

During the 2007 flood Fairford suffered from both overflowing of the River Coln and also from surface runoff from fields and paved areas and the sewerage system was overwhelmed during the event. The Hyder post-flood report of 2008 summarised the flood problems experienced and proposed a number of remedial actions which in most cases have now been implemented.

Similarly, the Thames Water Strategy study report identified a number of problems within the town where sewers had been overwhelmed during heavy rainfall events and some of these issues have subsequently been resolved with a major survey of the piped sewerage system undertaken recently. Some of the remaining sewer problems arise from infiltration of high groundwater levels into the system, a major problem because of the alluvial and terrace gravels which underly much of the town. Other problems arise from surface water mis-connections and surface runoff from roads and public spaces finding their way into the system.

5-2 SuDS

Urban sustainable drainage systems [SuDS] are current 'best practice' for new urban development with the objective of minimising the impacts upon the local pre-development drainage regime. This may be achieved through the use of permeable areas to encourage infiltration or through construction of attenuation ponds to restrict runoff from the site to less than the original 'green field' rate.

Thames Water suggests that SuDS solutions using infiltration are unlikely to be effective in the low-lying areas to the south of the town because of frequent high groundwater levels. In their CDC Strategic Flood Risk Assessment report, JBA also suggest that SuDS drainage using infiltration is unlikely to be feasible for those areas to the south and southeast of Fairford. Thus, it is likely that SuDS drainage in such areas would only be possible through the use of quite significant areas of shallow attenuation ponds because of the high groundwater levels in these areas; attenuation ponds would have to be shallow to avoid ingress of groundwater and hence would have to occupy a significant portion of any site.

Some SuDS designs may aim to raise the ground level which would have the following result:

- i) Reduction in floodplain storage and conveyance capacity thereby increasing flood risk elsewhere.
- ii) Risk of increasing run-off and flooding elsewhere, although reducing flood risk on the site itself.
- iii) Improved viability of infiltration systems due to the increased margin above the maximum groundwater level.
- iv) Improved freeboard for attenuation storage, thereby reducing the land area required.
- v) Increased elevation and visual impact of the development on the landscape.

Such schemes imply raising ground levels significantly over large areas, which would generally be impractical or unacceptable.

6 Conclusions

6-1 Groundwater

- 6-1-1 The Summertown-Radley terrace deposit and underlying Cornbrash has permanent groundwater and represented by data from A2 and Coln House dug-well. Although groundwater levels are closer to the surface at Coln House dug-well, the area is generally unlikely to experience groundwater flooding and maximum levels remain well below ground surface for SuDS schemes.
- 6-1-2 Part of the F50 site along the southern boundary and south-west boundary will experience high groundwater levels, where the area lies along the boundary with the Northmoor terrace deposits and valley of the Dudgrove Brook.
- 6-1-3 Groundwater in the Northmoor Terrace reflects the regime of the River Coln which dominates F44. Although Horcott Road forms local high ground, F44 is low-lying and vulnerable to groundwater flooding. No area can be considered suitable at this location.
- 6-1-4 The other Northmoor terrace sites are located east of the river at F15, F38, F39C, F39D and F52. Represented by Cinder Lane F15 and F39D satisfy requirements and could be larger, whereas parts of sites F39C and F52 are likely not to have sufficient freeboard. F38 is closer to the monitoring well at Riverdale which showed a risk of groundwater flooding in T200 conditions.
- 6-1-5 The Cornbrash outcrop area is characterised by groundwater levels close to the surface during winter which give rise to numerous springs, followed by progressive dewatering of the formation during the spring and summer recession. Evidence of groundwater discharge was confirmed in the shallow valley infilled with head deposits west of Dynevor Place, which follows a route under Milton Farm and into the Coln. The Milton site F35B is distant from this dry valley, so should have reasonable freeboard during times of high groundwater, as confirmed in the dug-well at Dynevor Place.
- 6-1-6 At the Leaffield sites F51A-C, groundwater levels are artesian and close to the surface during winter at several locations, and geological data was provided by boreholes B2 and B5. The low-lying parts of this area do not achieve the desired freeboard, and would be subject to groundwater flooding.
- 6-1-7 Fairford Park site 51D is at a higher elevation and should achieve the required freeboard. Groundwater flowlines have been drawn to identify areas which would be expected to have higher aquifer permeability and high groundwater levels during flood condition.
- 6-1-8 The suitability of possible development sites has been summarised in [Table 6-1](#) by applying the CIRIA guideline that the base of soakaways should be built at least 1 metre above maximum groundwater level.

