TOWN AND COUNTRY PLANNING ACT 1990
SECTION 78 APPEAL

APPEAL BY GREAT LAKES UK LTD
REF: APP/C3105/W/20/3259189

CHESTERTON, BICESTER
OXFORDSHIRE OX26 1TE

VOLUME 2
APPENDICES TO THE PROOF OF EVIDENCE

OF

RICHARD BETTRIDGE
BSc (Hons) BA CEng CEnv MICE FCIHT MCIWEM

(DRAINAGE & FLOODING)

For

Great Lakes UK Limited

motion

Appendix A

CV and Experience

Richard George Bettridge – Bona Fides

1.1 I am a Chartered Engineer and a Chartered Environmentalist and since 1984 have been a member of the Institution of Civil Engineers. In 1982 I became a Member of the Chartered Institution of Highways and Transportation and was made a Fellow in 1994. I became a Member of the Institution of Public Health Engineers in 1983 and I am now a member of the Chartered Institution of Water and Environmental Management. I became a Member of the Society for the Environment in 2005. I hold an Upper 2nd Class Honours degree in Civil Engineering and a Bachelor of Arts degree in Humanities.

1.2 For 12 years I was Managing Director of the firm Bettridge Turner & Partners, Consulting Engineers and Transportation Planners, until the company was acquired by Hyder Consulting in 2006. I left Hyder Consulting in July 2009 to set up my own practice, Richard Bettridge and Partners, where much of my workload related to Flood Risk Assessments and Drainage work. I have acted as Engineer on numerous Infrastructure contracts ranging in value from £0.5m to £8m over the last 30 years. I have a particular interest in flood defence, drainage and sewer design and construction as well as flood studies and channel and watercourse analysis. I have designed large scale foul and surface water drainage schemes serving developments all over England.

1.3 I have assisted in the feasibility of large projects in the Avonmouth/Severnside area north of Bristol where I have developed the surface water drainage strategy for an area of over 1500ha. Over the last decade I have managed computer model studies for landowners in the Avonmouth/Severnside areas which have comprised the assessment of drainage network improvements to accommodate development. I have designed and administered contracts for roads, foul and surface water sewerage and flood management works all over the UK, including significant projects in Aylesbury, Macclesfield, Bristol, and Gloucestershire and for power stations in Bristol and Nottingham.

1.4 During the last 15 years I have acted as an expert in disputes dealt with in the courts, by Arbitration and at Planning Appeals. I have given evidence concerning the provision of off-site foul drainage infrastructure at Milton Keynes, on surface water drainage at the Runfold Bypass inquiry and produced numerous technical reports for a range of purposes including a case of flooding in Wandsworth, to support a claim against a statutory undertaker in Bromley and Croydon and to act for a major statutory undertaker in a construction engineering dispute.

1.5 I have also acted for developers at a Call In Inquiry in Maidenhead where I gave evidence on Flood Risk issues. Over the last ten years I have been responsible for the production of numerous Flood Risk Assessments under PPG25 and PPS25 to accompany planning applications for new developments. Over the last 3 years I have appeared as an Expert Witness during a drainage and flooding case heard in The County Court Maidstone, and produced expert reports for a case of flooding in Leeds and for a claim relating to a Flood Risk Assessment produced for a site in Market Harborough. I have acted as expert witness in a case heard in the High Court, Queens Bench Division in Birmingham which related to flooding of property at Weoley Castle and I have produced many reports under instructions from solicitors acting for Thames Water Utilities relating to allegations of sewer flooding.

1.6 I managed my new company, Richard Bettridge and Partners, for just over a year, where I was responsible for giving Drainage advice and assisting in the production of Flood Risk Assessments and Drainage Strategies in line with PPS25. I was appointed as Director of Infrastructure Services at Motion Consultants, Guildford in July 2010.

1.7 Between 1996 and 2001 I acted as Chairman of the Civil Engineering Advisory Committee at Kingston University, a committee set up to provide an external industrial balance to the teaching at Kingston University as well as to assist in teaching and research quality.

1.8 I am currently appointed through Motion, on a consultancy basis to the position of Consultant Engineer to the Lower Severn Drainage Board, a large internal drainage board which covers an area of Avonmouth/Severnside, much of which is the subject of development pressure. I have recently produced expert reports for cases involving flooding in Chainhurst, Kent and a dispute over prescriptive rights at Heathfield, also in Kent. I have also produced reports for cases of disputes relating to basement flooding in Richmond and in Kings Cross as well as acted as a Single Joint Expert in an engineering dispute between a piling contractor and his surveyor.

1.9 I have acted for Mole Valley District Council as an expert witness on drainage and flooding matters in a Planning Inquiry held in relation to residential development proposals. The inspector held that the Council were correct in refusing the application due partly to the inadequacy of the drainage proposals.

1.10 I acted as expert witness for Thames Water in a case of sewer flooding heard in the High Court of Justice, Queen's Bench Division in London in 2015. The case was brought by a resident who had alleged that they had suffered ill health due to foul sewer flooding. The action was successfully defended.

1.11 I have acted for Scottish Water in a cases of foul sewer flooding in Dollar, Clackmannanshire in 2018 and once again in relation to foul sewer flooding in Perth in 2019.

1.12 I acted as drainage and flooding expert in 2020 in the case of Patel -v- LB Barnet. The case was heard in the High Court of Justice – Business and Property Court and was the first to be held remotely due to the coronavirus pandemic. The case was settled by the parties after 5 days.

1.13 In 2020 I have also produced expert witness proofs for claimants in (i) a case of sewer flooding in Hastings and (ii) a case of a dispute involving the culverting of a boundary stream in Heathfield, East Sussex.

1.14 I have been involved all my working life in civil engineering design and operational aspects of public health engineering, including the design and construction of new sewerage schemes associated with development and the procurement of adoption (enabling new works to be taken over as maintainable at the public expense) agreements for new drainage schemes. As such I have interacted with Water Authorities and subsequently with Water Utility companies in matters relating to policies, regulation and legal framework relating to drainage and flooding in the UK.

Richard Bettridge BSc (Hons) BA CEng CEnv MICE FCIHT MCIWEM

Appendix B

Discussions with Lead Local Flood Authority

Application no: 19/02550/F
Location: Land to the east of M40 and south of A4095, Chesterton, Bicester

Lead Local Flood Authority

Recommendation:

Objection

Key issues:

Further information and clarification of points listed below required.

Detailed comments:

Discharge noted to be to Gagle Brook ordinary watercourse. Riparian ownership and consent to discharge to be justified. Ditch condition and capacity to take additional flows to be demonstrated.

Borehole/BRE to determine level of ground water to be provided.

Section 4.2.2. states that there will be an "increase in peak discharge from that of a greenfield site." This should occur and robust justification as to why this is deemed the case to be provided.

Section 5.2.2. identifies the use of Qbar methodology. For a site this size FEH should be used, (Qmed).
MicroDrainage calculations provided use default Cv values, these are not representative of the site. It is recommended values of 0.95 for roofs and 0.9 for paved areas are applied. The designer must justify where a Cv of less than 0.9 has been used.
Calculations should be undertaken for all relevant return periods and identify the critical duration used.

A sub-catchment approach should be applied to surface water management, with clearly defined flow controls, on site utilising a method of dispersed site storage.

Ground water depth to bottom of proposed tanking/attenuation requires justification as does the need for buried attenuation when it appears there is ample space to use on the surface SuDS and surface water management techniques.

Flow control from site should ensure greenfield discharge for relevant return periods, i.e. 1:10, 1:30, 1:100 and 1:100 + 40% climate change. It is doubtful the current proposed attenuation approach will maximise the attenuation and simply allow free discharge up to the 1:100 + 40%.

Section 5.1 notes proposal to divert two ditch lines. This should not be undertaken. It is also unclear what is meant by the two ditch lines being incorporated into the car park. It is noted that the proposed diversion had been previously agreed, evidence of this needs to be provided.

In conjunction the diversion of the two ditch lines is noted to have a potential impact on existing pond levels. Pond levels should remain unaffected to protect and promote bio-diversity.

With the amount of green space on site it is felt the use of on the surface SuDS features has not been maximised. Additional techniques should be explored, e.g. bio-retention, rain gardens etc.

Surface water storage locations, extents and critical levels including freeboard require further explanation.

Although we acknowledge it will be hard to determine all the detail of source control attenuation and conveyance features at concept stage, by Outline Design Stage we will expect the Surface Water Management Strategy to set parameters for each parcel/phase to ensure these are included when these parcels/phases come forward. Space must be made for shallow conveyance features throughout the site and by also retaining existing drainage features and flood flow routes, this will ensure that the existing drainage regime is maintained, and flood risk can be managed appropriately.

By the end of the Outline Design Stage evaluation and initial design/investigations Flows and Volumes should be known. Therefore, we ask that the following Pro-Forma is completed and returned as soon as possible:

OCC Pro-Forma.pdf

Officer's Name: Adam Littler
Officer's Title: Drainage Engineer
Date: 08 January 2020

40 Compton Street
London
EC1V 0BD

t: 020 7324 2240
e: london@curtins.com
w: www.curtins.com

Our Ref: 068535_CUR_CO_D_0001

18th February 2020

Dear Adam Littler

Great Wolf Lodge – LLFA Objection Response

Following your recent comments on the supporting documents of application 19/02550/F, relating to flood management and drainage, please see the below responses.

Comment:
Discharge noted to be to Gagle Brook ordinary watercourse. Riparian ownership and consent to discharge to be justified. Ditch condition and capacity to take additional flows to be demonstrated.

Response:
Discharge via ditched to Wendlebury Brook. Discharge to be in third party land to the south of the proposed site. Written permission to be demonstrated by the owner of Bicester Golf Resort and Spa. The existing back nine holes of the golf course are drained using a network of land drains, to the proposed outfall. As the proposed peak site discharge is to be at QBAR, the ditch should see no increase in peak discharge from the site.

Comment
Borehole/BRE to determine level of ground water to be provided.

Response
No intrusive surveys are able to be conducted due to the golf course remaining live until planning is granted. Unmanned Aerial Vehicle surveys of the site have demonstrated the groundwater levels. These will be confirmed post planning.

Comment
Section 4.2.2. states that there will be an "increase in peak discharge from that of a greenfield site." This should occur and robust justification as to why this is deemed the case to be provided.

Response
The comment included in Section 4.2.2 of the Flood Risk Assessment is reflective of the fact that the existing site includes artificial drainage in the form of perforated land drains and ditches. As these are artificial, they will affect the flow profile to differ from that of an undeveloped site. It is not a comment on the proposed development. The proposed development will not discharge at a rate higher than QBAR.

Comment
Section 5.2.2. identifies the use of Qbar methodology. For a site this size FEH should be used, (Qmed).

Response

The use of QBAR for the site discharge rate was confirmed by Richard Bennett from the LLFA via email on 22nd July 2019. The email is appended to this response as evidence.

Comment
MicroDrainage calculations provided use default Cv values, these are not representative of the site. It is recommended values of 0.95 for roofs and 0.9 for paved areas are applied. The designer must justify where a Cv of less than 0.9 has been used.

Response:
The results of the MicroDrainage model along with the Drainage Strategy was issued to the LLFA on the 25th September 2019 ahead of Pre-App #6 which took place on 7th October 2019 and a subsequent follow up meeting with the LLFA on 23rd October 2019. The parameters of the design were presented at these meeting. No objection or guidance was given by the LLFA with regard to the required volumetric run-off coefficient. The used values have been proved in the SuDS Pro-Forma

Comment
Calculations should be undertaken for all relevant return periods and identify the critical duration used.

