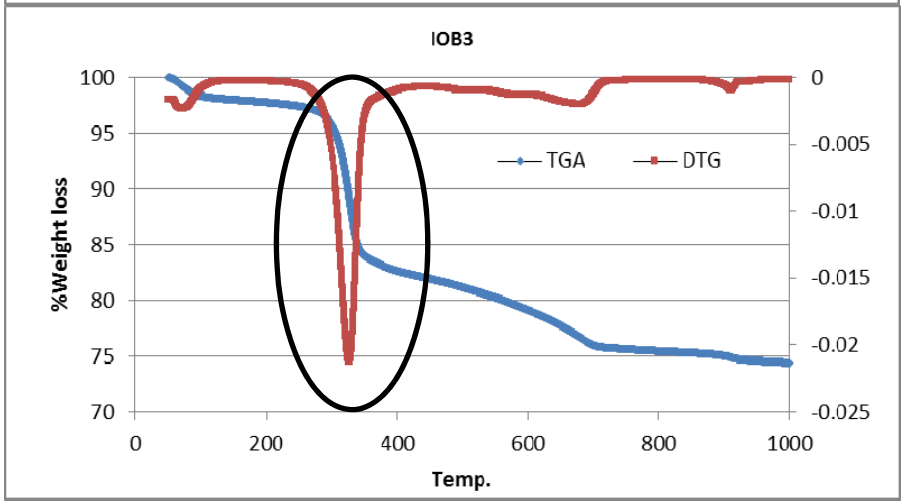


Materials Characterisation

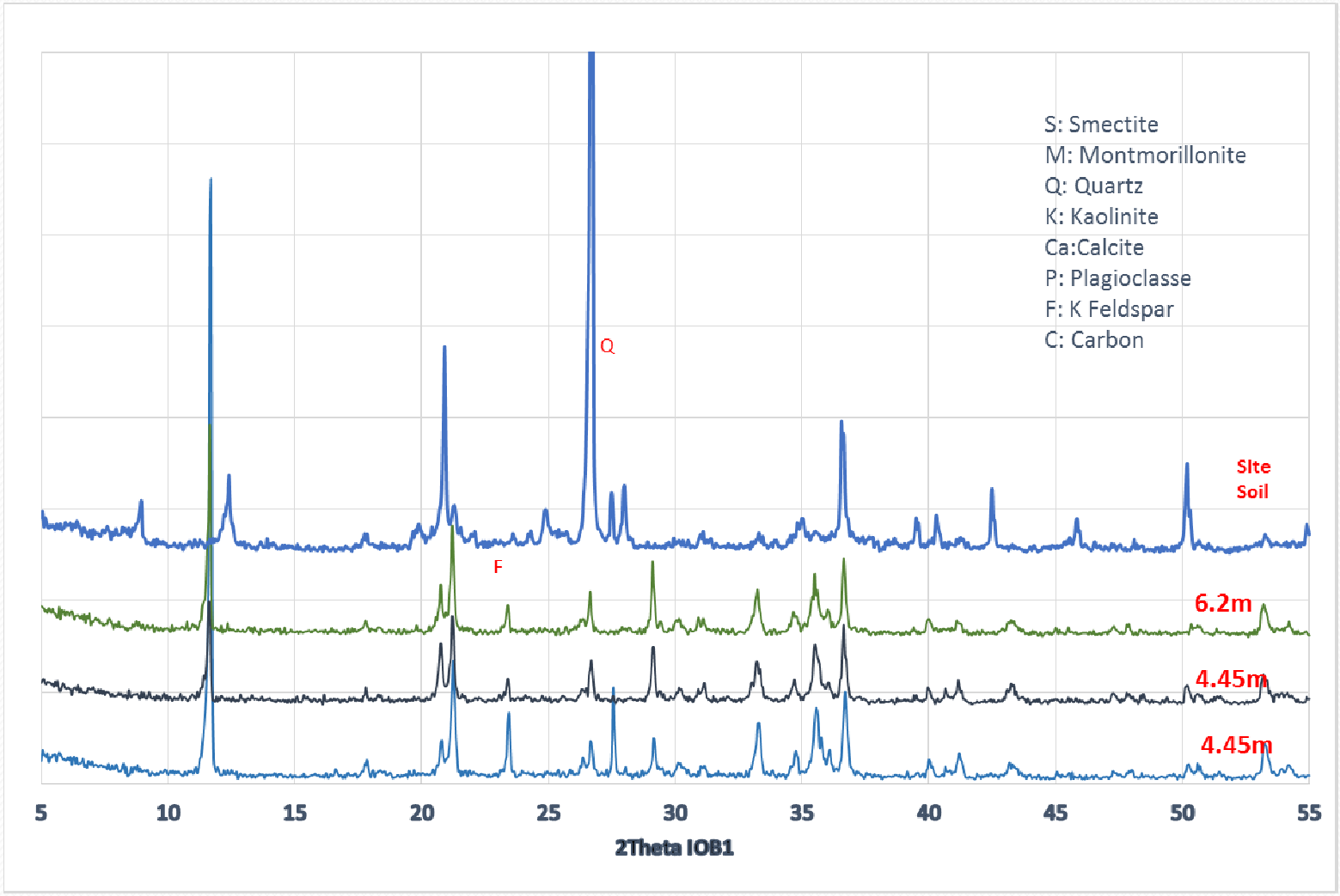