Table 6-1 Suitability of Development Sites from a Groundwater Perspective

Site	Description	Geology	Suitability	Map Area ¹	Comment
F_15	Jones Field	Northmoor	Full	\$02	
F_35B	Land behind Milton Farm	Cornbrash	Full	F_35B	
F_38	Land east of Beaumoore Place	Northmoor	No	n/a	
F_39C	Field SE of Keble Fields	Northmoor	Partial	n/a	Northern part only
F_39D	Land at London Road (Bovis)	Northmoor	Full	\$03	
F_44	Land at Faulkners Close	Northmoor	No	n/a	
F_50	Land West of Horcott Road	Summertown-Radley	Partial	\$01	Northern part only
F_51A	Land East of Leaffield Road	Cornbrash	Partial	\$04	Avoid flow-paths
F_51B	Land East of Leaffield Road	Cornbrash	Partial	\$05	Avoid flow-paths
F_51C	Land East of Leaffield Road	Cornbrash	Partial	\$06	Avoid flow-paths
F_51D	Land West of Leaffield Road	Cornbrash	Full	\$06	
F_52	Land West of Terminus Cottage	Northmoor	Partial	n/a	Northern part only

Note. ¹ Map reference refers to [Figure 4-9](#).

6-2 Floods and SuDS

- 6-2-1 Fairford has experienced significant fluvial flooding from the River Coln and Court Brook on a number of occasions and with a changing climate it is likely that such events will become more common.
- 6-2-2 There have also been floods from surface runoff and also from an overwhelmed sewer system. As part of any further development developers should contribute to significant improvement in the sewer system.
- 6-2-3 There is no scope for SuDS drainage using infiltration in the low-lying areas associated with alluvial deposits of the Coln valley due to frequent high groundwater levels.
- 6-2-4 Attenuation storage ponds in low-lying areas provided as a SuDS solution can only take the form of shallow depressions that would require significant land.
- 6-2-5 Ideally development should be directed away from the Coln and Court Brook corridor.



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Appendix A Terms of Reference

Introduction

This document provides an outline scope of work required by Fairford Town Council [FTC] from consultants, Water Resource Associates [WRA] for the proposed investigation and monitoring of groundwater levels in areas of proposed development at Fairford. The work also covers a review of documents produced by its consultants and utilities related to flooding in the town.

The Fairford Neighbourhood Development Plan [NDP] was recently rejected by the inspector partly on the grounds that insufficient hard evidence had been provided to support the strategy that future housing development should be located on land away from the River Coln and river terrace deposits. The NDP Steering Group is therefore commissioning a hydrological study to provide that hard evidence.

Objectives of the Assignment

The scope of the work will include:

- Review of relevant reports, maps and documents such as geological map and memoirs, borehole records and flood-related reports.
- Collation and review of all relevant geological, hydrological and hydrogeological data and documentation available from the Environment Agency [EA], the British Geological Survey [BGS] and other relevant bodies, including records of groundwater and surface water levels.
- Reconnaissance of the town area to identify existing water wells and springs, discussion with owners and retrieval of records where possible, to produce an inventory of data and water levels.
- Analysis of LiDAR [mapping] data and geological mapping to investigate lineaments and micro-relief of the town area and help locate proposed monitoring sites.
- Drilling of small diameter exploratory boreholes in two areas to determine water levels and formation thickness of the Cornbrash limestone and Summertown sand and gravel deposits.
- Construction of piezometers at two exploratory borehole sites for groundwater level monitoring.
- Installation of water level sensors and data loggers which are secure from vandalism.
- Groundwater level monitoring for a period of three months [December 2017 to February 2018].
- Hydrogeological analysis of long-term historical groundwater records and correlation with data captured by the new piezometers for prediction of conditions at the Development Sites listed in Appendix 1.
- Preparation of a draft report describing the results of the work, for comment by FTC.
- Preparation of a final report addressing FTC comments.

The overall assignment will focus on groundwater, but will also include a review of all previous studies to define comparative risk of surface flooding for sites close to the river and those further away.

The area of study is shown in Figure 1. A definitive list of development sites is given in Appendix 1. The study will investigate and report the comparative risk of flooding and groundwater levels in those areas. The consultant should be aware of two residential developments under construction, namely the Bloor2 and Bovis estates.

Task 1 Data acquisition, reconnaissance and Mapping

Relevant reports in the possession of FTC or Cotswold District Council [CDC] will be provided and supplemented where possible by other documents prepared either by Thames Water [TW] or Gloucestershire County Council [GCC] on the matter of flooding in the town.

Complete records of hydrological data will be requested from the two main organisations monitoring groundwater and surface water in the area, namely the Environment Agency and Thames Water. This will include but not be limited to acquisition of water level time series at the following locations:

- Cinder Lane Borehole
- River Coln Flow Gauge
- Ampney Crucis Borehole

The consultant will identify wells and springs in the study area which may provide important information on the seasonal variation in groundwater levels in different geological formations. This will be done using BGS records as a starting-point, then following up leads by on-foot reconnaissance talking to residents, with the support of FTC where

possible. Water levels will be measured and historical records retrieved when feasible, to produce an inventory of data and water levels.