Response
Updated MicroDrainage results have been appended to this correspondence showing the critical storm by return periods.

Comment
A sub-catchment approach should be applied to surface water management, with clearly defined flow controls, on site utilising a method of dispersed site storage.

Response
Orifice plates have been used extensively across the proposed surface water network to ensure that excess flows are attenuated in SuDS features higher up the SuDS hierarchy. Attenuation has been provided across the site, controlled close to the source using vortex flow controls and orifice plates. Please expand on this comment. The large below ground attenuation tank is driven by the requirement of volume for the proposed rainwater harvesting system designed by the MEP Engineer.

Comment
Ground water depth to bottom of proposed tanking/attenuation requires justification as does the need for buried attenuation when it appears there is ample space to use on the surface SuDS and surface water management techniques.

Response
As stated in the Drainage Strategy report, the proposed development is to use an innovative system where below ground storage systems are to function as rainwater harvesting tanks. This system, proposed by the MEP Engineer, designed by a third-party designer and facilitated by the Civil Engineer, holds rainfall for reuse whilst using up to date rainfall information from the MET office to ensure that the system can accommodate

imminent future rainfall. This offers a significant reduction in the water demand of the building. The tank is therefore deemed as necessary, this was discussed in a meeting with the LLFA on 23rd October.
The groundwater levels are anticipated to be higher than the bottom of the tank, to ensure that there is no floatation risk the tank is proposed to be anchored. This and the previous stated use as a rainwater harvesting tank are the main drivers for its design.

Comment
Flow control from site should ensure greenfield discharge for relevant return periods, i.e. 1:10, 1:30, 1:100 and 1:100 + 40% climate change. It is doubtful the current proposed attenuation approach will maximise the attenuation and simply allow free discharge up to the 1:100 + 40%.

Response
Updated results appended to this response showing attenuation levels and discharge rates for all return periods. To give a summary, the volume of water in the tank after each return period, and therefore the volume available for use by the water harvesting system is summarised below

1 year = 430m^3 (20% climate change allowance)
2 year = 600m^3 (20% climate change allowance)
10 year = 1050m^3 (20% climate change allowance)
30 year = 1528m^3 (20% climate change allowance)
100 year = 1870m^3 (20% climate change allowance)
100 year = 2000m^3 (40% climate change allowance)

Comment
Section 5.1 notes proposal to divert two ditch lines. This should not be undertaken. It is also unclear what is meant by the two ditch lines being incorporated into the car park. It is noted that the proposed diversion had been previously agreed, evidence of this needs to be provided.

Response
The requirement for these ditches and their location were discussed at length and agreed in a meeting with Richard Bennett (LLFA) and Clare Whitehead (CDC) on 23rd October 2019. In response to comments raised by the LLFA regarding the abandonment of two ditches on site, a technical note was issued stating the use and historic use and raising the case for their abandonment (included as an appendix to the Drainage Strategy). It was subsequently agreed after extensive discussions that the LLFA would accept their abandonment if one, ideally two, surface ditches running form north to south could be accommodated in the car park. The was subject to a last minute change from the design team to ensure the LLFA's requests were incorporated.

Comment
In conjunction the diversion of the two ditch lines is noted to have a potential impact on existing pond levels. Pond levels should remain unaffected to protect and promote bio-diversity.

Response

Levels in the existing ponds to remain in the north are to be protected. The existing ditch network across the site is the driver for the groundwater levels. The proposed, diverted ditches, are to be designed to maintain these levels. Following the planning stage, groundwater monitoring will be conducted across the site to better understand how the groundwater levels react to rainfall and how they are recharged. This will allow a geotechnical engineer to input into the design to ensure the surface water strategy maintains the pond levels.

Comment

With the amount of green space on site it is felt the use of on the surface SuDS features has not been maximised. Additional techniques should be explored, e.g. bio-retention, rain gardens etc.

Response

Where SuDS have been specified, they specifically relate to the attenuation or conveyance of surface water. The collection system is to be proposed when a full external levels strategy is designed at a later design stage. It is the view of the designer that the use of SuDS are preferential to traditional collection system and where possible, tree pits, bio-retention systems, swales and filter drains will be used over linear channels and gullies.

Comment

Surface water storage locations, extents and critical levels including freeboard require further explanation.

Response

A summary note of the maximum water level in the surface water attenuation features will be provided. The location of the below ground tank is driven by the outfall location and it's size by MEP requirements for rainwater harvesting and storage volume to remove flood risk due to site topography. Further attenuation features and volume are driven by availability of space and topography of site. As the site slopes from north to south, the majority of storage is required in the south, where space is at a premium.

Comment

Although we acknowledge it will be hard to determine all the detail of source control attenuation and conveyance features at concept stage, by Outline Design Stage we will expect the Surface Water Management Strategy to set parameters for each parcel/phase to ensure these are included when these parcels/phases come forward. Space must be made for shallow conveyance features throughout the site and by also retaining existing drainage features and flood flow routes, this will ensure that the existing drainage regime is maintained, and flood risk can be managed appropriately. By the end of the Outline Design Stage evaluation and initial design/investigations Flows and Volumes should be known. Therefore, we ask that the following Pro-Forma is completed and returned as soon as possible:

Response

Pro-Forma to be issued as soon as possible

Yours faithfully

Michael Smith

Michael Smith
Principal Civil Engineer
For and on behalf of
Curtins Consulting Ltd

Oxfordshire County Council LLFA

SuDS Flows and Volumes - LLFA Technical Assessment Pro-forma

This form identifies the information required by Oxfordshire County Council LLFA to enable technical assessment of flows and volumes determined as part of drainage I SuDS calculations.

*Note : * means delete as appropriate; Numbers in brackets refer to accompanying notes.*

SITE DETAILS

1.1 Planning application reference 19/02550/F

1.2 Site name Proposed Great Wolf lodge Chesterton, Bicester

1.3 Total application site area (1 ...186000.........m2 ....18..6...ha

1.4 Is the site located in a CDA or LFRZ Y/[✓ N]

1.5 Is the site located in a SPZ Y/[✓ N]

VOLUME AND FLOW DESIGN INPUTS

2.1 Site area which is positively drained by SuDS (2 ..72000..... m2

2.2 Impermeable area drained pre development (3 ...0........... m2 extensive land drainage

2.3 Impermeable area drained post development (3l ...72000............m2

2.4 Additional impermeable area (2.3 minus 2.2) ...... 72000......m2

2.5 Predevelopment use (4 [✓ Greenfield]* / Brownfield / Mixed* enhanced greenfield

2.6 Method of discharge (5 Infiltration / [✓ waterbody] / storm sewer/ combined sewer*

2.7 Infiltration rate (where applicable) ....—.................m/hr

2.8 Influencing factors on infiltration high ground water

2.9 Depth to highest known ground water table...0.3 - 0.5.....m~~AOD~~ Non-intrusive survey

2.10 Coefficient of runoff (Cv) (6 0.75

2.11 Justification for Cv used $C_v = \frac{(0.829 \times PIMP + 25 \times SOIL + 0.078 \times UCWI - 27)}{PIMP}$

2.12 FEH rainfall data used (Note that FSR is no longer the preferred rainfall calculation method) [✓ Y]/N

2.13 Will storage be subject to surcharge by elevated water levels in watercourse/ sewer Y/[✓ N]

2.14 Invert level at outlet (invert level of final flow control) ...78.595.............mAOD

2.15 Design level used for surcharge water level at point of discharge(14l......0........mAOD

PIMP = 100%
SOIL = 0.45
UCWI = 60
Cv = 0.72

Oxfordshire County Council LLFA

SuDS Flows and Volumes - LLFA Technical Assessment Pro-forma

CALCULATION OUTPUTS

Sections 3 and 4 refer to site where storage is provided by attenuation and / or partial infiltration. Where all flows are infiltrated to ground omit Sections 3 -5 and complete Section 6.

3.0 Defining rate of runoff from the site

← for 1in 2 year event

3.2 Max. discharge for 1 in 1 year rainfall ...4.2......l/s/ha, ...30.5.....l/s for the site (N/A not avaliable with FEH)

3.2 Max. discharge for Qmed rainfall ...2.5......l/s/ha, ...18.3.....l/s for the site (advised to use Qbar)
Qbar 4.3 31.3

3.3 Max. discharge for 1 in 30 year rainfall ...4.3......l/s/ha, ...31.2.....l/s for the site

3.4 Max. discharge for 1 in 100 year rainfall ...4.3......l/s/ha, ...31.3.....l/s for the site

3.5 Max. discharge for 1 in 100 year plus 40%CC ...4.3......l/s/ha, ...31.3.....l/s for the site

4.0 Attenuation storage to manage peak runoff rates from the site

4.1 Storage - 1 in ~~1~~ 2 year 1242...m3 0.017...m3/m2 (of developed impermeable area)

4.2 Storage - 1in 30 year (7 2748 . m3 0.038...m3/m2

4.3 Storage - 1in 100 year (8) 3582.......m3 0.050...m3/m2

4.4 Storage - 1 in 100 year plus 40%CC (9) 5200 . .m3 0.072 m3/m2

Conservative estimate using Source Control due to complex attenuation arrangement

5.0 Controlling volume of runoff from the site

5.1 Pre development runoff volume(b) 5564.... m³ for the site Qbar 100 6hr (Conservative)

5.2 Post development runoff volume (unmitigated) (b) 4086 . m³ for the site 3410m³ for underdeveloped site area
676m³ for developed site @ Qbar

5.3 Volume to be controlled/does not leave site (5.2-5.1).......*....... m³ for the site

5.4 Volume control provided by
Interception losses(11) ...360..m3
Rain harvesting(12) ...*.....m3
Infiltration (even at very low rates) ...0.....m3
Separate area designated as long term storage(13) ...–.....m3

* rainwater harvesting offers 13.86 million litres reduction Per annum

5.5 Total volume control (sum of inputs for 5.4) ...*.....m3 (15)

6.0 Site storage volumes (full infiltration only) N/A

6.1 Storage - 1in 30 year (7 ....m³ ....m³/m² (of developed impermeable area)

6.2 Storage - 1 in 100 year plus CC (9 ....m3 ....m3/m2

Rachel Tibbetts

From: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Sent: 24 March 2020 14:30
To: Nathanael Stock; Planning
Cc: Alex Keen; Bennett, Richard - Communities
Subject: RE: 19/02550/F - Great Wolf Lodge - Land to the east of M40 and south of A4095 Chesterton Bicester

Dear Both,

I was reviewing the information we had. I was not impressed by the drainage strategy so I am happy to go with your refusal.

Kind regards,

Adam.

From: Nathanael Stock <Nathanael.Stock@Cherwell-DC.gov.uk>
Sent: 24 March 2020 14:11
To: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>; Planning <Planning@Cherwell-DC.gov.uk>
Cc: Alex Keen <Alex.Keen@Cherwell-DC.gov.uk>
Subject: RE: 19/02550/F - Great Wolf Lodge - Land to the east of M40 and south of A4095 Chesterton Bicester

Hi Adam,

Many thanks for your email re the above. I hope this finds you safe and well.

This application was refused by Planning Committee on Thursday 12th March.

