Technical Memorandum

To:	Andrew Brett	**From:**	Jon Parry
Company:	Priory CC44 Limited	**SLR Consulting Limited**	
cc:		**Date:**	2 November 2023
		Project No.	402.012442.00002

RE: Church Street, Epsom, Hydrogeological Basement Impact Assessment

1.0 Background

Further to the following listed previous site assessments and correspondence relating to this issue, please find enclosed an additional technical assessment of the hydrogeological setting of the site and assessment of the impact of the proposed basement structure on the existing hydrogeology.

- SLR Consulting Ltd, Response to Groundwater Flooding Comments, letter dated 28th September 2022, ref 402.012442.00002
- Letter of Objection from Residents of 50 The Parade. Redevelopment of Former Police Station, Church Street, Epsom, dated 28th September 2022
- SLR Consulting Ltd, Preliminary Land Quality Risk Assessment, Former Police and Ambulance Station, Epsom. Report ref 402.012442.00002, dated May 2022
- Crossfield Consulting Ltd, Site Investigation Report. Former Police and Ambulance Station, Epsom dated March 2019.

The proposed development comprises construction of a basement underneath the footprint of the proposed building, which extends to a depth of 3mbgl, and equates to a basal formation elevation of 45mAOD.

2.0 Review of Site Hydrogeological Setting.

The site is located at an elevation of 48mAOD, near the town centre of Epsom, Surrey. Published mapping, previous investigations and assessments have recorded the shallow ground conditions and deeper geological sequence beneath the site to comprise:

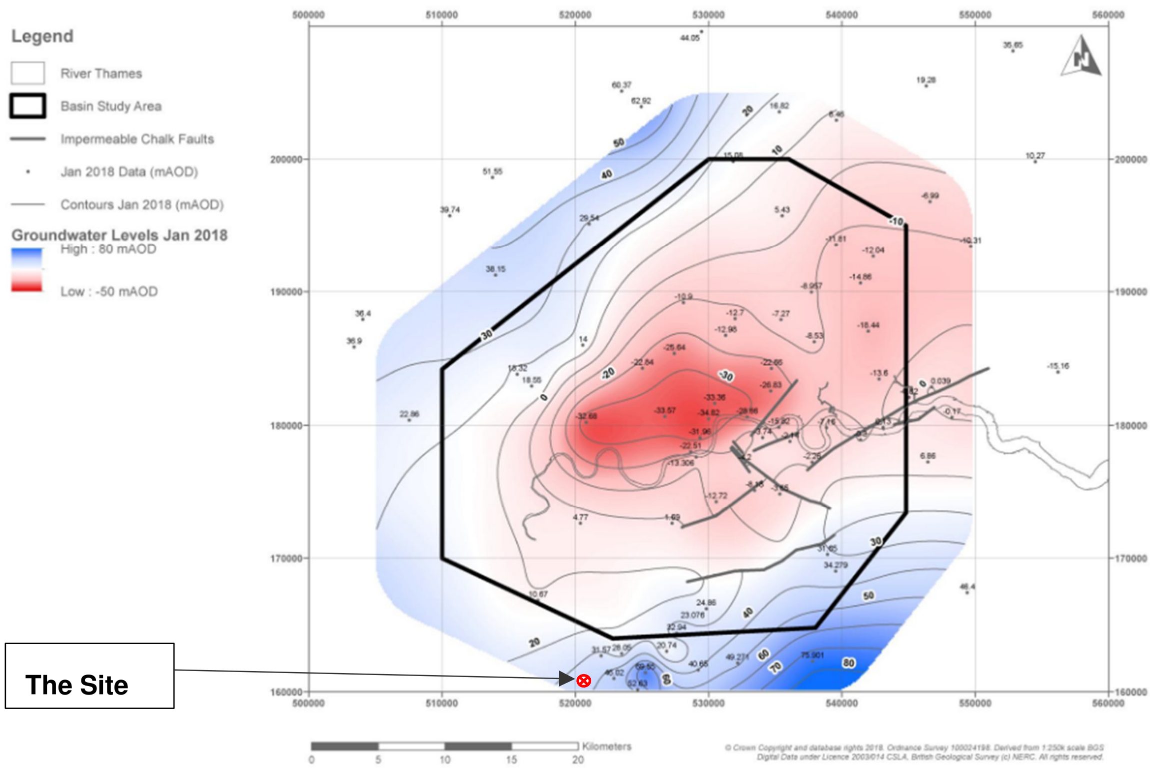
- Made Ground: comprising granular material to approximately 1m depth;
- River Terrace Deposits (RTDs): logged as very gravelly sand to sandy fine to coarse gravel to depths of between 4.6m to 5.0m (43m to 43.5mAOD);
- Thanet Sand: logged as greyish brown silty sand or sandy silty clay to depths of 5.9m (previously described erroneously as (RTDs) in the borehole logs);
- Lewes Nodular Chalk Formation – white structureless chalk to the maximum drilled depth of 10m.

