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**ASSESSMENT OF GROUNDWATER AND SURFACE WATER
FLOOD RISK IN CUMNOR PARISH**
For
CUMNOR PARISH COUNCIL

February 2019

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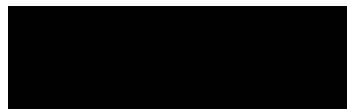
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ASSESSMENT OF GROUNDWATER AND SURFACE WATER FLOOD RISK IN CUMNOR PARISH

1. INTRODUCTION

GWP Consultants LLP (GWP) has been commissioned by the Cumnor Parish Council to identify potential sources of flooding in selected areas within Cumnor Parish, and to provide recommendations in terms of flood risk assessments for future developments.

2. LOCATION AND TOPOGRAPHY

Cumnor Parish is located directly west of Oxford (see Drawing No. CUMFRA1812-1). Topographic elevations decrease from *c* 160mAOD at the top of Cumnor Hill and Wytham Hill; to *c* 60mAOD at the River Thames, along the western and north-western edges of the Cumnor Parish boundary.

West of the A420 and south of the B4044 (Eynsham Road), the ground is relatively flat, varying between *c* 60 and 70mAOD (see Drawing No. CUMFRA1812-2). However, ground elevations significantly rise north of the B4044, east of the A420 and towards the southern reaches of Cumnor Parish (see Drawing No. CUMFRA1812-2).

It is important to note Cumnor Parish is only partially covered by high-resolution topographic LiDAR datasets (which have a 1m spatial resolution), thus LiDAR data is not available for some areas within the Parish (see Drawing No. CUMFRA1812-3). Consequently, coarser-resolution satellite-derived SRTM data (which have a 30m spatial resolution) have been used instead to contour ground elevations in Drawing No. CUMFRA1812-2.

Whilst SRTM data may be fit-for-purpose at the regional scale and for steep areas, it fails to accurately represent flat terrains and local-scale topographic variations. This is apparent towards the western banks of the River Thames, immediately west of the Cumnor Parish boundary, where topographic contours generated using SRTM data show inconsistent shapes (see Drawing No. CUMFRA1812-2). However, due to the significant changes in topographic elevations within Cumnor Parish more generally, SRTM data provides an acceptable representation of the Parish topography at the regional scale.

2.1 Areas of Interest

As requested by the Client, this report focusses on 4 No. Areas of Interest (AOI) located within Cumnor Parish; these are:

1. Cumnor Hill & Dean Court;
2. Farmoor;
3. Filchampstead; and the
4. Catchment area draining to Wootton.

The AOIs are shown on Drawing No. CUMFRA1812-3.

3. GEOLOGY

The geology of Cumnor Parish is described on British Geological Survey (BGS) Geological Sheet 236 Witney [Oxford] (see Drawings No. CUMFRA1812-4A and 4B).

3.1 Superficial Geology

The major part of Cumnor Parish is not underlain by any superficial deposits (see Drawing No. CUMFRA1812-4A). At Farmoor, and surrounding Farmoor Reservoir, there is superficial alluvium comprising of clay, silts, sands and gravels. Other localised areas within the Parish are also underlain by sand and gravel deposits of fluvial origin (*i.e.* Northern Drift Formation and Northmoor Sand and Gravel Member).

3.2 Bedrock Geology

The low-lying areas to the north and west of Cumnor Parish are underlain by the Oxford Clay Formation and the West Walton Formation (mudstones) (see Drawing No. CUMFRA1812-4B).

As the land rises to the south-east, at Hurst Hill, and to the north, at Wytham Hill, the geology changes from clay to the Hazlebury Bryan Formation. The Hazlebury Bryan Formation outcrops between c 94 to 103mAOD and is described by the BGS as a sandy mudstone, which comprises of sandstone, siltstone and mudstone.

Moving up Hurst Hill and Wytham Hill, the Kingston Formation overlies the Hazlebury Bryan Formation. The Kingston Formation outcrops between c 103 to 121mOAO. The BGS characterise this formation as a "medium-grained quartzose sand, locally fine and coarse-grained, with carbonate cemented beds and doggers which are sandy limestone or calcareous sandstone.

The Stanford Formation overlies the Kingston Formation, outcropping generally between c 110 to 133mAOD. The BGS characterise this formation as interbedded limestone, marl and mudstones. The Stanford Formation forms the top of Wytham Hill to the north of the Parish.

The Ampthill Clay Formation overlies the Stanford Formation, described by the BGS as a mudstone. This formation forms the top of the geological sequence within Cumnor Parish. These formations are part of the Corallian Group. Within the boundary of development that may impact neighbouring Wootton, the Lower Greenstone Group can be found. This formation can be found at the top of the Cumnor Hill and is comprised of sandstone.

In addition to the solid bedrock geology, to the north of the Parish and on the westerly slopes of Wytham Hill several geological slope failures, or mass movements, have been mapped. These features are broadly mapped at the geological contact between the Kingston (and/or the Hazlebury Bryan) Formation and the underlying Oxford Clay Formation. In some of the areas where mass movement events have occurred, slump debris sediments consisting of Hazlebury Bryan and/or Kingston Formations overlay the Oxford Clay Formation some distance (c 200m) downgradient of the contact (see Drawing No. CUMFRA1812-4B).

4. HYDROLOGY

The hydrological setting of Cumnor Parish is strongly determined by the topography and underlying geology. In this regard, rainfall occurring on the hillside areas (*i.e.* Cumnor Hill and Wytham Hill) drains, either by means of surface water runoff or groundwater flow, to the surrounding low-lying areas; to eventually discharge into the River Thames.

High proportions of surface water runoff are generated from those areas directly underlain by impermeable clay (*i.e.* Ampthill Clay Formation, which outcrops on top of Cumnor Hill, and Oxford Clay Formation at the low-lying valley areas; see Drawing No. CUMFRA1812-4B). Conversely, high infiltration rates are expected in those areas underlain by permeable strata (*e.g.* Stanford Formation, Kingston Formation, and Hazlebury Bryan Formation).

Surface water runoff generated from both permeable and impermeable ground on top of the hillside areas drains to the surrounding lowlands, concentrated along flow paths, which have, over time, eroded the underlying sediments to form valleys. These valleys cut down through the above mentioned geological formations, into the Oxford Clay Formation. Examples of these features are visible on Drawing No. CUMFRA1812-4B.

5. HYDROGEOLOGY

The mudstones associated with the Oxford Clay and Ampthill Clay Formations are impermeable and act as aquicludes (*i.e.* prohibiting the flow of groundwater).

In contrast, the Kingston, Stanford and Hazlebury Bryan Formations are permeable strata. Downward vertical groundwater flow within these formations is blocked at depth by the impermeable Oxford Clay Formation. As a result, 'contact springs' occur along the exposed lengths of contact between the overlying permeable strata and the underlying Oxford Clay Formation, where groundwater is forced to move laterally to ground surface and discharge out into the surrounding areas.

The BGS has inferred a regional south-east groundwater flow direction within the permeable Kingston and Stanford Formations (see groundwater level contours reducing to the south-east within the Corallian Formation on Drawing No. CUMFRA1812-5). It is not known if groundwater levels have been measured directly or inferred from the elevation of the top of the Oxford Clay.

Locally, however, on the northern edge of this Corallian Formation, some northwards groundwater flow is still likely to occur, supporting contact springs along the northern contact with the underlying Oxford Clay.

The residents of Third Acre Rise – this is located along and perpendicular to Eynsham Road (B4404), towards the eastern edge of Cumnor Parish (grid reference: 447844mE, 205841mN), immediately down gradient of the geological contact between the Kingston Formation and Oxford Clay Formation – noted that the ground beneath (and adjacent to) some properties is saturated all-year-round (including throughout the recent 2018 Summer drought). This phenomenon suggests the presence of shallow groundwater (*i.e.* “contact springs”).

Furthermore, the presence of mass movement slumping along the contact of the Kingston and Oxford Clay Formations also suggests the “contact springs” present along the contact reduce friction, encouraging and promoting mass movement events to occur.

6. RISK OF FLOODING

6.1 Risk of Fluvial Flooding

According to the Environment Agency’s (EA) map of fluvial (river) flood zones, there are areas within Cumnor Parish that are at risk of fluvial flooding (see Drawing No. CUMFRA1812-6).

These are located along the western Parish boundary, which runs parallel to the River Thames; and towards the east and north of Farmoor Reservoir. These areas partially sit within Flood Zone 2 - *i.e.* areas that sit within the 1:1000 year (plus climate change allowance) flood extent – and Flood Zone 3 – *i.e.* areas that sit within the 1:100 year (plus climate change allowance) flood extent.

