

Appendix L

GROUNDWATER ASSESSMENT STUDY



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ANGEL'S NURSERY REDEVELOPMENT GROUNDWATER ASSESSMENT

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Angel's Nursery redevelopment groundwater assessment

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Table of Contents

Project Background	5
Ground Investigation	5
Soakaway Infiltration Rate Testing	5
Groundwater Level Monitoring	6
Results	6
Conclusions.....	6
Discussion	7
Figures	8

Project Background

WSP Environmental Limited (WSP) has been commissioned by WSP UK on behalf of West Sussex County Council (the Client) to undertake ground investigation at a potential housing development located at Angel's Nursery, Barnham (the Site).

The Site is located in a predominantly rural area, approximately 0.5 km southeast of the centre of the village of Barnham. The Site is centred on National Grid Reference 496260, 104030 and consists of 3.51 hectares bounded by open fields to the west, nurseries to the south and east and Yapton Road (the B2233) to the north. The Site has previously been occupied by two separate plant nursery businesses.

The main purpose of the Ground Investigation is to characterise the shallow groundwater conditions at the Site. This information shall be used to inform the outline design of infiltration drainage for the proposed development, and provide further reassurance in pursuit of the discharge of planning condition 4.

Ground Investigation

The Ground Investigation consisted of installing eight strategically positioned boreholes and five soakaways excavations on the site. Figure 1 shows the proposed site layout and monitoring well locations. The boreholes were completed as groundwater monitoring wells and have been used to map the geological and hydrogeological regime. The Ground Investigation revealed that the site is underlain (in chronological order from younger to older) with Made Ground, Langley Silt, Raised Beach Deposits and London Clay.

Soakaway Infiltration Rate Testing

BRE Digest 365 recommends that the tests are repeated at least three times and the minimum soil infiltration rate calculated over these three occasions be used for design. The infiltration rate is calculated based upon the time taken for the water level to drain between 75% and 25% of the initial effective submerged depth.

For the infiltration tests the pits were backfilled with 20mm gravel, including standpipe, to prevent collapse of the sidewalls and to assist with monitoring and subsequent re-instatement. Infiltration rate calculations assume a porosity of 30% within the gravel placed across the test depth.

The soakaway infiltration rate tests undertaken at the Angels Nurseries site did not yield results that were complied with the BRE 365 standards, but it should be noted that these works yielded low infiltration rates. WSP has undertaken soakaway infiltration testing in compliance to the BRE 365 standards at an adjacent site to the Angels Nurseries site, where the geological setting is similar, and these test results are provided in Table 1.

Table 1: 2011 Soil infiltration values – BRE 365 Compliant

Trial Pit	Test Number	Soil Infiltration Rate m/s
Barnham SA1	One	7.21e ⁻⁰⁶
	Two	1.03e ⁻⁰⁵
	Three	6.48e ⁻⁰⁶
	Four	6.97e ⁻⁰⁶

Groundwater Level Monitoring

Groundwater monitoring data have been collected by use of data loggers and manual dips. Cumulatively these data provide a continuous sense of how groundwater conditions change over time notably in relation to the influence from rainfall. A rain gauge was therefore installed on an adjacent development site to collect site specific data. Continuous monitoring of local groundwater and rainfall was performed between November 2013 and April 2014 to assess the hydrodynamics associated with the proposed development site and in particular to:

- ✱ Assess general groundwater conditions across the proposed development
- ✱ Assess the general 'reactivity' of groundwater levels to rainfall events.
- ✱ Assess the general changes in the thickness of unsaturated materials.
- ✱ Provide comment with respect to the practicalities of constructing and operating a storm water attenuation pond within the proposed development area in relation to temporal changes of local groundwater conditions.

The groundwater monitoring wells are spatially spread across the site to provide hydrogeological information upon alternative attenuation pond locations. Figure 2 shows temporal changes in groundwater levels and rainfall for the Angels Nurseries site.

Results

- ✱ Local infiltration rate testing indicates that on site infiltration will be less than 1.03e^{-05} m/s. Groundwater levels are highly responsive to recharge events. Typical high groundwater elevations representative of the wet conditions of Spring 2014 are shown as Figure 3.
- ✱ Sustained rainfall occurring between December and February resulted in groundwater levels across the site remaining elevated.
- ✱ Boreholes WS01, WS05, WS06 and WS07 are the most responsive to rainfall, with groundwater levels rising between 1.24m and 1.34m (compared to 0.66m & 0.77m for the remaining boreholes).
- ✱ Artesian conditions experienced at WS1 between December 2013 and April 2014. WS1 is within the eastern area of the proposed site.
- ✱ Excluding WS1, maximum groundwater levels are recorded between 0.26 and 0.79m from ground surface levels.
- ✱ The largest unsaturated zone thickness is found at WS3 (0.79m below surface), located near to the southern periphery of the site (see Figure 4).

Conclusions

- ✱ Based on these locally calculated infiltration rate test permeabilities the drainage conditions would be described as poor by Carter & Bentley¹
- ✱ Current best practice suggests that there should be a minimum of 1m (unsaturated zone) between the base of the soakaway and the groundwater. During wet winter conditions this condition will not be met at the Angels Nursery site.

¹ Carter, M. and Bentley, S. (1991). Correlations of soil properties. Pentech Press Publishers Ltd.

Discussion

The groundwater levels at the proposed Angels Nurseries development site are responsive to rainfall events. All recorded groundwater levels within the site rise to within at least 0.8 metres from ground surface, excluding borehole WS1 where artesian conditions were recorded. The period of time over which the seasonally influenced groundwater levels have remained high is in the order of 2 to 3 months. The implications of seasonally influenced groundwater levels at or close to ground surface are that the proposed current invert of 1m below land surface for a storm water attenuation pond or an invert of <1m below ground level would be compromised by the presence of seasonally influenced groundwater.

The totality of the groundwater monitoring data suggests that groundwater across the Angels Nurseries site is seasonally influenced and that it rises to <1m below ground surface for approximately 2 to 3 months and in the case of WS01, to an elevation equivalent to or above ground surface level.

Figures