The underlying chalk is a regionally important principal aquifer and a source of public water supply, the site is located within a groundwater source protection zone 1 for an abstraction from the Chalk c. 490m to the north.

Regionally, the site is located close to the boundary of the Chalk bedrock with the overlying Thanet Sand Formation. The Chalk bedrock outcrop dominates the regional topography and landscape and rises to elevations of over 150mAOD where it forms the North Downs approximately 8km to the southeast. The high elevations of the North Downs act as the principal recharge zone to the chalk aquifer. In proximity of the site the Chalk bedding dips to the northwest and regional groundwater flow follows this bedding dip.

This is illustrated in an extract of the groundwater levels for the regional chalk aquifer included as Figure 1.:

Figure 1: Contour plan of the Regional Chalk Aquifer January 2018 (after EA 2018[1])



Based on this regional information, the groundwater elevations for the Chalk aquifer are indicated to be present at an elevation of between 35m and 40m AOD, although a range of seasonal fluctuation will be expected to occur around these values, as is typically recorded in the Chalk.

Previous ground investigation at the site by Crossfield Consulting completed two boreholes (BH1 and BH2) as monitoring wells to depths of 10m bgl installed with response zones extending into the Chalk bedrock. These were monitored by SLR between November 2021 and March 2022. The previously reported groundwater monitoring data has been converted to elevations in metres relative to Ordnance datum (mAOD) in Table 1 below.

Table 1: Groundwater Monitoring Data

BH Ref	Ground Elevation (mAOD)	Monitoring Date	Depth to GW (mbgl)	Groundwater Elevation (mAOD)
BH1	48.1	16/11/2021	8.06	40.04
	48.1	10/12/2021	8.49	39.61
	48.1	21/01/2022	9.01	39.09
	48.1	16/02/2022	Dry at 9.3	38.8
	48.1	31/03/2022	Dry at 9.3	38.8

[1] EA 2018. Management of the London Basin Chalk Aquifer. Status Report 2018. Environment Agency.

BH Ref	Ground Elevation (mAOD)	Monitoring Date	Depth to GW (mbgl)	Groundwater Elevation (mAOD)
BH2	48.0	16/11/2021	Dry at 7.27	<40.73
	48.0	10/12/2021	Dry at 7.27	<40.73
	48.0	21/01/2022	Dry at 7.27	<40.73
	48.0	16/02/2022	Dry at 7.27	<40.73
	48.0	31/03/2022	Dry at 7.27	<40.73

The monitoring indicated a falling groundwater level encountered at elevations of between <38mAOD to 40.04mAOD within the Chalk across the monitoring period. The overlying RTDs were recorded to be dry. The recorded groundwater elevations at the site are consistent with the regionally reported elevations.

Given the sites location, and recorded groundwater elevation, it is situated at the zone of the aquifer where the groundwater within the chalk transitions from one of being unconfined to the southeast, to becoming confined to the northwest by the overlying Palaeogene deposits (Thanet Sands, Lambeth Group and London Clays).

The expected range of groundwater fluctuation of the Chalk bedrock groundwater levels beneath the site can be estimated from regional EA monitoring borehole data of the aquifer reported online[2]. The nearest boreholes to the site are:

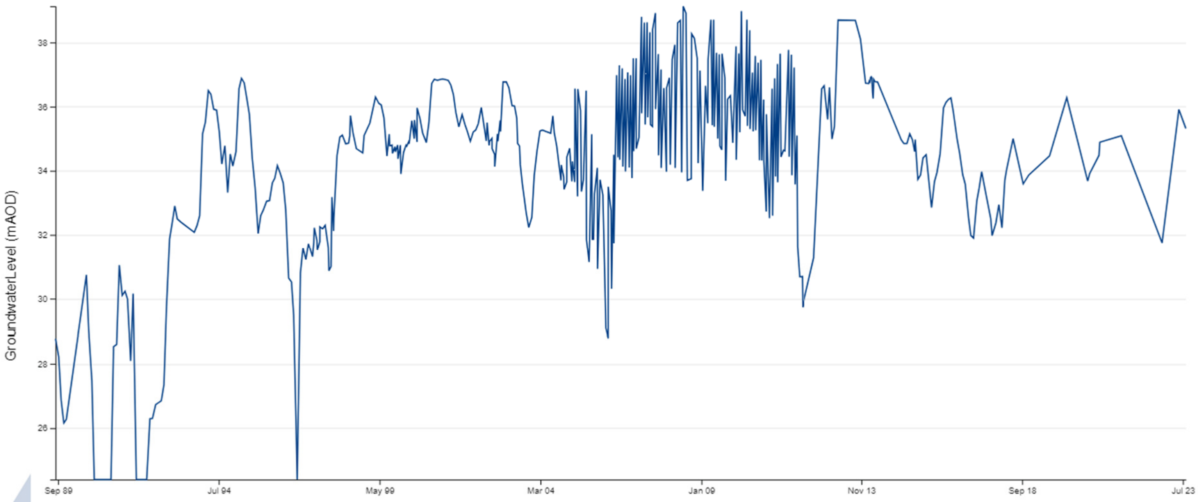
- Chipstead borehole (TQ 2584055280): Located approximately 7km to the southeast of the site at a ground elevation of 129m AOD, and representative of the aquifer recharge zone (interfluve) close to the top of the catchment (The data for this borehole was cited by the objection letter of the residents from no. 50 The Parade), and
- St Philomenas borehole (TQ 2758264390): Located approximately 7km to the northeast of the site at a ground elevation of 39mAOD, and very close to the contact of the chalk outcrop and the overlying Thanet Sand.

Of the above boreholes, St Philomenas borehole is considered to be a much closer analogue to the hydrogeology expected beneath the site, given its setting within the chalk catchment is conceptually very similar to the site.

The groundwater level record for this borehole extends back to 1989 and is presented in Figure 2 overleaf.

[2] https://environment.data.gov.uk/hydrology/explore

Figure 2: EA Groundwater level record for St Philomenas Borehole



This indicates that since 2000, a groundwater elevation for this location has been between 29m and 39m AOD (averaging around 35mAOD), and also indicating a groundwater fluctuation range extending over 10m. Notably, the record also shows a period of sustained high groundwater elevation of 39mAOD in the winter of 2013 / 2104 which is the same as the reported ground elevation at this location, and therefore indicates likely groundwater flooding from the Chalk aquifer. This event corresponds to the timing of the suspected groundwater flooding incident reported by the residents of No. 50 the Parade.

Review of the Jacobs Strategic Flood Risk Assessment report for Epsom and Ewell Borough Council[3] also corroborates this flooding event, and reports that groundwater flooding incidents were recorded in the area of the site in 2000, 2002 and 2014. Figure 110 of this report shows that all of these incidents were located at areas associated with the contact of the Chalk bedrock with the overlying Palaeogene deposits, and also where these locations interface with the mapped RTDs.

3.0 Basement Impact Assessment

The hydrogeological assessment of the presented information indicates a conceptualisation whereby the proposed basement structure will be constructed within dry, unsaturated RTDs, which for the majority of the time will be substantially above the recorded groundwater level within the underlying Chalk aquifer and therefore provide no interference with groundwater flows.

However, during occasional short periods during unseasonably wet winters, it is possible that groundwater levels within the Chalk will rise close to ground level and over top the contact with the overlying Thanet Sands Formation and flood the overlying RTDs. This groundwater will normally distribute throughout the RTDs, given the significant storage capacity of these deposits. However, if the high Chalk groundwater levels are sustained over an extended time period (c. several weeks) it is possible that occasionally groundwater levels could rise within the RTDs to elevations above the base of the proposed basement. Under this scenario, the basement structure would therefore reduce the cross-sectional area of RTDs through which the groundwater could flow and disperse, which could result in a rise in the groundwater level on the upgradient side of the structure.