In particular, the EA-mapped flood extents partially intersect with (or are immediately adjacent to) Areas of Interest 2 (Farmoor) and 3 (Filchampstead).

6.2 Risk of Surface Water Flooding

According to the EA’s map of surface water flood zones, there are various areas within Cumnor Parish that are at a significant risk of surface water (pluvial) flooding (see Drawing No. CUMFRA1812-7).

These are located along the main runoff drainage paths, especially across the steep slopes located in the hillside areas along the eastern and northern edges of Cumnor Parish; and also within the flat, low-lying areas surrounding (and particularly towards the east of) the Farmoor Reservoir.

Areas of Interest 1 (Cumnor Hill & Dean Court), 2 (Farmoor) and 3 (Filchampstead) are partially at risk of surface water flooding. Part of Area of Interest 4 (Catchment to Wootton) also shows a surface water runoff route heading southwards into Wootton Village.

6.3 Risk of Groundwater Flooding

The information presented in Section 5 suggests that regional groundwater flow within the Corallian Group is to the south-east, as well as hypothesised local northerly flows. As a result, groundwater egress occurs above the contact with the underlying Oxford Clay Formations, along ‘contact springs’.

Therefore, a ‘Zone of Potential Groundwater Flooding’ exists on or above the geological contact between the Kingston Formation (and/or Hazelbury Bryants Formation) and the underlying Oxford Clay Formation. The upper most limit of this zone has been assumed to be 10 metres in vertical height above this contact, allowing for a 5-7m rise in groundwater levels within the Corallian Group (see Drawing No. CUMFRA1812-8: Groundwater bearing strata above Oxford Clay Formation) and a 3m deep basement excavation.

Although geologically mapped by the BGS, the actual position of the Oxford Clay Formation may vary locally, due to a lack of outcrop for geological mapping purposes, but also the presence of mass movement sediments extending further down gradient of the contact. Therefore, the lower most limit of this zone is assumed to be ten metres in vertical height below this contact (see Drawing No. CUMFRA1812-8: Oxford Clay Formation – zone of uncertainty).

It should be noted this zone has been estimated without the availability of groundwater level data. The zone definition should be reviewed periodically based upon available groundwater level monitoring data from future planning applications. A zone of groundwater flood risk has therefore

been estimated based upon a 20m vertical height range; it centres on the Oxford Clay contact with the overlying Kingston Formation. The width of this zone on the ground varies depending on the ground topographic gradient. It is, on average, 200-250m wide but can range from 150m to 650m.

It is important to note the above mapping exercise is reliant on the availability of high resolution ground elevation data (*i.e.*, EA LiDAR DEM). Therefore, "Zone of Potential Groundwater Flooding" areas have only been defined within the extent covered by EA LiDAR data (see Drawing No. CUMFRA1812-8). In the absence of EA LiDAR data, a 300m wide band centred on the geological contact could be reasonably used by the Parish Council to demarcate this zone immediately north of Cumnor Village.

6.4 Areas of Interest

A summary of risk of flooding from different sources for each AOI is presented in Table 1 and the sub-sections below.

6.4.1 *Area of Interest 1: Cumnor Hill & Dean Court*

This AOI is at:

- No risk of fluvial flooding;
- Medium to high risk of surface water flooding; and
- High risk of groundwater flooding.

6.4.2 *Area of Interest 2: Farmoor*

This AOI is at:

- Low risk of fluvial flooding;
- Medium to high risk of surface water flooding; and
- Very low risk of groundwater flooding.

6.4.3 *Area of Interest 3: Filchampstead*

This AOI is at:

- High risk of fluvial flooding;
- High risk of surface water flooding; and
- Very low risk of groundwater flooding.

6.4.4 *Area of Interest 4: Catchment area draining to Wootton*

This AOI is at:

- No risk of fluvial flooding;
- Medium to high risk of surface water flooding; and
- Low risk of groundwater flooding.

7. RECOMMENDATIONS

7.1 Fluvial Flooding

Any future developments should consider their potential impacts in terms of fluvial flooding; and, if required, undertake a bespoke Flood Risk Assessment (FRA), following:

- the [National Planning Policy Framework \(NPPF\)](#); and
- the Environment Agency's Guidance on "[Flood risk assessment for planning applications](#)".

Consequently, and in line with the NPPF Sequential Test approach for FRAs, new developments should be located in those "areas with the lowest risk of flooding. Development should not be allocated or permitted if there are reasonably available sites appropriate for the proposed development in areas with a lower risk of flooding". In that regard, areas within Flood Zone 1 should be prioritised (over areas at Flood Zones 2 and 3) for new developments.

Additionally, it is important to note that not all types (or classes) of developments are permitted within Flood Zones 2 and 3. Also, the EA does only accept developments within Flood Zone 3 if these are classified as 'water compatible' and result in no net loss of floodplain storage, by providing "like for like" (*i.e.*, level for level and volume for volume) flood storage compensation.

"Level for level and volume for volume compensation is the replacement of volumes lost from the flood plain through development with new flood plain volume by reducing nearby ground levels. The compensatory volume must be at the same level (within reasonable working limits) as the lost storage. In general, level for level compensation should only be applied in areas where flood water is stored; flood flow routes should be protected. There may sometimes be benefits in altering routes or increasing flood flow capacity, however it should only be carried out after careful assessment of the downstream impacts. This assessment must be included in the developer's FRA."¹

Further detailed guidance on new developments within Flood Zones 1, 2 and 3, is provided in the EA's Guidance on ["Flood risk assessment for planning applications"](#).

7.2 Surface Water Flooding

Cumnor Parish suffers from surface water flooding. Therefore, any future developments must consider their impact in terms of runoff generation (increase) and surface water drainage; and must provide the required mitigation measures to ensure no increase in surface water flood risk.

In this regard, the use of Sustainable Drainage Systems (SuDS) is encouraged as these systems have the ability to provide multiple benefits. According to The SuDS Manual², "the SuDS approach involves slowing down and reducing the quantify of surface water runoff from a developed area to manage downstream flood risk, and reducing the risk of that runoff causing pollution. This is achieved by harvesting, infiltrating, slowing, storing, conveying and treating runoff on site and, where possible, on the surface rather than underground."

The choice of SuDS and/or other drainage systems must always be assessed in relation to the wider context (*i.e.*, topography, geology, hydrogeology, neighbouring developments, *etc.*). Infiltration-based SuDS (*e.g.*, soakaways) are usually the preferred (and most beneficial) option for developments that are underlain by permeable geological formations (*e.g.*, Sandstones or Limestones). These systems enhance runoff infiltration and thus minimise off-site runoff discharge.

However, enhancing infiltration in certain areas within Cumnor Parish – *i.e.*, those areas underlain by permeable strata but in close proximity to "contact springs" (see Section 5 and Section 6.3) – could potentially aggravate the risk of flooding in adjacent downstream areas.

Therefore, and in general terms, the following actions are recommended prior to choosing, designing and sizing SuDS and/or other drainage systems:

- Estimating runoff generated within (and/or flowing into) the proposed development;
- Excavating trial pits to gain information regarding soils and geological (superficial and bedrock) layers underlying the site;
- Assessing the ground infiltration capacity by undertaking ground permeability tests (using the excavated trial pits); and
- Understanding the hydrogeological (groundwater) regime within and around the site area.

Ultimately, any future developments must ensure that the additional runoff generated within the site is managed in such a way so that the overall runoff discharge from the site does not increase compared to the pre-development (greenfield or brownfield) site condition. This has to be ensured for all rainfall events up to the 1:100 year design rainfall event, including appropriate climate change allowances (as per the [EA's Thames Area Climate Change Allowances](#)).

The risk posed to new developments from overland flow routes should also be avoided. It is recommended therefore that new developments are not located within areas of identified surface

¹ Flood Storage Compensation Schemes: <http://planningregister.londonlegacy.co.uk/swift/MediaTemp/5887-97579.12.2015.pdf>

² The SuDS Manual (C753): https://www.ciria.org/Resources/Free_publications/SuDS_manual_C753.aspx

water flood risk of 1 in 30 and 1 in 100 year return periods. In addition, new developments should ideally be excluded from areas of 1 in 1000 year return periods unless the risk is fully mitigated.