The relevant LiDAR data-tiles will be downloaded by the consultant from the Environment Agency website and processed using GIS software to produce a digital terrain model and contouring for the study area. This topographic information will be overlain on geological mapping to investigate lineaments and micro-relief of the town area and help improve the siting of proposed groundwater monitoring points.

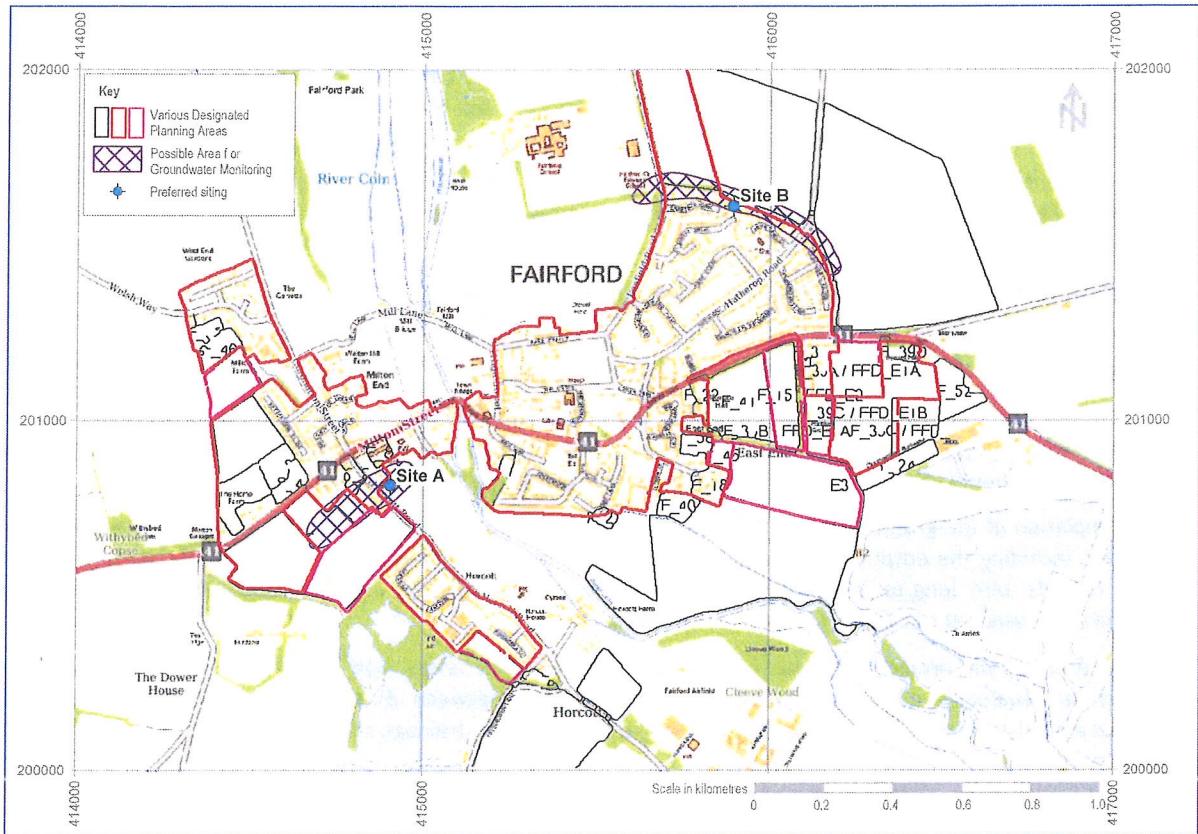


Figure 1 Fairfield Town Study Area and Monitoring Sites

Task 2 Exploratory Drilling and Piezometer Construction

The aim of the drilling and piezometer construction is to establish the thickness of formations and variation in groundwater level at two proposed sites, designated as follows:

- Site A will be located on the western edge of the Coln House School rugby pitch field [owned by GCC Education Department] north of the Horcott Road gate, to establish groundwater levels in the Summertown-Radley Sand and Gravel Member of the Quaternary Period.
- Site B will be located on the north-eastern edge of town at the end of St Marys Drive, to establish groundwater conditions in the Cornbrash limestone.

If these locations are considered to be inappropriate by the consultant, or if there are difficulties in obtaining landowner permission, the consultant will advise on alternative siting to achieve the aims of characterising and monitoring the two geological formations.

The drilling of the two boreholes will be carried out using small diameter and lightweight drilling rigs, at size sufficient to identify the lithology of samples retrieved from the borehole and to allow for piezometer construction.

The maximum drilling depth will be dictated by the underlying clay formation, and allowance should be made to penetrate the clay layer by at least 0.3 metres.