Refusal Reason 5 (of 6) states:

“5. The submitted drainage information is inadequate due to contradictions in the calculations and methodology, lack of robust justification for the use of tanking and buried attenuation in place of preferred SuDS and surface management, and therefore fails to provide sufficient and coherent information to demonstrate that the proposal is acceptable in terms of flood risk and drainage. The proposal is therefore contrary to Policies ESD6 and ESD7 of the Cherwell Local Plan 2011-2031 Part 1 and Government guidance contained within the National Planning Policy Framework.”

Were you sending comments on revised information?

Please ring Alex Keen (Clare’s team leader, copied in) in advance of sending through your comments.

Kind regards,
Nat

Nathanael Stock MRTPI
Team Leader – General Developments Planning Team
Development Management
Place and Growth Directorate
Cherwell District Council
Direct Line: 01295 221886
www.cherwell.gov.uk

Details of applications are available to view through the Council's Online Planning Service at
http://www.publicaccess.cherwell.gov.uk/online-applications
Instructions on how to use the Public Access service to **view, comment on and keep track of applications** can be found at http://www.cherwell.gov.uk/viewplanningapp

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From: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Sent: 24 March 2020 10:53
To: Planning <Planning@Cherwell-DC.gov.uk>
Cc: Nathanael Stock <Nathanael.Stock@Cherwell-DC.gov.uk>
Subject: 19/02550/F - Great Wolf Lodge - Land to the east of M40 and south of A4095 Chesterton Bicester
Importance: High

Dear Cherwell Planning,

I am hoping you can advise in Clare's absence please?

I am trying to focus on this application today and tomorrow in the hopes I can get a formal response to you.

I realise this is overdue and apologise.

Is it too late to send you LLFA comments? I note this is also political with a lot of local opposition. What is the stance of Cherwell Planning in relation to this?

Thanks,

Adam.

Drainage Engineer
Oxfordshire County Council
County Hall
New Road
Oxford
OX1 1ND

From:	Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>
Sent:	22 July 2019 13:50
To:	Michael Smith
Cc:	Drainage - E&E; White, Joy - Communities; Renee Upton
Subject:	RE: Request for Comments on Proposed SW Strategy for Development

Dear Mike,

I have yet to see a drainage strategy for the site so apologies if you have previously sent this. I can confirm that a pumped solution will not be acceptable.

We will expect a restricted discharge to greenfield (QBAR for all events up to the 1 in 100 year event plus 40% allowance climate change) if infiltration isn’t feasible. We will require evidence that infiltration isn’t feasible which you state you have already obtained.

As stated in my previous comments we will expect the drainage strategy to mimic the existing drainage regime and therefore discharging at greenfield to the current outfall point will be acceptable. There are 2 existing watercourses and large pond that are currently planned to be removed and these must be retained to ensure the current drainage regime is maintained.

I am happy to attend a meeting if you feel it is still beneficial. We are just disappointed that the drainage was not considered by your client at an early stage despite our early comments and availability to be involved in the early planning meetings to influence the initial layout proposals.

Regards,

Richard

Richard Bennett
Flood Risk Engineer
Oxfordshire County Council
County Hall
New Road
Oxford
OX1 1ND

Telephone (mob) : 07919175897
www.oxfordshire.gov.uk

From: Michael Smith <Michael.Smith@curtins.com>
Sent: 22 July 2019 13:13
To: Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>
Cc: Drainage - E&E <Drainage@Oxfordshire.gov.uk>; White, Joy - Communities <Joy.White@Oxfordshire.gov.uk>; Renee Upton <Renee.Upton@curtins.com>
Subject: RE: Request for Comments on Proposed SW Strategy for Development

Good Afternoon Richard,

Thank you for your reply.

Meeting Minutes

Date/Time of Meeting: 20 November 2020, 11:00am
Venue: Teams Call
Subject: Great Wolf Lodge, Chesterton, Bicester
Attendees: Adam Littler (AL) – OCC LLFA; Richard Bennett (RB) – OCC LLFA
Richard Bettridge (RGB) – Motion; Neil Jaques (NJ) – Motion
Michael Smith (MS) - Curtins
Apologies: None

Purpose of Meeting

Meeting with LLFA to discuss surface water drainage and SuDS proposals for the proposed Great Wolf Lodge development, at Chesterton, Bicester.

Agenda

		Action
1.0	**Introductions**	
1.1	NJ explained that Motion had been brought on board to represent Great Wolf Lakes UK Limited at the upcoming Public Inquiry for the appeal against refusal of planning permission for the proposed development.	
1.2	It was agreed that as a basis for the discussion we would review Curtins response to the latest LLFA comments. See Curtins note dated 18th February 2020.	
2.0	**Review of Curtins Response to LLFA Comments**	
2.1	MS confirmed that there would be no increase in discharge to the Gagle Brook and the flows would be reduced because the site was being restricted to Qbar. AL confirmed that this was acceptable.	Note
2.2	MS confirmed that no intrusive investigations have been carried out to date, because the site was not yet in Great Lakes ownership and it was an active golf course. However, a drone survey had been carried out to give an indication of the groundwater levels on the site, which indicated that groundwater levels were as high as 0.5m below ground level in the eastern part of the site. RGB also pointed out that the BGS boreholes indicated that ground levels were high and confirmed the findings of the drone survey. AL confirmed that further investigations could be conditioned and stated that it should not be a reason for refusal	Note
2.3	MS confirmed that there would be no increase in peak discharge from the site and flows would be restricted to Qbar.	Note
2.4	MS confirmed that IoH124 calculations had been used for calculating the greenfield runoff rates for the site and FSR rainfall data had been used for the hydraulic modelling. RB confirmed that they were happy with the Qbar runoff rate to be utilised. AL confirmed that he would want the site wide hydraulic modelling of the proposals to utilise FEH rainfall data. MS confirmed that he would re-run their modelling using the FEH rainfall data.	MS

2.5	MS confirmed that the Cv value had been calculated and was shown on the submitted SuDS Pro-forma. This showed that the default Cv values of 0.75 for a summer storm and 0.84 for a winter storm were greater than the calculated Cv value. MS also confirmed that runoff from hard areas had been taken as 100% and this had been used in the calculation of Cv. AL confirmed that this was acceptable.	Note
2.6	MS confirmed that updated MicroDrainage calculations had been provided, which covered all relevant return periods and identified critical durations. AL agreed to review.	AL
2.7	MS explained that sub-catchment approach had been used across the site and flow controls were utilised across the site to maximise the storage within the SuDS features.	Note
2.8	RB explained that they had concerns about having a large tank at the end of the system, due to ongoing maintenance of the tank and what would happen if the tank was not properly maintained, and therefore considers a pond or similar would be more suitable. NJ pointed out that the tank was part of a site wide SuDS strategy that utilised permeable paving, swales, detention basins and green roofs. Additionally, the tank would be used for rainwater harvesting.	Note
2.9	MS explained that due to the high groundwater levels in this part of the site it was not possible to utilise a pond in this location. MS confirmed that they had considered the options and a tank had been chosen in this location as it could be anchored down to resist flotation from groundwater. Whereas, with a pond the groundwater would have more of an impact on the practicalities of keeping the groundwater out of the pond. Due to the hydrostatic pressure pushing up on any liner to a pond it is difficult to anchor the liner down without affecting the integrity of the liner. Also, the rainwater harvesting would reduce the volume of runoff from the site and reduce water demand of the proposals.	Note
2.10	AL was a little bit concerned about incorporating attenuation and rainwater harvesting. MS explained that ordinarily it would not be appropriate to combine attenuation storage and rainwater harvesting, however the proposals include arrangements for the tank to automatically empty when rain was predicted. As such, there will be capacity to attenuate flows from the development.	Note
2.11	AL explained that he had concerns over this type of rainwater harvesting system. He explained that he was concerned that there could be a build-up of pathogens which could become airborne when used for irrigation. However, he had encouraged rainwater harvesting in the past on major developments and recognised that it was something that needed to be considered in Oxfordshire. OCC's 'Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire' section 4.4 states that the 'Thames River Basin District is one of the driest in the UK' and 'developers should consider opportunities for rainwater harvesting'. MS explained that the water would be reused as greywater for use in flushing toilets and the water would be treated before use. AL requested further details to review and MS agreed to forward further information.	MS
2.12	The OCC's 'Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire' states that the use of underground storage should be justified due to the additional maintenance burden that this form of storage affords and the lack of additional benefits provided by more natural SuDS solutions. However, this is on the assumption that the storage is the only form of SuDS being used on a site and where combined with other features as part of a site wide SuDS strategy it can form an important part of the SuDS chain. In this instance it provides the balance of storage required to protect the site and areas downstream, as well as being utilised for rainwater harvesting.	

2.13	MS confirmed that the system had been designed to restrict flows to Qbar for all return periods, including a 40% allowance for climate change.	Note
2.14	AL and RB expressed concern that the proposals radically changed the natural drainage of the site. They argued that the existing regime comprised of ponds and ditch drainage that was not replicated under the proposals. MS argued that the runoff from the existing site is not restricted in any way as a result the more extreme the event the greater the flood risk downstream. The new proposals incorporate stricter controls on discharge from the site. The tank is designed to store runoff from the 1 in 100 year event plus 40% for climate change, by limiting the flow to Qbar (1 in 2.3 year return period storm) for all events up to the design event. This means that the proposals generally reduce flood risk both on the site and downstream for storms above the 1 in 2.3 year return period.	Note
2.15	MS confirmed that the existing ditch diversions had previously been agreed with RB. It is proposed that the existing ditches would be re-routed through the car park area in swales.	Note
2.16	AL explained that he was concerned that the ditch diversions could affect the existing ponds to the north that were remaining. AL stated that the pond water levels need to be maintained to protect and promote biodiversity. MS confirmed that they would be maintained.	Note
2.17	MS confirmed that wherever possible SuDS features would be utilised over traditional collection systems, such as linear channels and gullies. A number of SuDS features were already incorporated into the proposals as detailed in 2.8 above.	Note
2.18	AL requested further details of surface water storage locations, extents, critical levels and freeboard. MS agreed to provide these details.	MS
3.0	**Summary**	
3.1	It was agreed that some points of detail could be conditioned, and AL agreed to discuss wording of suitable conditions.	Note
3.2	AL suggested that regular meetings were held to keep things moving forward. NJ agreed to arrange the meetings accordingly.	NJ

From: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Sent: 27 November 2020 14:19
To: Neil Jaques
Cc: Bennett, Richard - Communities
Subject: RE: Great Wolf Bicester [Filed 27 Nov 2020 14:41]

Dear Neil,

I would make the following points:

2.6: Re-run MicroDrainage results to be validated against updated surface water design strategy upon receipt.
2.8: Tank, as advised, should be designed out – note noted in minutes.
2.11: Rainwater only recommended where site specifics clearly lend themselves to this approach – this was a London centric approach discussed.
2.14: Further discussion is required around this point.
2.18: Requested details and all revised drainage strategy drawings to be submitted by 30th November.
3.2: Next meeting to be set up.

Kind regards,

Adam.

From: Neil Jaques <NJaques@motion.co.uk>
Sent: 27 November 2020 09:22
To: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Michael Smith <Michael.Smith@curtins.com>; Richard Bettridge <rbettridge@motion.co.uk>
Subject: RE: Great Wolf Bicester

Hi Adam,

Further to my email below, please can you confirm that you are happy with the minutes, or provide any comments.