7.3 Groundwater Flooding

It is also advised that any future planning applications located within the "Zone of Potential Groundwater Flood Risk" undertake a rigorous groundwater assessment to confirm groundwater conditions beneath the development. Where a development excavation is proposed, the assessment should include:

- A minimum of 3 No. groundwater monitoring boreholes within the planning application boundary to confirm groundwater depths and establish groundwater flow directions;
- A minimum of 3 to 6 months of groundwater level monitoring, preferably monitoring annual seasonal groundwater fluctuations during the dry and wet season. Where project lead-in times allow, groundwater monitoring should be repeated over multiple years to confirm seasonal groundwater level fluctuations;
- Groundwater monitoring information can be augmented or replaced by local Environmental Agency groundwater level monitoring information if found to exist;
- Groundwater monitoring information should be used to investigate whether or not maximum groundwater levels will come into contact with the proposed development. If so, dewatering requirements during the construction phase should be evaluated and an impact assessment undertaken on local houses, including identification of any necessary mitigation measures; and
- Furthermore, an assessment of any post-construction groundwater flow truncation and subsequent groundwater rise effects should be evaluated and mitigation measures proposed if necessary to prevent flooding or damage to adjacent properties.

The Cumnor Parish Council may wish to note that the London Borough of Camden Borough Council has introduced a Basement Impact Assessment (BIA) methodology as part of its planning application process. Whilst this considers multiple issues as well as groundwater flooding, it provides a useful framework and potential guidance to developers on how to assess and demonstrate adequate consideration and mitigation of groundwater risks to surrounding properties.

The Camden BIA approach and toolkit can be downloaded from the Basement Flooding section of:

<https://www.camden.gov.uk/ccm/content/environment/planning-and-built-environment/two/planning-policy/local-development-framework/core-strategy/evidence-and-supporting-documents/>

7.4 Areas of Interest

Additional recommendations in relation to future developments in the Areas of Interest are outlined as follows.

7.4.1 *Area of Interest 1: Cumnor Hill & Dean Court*

Groundwater flooding is clearly an issue within this AOI. Therefore, it is recommended that the amount (and extent) of new developments is limited along and/or in close proximity to the geological contact between the Kingston/Hazelbury Bryants Formations and the Oxford Clay Formation, *i.e.*, where 'contact springs' occur.

In terms of surface water flooding, frequent maintenance of the road drainage network and gullies should be ensured, particularly in those developed areas located on steep slopes, where the potential for runoff generation and overland flow is greater.

Furthermore, further efforts should be placed on effectively managing runoff draining into the areas directly east of the A420 embankment. Residents noted extreme surface water flooding episodes (with high flow depths and speeds) have occurred in recent years. It should be noted that the A420 embankment truncates the natural surface runoff pathways draining down from Cumnor Hill – runoff pathways previously flowing to the north-west are now forced to run along the embankment, to the north-east, to eventually cross the A420 *via* a culverted structure. This represents a significant alteration of the hydrological regime; therefore, frequent maintenance of

(and, if required, upgrades to) the existing drainage system are essential to ensure residents' safety in terms of surface water flood risk.

7.4.2 Area of Interest 2: Farmoor

Due to its proximity to the River Thames, the Farmoor Reservoir and Wytham Hill, no further developments are recommended in this AOI, as these could severely impact on the risk of surface water and river flooding, which are clearly interlinked at this location. This is consistent with the current planning restriction for Farmoor, which states no new developments shall take place until 2031.

In relation to the prospective cycle path along the B4404 (Eynsham Road), this should be designed to be able to cope with runoff generated from areas uphill. In this regard, a SuDS-based approach consisting of, *e.g.*, permeable pavements and/or vegetated areas could provide mitigation to surface water flood risk, as well as other environmental and amenity benefits.

7.4.3 Area of Interest 3: Filchampstead

No further developments should be permitted within the Filchampstead area, which is clearly at high risk of river and surface water flooding. The majority of this area sits within Flood Zone 3 and, due to its flat topography, "like for like" flood storage compensation is very difficult to achieve. On that basis, the EA is likely to object to any new development within this area.

7.4.4 Area of Interest 4: Catchment area draining to Wootton

This AOI is currently undeveloped but, according to Cumnor Parish residents, various stakeholders have expressed their intentions of developing infrastructure (*e.g.* park and ride and/or housing developments). Such developments would inevitably and very significantly increase impermeable footprint of (and, in turn, also runoff generation within) this area. Consequently, the risk of surface water flooding to the adjacent downstream areas in Wootton can be affected by such developments. Careful design of run-off attenuation structures will be required in this area.

8. CONCLUSIONS

Publicly available topographic, geological, hydrogeological and flood risk data, combined with field observations, have been used to assess the risk of flooding from different sources within Cumnor Parish, with specific attention paid to the 4 No. Areas of Interest.

Where available, high-resolution topographic data (*i.e.* LiDAR) has been used to inform the analysis. However, LiDAR data is not available for the entire Parish. In those areas where LiDAR data is not available, coarser-resolution satellite-derived topographic data (*i.e.* SRTM) has been used instead.

Some (low-lying) areas of Cumnor Parish (*e.g.*, Farmoor and Filchampstead) sit within Flood Zones 2 and 3 (see Drawing No. CUMFRA1812-6), thus are at medium to very high risk of fluvial (river) flooding. Future developments should avoid, as much as reasonably practicable, Flood Zones 2 and 3. In this regard, any new developments proposed within Flood Zones 2 and 3 should be able to justify the need for such a location, demonstrating no alternative (suitable) locations exist within Flood Zone 1 (*i.e.*, following the Sequential Test approach), and ensure these will result in no increase of fluvial flood risk elsewhere.

Various areas within Cumnor Parish (*e.g.*, Cumnor Hill & Dean Court, Farmoor, Filchampstead and Wootton catchment area) are also at risk of surface water flooding (see Drawing No. CUMFRA1812-7). For that reason, it is recommended that future planning applications consider the use of SuDS, and take a holistic approach to surface water management. To do so, and as part of the FRA, a set of recommended actions – to be undertaken prior to choosing, designing and sizing the proposed SuDS or drainage systems – has been provided.

In terms of groundwater flooding, information suggests that the areas along and up gradient of the geological contact between the Oxford Clay Formation and Kingston Formation (*e.g.*, Cumnor Hill & Dean Court) are most prone to groundwater flooding as a result of groundwater egress along "contact springs".

Geological and topographic modelling techniques have been used to estimate the extent of a groundwater flood risk zone within Cumnor Parish. It should be noted this zone has been estimated without the availability of groundwater level data. The zone definition should therefore be

periodically reviewed, based upon available groundwater level monitoring data from future planning applications.