3

The potential impact of this groundwater level rise can be evaluated through a simplified assessment of Darcys Law. A conceptual model of this evaluation is provided as Appendix A, and a calculation sheet included as Appendix B.

Using building specific dimensions (the depth and width of the basement, perpendicular to groundwater flow, and length of the basement parallel to groundwater flow), literature referenced values for hydraulic conductivity of the RTDs[4], and typical value of hydraulic gradient for RTD deposits (0.003 – professional judgement), the potential rise in groundwater level in the RTDs on the upgradient side of the basement during a short duration groundwater flooding event, has been calculated to be **6.7cm.** This is a conservative assessment assuming groundwater will rise to the top of the RTDs.

When considering the distance between this location and the location of "No. 50 The Parade" (25m), it is assessed that the ensuing effect on groundwater levels beneath "No. 50 The Parade" will be negligible, and not contribute to any additional risk of flooding.

3.1 Climate Change Considerations

The potential long-term impact on the Chalk Aquifer groundwater levels as a result of climate change, has been evaluated and reported by the enhanced future flows and groundwater assessment programme[5].

This indicates that for the AquiMod borehole in the Chalk catchment nearest the site (Sweeps Lane TQ 46/23), the median groundwater levels are predicted to reduce between 0% and 2.5% of current baseline, based on the UKCP18 climate projection. This indicates the basement impact assessment is not sensitive to future climate change impacts.

4.0 Conclusion

A hydrogeological assessment of the site setting and basement impact assessment has been completed. The assessment has indicated that under normal circumstances, the proposed basement will be dry, and above the prevailing groundwater table. The site is located in an area susceptible to occasional short duration groundwater flooding from seasonal water table rises in the underlying Chalk Aquifer.

A simple quantitative assessment of the impact of the basement indicates a potential localised rise in groundwater level of 6.7cm on the upgradient side of the basement during these groundwater flooding events.

The proposed basement is therefore not considered to pose a significant risk of flooding on site or at surrounding properties.

An evaluation of impact from future climate change indicates that groundwater levels in the regional Chalk catchment are predicted to reduce between 0 and 5% based on the UKCP18 projections, which would indicate a lower overall risk of impact from the basement in the future.

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[4] S. H. Bricker and J. P. Bloomfield, 2014. Controls on the basin-scale distribution of hydraulic conductivity of superficial deposits: a case study from the Thames Basin, UK. Quarterly Journal of Engineering Geology and Hydrogeology2014, v.47; p223-236

[5] https://eip.ceh.ac.uk/hydrology/eflag/

5.0 Closure

Information reported herein is based on the interpretation of public domain data collected by SLR, and/or information supplied by the Client and/or its other advisors and associates. These data have been accepted in good faith as being accurate and valid.

If further clarity is sought about the information and conclusions provided in the above document, please contact the undersigned.