Kind regards

Neil Jaques | Technical Director

motion | 84 North Street, Guildford, GU1 4AU
t 01483 531300 | m 07557 304223 | e njaques@motion.co.uk | w www.motion.co.uk
LinkedIn | Twitter

From: Neil Jaques
Sent: 25 November 2020 14:42
To: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Michael Smith <Michael.Smith@curtins.com>; Richard Bettridge <rbettridge@motion.co.uk>
Subject: Great Wolf Bicester

Hi Adam,

Further to our meeting on Friday please find attached a copy of the minutes.

Please can you confirm that the attached are a true and accurate representation of the matters discussed.

Michael, will be issuing further information on the rainwater harvesting system today and we would be grateful if you could confirm receipt once received.

Should you have any queries or wish to discuss please do not hesitate to contact us.

Kind regards

Neil Jaques | Technical Director

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Meeting Minutes

Date/Time of Meeting: 8 December 2020, 11:00am
Venue: Teams Call
Subject: Great Wolf Lodge, Chesterton, Bicester
Attendees: Adam Littler (AL) – OCC LLFA   Richard Bennett (RB) – OCC LLFA
Richard Bettridge (RGB) – Motion   Neil Jaques (NJ) – Motion

Apologies: Peter Twemlow (PT) – DP9

Purpose of Meeting

Meeting with OCC LLFA to discuss the surface water drainage and SuDS proposals for the proposed Great Wolf Lodge development, at Chesterton, Bicester.

Agenda

Action

1.0 Review of Minutes from meeting on 20th November 2020

1.1 NJ ran through the additional points raised by AL following the issue of the minutes from the previous meeting. For completeness AL's response is set out in full below: Note

Dear Neil,

I would make the following points:

2.6: Re-run MicroDrainage results to be validated against updated surface water design strategy upon receipt.

2.8: Tank, as advised, should be designed out – note noted in minutes.

2.11: Rainwater only recommended where site specifics clearly lend themselves to this approach – this was a London centric approach discussed.

2.14: Further discussion is required around this point.

2.18: Requested details and all revised drainage strategy drawings to be submitted by 30th November.

3.2: Next meeting to be set up.

Kind regards,

Adam

1.2 In response to point 2.6 MS confirmed that he had re-run the MicroDrainage calculations using the FEH rainfall data. This showed that there was no detriment to the system and the discharge rate for the site did not increase above Qbar for all return periods. MS confirmed that these had been issued to AL. Note

1.3 There was a discussion on designing the tank out of the proposals and the potential issues in trying to do so. Note

1.4	NJ confirmed that the proposals controlled the discharge rate to Qbar (1 in 2.3 year event) for all return periods up to the 1 in 100 year plus 40% for climate change.	Note
1.5	AL and RB expressed their opinion that the tank should be removed from the scheme. RGB explained that the reason for refusal was that a robust justification had not been provided for utilising tanking and buried attenuation. RGB confirmed that this would be provided.	MS
1.6	There was further discussion on the benefits that Rainwater Harvesting would bring to the development and it was recommended in OCC's SuDS guidance that Developers should consider these opportunities in water stressed areas. MS confirmed that the proposed system was an active system and was covered by the C753 The SuDS Manual. AL confirmed that he had received the additional information on the Rainwater Harvesting system that MS had forwarded.	Note
1.7	RB explained that he felt the existing watercourses should remain in place. MS explained that these were being diverted as part of the proposals and were being only being culverted where necessary. RB said that amendments to the watercourses and culverts required consents from the LLFA and that this may not be forthcoming. RGB pointed out that a Land Drainage Consent was subject to the test of reasonability and could not be unreasonably withheld and applications would be made following award of a planning consent.	Note
1.8	AL asked MS if he could forward a copy of the Drainage Strategy report, which MS agreed to do. AL also asked for confirmation of hard areas, roof areas and landscaping areas. MS confirmed that this was provided within the available documents.	MS
1.9	RB explained that he felt the proposals would affect the biodiversity of the site as a result of removal of ponds and existing ditches. NJ explained that the proposals included replacement SuDS features.	Note

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Our Ref: 068535_CUR_CO_D_0003

11th December 2020

Dear Adam Littler – Oxfordshire Lead Local Flood Authority

Proposed Great Wolf Lodge, Chesterton, Bicester – Proposed Attenuation Tank

Following our meeting on 20th November, as agreed, this letter has been written to provide further information and justification on the use of the below ground attenuation tank as part of the above scheme.

The proposed surface water strategy for the project includes a number of SuDS as detailed in the Drainage & SuDS Strategy (068535-CUR-00-XX-RP-C-00002 P02) submitted for planning. The intention of these SuDS is to provide benefits to water quantity, water quality, biodiversity and amenity. The design parameters of the water quantity aspect of the SuDS design are dictated by Oxfordshire Lead Local Flood Authority (LLFA). Notably it has been agreed that the site will discharge at a rate no greater than QBAR (calculated as 31.3l/s) and that flood water should not leave the site during a 1 in 100 year event with a 40% allowance for climate change.

Site wide modelling of the surface water network showed that in order to achieve the aforementioned LLFA requirements, 2000m^3 of storage would be required, in addition to the other SuDS features shown on the General Arrangement drawing (068535-CUR-00-XX-DR-C-92000 P05). The method by which this volume is to be provided is affected by the following factors.

Outfall

The proposed outfall of the surface water network is located to the south of the site as identified on the Drainage General Arrangement drawing (068535-CUR-00-XX-DR-C-92000 P05). The location of the outfall is set by the site topography which falls from north to south. The outfall is the existing ditch network that traverses the site. There are no alternative feasible outfalls located in the vicinity of the site.

Topography

The site topographical survey is contained in Appendix A of the Drainage & SuDS Strategy report. The survey shows that the site falls from north west to south east, with the low spot being located in the vicinity of the proposed outfall from the site. The proposed surface water network is a gravity solution which is required to discharge to a surface feature.

Groundwater

A UAV Survey was conducted across the site to establish the groundwater levels. The results and discussion around this are contained in the site-specific Flood Risk Assessment (068535-CUR-00-XX-RP-C-00001). The results of this survey were calibrated with the water levels in the ponds which are groundwater fed. The survey showed high groundwater levels are present across the south and east of the site.

In the area surrounding the outfall, the groundwater levels have been estimated to be 0m – 0.5m below ground. Further anecdotal evidence from site maintenance staff indicated that this area is prone to groundwater flooding. Therefore, any surface storage system would only have a maximum effective storage depth of 0.2m when a 300mm freeboard is accounted for and no anchorage is assumed. The freeboard requirement is outlined by Policy L10 of the “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire”. Based on this assessment, to provide the 2000m^3 of storage without using a tank, 10,000m^2 of area would be required (this figure does not include an allowance for side slopes or edge protection). This is approximately 6% of the total site area and 7.8% of the area which is proposed for development and this space is not available in the area local to the outfall.

Furthermore, the available storage depth of 0.2m would not allow for the required head over the vortex flow control device to control flows to 31.3l/s.

The approach adopted is consistent with Policy L9 in the “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire”

Tank Design

The tank arranged has been designed with a number of parameters and features in mind as summarised below.

Discharge Rate and Flood Risk

The LLFA have previously noted that the area downstream of the existing ditch network is at risk of flooding. The site is currently drained via a land drainage network that consists of a series of perforated pipes and ditches. The site has been assessed as a greenfield site for the purposes of this development but this is overly robust because the reality is that the existing site discharge will be greater than estimated. However, for the purpose of discussion, the greenfield run-off rates from the site (flow off an undeveloped site) are given below.

Return Period	Greenfield Run-off Rate (l/s)
1 in 1 year	26.6
QBAR (~1 in 2.3 year)	31.3
1 in 30 year	70.8
1 in 100 year	99.7

As agreed with the LLFA, the proposed surface water network with the development in place will be limited to QBAR. This will mean that the development will offer a significant reduction in flow from the site of 68.4l/s (not including an allowance for climate change or the existing drainage system on the site) as compared with the existing situation during the 1 in 100 year event. The development with the proposed tank arrangement therefore offers a significant reduction in the existing flood risk posed to areas downstream and therefore a significant improvement generally.

In the meeting attended by the LLFA on 30th November, it was suggested by the LLFA that the volume of storage might be reduced if the discharge rate were to be increased to allow for a surface feature. We do not consider that this is advisable or necessary. It would reduce the flood risk benefits of the development to residents downstream of the site for no good reason. The development provides an opportunity to provide attenuation provision on the site which enables the site to reduce the flood risk for those downstream.

Local standards would technically permit surface flooding to occur on site in the event of rainfall events greater than the 1 in 30 year event, but we have avoided such a result. The site topography falls towards the existing hotel and golf course site to the south and therefore any controlled flooding would pose a flood risk, greater than existing, to the southern site. It has therefore proposed to store all excess rainfall for events up to and including the 1 in 100 year event (+40% climate change) within the proposed SuDS and below ground tank. This delivers benefits to both the neighboring site and downstream residents.

This approach is consistent with Policy L6 in the "Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire"

Anchorage

As previously mentioned, the area to the south of the site is subject to high groundwater. This therefore renders many storage options unfeasible. The inclusion of a tank allows the use of tensions piles to be constructed beneath it. This will protect the system from floatation, whilst maximizing the storage offered by it. This method of anchorage is not a feasible option for ponds or similar SuDS features.

Again, this approach is consistent with Policy L9 in the "Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire"

Wider SuDS Network

A SuDS system is assessed on the four pillars of sustainable drainage (water quantity, water quality, biodiversity and amenity). The below ground storage tank offers benefits to water quantity and the proposed surface water network generally has been designed with a holistic view in light of these four pillars.

The site wide collection system included filter drains, swales, ponds, permeable pavements and green roofs. These SuDS when combined with the proposed tank cover all four of the SuDS pillars.

Water quality will be strictly managed by these SuDS as collection from any areas at risk of pollution will only be carried out by SuDS. These measures have also been reviewed against the hazard indices contained in CIRIA C753 – The SuDS Manual, to ensure that they offer the required level of mitigation to manage pollutants on site.

Attenuation provision from these additional SuDS features has also been maximized, so as to reduce the volumetric requirements of the tank. Through design progression prior to planning, the tank volume has been reduced from 5244m^3 to 2000m^3. However, as the site discharge is limited to QBAR and it is required to manage surface water flows for events up to the 1 in 100 year +40% event (something that the site in its existing state cannot manage) the remaining storage volume in the tank enables the scheme to reduce flood risk both on site and downstream. The provision of such a tank is more desirable than increasing (or not decreasing) flood risk elsewhere.

As summarised in Table 2 of the Drainage & SuDS Strategy (068535-CUR-00-XX-RP-C-00002 P02), the tanks volume accounts for 38% of the total storage volume provided by the site.

Rainwater Harvesting

In addition to this significant benefit in terms of flooding, the tank also offers important other sustainability benefits. The system to be employed allows the storage volume in the tank to be used for rainwater harvesting when its full storage volume is not required for flood prevention. Details of this system have been discussed with the LLFA prior to the application and submitted via email on 25th November 2020. The information submitted via email has been appended to this letter for ease of reference.

The proposed system offered by SDS (and in regular and successful use elsewhere in the country) monitors water levels in the tank alongside receiving rainfall forecast data. This information is then used to calculate incoming rainfall volume and ensure adequate volume is provided in the tank for its storage. The system is also designed with a number of fail safes, so that in the event of any power outage or connection issues, the valves controlling the tank remain open and the rainwater harvesting function is suspended until it is safe to reinstate it.

