Basement Waterproofing

Assessment of Groundwater and External Drainage

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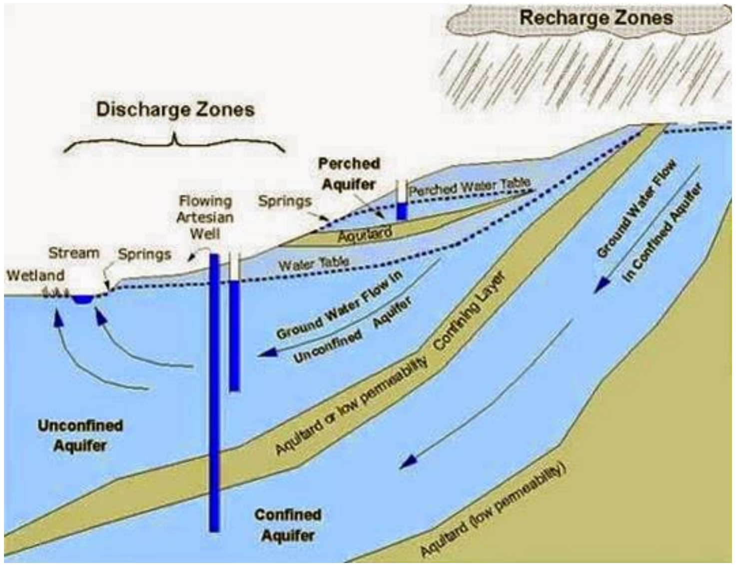
Drainage design begins with assessment of groundwater

- Assessment of ground and groundwater conditions is important for external drainage design
- But also for:
  - Waterproofing risk assessment
  - Cavity drainage design – required for realistic assessment of water leakage and risk from contamination entering the system
  - Volatile Organic Carbon (VOC) or hydrocarbon assessment – groundwater levels determine approach to permeation modelling that is required for design
  - Ground gas risk assessment – groundwater levels determine whether BS8485 is appropriate for the assessment and design



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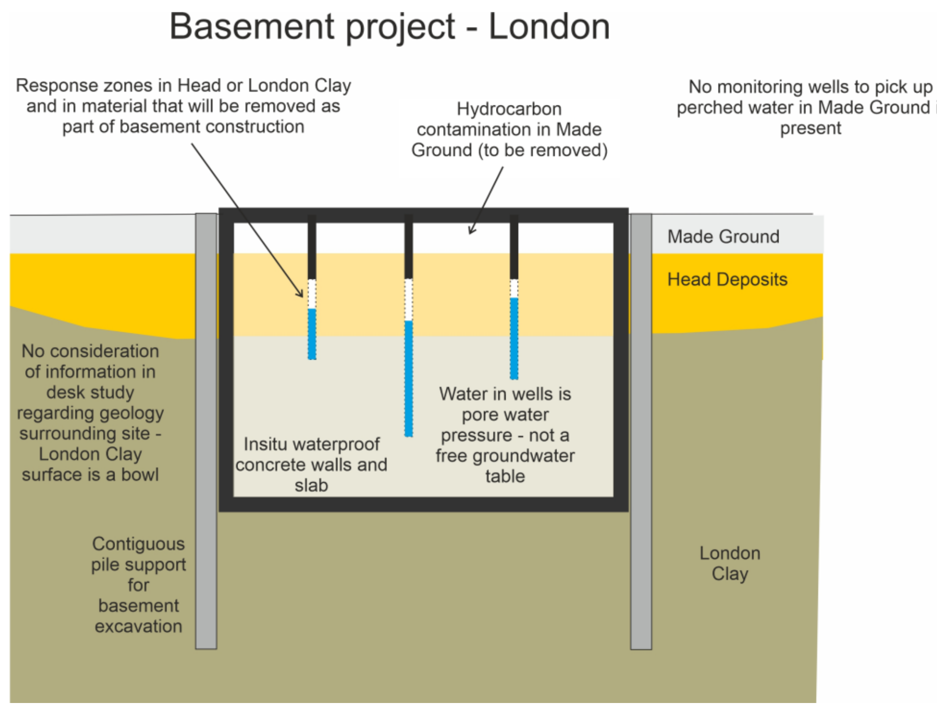
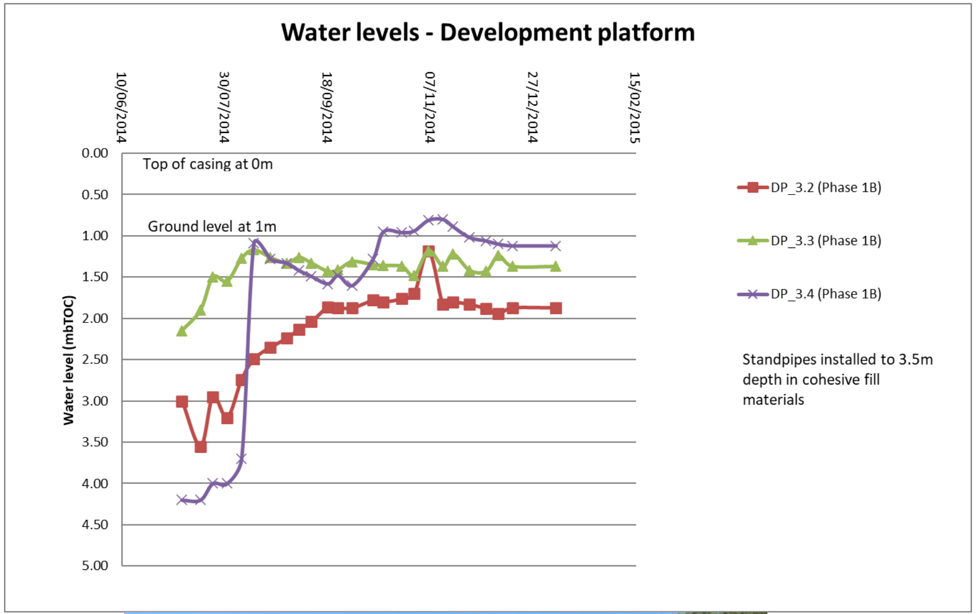
Hydrogeological assessment – the issues

