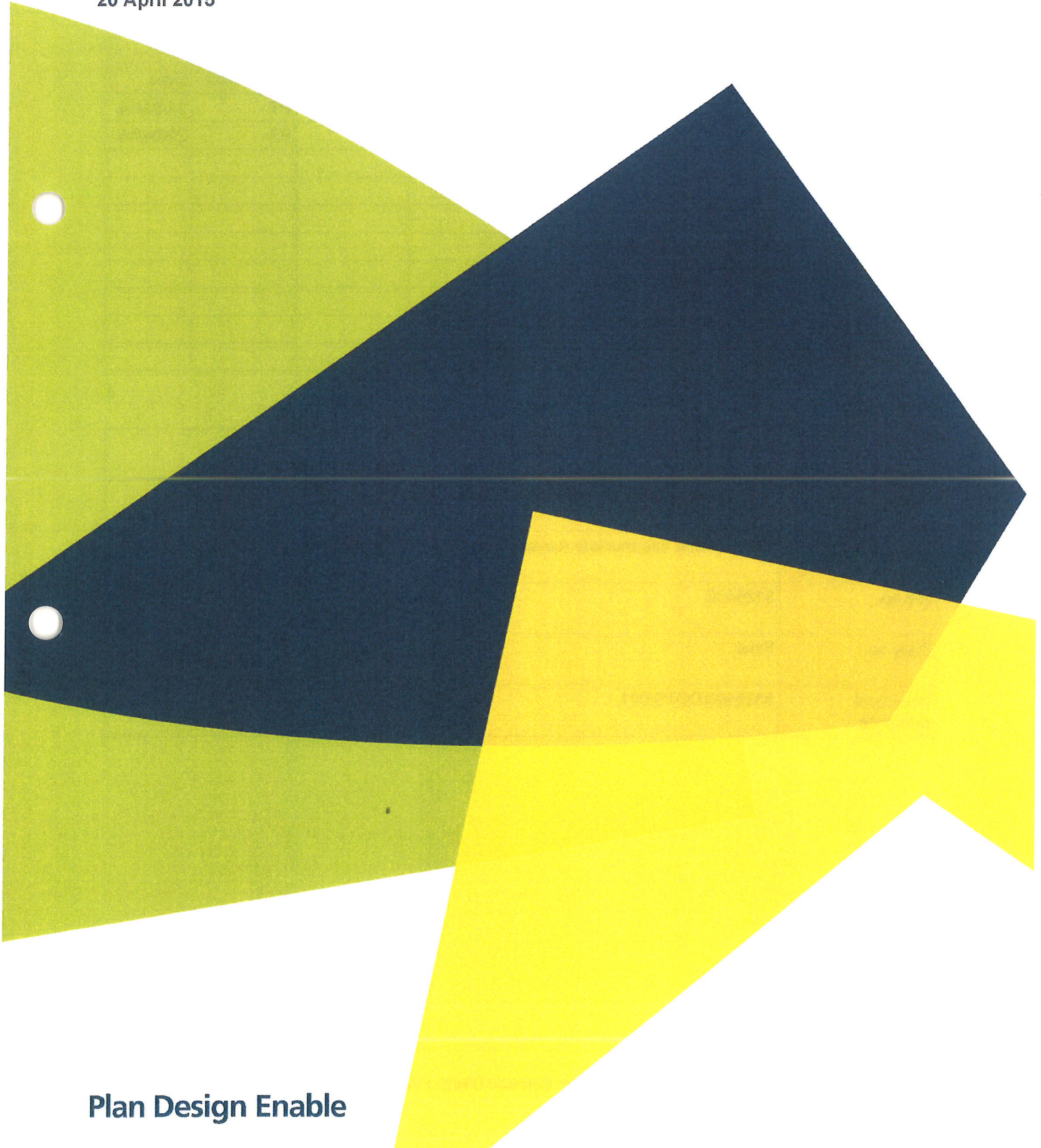


(iii) Gloucestershire Groundwater Management
Plan: Groundwater Intermediate Assessment –
South Cotswold District, Atkins, April 2015

**Gloucestershire Groundwater
Management Plan**
Groundwater Intermediate
Assessment - South Cotswold District
Gloucestershire County Council