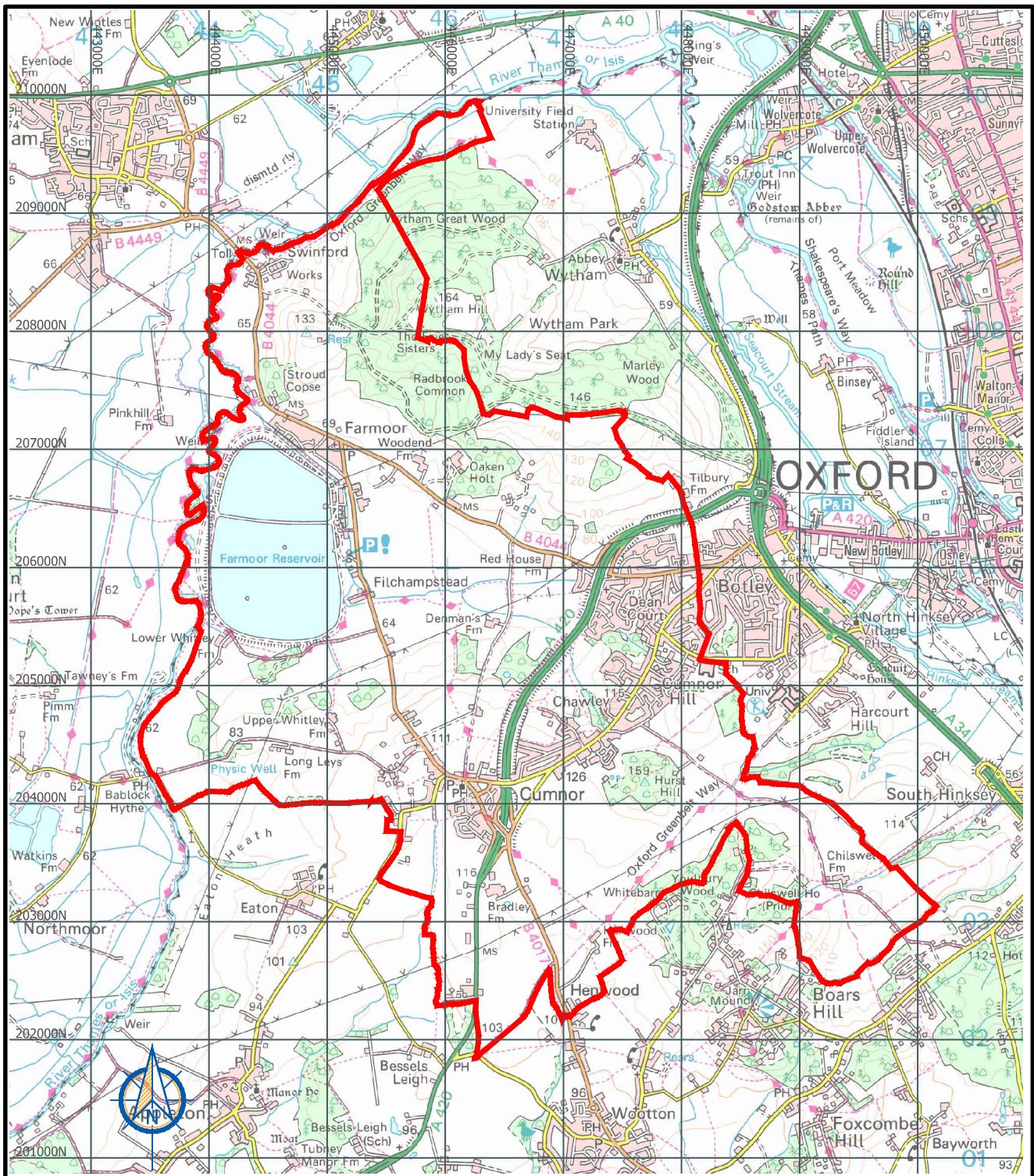
For an accurate assessment of groundwater flooding potential in those areas not covered by high-resolution topographic data (*i.e.* LiDAR), additional surveying input is required. In this regard, the procurement of traditional GPS topographic surveying along (and around) the geological contact of interest (see Drawing No. CUMFRA1812-8) may be the most appropriate (and cost effective) option.

It is advised that any future planning applications located within these zones should undertake a rigorous groundwater assessment to confirm groundwater conditions beneath the development. Guidance for investigating and mitigating basement groundwater impacts has been published by the London Borough of Camden Council and may be of value to local regulators and developers.

GWP CONSULTANTS
FEBRUARY 2019

Table 1 – Risk of flooding from different sources at the Areas of Interest (AOI).

| Area of Interest | Source of flood risk | | |
|----------------------------------|-----------------------------|----------------------|--------------------|
| | Fluvial | Surface water | Groundwater |
| Cumnor Hill & Dean Court (AOI 1) | NONE | HIGH | HIGH |
| Farmoor (AOI 2) | LOW | HIGH | VERY LOW |
| Filchampstead (AOI 3) | HIGH | HIGH | VERY LOW |
| Wootton Catchment Area (AOI 4) | NONE | MEDIUM | LOW |



LEGEND



Cumnor Parish Boundary

| Version | Revision and compilation notes | Date |
|---------|--------------------------------|------------|
| A | Issued | 04.12.2018 |
| B | Issued with report v.02 | 22.02.2019 |

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Client

Cumnor Parish Council

Project

Cumnor Parish FRA

Site location

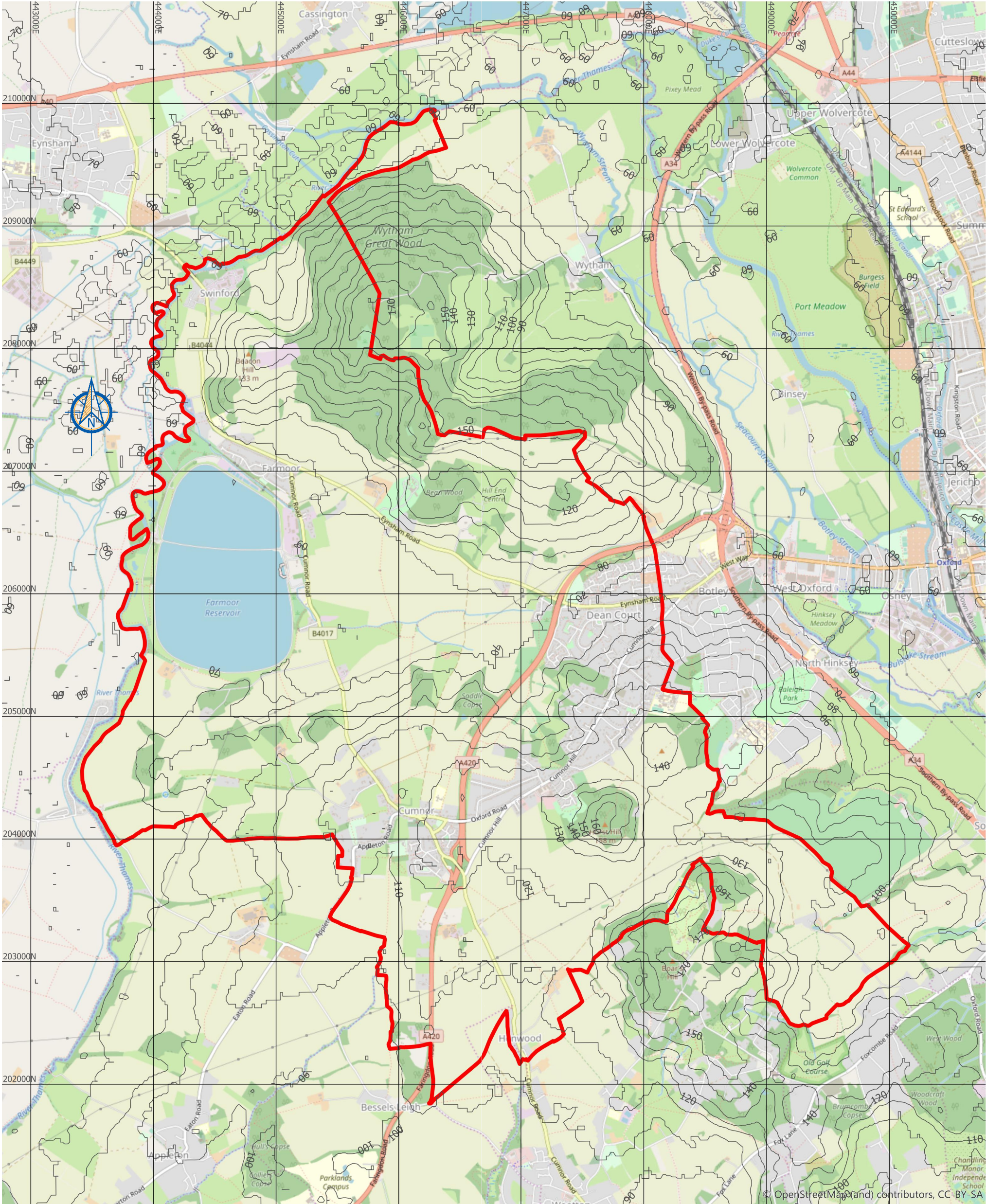
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|---------------------------|------------------|---------------|-------------------------|
| Date 22.02.2019 | Drawn MGM/EMB | Checked CC | Scale 1:50,000 at A4 |
| Drawing Ref CUMFRA1812 | Drawing No 1 | Version B | |