- Is there sufficient site investigation data of an acceptable quality ?
- This often limits the potential for good assessment – uncertainty is addressed by over design of the waterproofing leading to increased costs
- The site investigation should be designed with basement waterproofing (and gas proofing) in mind (sometimes this is not possible – eg access outside basement footprint)
- Understand the basement construction and geology – where to install monitoring wells and at what depths
- "*You pay for a site investigation whether you have one or not*"



Hydrogeological assessments

- Interpretation of groundwater monitoring data
- Wells installed in cohesive soils – gradual increase in water level over time
- This indicates pore water pressure in clay – it is not a free water table and is low risk
- There is no water in the adjacent excavation



Myths about external drainage

- If it is designed correctly:
  - It can have a long design life, the same as other parts of the waterproofing system
  - Water flows into it can be assessed and it can be designed to have an adequate capacity including any pumps
  - It will not cause wash out of fines from the soils around the basement and it will not clog
  - It can be maintained and if necessary repaired

- HOWEVER!
- It is usually impractical on many sites because there is no effective outfall available or because of basement construction method (contiguous piles walls, etc)

External drainage - outfalls

- External drainage needs a suitable outfall – either a watercourse or soakaway
- Sewerage Sector Guidance Appendix C - A9 LAND DRAINAGE
- "*Sewerage companies have no duty to accept land drainage runoff, flows from natural watercourses or groundwater to the public sewer system, and this is not normally permitted*"
- Discharge of groundwater to surface water sewers is not likely to be acceptable to the water company – the advice in BS8102: 2022 on discharging external drainage to a stormwater sewer is not correct
- Soakaways should be below the level of the basement and designed so that the storage water level during operation remains below the basement
- Need robust assessment of infiltration rate with permeability tests

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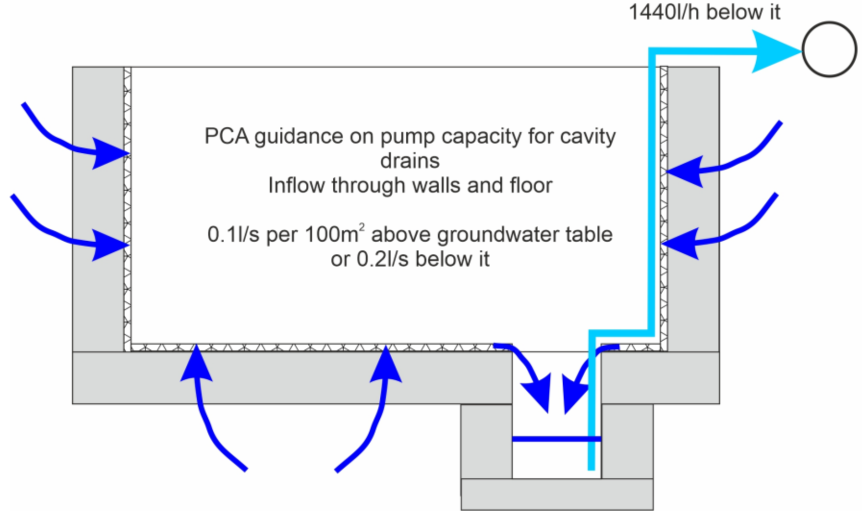
Same applies to cavity drains