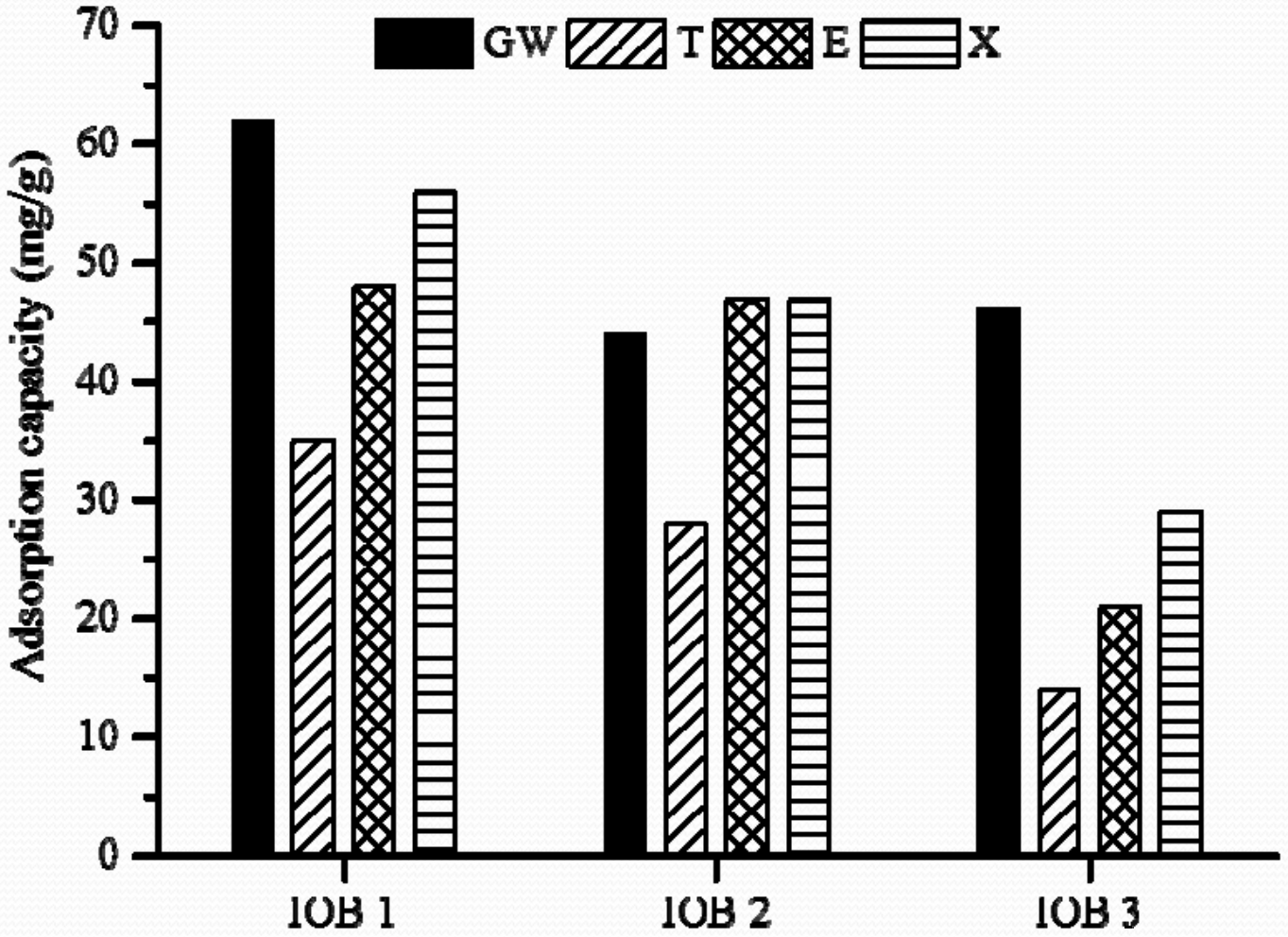
Materials mixing quality & cores characterisations