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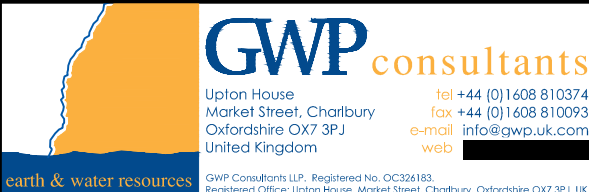
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 tel +44 (0)1608 810374
 fax +44 (0)1608 810093
 e-mail info@gwp.uk.com
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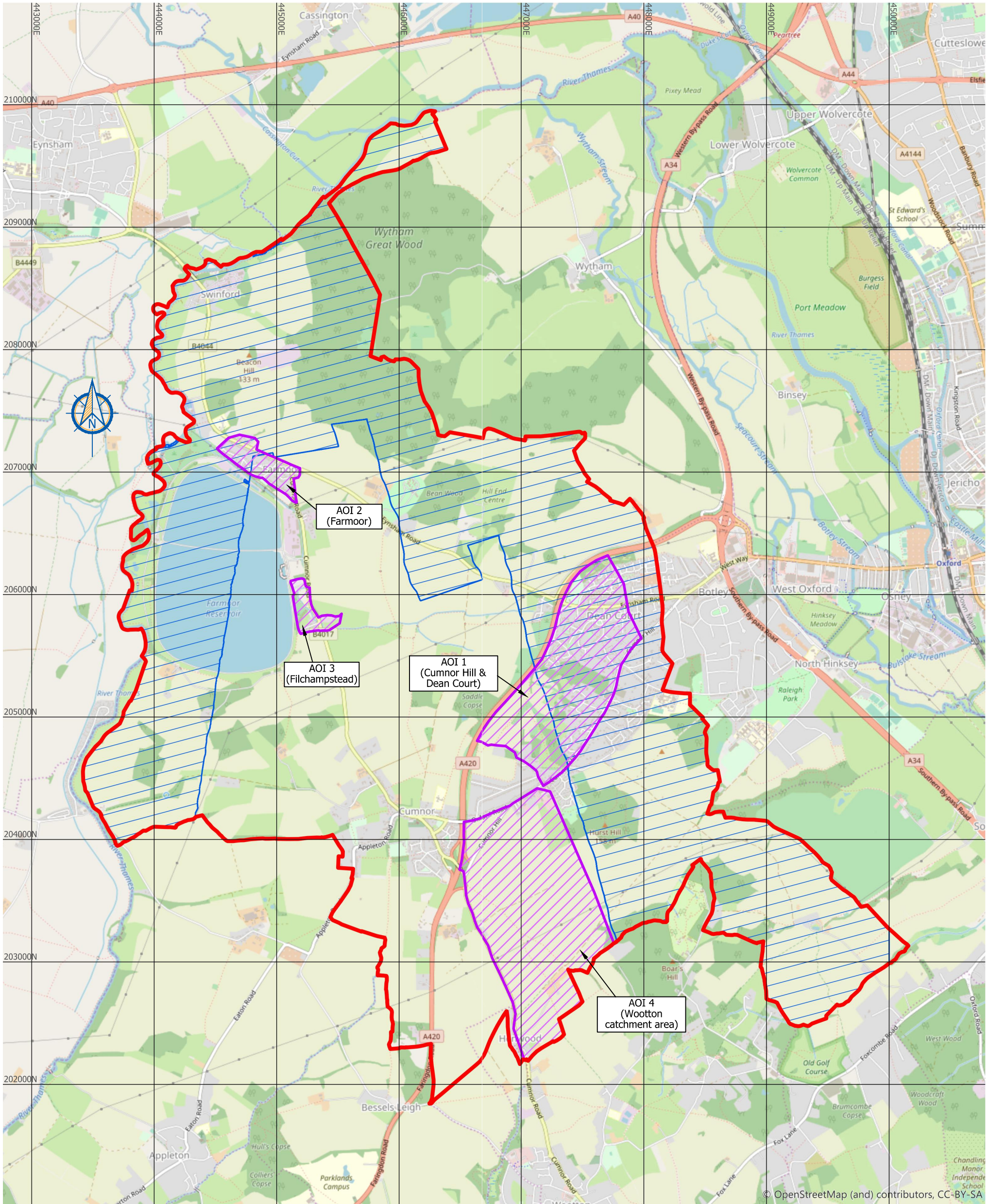
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LEGEND


-  Cumnor Parish Boundary
-  Ground surface contour (derived from SRTM elevation data)

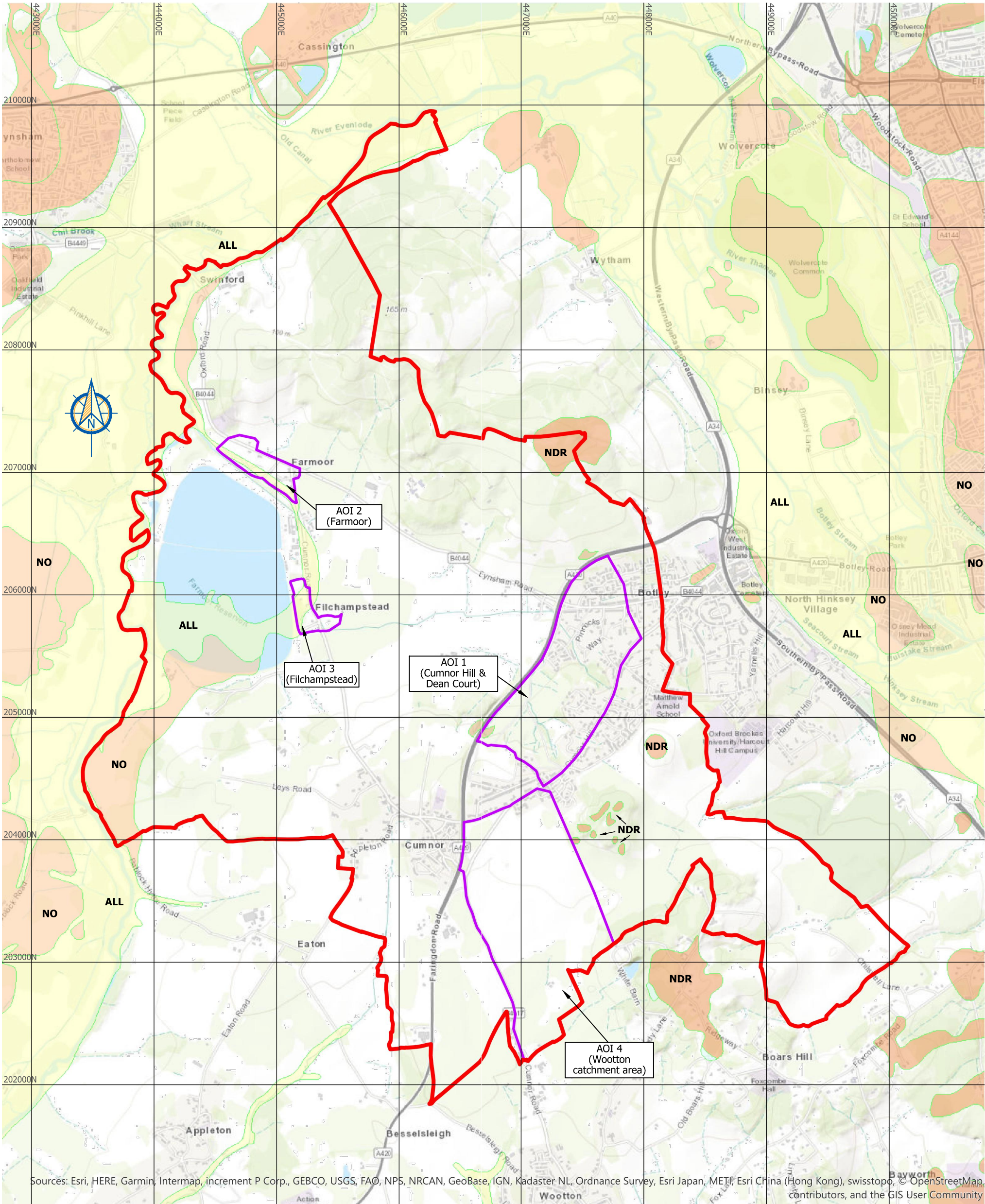
| Version | Revision and compilation notes | Date | Client |
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| A | Issued | 04.12.2018 | Cumnor Parish Council |
| B | Issued with report v.02 | 22.02.2019 | Cumnor Parish FRA |
|  | | Topographic setting | |
| Date | 22.02.2019 | Drawn | MGM/EMB |
| Checked | CC | Scale | 1:30,000 at A3 |
| Drawing Ref | CUMFRA1812 | Drawing No | 2 |
| Version | B | | |



LEGEND

-  Cumnor Parish Boundary
-  Areas of Interest (AOI)
-  Extent of LiDAR coverage within Cumnor Parish

| Version | Revision and compilation notes | Date | Client |
|--|--------------------------------|------------|--------------------------------------|
| A | Issued | 04.12.2018 | Cumnor Parish Council |
| B | Issued with report v.02 | 22.02.2019 | Cumnor Parish FRA |
|  Upton House Market Street, Charlbury Oxfordshire OX7 3PJ United Kingdom tel +44 (0)1608 810374 fax +44 (0)1608 810093 e-mail info@gwp.uk.com web earth & water resources | | | Areas of Interest and LiDAR coverage |
| Date | 22.02.2019 | Drawn | MGM/EMB |
| Checked | CC | Scale | 1:30,000 at A3 |
| Drawing Ref | CUMFRA1812 | Drawing No | 3 |
| Version | B | | |




Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

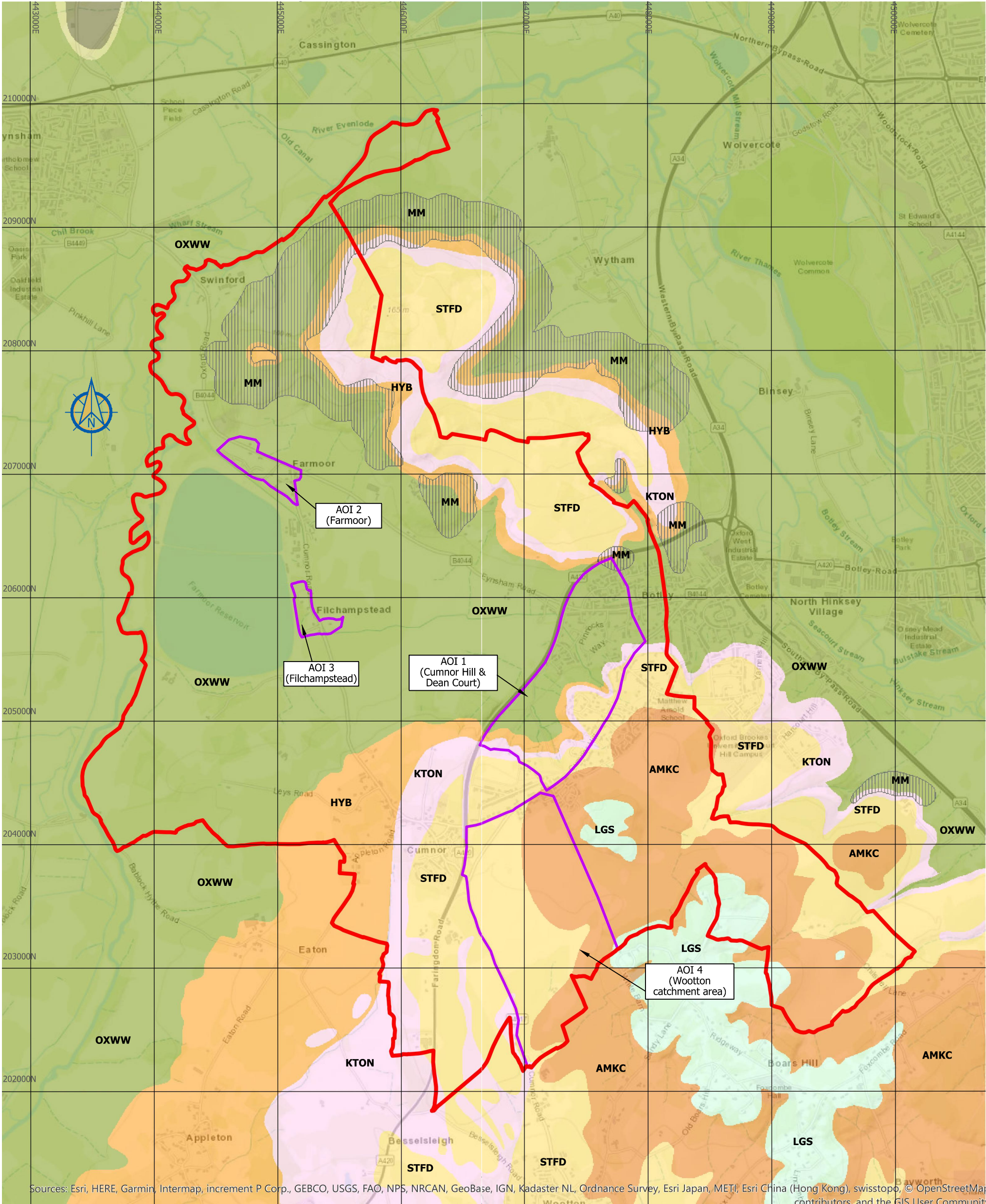
LEGEND



SUPERFICIAL DEPOSITS


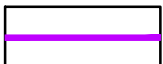
ALL Alluvium
NDR Northern Drift Formation
NO Northmoor Sand and Gravel Member

| Version | Revision and compilation notes | Date | Client |
|--|--------------------------------|---------------|-----------------------|
| A | Issued | 04.12.2018 | Cumnor Parish Council |
| B | Issued with report v.02 | 22.02.2019 | Cumnor Parish FRA |
|  Upton House Market Street, Charlbury Oxfordshire OX7 3PJ United Kingdom tel +44 (0)1608 810374 fax +44 (0)1608 810093 e-mail info@gwp.uk.com web www.gwp.uk.com GWP Consultants LLP. Registered No. OC326183. Registered Office: Upton House, Market Street, Charlbury, Oxfordshire OX7 3PJ, UK | | | Superficial geology |
| Date 22.02.2019 | | Drawn MGM/EMB | Checked CC |
| Drawing Ref CUMFRA1812 | | Drawing No 4A | Version B |
| Scale 1:30,000 at A3 | | | |



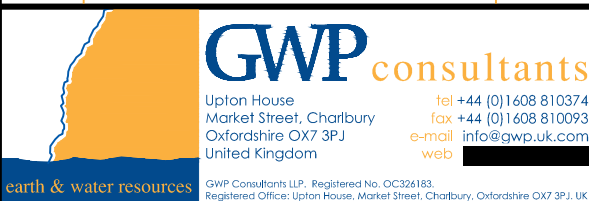
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LEGEND

-  Cumnor Parish Boundary  Areas of Interest (AOI)

- BEDROCK**
MM Mass Movement
LGS Lower Greensand Formation
AMKC Amphill Clay Formation and Kimmeridge Formation
STFD Stanford Formation
KTON Kingston Formation
HYB Hazelbury Bryan Formation
OXWW Oxford Clay Formation and West Walton Formation

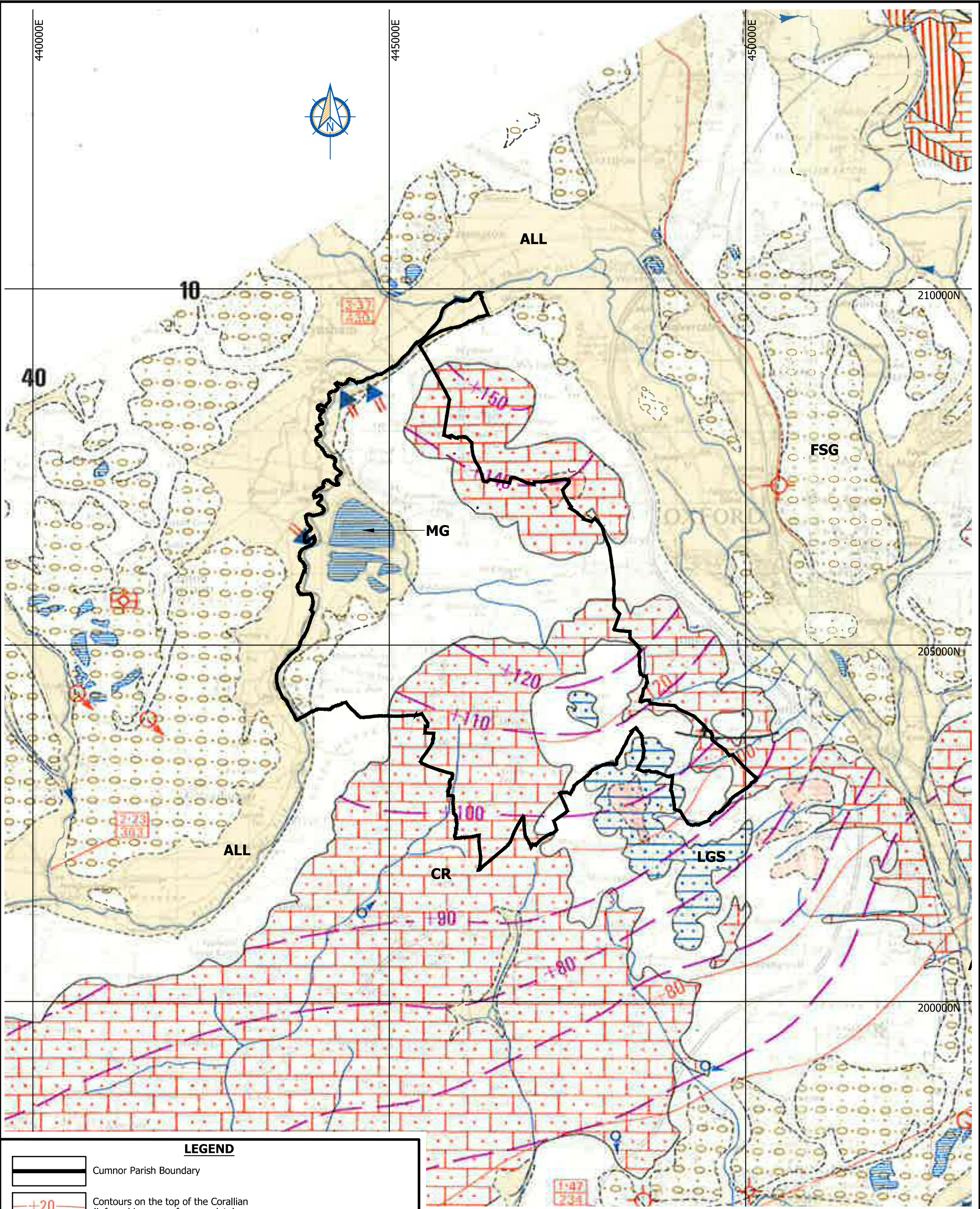
| Version | Revision and compilation notes | Date | Client |
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| 22.02.2019 | MGM/EMB | CC | 1:30,000 at A3 |
| Drawing Ref | Drawing No | Version | |
| CUMFRA1812 | 4B | B | |