- PCA – Groundwater pumping stations serving Type C waterproofing systems – large volume of inflow assumed ≈ 4x greater than allowable discharge for SuDS
- Site specific assessment of groundwater - smaller volumes and saving in pump costs
- Is it acceptable to increase urban flood risk by discharging groundwater into sewers that are already at or above capacity?
- BS8102: 2022 Cl 10.2.7 trade effluent discharge consent required for discharge to combined sewer – most water authorities do not allow groundwater discharge into sewers

Typical residential basement

Discharge rate

720l/h above groundwater and
1440l/h below it



Typical urban sewer

Often at or exceeding capacity with flooding problems - adding more water makes these problems worse

Greenfield Runoff Rate for SuDS design is 180l/h
Cavity drain discharge rate exceeds it by 4 times

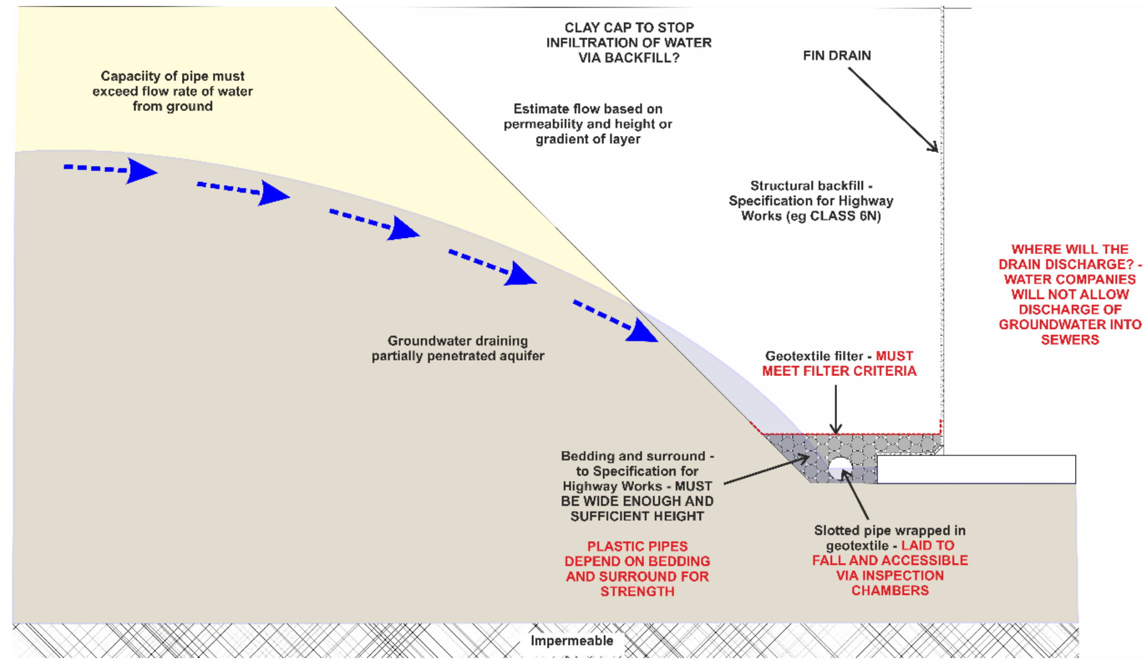
Is this acceptabe?

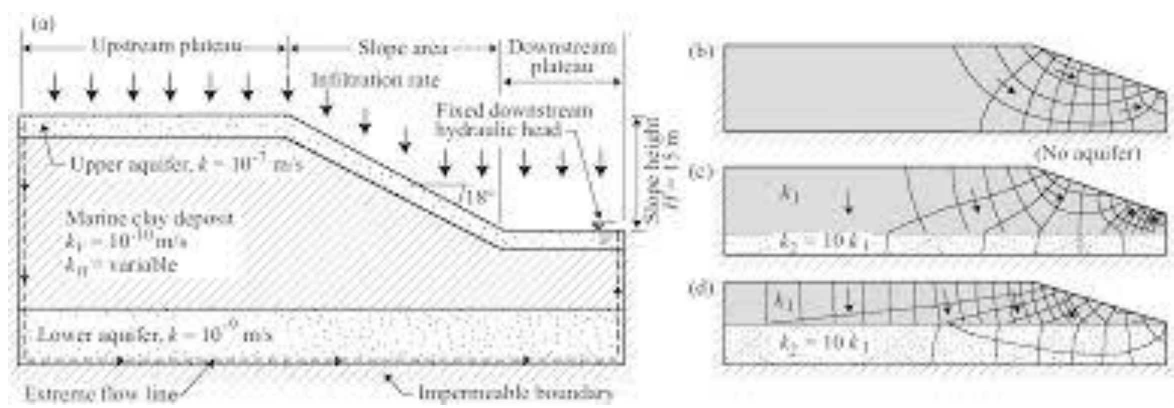
Does not include the Factor of Safety of 5