At Site A, the anticipated geological succession will be:

- 0.0 - 4.0m Summertown sand and gravel
- 4.0 - 9.0m Cornbrash Limestone

- 9.0 - 9.3m Forest Marble mudstone [clay]

At Site B the anticipated geological succession will be

- 0.0 - 6.0m Cornbrash Limestone
- 6.0 - 6.3m Forest Marble mudstone [clay]

The anticipated drilling depth will therefore not exceed 10 m, and the more complex drilling will occur at Site A, which may have two separate groundwater levels, one in the sand and gravel deposits and another level in the Cornbrash limestone, unless the two formations have hydraulic continuity.

It may be appropriate to install two piezometers in the same borehole at Site A, in order to monitor groundwater levels in each aquifer. This option should be investigated by the consultant, and the appropriate drilling and construction method identified.

Each piezometer will be equipped with a groundwater level sensor and data-logger, housed securely in a small concrete chamber at the head of the borehole and protected by a steel plate which can be locked and opened for ease of access during the monitoring activities.

Task 3 Groundwater Level Monitoring and Hydrogeological Analysis

Once the field activities and piezometer construction has been completed, the two monitoring sites will be maintained during a period of three months. This will involve monthly download of the data-loggers to ensure accuracy and to carry out manual observation of water levels to verify logger accuracy.

If other wells and groundwater features in the town and vicinity are deemed to be important by the consultant, arrangements should also be made to include those sites in the monitoring campaign.

On completion of the groundwater monitoring period, the consultant will process and analyse all hydrological data collated, including the output from the data-loggers at piezometers A and B, and examine the correlation of short-term records with long-term groundwater records in order to predict seasonal fluctuation and the range in groundwater levels at the development sites of interest.

The final result will provide a frequency analysis of groundwater levels, and identify the freeboard available for residential development. The freeboards will be compared between different development sites to make a comparative risk of groundwater flooding and to examine whether drainage schemes such as SuDS would be able to operate effectively.

Duration of the Assignment and Deliverables

Duration of the proposed assignment will be five months, divided into two main stages. The bulk of the work will be done in the first month, and this will then be followed by monitoring activities, analysis and reporting. The two stages are expected to be divided as follows between the two stages:

Stage 1 will take three months to complete, and will involve data acquisition, reconnaissance, mapping, drilling, piezometer construction, groundwater monitoring, hydrogeological analysis and preparation of a draft report. This report will be submitted before the **end of March 2018**.

Stage 2 will involve a review of the results of the work by FTC, facilitated by a presentation and meeting in Fairford. FTC may wish to follow up queries raised during the meeting, or not addressed in the draft report, and would provide the consultant with comments so that a final version of the consultant's report can be prepared for submission by the **end of May 2018**. The final report will be used to substantiate the revised NDP and provide quantified evidence of groundwater at appropriate locations.

All data collated and used in the study will be provided in electronic form, together with two bound hard-copies of the report and copy in digital form.

The study will be carried out for a Lump Sum fee, against work identified in a brief proposal to be submitted no later than **12th December 2017** for a start date in **early January 2018**. The cost should be broken down into the individual work components, and allow for the submission of regular progress bulletins and a final presentation of the conclusions to the client.

FTC will arrange with respective landowners the necessary permissions for the consultant to enter land and carry out the exploratory drilling and piezometer construction. This will include the arrangement to subsequently monitor water levels during the project duration.



TOR APPENDIX 1 – Potential Development Sites

SHLAA Ref	FNP Ref	Site Location
F_15	x	Jones's Field (Morgan Hall Field)
F_20A	x	Land south of Cinder Lane
F_35B	x	Land behind Milton Farm
F_39A	x	Land off London Road (FTFC Practice Ground)
F_39B	x	Fairford Town Football Club football ground site
F_39C	x	Field South East of Keble Fields (Bovis).
F_44	x	Land behind Faulkners Close
F_45	x	Land south of Morgan Hall
F_50	x	Land west of Horcott Road
F_51A	x	Land east of Hatherop Road
F_51B	x	Land west of Hatherop Road
F_51C	FNP 16	Land east of Leafield Road
F_2	FNP 19	Lower Croft
x	FNP 22 (vii)	Land off Rhymes Lane
x	FNP 3	Land at East End (SHLAA ref F_38)
x	x	Jones Field west of Cinder Lane

UPDATE OF SITE ASSESSMENT DURING THE COURSE OF THE PROJECT:

NB: The following seven sites were excluded from the study, since they had already been developed or are no longer in scope: F_20A, F_39A, F_39B, F_45, F_2, FNP-22, FNP-3.

Furthermore, the following four sites were added:

- F_38 Land East of Beaumoor Place
- F_39D Land at London Road [Bovis]
- F_51D Land West of Leafield Road
- F_52 Land West of Terminus Cottage