Rainwater harvesting is rightly encouraged by Section 4.8.1.2 of the "Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire". It is recognised as top of the drainage disposal hierarchy by the current London Plan. Furthermore, the use and design of rainwater harvesting systems is supported by CIRIA C753 – The SuDS Manual. The SuDS Manual highlights its benefits to include;

- They can meet some of the buildings water demand, delivering sustainability and climate resilience benefits
- They can help reduce the volume runoff from a site
- They can help reduce the volume of attenuation storage required on the site.

Moreover, the form of rainwater harvesting proposed for the scheme is directly outlined in Table 11.1 of CIRIA C753, where it is covered under "RWH for water conservation (supply) and surface water management, active systems".

LLFA Comments

The LLFA has previously suggested that the proposed drainage system does not adhere to the existing drainage regime of the site, but these comments related to the removal of a pond and existing ditches across the site. In response to these comments two ponds have been included in the site wide drainage strategy and both ditches have been reinstated and realigned across the site.

For the sake of completeness, we note that in Section 4.6 of "Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire" that the LLFA will not comment on the landscape implications of a proposal and that early engagement with the LPA should be carried out at the masterplanning stage. This was carried out and no comments were raised with regards to the existing ponds or proposed ponds by the LPA.

The LLFA has also asked about the effect the proposed strategy will have on the water levels in the northern ponds, especially in regard to existing habitats. This has been discussed and we have confirmed that a condition would be accepted whereby the water levels in the northern ponds would be monitored and maintained. Again, for the sake of completeness we note in Section 4.7 of "Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire" it is stated that the LLFA will not comment on the nature conservation aspects of the application.

Prior to submission of the planning application, a pre-application meeting was attended by Curtins, DP9 and Richard Bennett from Oxfordshire LLFA, where the tank and its functionality was presented. At that meeting the LLFA stated that a geo-cellular form of tank would not be acceptable to them and that they required a concrete tank. The design was progressed based on this discussion as it was understood from this meeting that a tank would be acceptable to the LLFA. The view that a geo-cellular tank would not be permitted is not the view expressed in Section 4.8.1.4 of "Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire".

We trust that this letter clearly outlines the reasons behind the inclusion of a below ground storage tank as part of the proposed development and that the LLFA are now able to remove their objection to the planning application. If there are any remaining concerns, please could you let us know what they are so that we can consider them and discuss them with you as a matter of priority.

Yours faithfully

Michael Smith

Michael Smith
Principal Civil Engineer
For and on behalf of
Curtins Consulting Ltd

From:	Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>
Sent:	11 December 2020 10:06
To:	Neil Jaques; Littler, Adam - Communities
Cc:	Michael Smith; Richard Bettridge
Subject:	RE: Great Wolf Bicester [Filed 11 Dec 2020 10:02]

Good morning Neil,

Thank you for sending through the minutes which we are happy that they reflect the meeting. We have received the response letter from Michael this morning which we will review and respond to in due course.

Regards,

Richard

Richard Bennett
Flood Risk Engineer
Oxfordshire County Council
County Hall
New Road
Oxford
OX1 1ND

Telephone (mob) : 07841829787
www.oxfordshire.gov.uk

From: Neil Jaques <NJaques@motion.co.uk>
Sent: 09 December 2020 17:32
To: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>; Michael Smith <Michael.Smith@curtins.com>; Richard Bettridge <rbettridge@motion.co.uk>
Subject: Great Wolf Bicester

Adam,

Further to our meeting on Tuesday please find attached a copy of the minutes.

We trust the attached are a true and accurate representation of the matters discussed.

Should you have any queries or wish to discuss please do not hesitate to contact us.

Kind regards

Neil Jaques | Technical Director

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OXFORDSHIRE
COUNTY COUNCIL

15th December 2020

Appeal for the Redevelopment of part of golf course to provide new leisure resort (sui generis) incorporating waterpark, family entertainment centre, hotel, conferencing facilities and restaurants with associated access, parking and landscaping at Land to the east of M40 and south of A4095 Chesterton Bicester Oxon

PINS reference: APP/C3105/W/20/3259189

Cherwell District Council ref: 19/02550/F & 20/00030/REF

LLFA response to Curtins Letter dated 11th December 2020

Following meetings held on the 20th November 2020 and 8th December 2020, a response letter was sent to the LLFA from Michael Smith from Curtins, the drainage consultant acting on behalf of the appellant.

The main body of the letter is provided below with further comments from the LLFA provided in blue.

Proposed Great Wolf Lodge, Chesterton, Bicester – Proposed Attenuation Tank

Following our meeting on 20th November, as agreed, this letter has been written to provide further information and justification on the use of the below ground attenuation tank as part of the above scheme.

The proposed surface water strategy for the project includes a number of SuDS as detailed in the Drainage & SuDS Strategy (068535-CUR-00-XX-RP-C-00002 P02) submitted for planning. The intention of these SuDS is to provide benefits to water quantity, water quality, biodiversity and amenity. The design parameters of the water quantity aspect of the SuDS design are dictated by Oxfordshire Lead Local Flood Authority (LLFA). Notably it has been agreed that the site will discharge at a rate no greater than QBAR (calculated as 31.3l/s) and that flood water should not leave the site during a 1 in 100 year event with a 40% allowance for climate change.

Site wide modelling of the surface water network showed that in order to achieve the aforementioned LLFA requirements, 2000m3 of storage would be required, in addition to the other SuDS features shown on the General Arrangement drawing (068535-CUR-00-XX-DR-C-92000 P05). The method by which this volume is to be provided is affected by the following factors.

This is not LLFA requirements, this is national requirements and best practice.

Whilst some SuDS measures are proposed, we do not accept that biodiversity benefit arises part of the SuDS proposal, particularly when assessed against the impact of the loss of the existing ponds and wide swales/ditches.

Outfall

The proposed outfall of the surface water network is located to the south of the site as identified on the Drainage General Arrangement drawing (068535-CUR-00-XX-DR-C-92000 P05). The location of the outfall is set by the site topography which falls from north to south. The outfall is the existing ditch network that traverses the site. There are no alternative feasible outfalls located in the vicinity of the site.

The outfall is set by site topography, but the existing outfall in the calculations is shown to be 78.262m which we are now aware is assumed and the ditch level adjacent to this manhole is shown to be 79.778m.

Topography

The site topographical survey is contained in Appendix A of the Drainage & SuDS Strategy report. The survey shows that the site falls from north west to south east, with the low spot being located in the vicinity of the proposed outfall from the site. The proposed surface water network is a gravity solution which is required to discharge to a surface feature.

The existing drainage outfalls via shallow ditches/swales to a manhole on the southern boundary of the proposed site. The level in existing MH EXSW1 is not known but the ditch level adjacent to this manhole is shown to be 79.778m. The proposed level is 1.5m lower which suggests a significant change in level to manage the drainage is proposed.

The FRA and Drainage Strategy are misleading as they have not mentioned at all that this outfall level is assumed. Looking at the existing topography downstream, we cannot see evidence that demonstrates how the drainage will work at the proposed level and this needs to be confirmed.

Groundwater

A UAV Survey was conducted across the site to establish the groundwater levels. The results and discussion around this are contained in the site-specific Flood Risk Assessment (068535-CUR-00- XX-RP-C-00001). The results of this survey were calibrated with the water levels in the ponds which are groundwater fed. The survey showed high groundwater levels are present across the south and east of the site.

In the area surrounding the outfall, the groundwater levels have been estimated to be 0m – 0.5m below ground. Further anecdotal evidence from site maintenance staff indicated that this area is prone to groundwater flooding. Therefore, any surface storage system would only have a maximum effective storage depth of 0.2m when a 300mm freeboard is accounted for and no anchorage is assumed. The freeboard requirement is outlined by Policy L10 of the “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire”. Based on this assessment, to provide the 2000m3 of storage without using a tank, 10,000m2 of area would be required (this figure does not include an allowance for side slopes or edge protection). This is approximately 6% of the total site area and 7.8% of the area which is proposed for development and this space is not available in the area local to the outfall.

Furthermore, the available storage depth of 0.2m would not allow for the required head over the vortex flow control device to control flows to 31.3l/s.

The approach adopted is consistent with Policy L9 in the “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire”

Not agreed. Its good to see that you are now quoting our guidance which the FRA and Drainage strategy failed to acknowledge even though we have consistently raised this in our comments throughout the planning process. The outfall is assumed so there is no reliable evidence to support the claim that L9 is met and high water levels at the outfall will not affect the performance of the proposed system, especially when surface water is being proposed to be managed at over 1.5m lower than it is currently with no appreciation of water levels downstream.

We also do not agree with the point of effective storage depth and freeboard as this can easily be designed out to provide the attenuation base above groundwater level but the flow control at a lower level. The site is proposed to be raised at least 0.5m anyway where the tank is proposed.

As you have stated groundwater is between 0-0.5m below ground level in places, especially where the tank is proposed. That is why the existing features are shallow to manage surface water above the groundwater which is in line with best practice. However, the proposed solution is proposing to manage surface water significantly lower with the proposed tank invert level 2.5m below the proposed ground level.

As you have stated this area is at high risk of groundwater flooding. The proposed scheme to manage groundwater is to reinstate the land drains on the proposed site at a lower level however, there is no evidence to demonstrate this will have a positive effect as this is controlled by the levels downstream which are not being altered.

There are three ponds to be removed and part of a further pond on the northern boundary is also shown to be removed. The largest pond is 2600m² in area with approximately 400mm of free depth recorded from the water level and lowest bank level on the topographical survey. The depth is unknown, but the water level currently takes up approximately 2000m² in area which will fluctuate with groundwater levels. There is a significant volume of water in this pond that will be lost post development. There is also a significant area of groundwater storage which will be lost by the introduction of the tank. This loss of groundwater storage has not been compensated for.

Tank Design

The tank arranged has been designed with a number of parameters and features in mind as summarised below.

Discharge Rate and Flood Risk

The LLFA have previously noted that the area downstream of the existing ditch network is at risk of flooding. The site is currently drained via a land drainage network that consists of a series of perforated pipes and ditches. The site has been assessed as a greenfield site for the purposes of this development, but this is overly robust because the reality is that the existing site discharge will be greater than estimated. However, for the purpose of discussion, the greenfield run-off rates from the site (flow off an undeveloped site) are given below.

Return Period	Greenfield Run-off Rate (l/s)
1 in 1 year	26.6
QBAR (~1 in 2.3 year)	31.3
1 in 30 year	70.8
1 in 100 year	99.7

As agreed with the LLFA, the proposed surface water network with the development in place will be limited to QBAR. This will mean that the development will offer a significant reduction in flow from the site of 68.4l/s (not including an allowance for climate change or the existing drainage system on the site) as compared with the existing situation during the 1 in 100 year event. The development with the proposed tank arrangement therefore offers a significant reduction in the existing flood risk posed to areas downstream and therefore a significant improvement generally.

In the meeting attended by the LLFA on 30th November, it was suggested by the LLFA that the volume of storage might be reduced if the discharge rate were to be increased to allow for a surface feature. We do not consider that this is advisable or necessary. It would reduce the flood risk benefits of the development to residents downstream of the site for no good reason. The development provides an opportunity to provide attenuation provision on the site which enables the site to reduce the flood risk for those downstream.