Time to fill cavity system if outfall is locked – 1 to 2 hours if below groundwater

External drainage - design

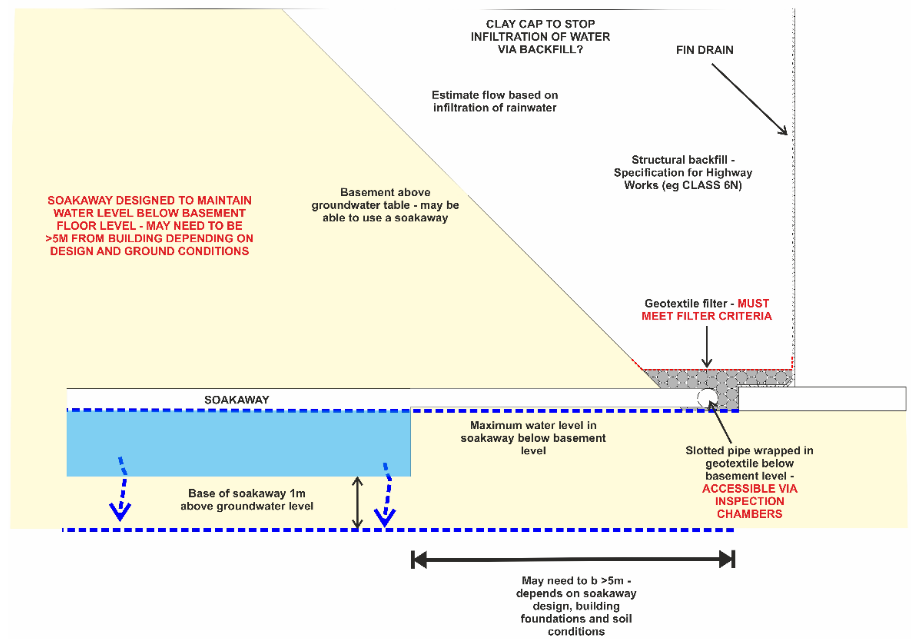
- Estimate water flow to the perforated pipe - simple equations based on saturated groundwater flow to slots , flow nets or computer software
- Standard approach to assess effectiveness of cutting toe drainage and slope stability, design of land drains, dewatering design
- For small basements a 100mm or 150mm diameter pipe will be sufficient. Larger and deeper basements in higher permeability soils need a specific design





External drainage - design

- Ensure pipe is laid to required falls to achieve required capacity
- Provide inspection chambers to allow access for cleaning
- Ensure geotextiles are compatible with the soils to prevent clogging – standard geotextile filter criteria – water must be allowed to enter quickly enough while preventing soil particles from washing in and forming a filter zone in the soil
- Non woven filters are generally so permeable and suit a wide range of soil gradings that excessive clogging is not a problem – but recognise when assessment is required – eg poorly graded soils such as PFA, Loess; gap graded soils, alkaline groundwater where precipitates can be deposited (recycled concrete backfill, contaminated groundwater)