ATKINS

20 April 2015



Plan Design Enable

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Glossary/Abbreviations

Term	Meaning / Definition
AOD	Above Ordinance Datum
ASTGWF	Areas Susceptible to Groundwater Flooding
BGL	Below Ground Level
BGS	British Geological Survey
DEFRA	Department for Environment, Food and Rural Affairs
EA	Environment Agency
FRA	Flood Risk Assessment
FRR	Flood Risk Regulations
GIS	Geographical Information System
GWMP	Groundwater Management Plan
LLFA	Lead Local Flood Authority
NGR	National Grid Reference
NPPF	National Planning Policy Framework
OS	Ordinance Survey
PFRA	Preliminary Flood Risk Assessment
SFRA	Strategic Flood Risk Assessment
SPZ	Source Protection Zone
SWMP	Surface Water Management Plan

1. Introduction

1.1. Background

Atkins Limited (Atkins) has been commissioned by Gloucestershire County Council to complete an Intermediate Assessment of Groundwater Flooding for the south of the Cotswold District. A Groundwater Strategic Assessment was completed by Atkins in 2013¹ in order assist Gloucestershire County Council as Lead Local Flood Authority (LLFA) in their remit to include groundwater flooding in addition to pluvial and non-main river flooding as a result of the implementation of The Flood and Water Management Act 2010.

The Intermediate Assessments further develop the Groundwater Strategic Assessment. The Groundwater Strategic Assessment¹ carried out by Atkins was focussed at a County scale and incorporated the principles of the Defra Surface Water Management Plan Guidance² (SWMP) which was identified by Atkins and Gloucestershire County Council as an appropriate basis for the Groundwater Management Plan (GWMP). The intermediate assessment also follows these principles and utilises the format, methodologies and principles within the current SWMP guidance as far as reasonably practicable to maintain consistency.

The principal purpose of the strategic assessment was to identify broad locations which were considered to be vulnerable to groundwater flooding at a range of scales. The locations identified were then used to prioritise the areas requiring an intermediate assessment. The prioritised areas were then reviewed to identify whether flood management schemes were currently in place and whether the areas held potential planning importance within the County. This review shortlisted four of the prioritised areas for further intermediate level assessment and included:

- Bishop's Cleeve;
- Innsworth;
- Churchdown; and
- South of the Cotswold District (including Cirencester, Siddington, South Cerney, Lechlade on Thames and Fairford);

The SWMP guidance outlines that the intermediate assessment is applicable at the town and city scale. The intermediate assessments for the areas above are at a town scale with the exception of the Cotswold District which is at a larger scale due to the extent of land requiring assessment. This report focuses on the south of the Cotswold District.

1.2. Groundwater Flooding

Groundwater flooding arises when groundwater overtops the ground surface. Groundwater flooding events tend to occur over a relatively long duration compared with fluvial flooding which are typically of shorter duration. Flooding from groundwater may occur several days after heavy rainfall and it may even occur before the water table reaches the surface as assets may be present below ground level (cellars etc).

The British Geological Survey (BGS)³ has identified that there are three main settings in the UK where significant groundwater flooding can occur:

- Unconfined major aquifers
- Shallow unconsolidated sedimentary aquifers
- Groundwater rebound in urban centres

These settings are relevant to the south Cotswold area with the exception of groundwater rebound in urban centres. Rising groundwater levels in response to reduced groundwater abstraction in an urban area (groundwater rebound) or a mining area (termed mine water rebound) occurs when high levels of abstraction

¹ Atkins (2013) Gloucestershire Groundwater Management Plan Groundwater Strategic Assessment

² Defra (2010) Surface Water Management Plan Technical Guidance

³ British Geological Survey Susceptibility to Groundwater Flooding Maps
<http://www.bgs.ac.uk/products/hydrogeology/groundwaterFlooding.html>

reduce dramatically following the decline of industry and there is a consequent increase in groundwater levels as they return to their natural state. The subsequent risk from the groundwater is that the urban areas have developed largely during the period of lowered groundwater levels and, as a result, basements, underground services and the structural integrity of deep foundations are in danger of being compromised by the effects of rising groundwater.