Local standards would technically permit surface flooding to occur on site in the event of rainfall events greater than the 1 in 30 year event, but we have avoided such a result. The site topography falls towards the existing hotel and golf course site to the south and therefore any controlled flooding would pose a flood risk, greater than existing, to the southern site. It has therefore proposed to store all excess rainfall for events up to and including the 1 in 100 year event (+40% climate change) within the proposed SuDS and below ground tank. This delivers benefits to both the neighboring site and downstream residents.

This approach is consistent with Policy L6 in the "Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire"

The design points raised above are requirements which are also required from national best practice and these are not issues we are disputing.

We do not agree that the existing site drainage currently discharges greater than greenfield rates and we have repeatedly confirmed that we don't agree with this in our planning responses and during meetings. The existing drainage measures are mimicking natural measures that we promote, and they currently don't have any impermeable areas draining to them. They are managing both surface water and the groundwater level.

The proposed strategy may be designed based on QBar and sized accordingly to manage surface water, but it is based on an assumed outfall and attenuation at a significantly lower level than existing. We are not convinced it is managing groundwater appropriately.

The introduction of the tank and managing water underground is also introducing a significant increase in maintenance requirements and operational standards compared to the existing system which is not in line with planning policy and best practice and in the event of blockage or failure, there is a significant increase to flood risk elsewhere compared to the existing above ground features which will be easier to maintain and to identify any blockages.

Anchorage

As previously mentioned, the area to the south of the site is subject to high groundwater. This therefore renders many storage options unfeasible. The inclusion of a tank allows the use of tensions piles to be constructed beneath it. This will protect the system from floatation, whilst maximizing the storage offered by it. This method of anchorage is not a feasible option for ponds or similar SuDS features.

Again, this approach is consistent with Policy L9 in the “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire”

The use of a deep underground tank would normally be rendered unfeasible due to the same reasons. Anchorage is only required because of the current proposal. You would not have to anchor a pond but use other significantly lower cost measures to protect it from groundwater if required which will be easy to replace in the event of failure. It is common to have a clay lined pond proposed in a sustainable drainage scheme.

The tank invert level is proposed to be at 79.00m so will always be surcharged in groundwater which will have a significant effect on the structure of the concrete tank. It is best practice to manage surface water on the surface and for any features to be lined if necessary, to ensure their capacity is not affected by groundwater.

Policy L9 states, *“It should be demonstrated that high water levels at the outfall for the design storm event would not affect the performance of the system.”* I am struggling to see how this relates to Anchorage however, this policy has yet to be demonstrated as the outfall level is assumed and doesn’t take into account the water levels downstream.

Wider SuDS Network

A SuDS system is assessed on the four pillars of sustainable drainage (water quantity, water quality, biodiversity and amenity). The below ground storage tank offers benefits to water quantity and the proposed surface water network generally has been designed with a holistic view in light of these four pillars.

The site wide collection system included filter drains, swales, ponds, permeable pavements and green roofs. These SuDS when combined with the proposed tank cover all four of the SuDS pillars.

Water quality will be strictly managed by these SuDS as collection from any areas at risk of pollution will only be carried out by SuDS. These measures have also been reviewed against the hazard indices contained in CIRIA C753 – The SuDS Manual, to ensure that they offer the required level of mitigation to manage pollutants on site.

Attenuation provision from these additional SuDS features has also been maximized, so as to reduce the volumetric requirements of the tank. Through design progression prior to planning, the tank volume has been reduced from $5244m^3$ to $2000m_3$. However, as the site discharge is limited to QBAR and it is required to manage surface water flows for events up to the 1 in 100 year +40% event (something that the site in its existing state cannot manage) the remaining storage volume in the tank enables the scheme to reduce flood risk both on site and downstream. The provision of such a tank is more desirable than increasing (or not decreasing) flood risk elsewhere.

As summarised in Table 2 of the Drainage & SuDS Strategy (068535-CUR-00-XX-RP-C-00002 P02), the tanks volume accounts for 38% of the total storage volume provided by the site.

We acknowledge the other measures provide some benefits, but the SuDS proposals do not deliver benefits in terms of biodiversity having regard to the loss of existing features and as referred to on our response on page 1 above. We have been consistent in our responses, from pre-app and throughout the planning process, stating that these measures must be retained especially the ditches.

However, the more fundamental concern is regarding the suitability of the tank at the location and the proposed depth.

Rainwater Harvesting

In addition to this significant benefit in terms of flooding, the tank also offers important other sustainability benefits. The system to be employed allows the storage volume in the tank to be used for rainwater harvesting when its full storage volume is not required for flood prevention. Details of this system have been discussed with the LLFA prior to the application and submitted via email on 25th November 2020. The information submitted via email has been appended to this letter for ease of reference.

The proposed system offered by SDS (and in regular and successful use elsewhere in the country) monitors water levels in the tank alongside receiving rainfall forecast data. This information is then used to calculate incoming rainfall volume and ensure adequate volume is provided in the tank for its storage. The system is also designed with a number of fail safes, so that in the event of any power outage or connection issues, the valves controlling the tank remain open and the rainwater harvesting function is suspended until it is safe to reinstate it.

Rainwater harvesting is rightly encouraged by Section 4.8.1.2 of the “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire”. It is recognised as top of the drainage disposal hierarchy by the current London Plan.

Furthermore, the use and design of rainwater harvesting systems is supported by CIRIA C753 – The SuDS Manual. The SuDS Manual highlights its benefits to include;

- They can meet some of the buildings water demand, delivering sustainability and climate resilience benefits
- They can help reduce the volume runoff from a site
- They can help reduce the volume of attenuation storage required on the site.

Moreover, the form of rainwater harvesting proposed for the scheme is directly outlined in Table 11.1 of CIRIA C753, where it is covered under “RWH for water conservation (supply) and surface water management, active systems”.

We promote the use of rainwater harvesting but the design of the rainwater harvesting needs to be carefully considered.

As stated in our guidance, “*rainwater harvesting volumes are not considered to contribute to the overall attenuation volume for a SuDS system as it cannot be guaranteed that the storage will be empty prior to rainfall. Rainwater harvesting would however be accepted as a means of removing the first 5mm of rainfall in terms of water quality protection.”*

The SuDS system must be designed to ensure the required capacity is available in the system when the tank required for rainwater harvesting is full. At the moment it is has not been demonstrated how the proposed SDS rainwater harvesting system will be implemented appropriately in the design.

LLFA Comments

The LLFA has previously suggested that the proposed drainage system does not adhere to the existing drainage regime of the site, but these comments related to the removal of a pond and existing ditches across the site. In response to these comments two ponds have been included in the site wide drainage strategy and both ditches have been reinstated and realigned across the site.

For the sake of completeness, we note that in Section 4.6 of “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire” that the LLFA will not comment on the landscape implications of a proposal and that early engagement with the LPA should be carried out at the masterplanning stage. This was carried out and no comments were raised with regards to the existing ponds or proposed ponds by the LPA.

The LLFA has also asked about the effect the proposed strategy will have on the water levels in the northern ponds, especially in regard to existing habitats. This has been discussed and we have confirmed that a condition would be accepted whereby the water levels in the northern ponds would be monitored and maintained. Again, for the sake of completeness we note in Section 4.7 of “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire” it is stated that the LLFA will not comment on the nature conservation aspects of the application.

Prior to submission of the planning application, a pre-application meeting was attended by Curtins, DP9 and Richard Bennett from Oxfordshire LLFA, where the tank and its functionality was presented. At that meeting the LLFA stated that a geo-cellular form of tank would not be acceptable to them and that they required a concrete tank. The design was progressed based on this discussion as it was understood from this meeting that a tank would be acceptable to the LLFA. The view that a geo-cellular tank would not be permitted is not the view expressed in Section 4.8.1.4 of “Local Standards and Guidance for Surface Water Drainage on Major Development in Oxfordshire”.

We trust that this letter clearly outlines the reasons behind the inclusion of a below ground storage tank as part of the proposed development and that the LLFA are now able to remove their objection to the planning application. If there are any remaining concerns, please could you let us know what they are so that we can consider them and discuss them with you as a matter of priority.

We have never approved the proposed replacement/realignment of the ditches. The proposed ditches are not being reinstated appropriately. The existing ditches are on average 3-4m wide and 0.3-1m deep. The proposal has squeezed 1m wide ditches in the proposed layout which are culverted in many places. This is not an acceptable replacement. We have repetitively stated in our responses and during meetings that the existing drainage features must be retained. All ditches, no matter when installed are classed as ordinary watercourses.

A number of design issues were discussed at the pre app meetings along with the tank. We raised concerns with the tanks for a number of reasons including suitability under the parking area, especially if it was of geo-cellular construction. We did not require a concrete tank, the design was unilaterally amended by Curtins to include a concrete tank.

It was suggested at the pre app meetings that a tank was required due to the topography. We stated that we will expect the existing features to be retained and further above ground features to be integrated wherever possible and if a tank was felt to be still required, then it must be fully justified to why it is required over other SuDS measures.

At the pre app stage, we were not provided with the FRA and drainage strategy documents until after these meetings so were not fully aware of the issues such as high groundwater at the site.

Apart from design principles such as the QBar rate, we have never agreed to the scheme as proposed.

As stated in our comments on several occasions, surface water management must be considered from the beginning of the development planning process and throughout – influencing site layout and design. The proposed drainage solution should not be limited by the proposed site layout and design.

The LLFA advice has been consistent throughout but the fundamental points have continued to be ignored and no effort has been made to change the layout to accommodate an adequate drainage strategy to manage flood risk appropriately. The LLFA feels the current proposals completely alter the existing drainage regime and do not manage all flood risk elements appropriately.

The LLFA are happy to continue to work with the applicant to try and address the issues however, as stated above, we do feel there needs to be a change to the layout, specifically in the area of high groundwater where the car park is proposed, to ensure an adequate sustainable drainage scheme can be implemented.

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Richard Bennett
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County Hall
New Road
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Our ref. 1gwbic/2011013/RGB

22 December 2020

Dear Richard,

Great Wolf, Bicester
Drainage and Flood Risk Matters
PINS Ref – APP/C3105/W/20/3259189

I refer to your letter dated 15th December 2020 written in response to Curtin's Letter dated 11th December 2020. I also refer to the meetings held between Motion and Curtins and you and Adam Littler representing the Lead Local Flood Authority (LLFA) on 20th November and 8th December 2020.

I would comment as follows on the matters raised in your comprehensive response.

Proposed Attenuation Tank

The tank will be required as part of a site wide scheme to attenuate surface water flows off site at the agreed rate of Qbar. The storage of surface water is part of an 'active' system to harvest surface water runoff for use on site and to provide attenuation storage. The system will be designed to empty in order to accommodate runoff prior to a rainfall event by virtue of intelligent controls linked to daily automatic rainfall predictions. The tank will enable run off from the site to be limited to predevelopment levels in such a way as to improve flood risk downstream by limiting the runoff to the Qbar level. I attach a project profile relating to a similar installation by SDS Water Infrastructure Systems which shows that these systems are being used to minimise the impact of development on the supply and disposal of water.

Outfall

The site outfall is an existing 450 mm pipe situated at the southern end of the appeal site which discharges into the existing system serving the golf course south of the site. The depth of the outfall has been established at a level of 79.60 m AOD and the model has been re-run to check against the confirmed level

Continued…

of the outfall. The original modelling was based on an assumed depth of pipe and the original outfall level was used in the calculations. The remodelling exercise has shown that the system remains effective in restricting the discharge to Qbar whilst at the same time utilising the attenuation tank as intended.