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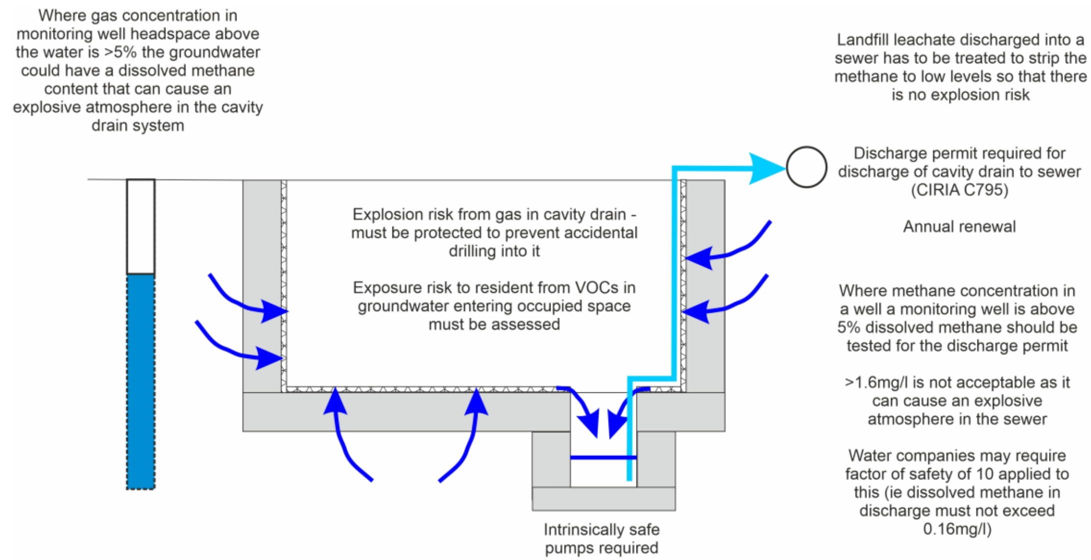
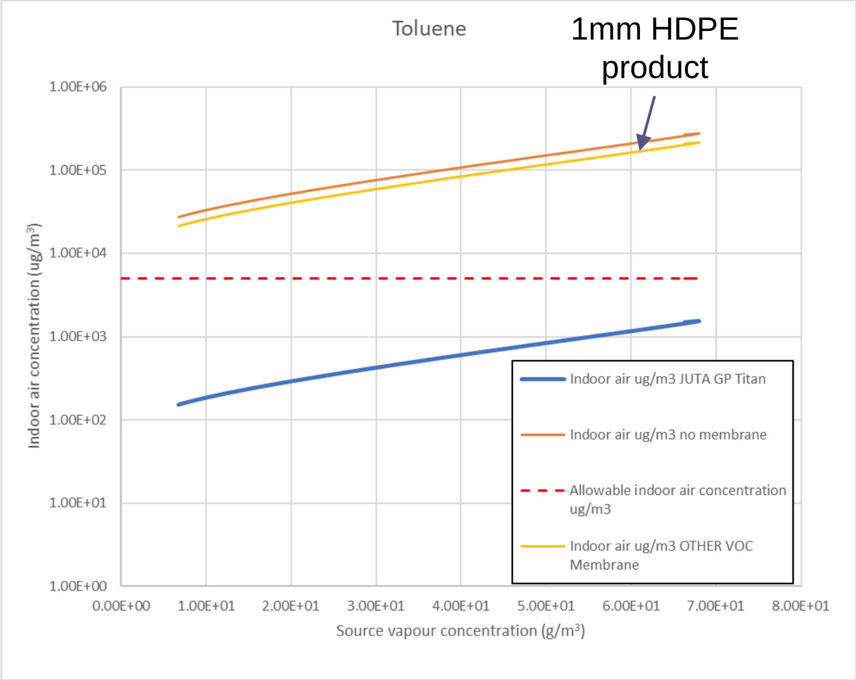
External drains and contamination

- Discharge of water to sewers with contaminants that can cause an explosive atmosphere is not allowed and discharge of contaminated water to soakaways is not allowed – external or cavity drains
- CIRIA C795 "*Discharge of groundwater that infiltrates to a basement into public sewers requires a Consent to Discharge to Sewer permit (Defra/EA, 2020) from the water company (London Borough of Richmond Upon Thames, 2015). This will apply to external and cavity drain systems.* ***Any discharge made without a permit is deemed illegal***"
- Is the external or cavity drain durable when exposed to VOC and other contaminants?
- Precipitation causing clogging (eg iron hydroxide?)



Basement waterproofing in contaminated sites

- **<u>VOC/hydrocarbon membranes do not completely stop VOC/hydrocarbon ingress into a basement, especially when in contact with contaminated groundwater or NAPL</u>**
- Reduce rate of ingress – sometimes it is not enough – 1mm HDPE is not a good VOC membrane
- This is especially true for chlorinated solvents eg Trichloroethylene (TCE)
- TCE –exposure to ppb levels of TCE during the three-week period of heart formation in the first trimester of pregnancy could result in an increased risk of a heart defect in unborn baby
- Site specific vapour intrusion risk assessment incorporating the permeation rates is required as part of the basement waterproofing design – increased permeation rates for dissolved phase groundwater migration



	Permeation Coefficient for TITAN from original tests (potentially saturated conditions)	Increase in permeation coefficient for saturated conditions (dissolved phase migration)
	m^2/sec	
Benzene	4.12E-11	6.21E+02
Toluene	1.24E-10	1.72E+02
Ethyl Benzene	5.37E-11	1.51E+02
Xylene	1.39E-10	8.95E+01

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Thank you

- I will be pleased to discuss the presentation and answer any questions

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