Rebound has been reported in a number of cities overlying non-Chalk aquifers including Birmingham, Coventry, Doncaster, Liverpool, Manchester, Nottingham and Wolverhampton. The majority of these cities are underlain by the Permo-Triassic Sandstone aquifer which is not the Principal Aquifer present within the south of the Cotswold District and the risk from this type of flooding is considered minimal.

Groundwater flooding can also occur where there are exceptionally large flows from perennial springs or large flows from intermittent or dormant springs are present. These flows can cause both localised flooding in the vicinity of the springs and down gradient where surface water drainage channels may not be adequate. A number of springs are present along the southern escarpment of the Cotswold Hills. A discussion on the mechanisms of groundwater flooding in relation to the study area's setting is included in Section 4.

The aim of the study presented in this report is to consider groundwater flooding issues in the south of the Cotswold District as above but it does not address sewer flooding where it is occurring as a result of operational issues, i.e. blockages and equipment failure.

Historical flooding has also been summarised with information taken from the Strategic Flood Risk Assessment (SFRA) and the Environment Agency historic flood maps, which are assumed to be correct, however further investigation of these occurrences is outside the remit of this current study.

1.3. Aims and Objectives

The aim of this study is to complete an intermediate review of the south of the Cotswold District. The intermediate assessment will operate at a smaller spatial scale than the strategic assessment making it possible to gain a more thorough understanding of the localised conditions which may contribute to groundwater flooding.

The aim of the intermediate assessment is to identify the nature and sources of the flooding including both groundwater and surface water through the collation and analysis of area specific information, in order to improve the understanding of groundwater flooding and identify flood hotspots. The results will be utilised to improve the mapping to support spatial and emergency planning.

The identification of flood hotspots could lead to the recommendation of more detailed assessment (possibly through modelling approaches) for some areas, however this will only be recommended where groundwater level data is available. It may also be possible to scope out areas for further detailed assessment. Finally, where possible, mitigation measures will be recommended based on the evidence available.

1.4. Limitations

This report is based on information provided by Gloucestershire County Council, the Environment Agency and the British Geological Survey (BGS) which has not been verified by Atkins.

Historical groundwater level data obtained from BGS and the Environment Agency has also not been verified by Atkins. The historical groundwater levels from BGS are from single recorded events from singular occasions and whilst cannot be verified as the current groundwater levels provide some indication of where groundwater levels have been in the past.

The reporting is limited to the areas of potential risk of groundwater flooding based on the geology, hydrogeology and hydrology and does not identify areas where groundwater flooding will occur. This study does not determine the potential of groundwater flooding due to anthropogenic causes such as sewer, construction and other man made influences which may affect groundwater flooding.

The findings conveyed in this report should be treated with a degree of caution in respect of the constraints outlined above. The report is limited in identifying areas of potential risk based on the available data. This report does not seek to identify areas where groundwater flooding will occur.

This Intermediate Groundwater Flood Risk Assessment incorporates data from numerous sources and therefore copyright information has been shown on deliverables.

The Environment Agency developed the mapping for the Areas Susceptible to Groundwater Flooding (ASTGWF) which is a strategic scale map showing groundwater flood areas on a 1km square grid⁴. The susceptible areas are represented by one of four area categories showing the proportion of each 1km square that is susceptible to groundwater emergence. The ASTGWF maps do not show the likelihood of groundwater flooding occurring. Due to the limitation of the scale of this mapping the ASTGWF maps have not been used within the groundwater flooding matrix within the South East Cotswold as this would be disproportionate to the scale utilised here; 500 m grid squares.

⁴ Environment Agency ASTGFW
http://www.geostore.com/environment-agency/WebStore?xml=environment-agency/xml/dataLayers_ASOWF.xml

2. Assessment Methodology

With regard to flooding, groundwater management is relatively new and as such no set guidance on how to undertake a GWMP is available. The principles from the SWMP guidance have been identified as a suitable basis on which the GWMP for the County has been based. The technical guidance for SWMP was published by Defra in March 2010².

The SWMP is a tool used to identify areas which are more vulnerable to surface water flooding, and to establish a long term action plan to identify measures to reduce flooding, recognising that it is not economically viable to eliminate flooding altogether. Therefore the GWMP process undertaken has utilised the format, methodologies and principles within the current SWMP and the Defra Surface Water Management Plan (SWMP) guidance² as far as reasonably practicable to maintain consistency.