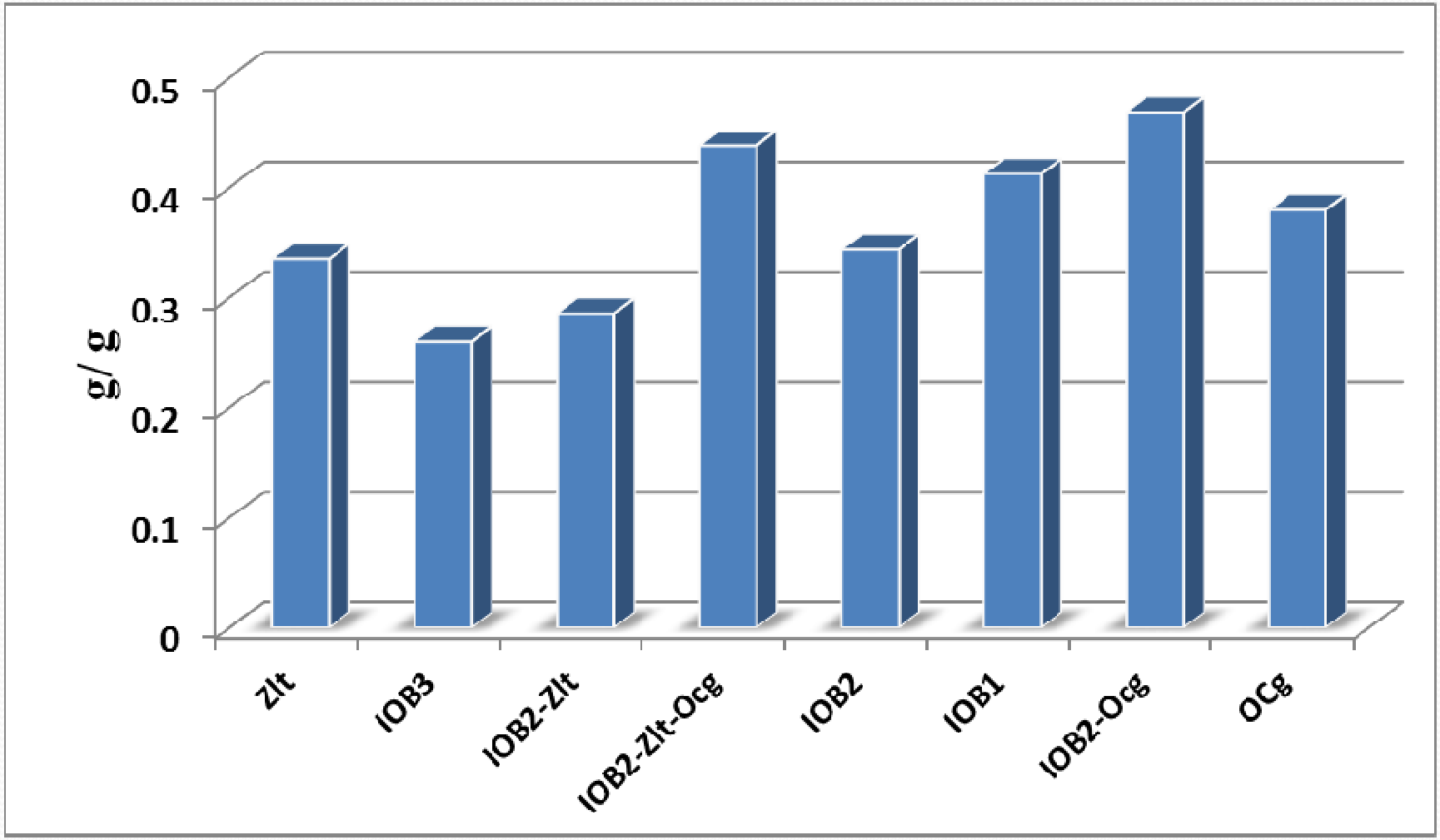
Isotherm parameters

	Freundlich IOB1			Langmuire			
	1/n	K	R2	Q mg/g	K L/mg	R2	RL
IOB1							
T	0.714	0.247	0.928	8.065	0.026	0.958	0.617
E	0.665	0.755	0.947	12.987	0.065	0.991	0.722
X	0.580	1.841	0.949	17.241	0.153	0.992	0.775
IOB2							
T	1.190	0.120	0.932	0.155	1.658	0.991	0.030