LEGEND

Cumnor Parish Boundary

Contours on the top of the Corallian (inferred in areas of sparse data)

Contours on the minimum potentiometric surface of the Corallian in metres relative to Ordnance Datum (inferred in areas of sparse data)

Geological Abbreviations

MG Made or worked ground
ALL Alluvium
FSG Fluvial sands and gravels
LGS Lower Greensand
CR Corallian

Based on 1:100,000 Hydrogeological Map by permission of the British Geological Survey © NERC. All rights reserved
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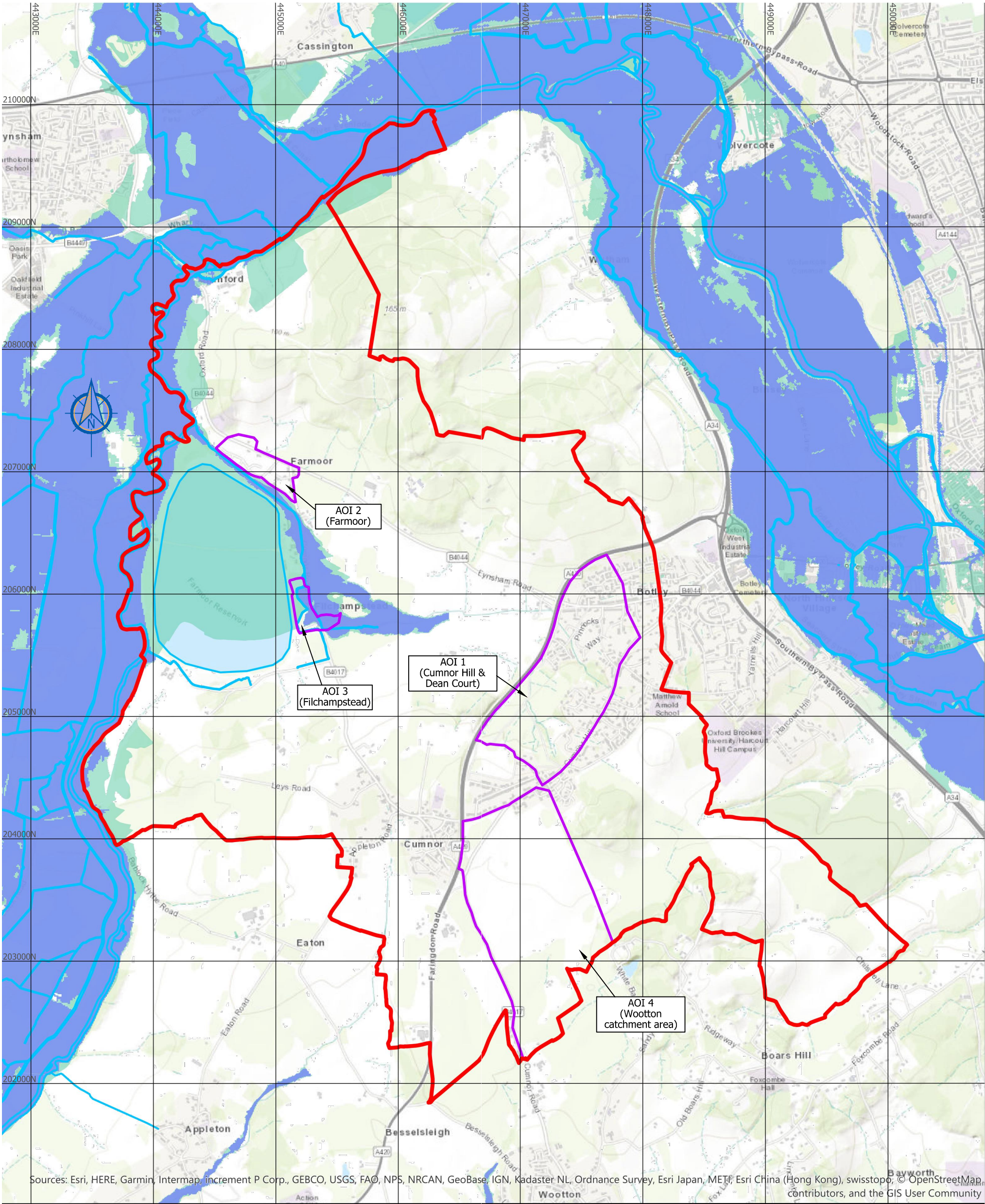
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|---------|--------------------------------|------------|-----------------------|
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| | | | |
|-------------------------|------------|---------|----------------|
| Hydrogeological setting | | | |
| Date | Drawn | Checked | Scale |
| 22.02.2019 | MGM/EMB | CC | 1:50,000 at A3 |
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LEGEND

- | | | | |
|--|------------------------|--|-------------------------|
| | Cumnor Parish Boundary | | Areas of Interest (AOI) |
| | Flood defences | | EA Flood Zone 3 |
| | | | EA Flood Zone 2 |

| Version | Revision and compilation notes | Date | Client |
|---------|--------------------------------|------------|-----------------------|
| A | Issued | 04.12.2018 | Cumnor Parish Council |
| B | Issued with report v.02 | 22.02.2019 | Cumnor Parish FRA |