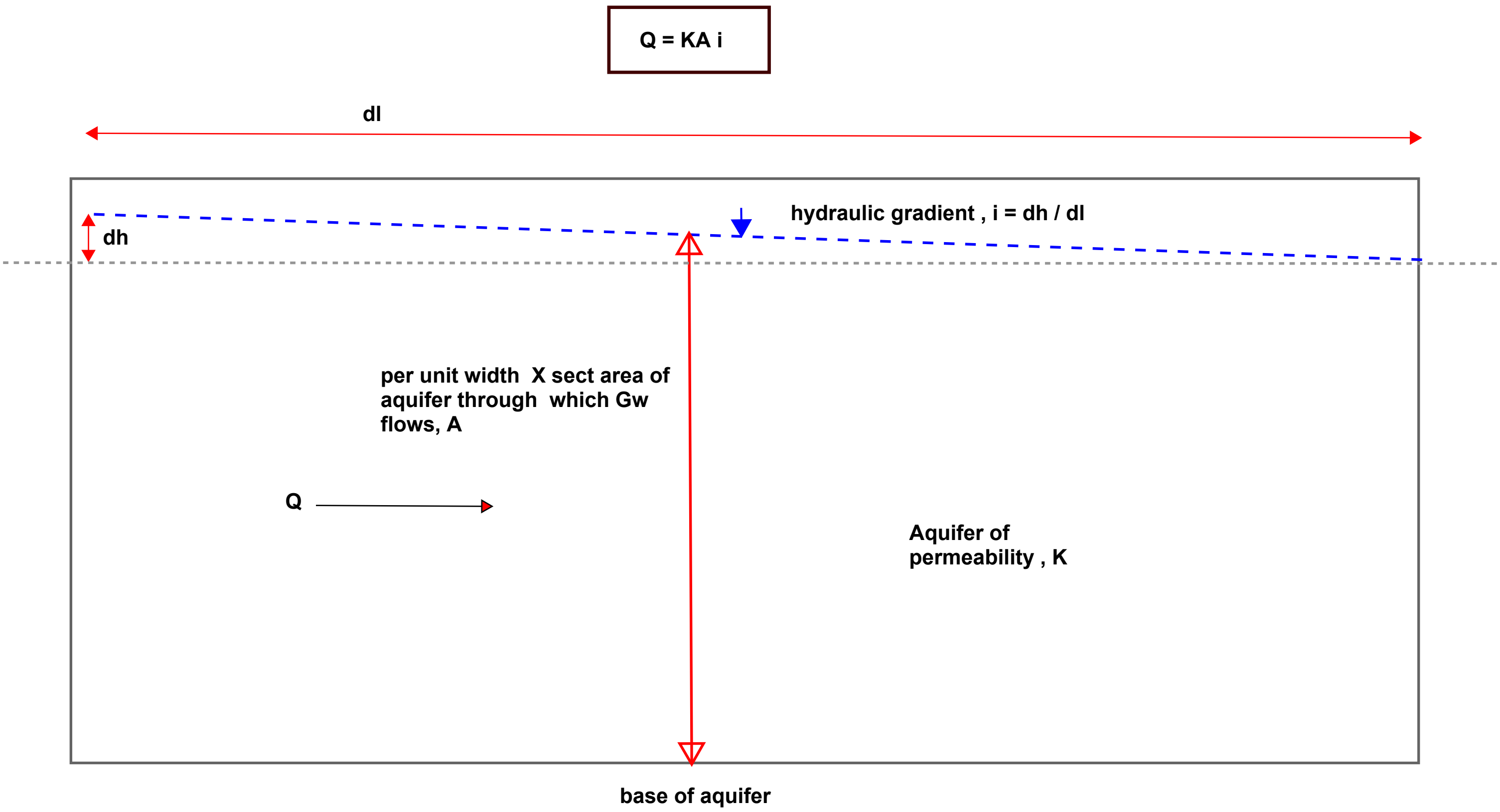
Regards,

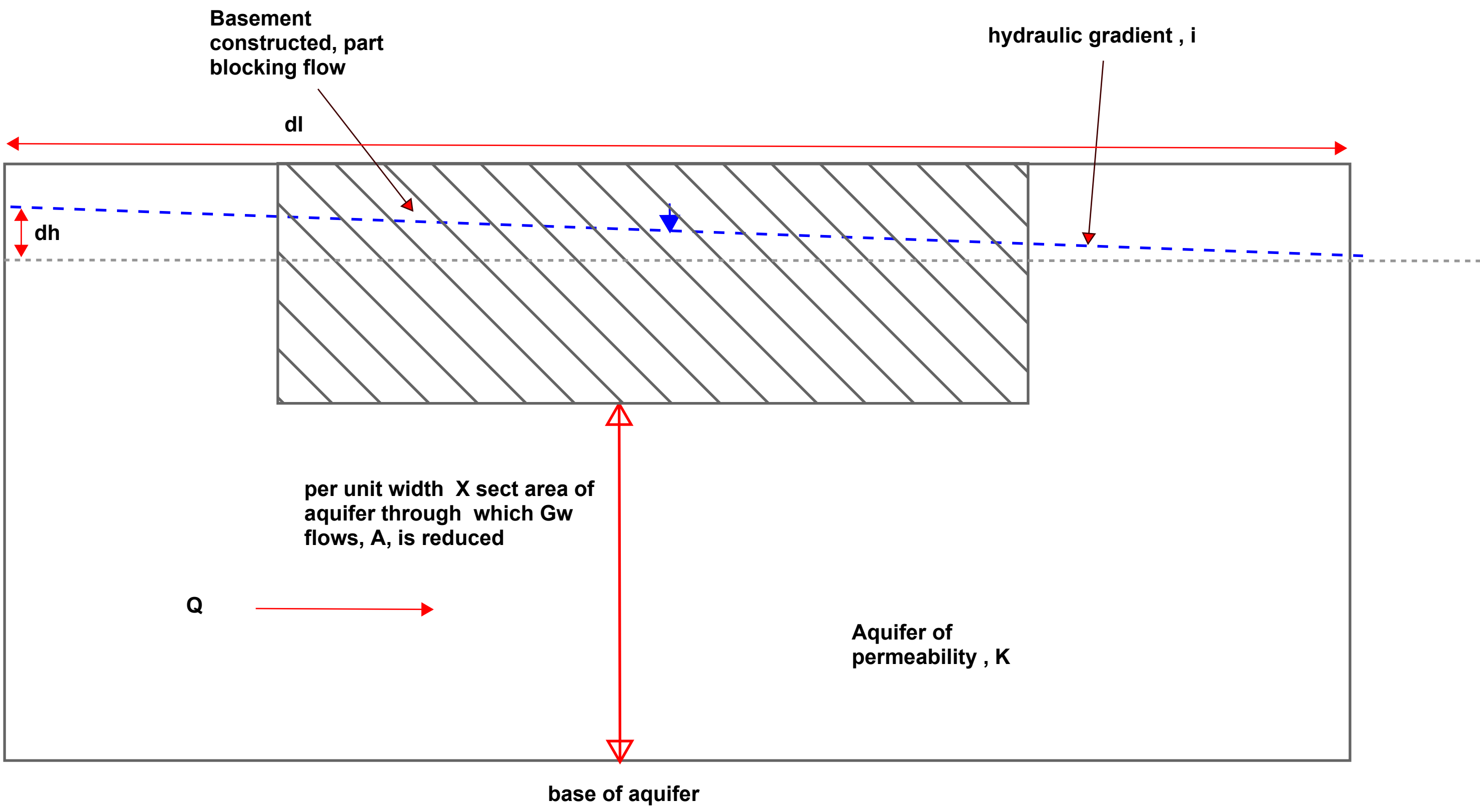
SLR Consulting Limited

Jon Parry, BSc, MSc, CGeol, FGS
Hydrogeologist, Technical Director

Attachments Appendix A: Conceptual Model

Appendix B: Calculation Sheet





Darcys Law, Q = KA i, rearranging for i, therefore Q / KA = i

if A is reduced, and Q and K remain the same (which they should), then the gradient needs to increase to derive the same Q. Given that the lateral distance of the gradient (dl) also doesnt change, the only way the gradient can change is an increase in the groundwater level (dh) on the upgradient side of the basement, and as we would expect, a mounding or rising of the groundwater level as a direct result of the basement obstruction.

Baseline Condition

Parameter	Unit	Value	Reference source
K	m/d	17.56	Average K of River Terrace Deposits (undifferentiated) from Broomfield and Bricker
height of saturated gravels	m	3.25	base of gravels to 1.5mbgl
width of building perpendicualr to groundwater flow	m	25	measured from plan
A	m2	81.25	Calculated
I	m/m	0.003	Assumed flat gradient typical of high K gravel
Q	m3/d	4.28025	Calculated

After Basement Development

Parameter	Unit	Value	Reference source
K	m/d	17.56	Average K of River Terrace Deposits (undifferentiated) from Broomfield and Bricker
height of saturated gravels	m	1.25	reduced thickness of gravels below basement
width of building perpendicualr to groundwater flow	m	25	measured from plan
A	m2	31.25	Calculated
I	m/m	0.003	Assumed flat gradient typical of high K gravel
Q	m3/d	4.28025	Same as baseline
length of basement in line with groundwater flow	m	8.6	measured from plan
Calculated change in groundwater level on upgradient side of basement, as a result of reduced gravel thickness	m	0.067	

Conclusion

In the event that seasonal groundwater flooding should occur from the chalk aquifer, which inundates and saturates the normally unsaturated river terrace gravels, to a depth of 1.5m below ground level, the reduced cross sectional area of gravel beneath the basement through which groundwater could flow, would result in a theoretical rise in groundwater level on the immediate upgradient side of the basement of 6.7cm. In reality, this change in water level would have a negligble effect on the groundwater level of the basement of no. 50 the Parade, as its distance 25m upgradient of the proposed basement and the high permeability of the underlying terrace gravels would mitigate any potential change, by dispersing groundwater around the basement structure.