E	0.928	1.199	0.915	7.692	0.283	0.978	0.606
X	0.593	5.333	0.982	17.544	0.740	0.982	0.778
IOB3							
T	1.129	0.119	0.931	5.051	0.039	0.893	0.503
E	1.062	0.301	0.939	3.650	0.276	0.808	0.422
X	0.876	0.564	0.912	1.198	0.102	0.903	0.193

Comparison between groundwater and TEX



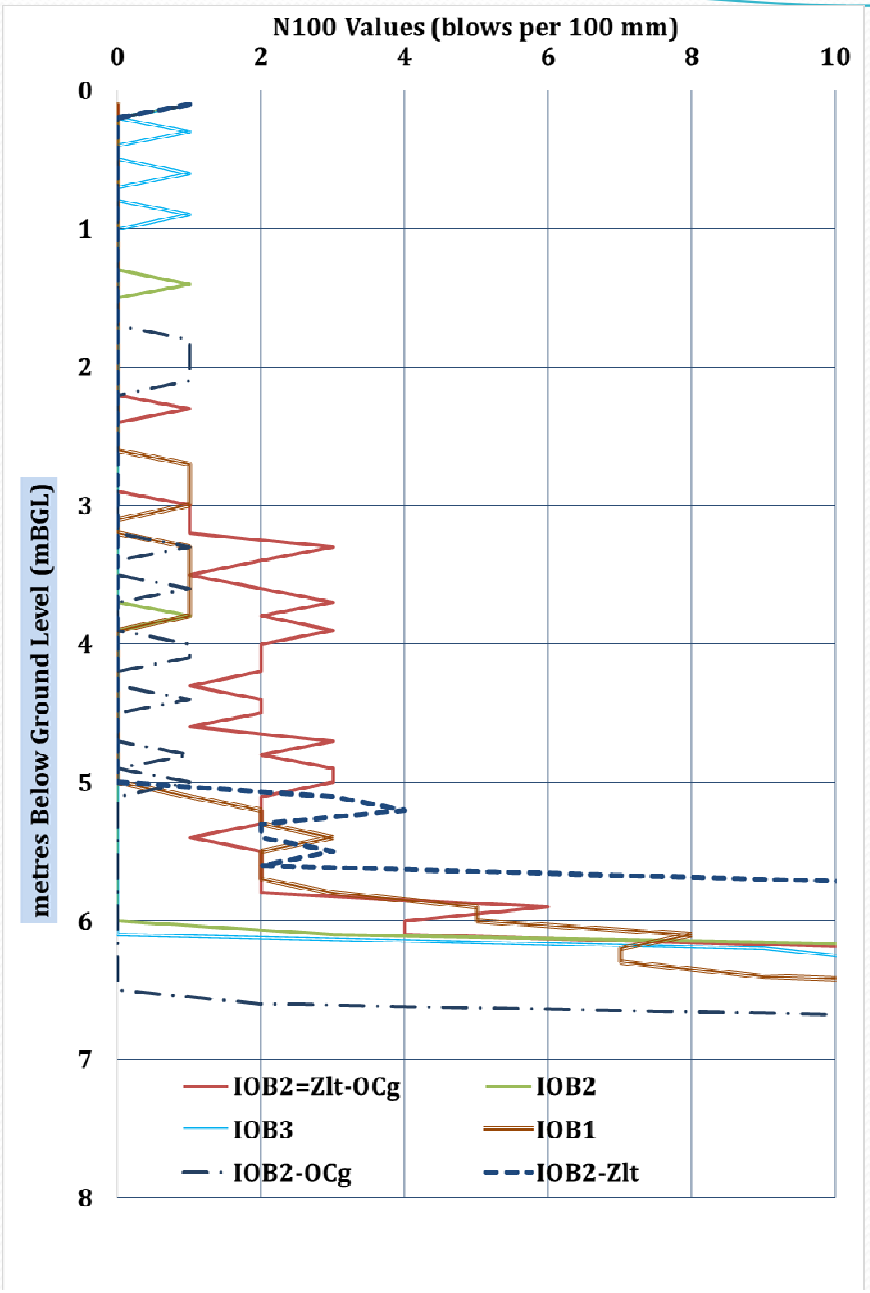
Dodecane adsorption ($C_{12}H_{26}$)