The methodology used to carry out the strategic assessment on groundwater flood risk for the county followed the advice set out in SWMP guidance for Phase 1 (the preparation phase) and Phase 2 (the strategic risk assessment phase). This approach has been utilised again for the intermediate risk assessment phase which is part of the Phase 2 risk assessment methodology outlined below.

2.1. Scope

The intermediate assessment includes the following sections:

- A site specific desk study including the following information:
 - Topography
 - Geology
 - Hydrogeology
 - Hydrology
 - Groundwater Level Data (where available)
 - Surface Water Flooding
 - Land use – quarrying activities
- Risk Assessment
- Conclusions and Recommendations

2.2. Phase 2: Risk Assessment

The strategic, intermediate and detailed risk assessments are carried out in this phase. The first stage of the Phase 2 risk assessment is the strategic assessment when little flood risk information is known. This assessment focuses on identifying the more vulnerable groundwater flooding areas for further assessment. At the strategic level, Gloucestershire was assessed as a whole on a large scale grid in order to gain a broad understanding of the locations that are potentially more vulnerable to groundwater flooding.

Intermediate assessments are carried out to identify flood hotspots in the chosen study area. These intermediate assessments can also identify quick fix mitigation measures, or scope areas out. The intermediate assessment as defined by the SWMP Guidance² is considered to be at the city or large town scale which will produce outputs that identify flood hotspots which might require further analysis through detailed assessment, identify immediate mitigation measures which can be implemented and inform spatial and emergency planning.

Detailed assessments are completed where additional understanding of the probability and consequences of flooding is required and where potential mitigation measures for high risk areas need to be tested. In these instances modelling is likely to be required.

This report details the intermediate risk assessment for the production of the more detailed higher resolution groundwater risk maps to identify those areas where more detailed assessment would be required. Whilst the assessment within the south of the Cotswold District has been mapped within a detailed scale and a detailed assessment of the variables that may lead to increased risk in groundwater flooding has been

completed it is still considered to be an intermediate level assessment as there is limited monitoring data and no modelling has been completed.

2.2.1. Groundwater Intermediate Assessment Methodology

The aim of the intermediate assessment is to utilise the prioritised list formed from the strategic assessment and to produce mapping outputs that identify flood hotspots which might require further analysis through detailed assessment. The assessment also identifies if and where immediate mitigation measures are required and can be used to inform spatial and emergency planning.

This section describes the selection and justification of the prioritised list. The data supplied for the study as described in Appendix A of this report was used to inform the assessments.

2.2.2. Identification of High Risk Areas or Hot Spots

The four locations put forward for intermediate assessment following the finalisation of the strategic assessment have either been identified as areas of potential planning importance or areas of higher risk within the risk matrix produced as part of the strategic assessment.

The potential for hot spots of groundwater flooding may be magnified locally within the area due to the interaction of a number of factors. The factors that may increase the potential for groundwater flooding include the following:

- Superficial Deposits – The presence of sands and gravels may indicate areas more vulnerable to groundwater flooding as a result of prolonged rainfall raising groundwater levels.
- Bedrock Geology – The underlying geology can indicate potential risk from groundwater flooding either from highly permeable formations which can provide a source for groundwater flooding and low permeability formations which can prevent or reduce infiltration of groundwater from superficial deposits.
- Springs – The presence of a spring may indicate where groundwater has emerged in the past and where it could potentially emerge in the future.
- Gradient – It is more likely that flooding would occur in flatter areas as emerging groundwater is likely to flow away from areas with a steep gradient.
- Historical flooding – Although the type of flooding cannot be determined within the Environment Agency mapping it does provide an indication of where flooding is likely to occur in the future.

These factors have been mapped in order to determine areas with greater potential risk.

2.3. Availability of Information

In order provide an intermediate assessment of the potential for groundwater flooding a number of data sources have been used within the analysis. These include the review of bedrock and superficial geology, available information from borehole monitoring and borehole drilling logs, historical records of groundwater flooding and data from Ordnance Survey mapping. A full list of the data that has been used for the study is available in Appendix A. The data was provided by the following organisations:

- Gloucestershire County Council
- British Geological Survey
- Environment Agency