Topography

The proposed outfall from the network is to EXSW1. The drainage strategy report did not state that this level was known and included the topographical survey as an appendix which clearly showed all information around the proposed outfall. As the proposed outfall was not known an assumption was made for the purpose of modelling the upstream attenuation. Following confirmation of the existing manhole level, the MicroDrainage model has been reworked to show that the recorded level of 79.60m can be achieved by the network. The outfall does not drain to the local ditch but to a pond within the golf course some 120 m south of the site.

Assumptions were made prior to submission of a planning application where site surveys are not sufficiently detailed, and this is not uncommon. We have established the level of the outfall from site measurement and the model has been re-checked to reflect this revision. I will issue this formally once design staff are back at work after the Christmas break.

Groundwater

The system has been re-simulated to reflect the actual level of the outfall. The outfall connects to a pond some 120m downstream of the site and the discharge conditions have been established in accordance with the NPPG. It would be possible to confirm the capacity of the system downstream of the site, however, the current discharge rates have been calculated and the results are with you. The current system operates well to discharge the existing site runoff and by restricting the proposed runoff to Qbar the new proposals will apply an upper limit to discharge from the site that is not in place at the moment. The current proposals restrict the flow to a maximum of Qbar which is less than the predevelopment runoff for rainfall events of a return period greater than 1 in 2.3 years. As such the flooding situation downstream is improved. The area downstream is not subject to flooding to my knowledge. The nearest Environment Agency Flood Zone is south of the A41 as I understand it. It would be possible to confirm these matters by modelling and this obligation could be secured by a suitable condition.

The groundwater table is shallow at this point, but the system will be designed to exclude groundwater from entering the surface water drainage system, the outfall for which is the existing pond some 120 m south of the site. I understand that the Invert level of the outfall to this pond is about 78.90 mAOD.

Tank Design

Continued…

The discharge rate from site and the outfall location were set by the LLFA in an email dated 22nd July 2020 addressed to Curtins:

"we will expect the drainage strategy to mimic the existing drainage regime and therefore discharging at greenfield to the current outfall point."

As stated previously, the outfall invert level had been assumed, but the remodelling exercise based on the actual outfall level has shown that the system is capable of operating efficiently. The capacity of the downstream network can be assessed if required and this could be achieved through a suitable condition to ensure that the modelling of the receiving drainage system would not be adversely affected by discharging surface water runoff at Qbar, however this does not change the principle contained in the NPPG to restrict post development discharge to Qbar.

As to maintenance matters, these are covered under the Construction (Design and Management) Regulations (CDM) which stipulate that a proper risk assessment relating to the construction and maintenance of construction projects is carried out at the concept stage. The applicant fully expects to secure a suitable maintenance regime utilising advice and guidance from CIRIA C753 The SuDS Manual.

Anchorage

All structures where the whole or part of the works lies below ground will have to accommodate hydrostatic pressures relating to groundwater fluctuations. Often the structure uses its own dead weight to provide a suitable factor of safety against flotation. However, in the case of structures like tanks or pumping stations where the facility may be empty on occasions at a time when the groundwater levels are high, then measures need to be taken to ensure the stability of the structure. This is not unusual in situations where underground tanks are installed. The proposal is for the tank to be laid at a shallow depth where their effect on and influence of groundwater can be minimised. The tank also provides surface level car parking as part of the scheme.

Rainwater Harvesting

The statement that rainwater harvesting does not contribute to the overall attenuation volume is not correct. Traditional systems do not permit the rainwater harvesting volume to be used as attenuation, however the proposed system is designed as an active system which enables the attenuation tank to be utilised fully as part of the requirements for attenuating the surface water discharge downstream. This is outlined in Table 11.1 and section 11.3.4 of the SuDS Manual. I refer you to the attached Project profile for Southbank Place which utilises a SDS 'Intellistorm' Rainwater Management System which is intended for this development.

Continued…

LLFA Comments

The existing drainage regime for the site is suitable for the current development it serves. The site is not a natural undeveloped site but is a golf course where all of the drainage provisions consist of land drains, some ponds and ditches. I can confirm that the area of the larger of the three ponds is approximately 2125m^2 and not 2,600m^2, with an approximate water area of 1,725m^2. The drainage network on site is artificial in that although it may give the appearance of natural drainage, it is in fact designed to render the golf course useable. Golf is an all-weather sport, and the system would normally allow play during even bad weather. Commonly on such redevelopment sites, the discharge limits are set a Qbar irrespective of the existing runoff from the site. The NPPG requires that surface water flows be restricted as discussed earlier in this correspondence.

The proposals are not for a new golf course but for an entirely different development. As such the surface water drainage system cannot remain unchanged given the new proposals. The drainage system shows that it would be possible to embrace the requirements of the NPPG in terms of maintaining flood protection for the development and downstream properties as well as incorporating SuDS techniques in the design.

I welcome the opportunity to continue to discuss the proposals, especially as we have reached some agreement on the calculations and permitted discharge. It would be preferable if we could secure other reasonable objectives through suitable conditions. I will call you to arrange our next meeting to see if we can generate Drainage Statement of Common Ground.

Yours sincerely

RICHARD BETTRIDGE
Director
E rbettridge@motion.co.uk

CASE STUDY

Water
Infrastructure
Systems

Southbank Place, London

SDS Intellistorm® Rainwater Management System installed at prestigious new development.

SDS SYSTEMS

Intellistorm® rainwater management system.

CLIENT

AECOM.

END CUSTOMER

Braeburn Estates (JV between Qatari Diar Real Estate Investment Company and Canary Wharf Group plc).

PROJECT

Construction of a new, mixed use real-estate development.

PURPOSE

To create a showcase development which reinforces the South Bank's reputation as the epicentre of culture, design and architecture in London and reflects the customer's hallmark vision of sustainable development.

CLIENT BRIEF

To minimise the additional pressure the development will have on London's water supply and drainage infrastructure.

TIMING

Three systems were installed in phases, starting in early 2018, to coincide with the construction of the new development. All of the systems have now been installed and the attenuation function is in full operation; the reuse function will be introduced in line with the operation of the new buildings.

PROJECT BACKGROUND INFORMATION

Southbank Place is located just across the River Thames from the Palace of Westminster and overlooks Jubilee Gardens. The development includes 49,000m^2 of office space, spread across 8 buildings, 877 homes and 4,500m^2 of retail space, plus restaurants and cafes.

PROJECT OBJECTIVES

To minimise the impact the development's requirement for the supply and disposal of water will have on the local environment and existing infrastructure.

PROJECT REQUIREMENTS

To ensure the development is able to meet an estimated demand of 100 megalitres of water, and to process more than 11 megalitres of surface water, per annum, whilst limiting discharge to the peak flowrate dictated by GLA and Thames Water.

INTELLISTORM® PRODUCT FEATURES

SDS Intellistorm® is a web-based intelligent rainwater management system which uses live weather forecast data from the Met Office to facilitate the efficient reuse of water and thereby reduce the volume discharged to drains. The system intervenes to retain, rather than discharge, rainwater, reusing it for non-potable purposes such as toilet flushing and cooling the air conditioning units, and delivering substantial cost savings. SDS Intellistorm® uses the data to understand how heavily it will rain and empties the attenuation tanks, prior to a rainfall event, sufficient to make space for the new influx of water; consequently, the tanks are always partly full, supplying recycled water to the site.

CAPACITY

The system at Southbank Place is able to harvest up to 15,000m³, or 15 million litres, of water per year.

ISSUES OVERCOME

Due to limitations on green infrastructure, and therefore no opportunity to consider the use of swales and soakaways, SuDS options for the site were effectively limited to attenuation of surface water and, due to the sub-basement levels on the build, controlled and pumped discharge to drain. With space at such a premium, and things tight both practically and financially, basement-level attenuation tanks were installed. Intellistorm enables these tanks to be used to collect and store the rainwater; the tanks create a storage void of more than 1,000m³, sufficient to provide the minimum viable solution using Intellistorm®.

Paul Taylor, Associate Director at AECOM.

"The London Plan directs that all developments should consider the re-use of rainwater in the design of stormwater drainage. For this project, we wanted to use a large proportion of rainwater to support the site's air-conditioning cooling tower plant. Intellistorm® ideally suits the Southbank Place project. Most recently, we are now planning to utilise some of the rainwater, supplemented with greywater, with which to irrigate the neighbouring Jubilee Gardens."

From:	Michael Smith <Michael.Smith@curtins.com>
Sent:	08 January 2021 15:14
To:	Bennett, Richard - Communities; Richard Bettridge; Littler, Adam - Communities
Cc:	Neil Jaques; Peter Twemlow; Farmer, Chanika - Communities; Andy Bateson
Subject:	RE: Great Wolf Lodge - LLFA Response
Attachments:	Great Wolf Lodge - Drainage Results.pdf

Good Afternoon Richards,

Happy New Year!

The manhole schedule contained in the results matches the MH references on the GA, the invert levels and cover levels can be read from there. I had noticed a few inconsistencies between the two so I have tidied it up so it's a match now.

Kind Regards,

Michael Smith Principal Civil Engineer
Curtins
T. 020 7324 2240 M. 07816 814 228 | michael.smith@curtins.com

---

From: Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>
Sent: 08 January 2021 10:57
To: Richard Bettridge <rbettridge@motion.co.uk>; Michael Smith <Michael.Smith@curtins.com>; Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Neil Jaques <NJaques@motion.co.uk>; Peter Twemlow <Peter.Twemlow@dp9.co.uk>; Farmer, Chanika - Communities <Chanika.Farmer@Oxfordshire.gov.uk>; Andy Bateson <Andy.Bateson@cherwellandsouthnorthants.gov.uk>
Subject: RE: Great Wolf Lodge - LLFA Response

Dear Richard,

Happy New Year and thank you for your letter and calculations. Would it be possible to get an updated plan with the invert and cover levels on to help with our review?

Likewise, we are available to work with you to try and resolve the outstanding issues.

Regards,

Richard

Richard Bennett
Flood Risk Engineer
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OX1 1ND

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www.oxfordshire.gov.uk

From: Richard Bettridge <rbettridge@motion.co.uk>
Sent: 07 January 2021 16:49
To: Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>; Michael Smith <Michael.Smith@curtins.com>; Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Neil Jaques <NJaques@motion.co.uk>; Peter Twemlow <Peter.Twemlow@dp9.co.uk>; Farmer, Chanika - Communities <Chanika.Farmer@Oxfordshire.gov.uk>; Andy Bateson <Andy.Bateson@cherwellandsouthnorthants.gov.uk>
Subject: RE: Great Wolf Lodge - LLFA Response
Importance: High

Dear Richard,
Happy New Year.
As promised we have now been able to remodel the drainage network using the correct information relating to the outfall.
Please could you review the information and confirm your acceptance that there is nothing wrong in your view with the analysis.
The calculations indicate that an effective drainage scheme can be achieved with the amended outfall level.
Please do not hesitate to contact me if you have any queries or require clarification.
I remain available as agreed to work with you to resolve any outstanding issues.

Kind Regards

Richard Bettridge | Director
BSc(Hons) BA CEng CEnv MICE FCIHT MCIWEM

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From: Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>
Sent: 16 December 2020 10:47
To: Michael Smith <Michael.Smith@curtins.com>; Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Richard Bettridge <rbettridge@motion.co.uk>; Neil Jaques <NJaques@motion.co.uk>; Peter Twemlow <Peter.Twemlow@dp9.co.uk>; Farmer, Chanika - Communities <Chanika.Farmer@Oxfordshire.gov.uk>; Andy Bateson <Andy.Bateson@cherwellandsouthnorthants.gov.uk>
Subject: RE: Great Wolf Lodge - LLFA Response

Good morning Michael,

Many thanks for your letter dated 11th December 2020. Please find attached our responses to your points raised.