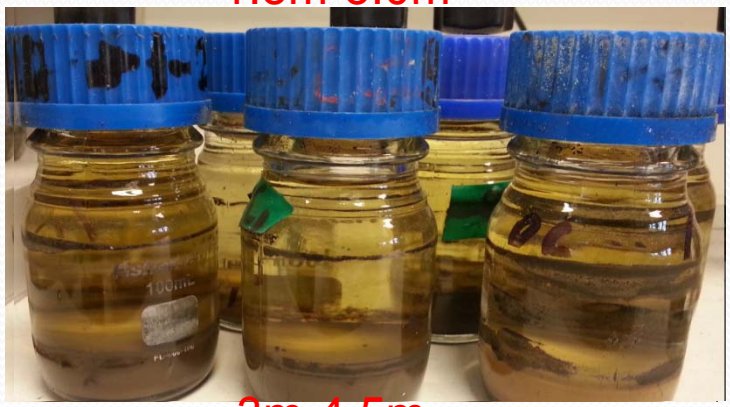
Site Work & Site Cores

- Control samples

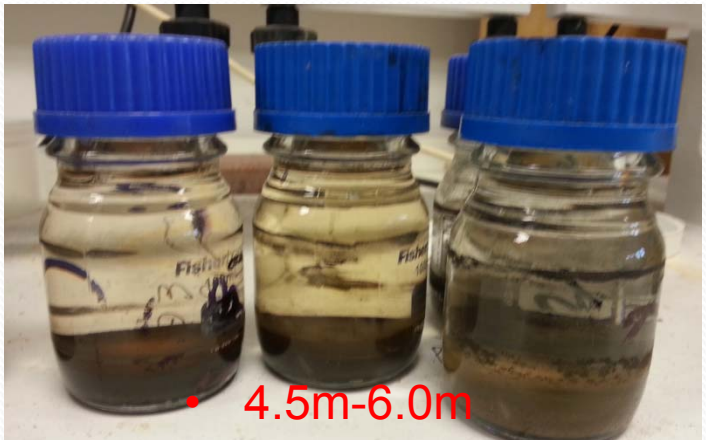
Materials mixing quality



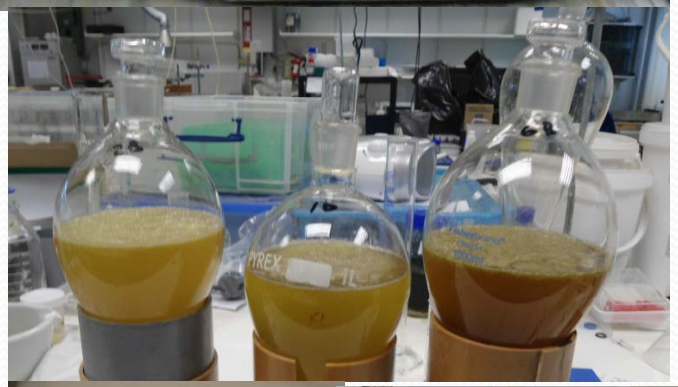
- 1.5m-3.0m

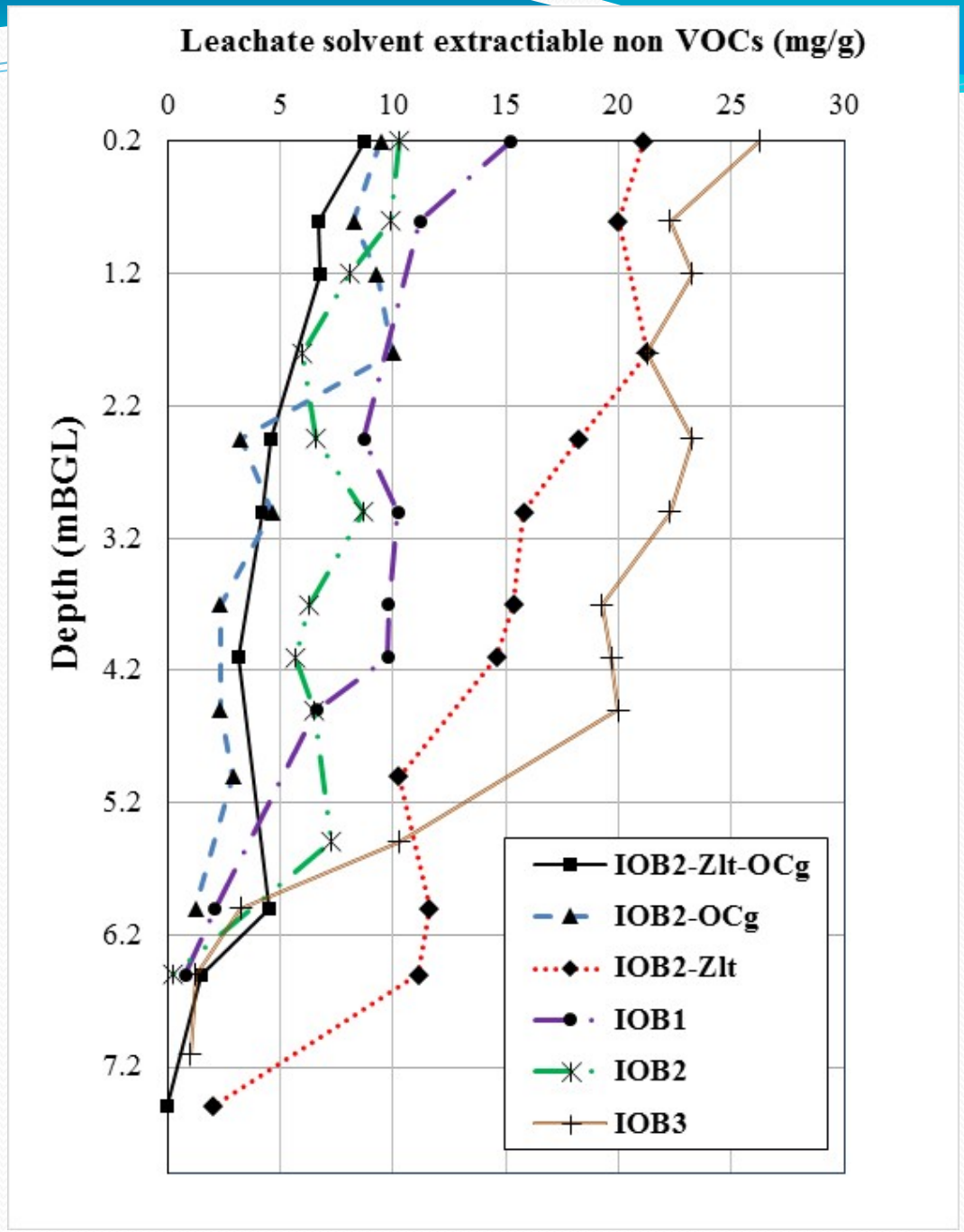


- 3m-4.5m



- 4.5m-6.0m




Leachate solvent extractiable non VOCs (mg/g)
0
5
10
15
20
25
30
Depth (mBGL)
0.2
1.2
2.2
3.2
4.2
5.2
6.2
7.2
IOB2-Zlt-OCg
IOB2-OCg
IOB2-Zlt
IOB1
IOB2
IOB3

Materials mixing quality & cores characterisations

- SMT is a recent technique able to offer a wide range of advantages over other remediation techniques
- The site provides unique opportunity to use the current results as useful data base.
- IOB has potential for the removal of toxic compounds found in soil, groundwater
- Results may vary depending on the scale, but with similar trend.
- Materials efficiency varies depending on contaminants under consideration,
- Combined materials showed higher sorptive capacity.
- The order of materials efficiency was
- IOB2-Zlt-OCg > IOB2-Ocg > IOB1> IOB2> IOB3> IOB2-Zlt

Prof Abir Al Tabbaa