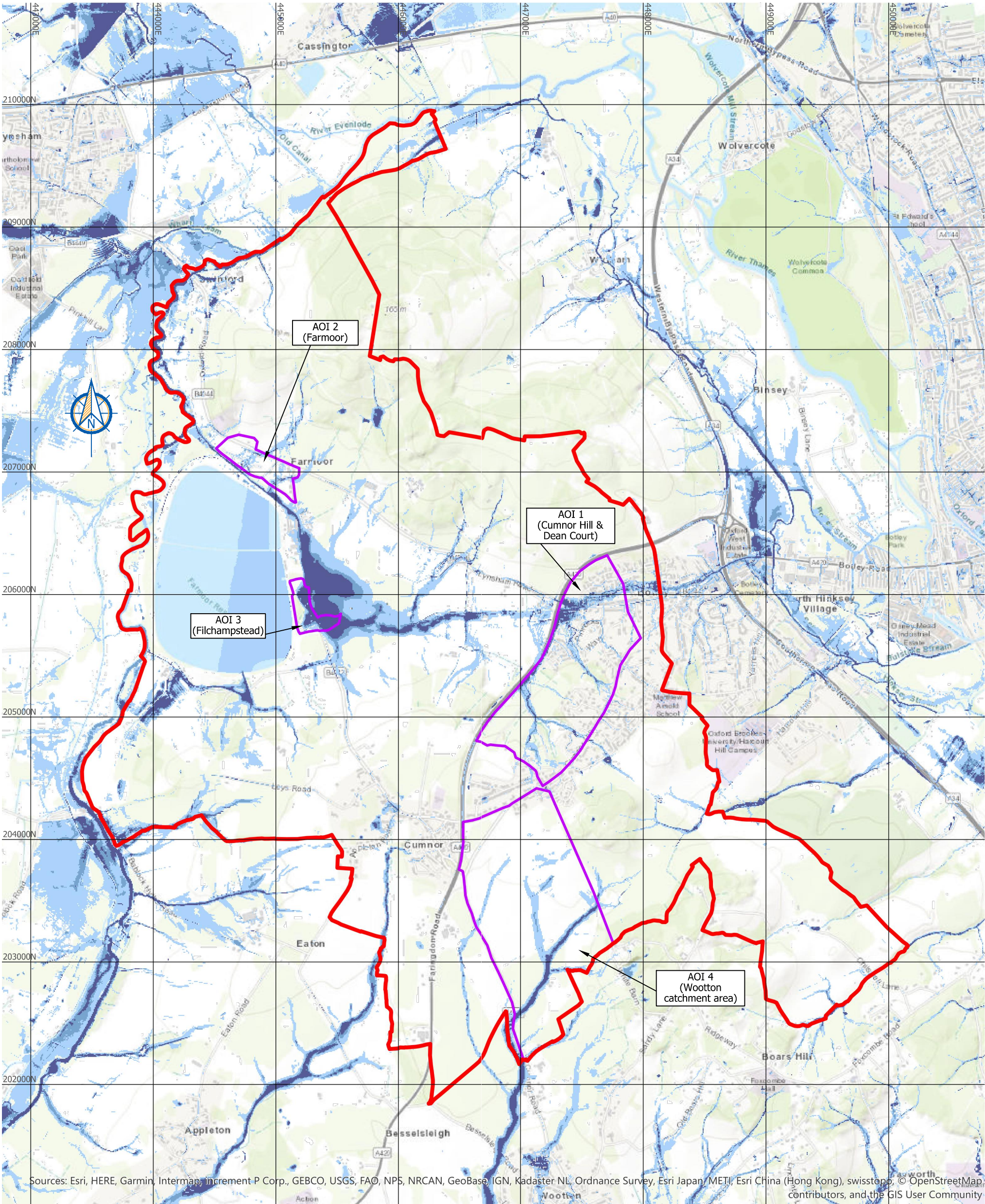
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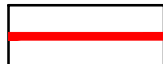



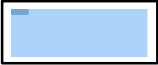
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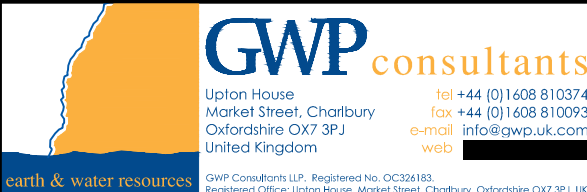
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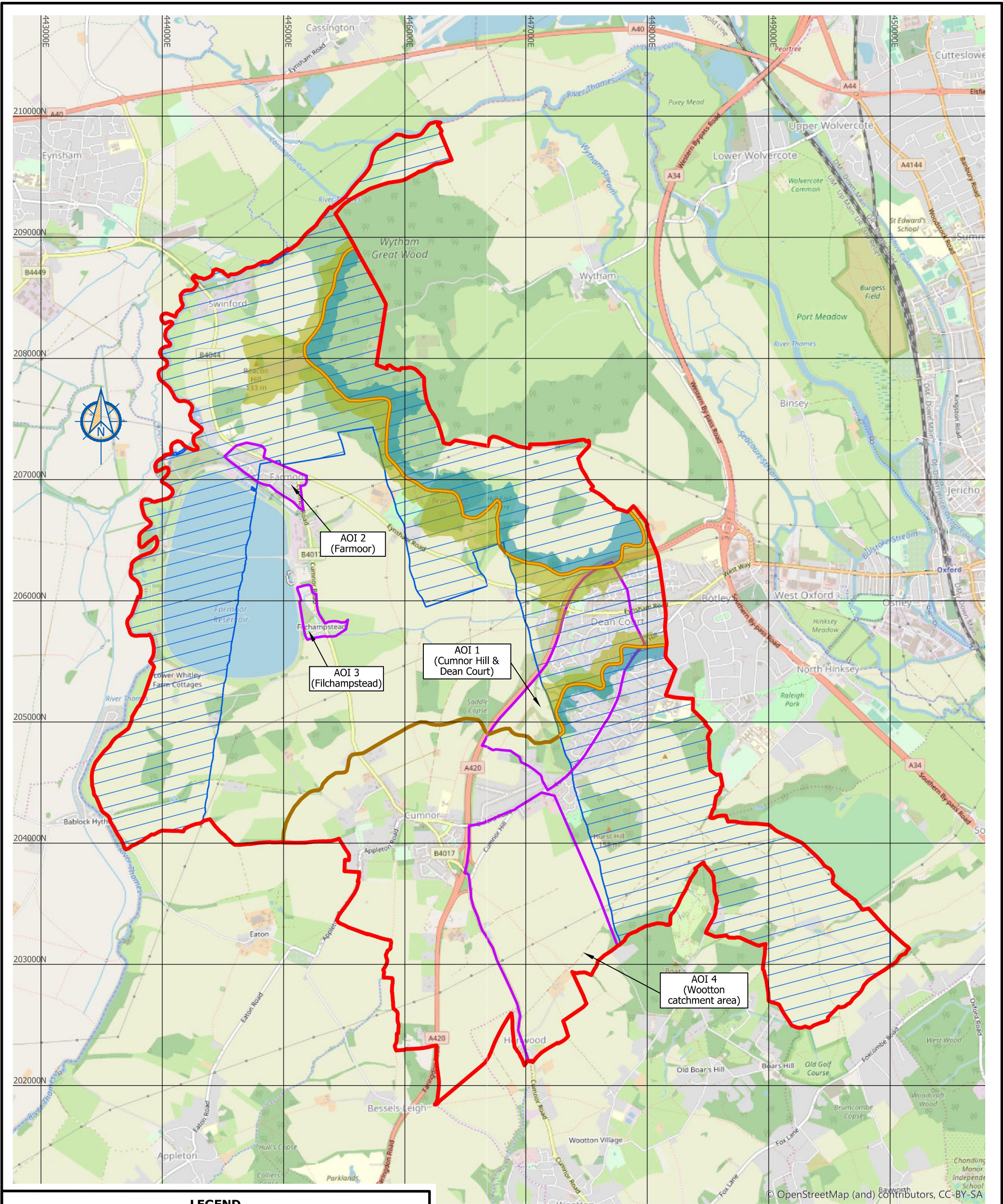
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| 22.02.2019 | MGM/EMB | CC | 1:30,000 at A3 |
| Drawing Ref | Drawing No | Version | |
| CUMFRA1812 | 6 | B | |



LEGEND

-  Cumnor Parish Boundary
-  1 in 30 year flood extent
-  Areas of Interest (AOI)
-  1 in 100 year flood extent
-  1 in 1000 year flood extent

| Version | Revision and compilation notes | Date | Client |
|--|--------------------------------|------------------|--------------------------------------|
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| B | Issued with report v.02 | 22.02.2019 | Cumnor Parish FRA |
|  Upton House Market Street, Charlbury Oxfordshire OX7 3PJ United Kingdom Tel +44 (0)1608 810374 Fax +44 (0)1608 810093 e-mail info@gwp.uk.com web earth & water resources | | | EA zones of surface water flood risk |
| Date 22.02.2019 | | Drawn MGM/EMB | Checked CC |
| Drawing Ref CUMFRA1812 | | Drawing No 7 | Scale 1:30,000 at A3 |
| | | | Version B |



LEGEND

| | | | |
|--|--|--|---|
| | Cumnor Parish Boundary | | Areas of Interest (AOI) |
| | Extent of LiDAR coverage within Cumnor Parish | | Zone of potential groundwater flooding |
| | Geological contact between Kingston & Oxford Clay Formations and groundwater seepage contact | | Groundwater bearing strata 10m above Oxford Clay Formation |
| | Extent of Geological contact converted by LiDAR data | | Oxford Clay geological contact - zone of uncertainty (10m vertical) |

| Version | Revision and compilation notes | Date | Client |
|-------------|--------------------------------|------------|--|
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| B | Issued with report v.02 | 22.02.2019 | Cumnor Parish FRA |
| | | | Zone of potential groundwater flooding |
| Date | 22.02.2019 | Drawn | MGM/EMB |
| Checked | CC | Scale | 1:30,000 at A3 |
| Drawing Ref | CUMFRA1812 | Drawing No | 8 |
| Version | B | | |