We are happy to continue to work with you to try and address the outstanding issues.

Regards,

Richard

Richard Bennett
Flood Risk Engineer

Oxfordshire County Council
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From: Michael Smith <Michael.Smith@curtins.com>
Sent: 11 December 2020 09:04
To: Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>; Richard Bettridge <rbettridge@motion.co.uk>; Neil Jaques <NJaques@motion.co.uk>; Peter Twemlow <Peter.Twemlow@dp9.co.uk>
Subject: Great Wolf Lodge - LLFA Response

Good Morning Adam,

I hope you are well,

Following our meetings to discuss the LLFA's objection to the proposed Great Wolf Lodge, Chesterton, Oxfordshire. Please see the attached response letter regarding additional justification for the inclusion of a below ground attenuation tank.

Kind Regards,

Michael Smith
Principal Civil Engineer
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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	100	PIMP (%)	100
M5-60 (mm)	20.000	Add Flow / Climate Change (%)	0
Ratio R	0.400	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	0.600
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	0.70
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.000	25.925	0.130	199.4	0.052	5.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.001	25.925	0.130	199.4	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.002	18.713	0.094	199.1	0.262	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.003	37.389	0.190	196.8	0.139	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S2.000	27.734	0.139	199.5	0.183	5.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S2.001	16.489	0.082	201.1	0.021	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.004	29.486	0.059	499.8	0.029	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.005	85.930	0.172	500.0	0.172	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.006	10.784	0.022	500.0	0.102	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.007	40.931	0.082	500.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.008	40.728	0.081	500.0	0.000	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S3.000	18.510	0.093	199.0	0.091	5.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S3.001	25.698	0.128	200.8	0.371	0.00	0.0	0.600	o	525	Pipe/Conduit	🔒
S1.009	90.845	0.182	500.0	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.000	50.00	5.30	81.821	0.052	0.0	0.0	0.0	1.44	228.4	7.0
S1.001	50.00	5.60	81.692	0.052	0.0	0.0	0.0	1.44	228.4	7.0
S1.002	50.00	5.82	81.562	0.314	0.0	0.0	0.0	1.44	228.6	42.5
S1.003	50.00	6.25	81.468	0.453	0.0	0.0	0.0	1.45	229.9	61.4
S2.000	50.00	5.32	81.500	0.183	0.0	0.0	0.0	1.44	228.3	24.8
S2.001	50.00	5.51	81.361	0.204	0.0	0.0	0.0	1.43	227.4	27.7
S1.004	50.00	6.79	81.278	0.686	0.0	0.0	0.0	0.90	143.6	92.9
S1.005	50.00	8.38	81.219	0.859	0.0	0.0	0.0	0.90	143.5	116.3
S1.006	50.00	8.58	81.047	0.961	0.0	0.0	0.0	0.90	143.5	130.1
S1.007	50.00	9.34	81.025	0.961	0.0	0.0	0.0	0.90	143.5	130.1
S1.008	50.00	10.09	80.943	0.961	0.0	0.0	0.0	0.90	143.5	130.1
S3.000	50.00	5.28	81.400	0.091	0.0	0.0	0.0	1.11	78.5	12.4
S3.001	50.00	5.55	81.082	0.463	0.0	0.0	0.0	1.58	341.4	62.7
S1.009	50.00	11.61	80.787	1.424	0.0	0.0	0.0	0.99	215.4	192.8

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S1.010	18.244	0.036	500.0	0.074	0.00	0.0	0.600	o	525	Pipe/Conduit	🔒
S4.000	17.546	0.088	199.4	0.094	5.00	0.0	0.600	o	300	Pipe/Conduit	🔒
S4.001	29.597	0.148	200.0	0.334	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.011	40.263	0.110	366.2	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S1.012	43.225	0.086	500.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S1.013	11.877	0.024	500.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S1.014	88.680	0.177	500.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S5.000	43.138	0.244	176.8	0.209	5.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S6.000	11.170	0.094	118.8	0.093	5.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S5.001	17.050	0.034	500.0	0.085	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S5.002	56.548	0.268	211.0	0.480	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
S5.003	119.208	0.238	500.0	0.395	0.00	0.0	0.600	o	500	Pipe/Conduit	🔒
S7.000	41.099	0.600	68.5	0.131	5.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S8.000	13.815	0.138	100.1	0.171	5.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S8.001	53.708	0.537	100.0	0.230	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S1.015	28.594	0.057	500.0	0.276	0.00	0.0	0.600	o	750	Pipe/Conduit	🔒
S9.000	13.720	0.116	118.3	0.000	5.00	0.0	0.600	o	150	Pipe/Conduit	🔓
S1.016	76.982	0.206	373.0	0.024	0.00	0.0	0.600	o	750	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S1.010	50.00	11.92	80.605	1.498	0.0	0.0	0.0	0.99	215.4	202.9
S4.000	50.00	5.26	81.400	0.094	0.0	0.0	0.0	1.11	78.4	12.8
S4.001	50.00	5.61	81.162	0.428	0.0	0.0	0.0	1.43	228.1	58.0
S1.011	50.00	12.45	80.494	1.926	0.0	0.0	0.0	1.27	358.1	260.9
S1.012	50.00	13.11	80.384	1.926	0.0	0.0	0.0	1.08	306.0	260.9
S1.013	50.00	13.29	80.297	1.926	0.0	0.0	0.0	1.08	306.0	260.9
S1.014	50.00	14.66	80.273	1.926	0.0	0.0	0.0	1.08	306.0	260.9
S5.000	50.00	5.47	81.875	0.209	0.0	0.0	0.0	1.53	242.7	28.3
S6.000	50.00	5.10	81.500	0.093	0.0	0.0	0.0	1.86	296.5	12.7
S5.001	50.00	5.79	81.406	0.388	0.0	0.0	0.0	0.90	143.5	52.5
S5.002	50.00	6.42	81.322	0.868	0.0	0.0	0.0	1.49	292.9	117.6
S5.003	50.00	8.48	81.054	1.263	0.0	0.0	0.0	0.96	189.4	171.0
S7.000	50.00	5.43	81.950	0.131	0.0	0.0	0.0	1.58	62.9	17.7
S8.000	50.00	5.11	81.700	0.171	0.0	0.0	0.0	2.03	323.2	23.2
S8.001	50.00	5.55	81.562	0.402	0.0	0.0	0.0	2.03	323.3	54.4
S1.015	50.00	15.04	79.946	3.997	0.0	0.0	0.0	1.24	549.9	541.3
S9.000	50.00	5.25	80.000	0.000	0.0	0.0	0.0	0.92	16.3	0.0
S1.016	50.00	15.93	79.889	4.021	0.0	0.0	0.0	1.44	637.5	544.5

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S10.000	15.276	0.034	449.3	0.000	30.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S10.001	57.051	0.569	100.2	0.650	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S11.000	12.952	0.109	118.8	0.000	30.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S11.001	9.455	0.144	65.5	0.322	0.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S10.002	16.772	1.006	16.7	0.123	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S12.000	11.319	0.095	119.1	0.000	30.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S12.001	15.510	0.039	397.7	0.435	0.00	0.0	0.600	o	450	Pipe/Conduit	🔒
S10.003	50.328	0.172	292.6	0.000	0.00	0.0	0.600	o	525	Pipe/Conduit	🔒
S13.000	27.093	0.228	118.8	0.000	30.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S13.001	25.584	0.078	328.0	0.155	0.00	0.0	0.600	o	350	Pipe/Conduit	🔒
S10.004	55.057	0.110	500.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S14.000	18.331	0.155	118.3	0.000	30.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S14.001	15.785	0.032	500.0	0.556	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S10.005	44.176	0.088	500.0	0.000	0.00	0.0	0.600	o	600	Pipe/Conduit	🔒
S15.000	19.864	0.167	118.9	0.000	5.00	0.0	0.600	o	225	Pipe/Conduit	🔒
S15.001	18.644	0.037	500.0	0.507	0.00	0.0	0.600	o	375	Pipe/Conduit	🔒
S10.006	18.723	0.037	500.0	0.000	0.00	0.0	0.600	o	675	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S10.000	50.00	30.00	82.000	0.000	0.0	0.0	0.0	0.85	93.7	0.0
S10.001	50.00	30.00	81.966	0.650	0.0	0.0	0.0	1.81	199.9	88.0
S11.000	50.00	30.00	81.800	0.000	0.0	0.0	0.0	1.20	47.6	0.0
S11.001	50.00	30.00	81.691	0.322	0.0	0.0	0.0	1.62	64.4	43.7
S10.002	50.00	30.00	81.397	1.095	0.0	0.0	0.0	4.46	492.2	148.3
S12.000	50.00	30.00	80.800	0.000	0.0	0.0	0.0	1.20	47.6	0.0
S12.001	50.00	30.00	80.480	0.435	0.0	0.0	0.0	1.01	161.2	58.8
S10.003	50.00	30.00	80.241	1.530	0.0	0.0	0.0	1.30	282.3	207.1
S13.000	50.00	30.00	80.800	0.000	0.0	0.0	0.0	1.20	47.6	0.0
S13.001	50.00	30.00	80.447	0.155	0.0	0.0	0.0	0.95	91.6	20.9
S10.004	50.00	30.00	79.994	1.684	0.0	0.0	0.0	1.08	306.0	228.1
S14.000	50.00	30.00	80.800	0.000	0.0	0.0	0.0	1.20	47.8	0.0
S14.001	50.00	30.00	80.495	0.556	0.0	0.0	0.0	0.80	88.7	75.2
S10.005	50.00	30.00	79.883	2.240	0.0	0.0	0.0	1.08	306.0	303.3
S15.000	50.00	5.28	80.800	0.000	0.0	0.0	0.0	1.20	47.6	0.0
S15.001	50.00	5.66	80.483	0.507	0.0	0.0	0.0	0.80	88.7	68.7
S10.006	50.00	30.00	79.720	2.747	0.0	0.0	0.0	1.17	417.0	372.0

Network Design Table for Storm

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
S16.000	40.188	0.007	5741.2	0.000	5.00	0.0	0.600	o	675	Pipe/Conduit	🔒
S1.017	107.829	0.083	1299.1	0.027	0.00	0.0	0.600	\/	40	Pipe/Conduit	🔒

Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
S16.000	50.00	6.99	79.690	0.000	0.0	0.0	0.0	0.34	120.2	0.0
S1.017	50.00	6.10	79.683	0.000	31.3	0.0	0.0	1.63	6408.4	31.3

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)		Pipe Out			Pipes In		
					PN	Invert Level (m)	Diameter (mm)	PN	Invert Level (m)	Diameter (mm)	Backdrop (mm)
S1	82.700	0.879	Open Manhole	1800	S1.000	81.821	450				
S1A	82.700	1.009	Open Manhole	1800	S1.001	81.692	450	S1.000	81.691	450	
S2	82.700	1.138	Open Manhole	1800	S1.002	81.562	450	S1.001	81.562	450	
S3	82.700	1.232	Open Manhole	1800	S1.003	81.468	450	S1.002	81.468	450	
S4	82.700	1.200	Open Manhole	1500	S2.000	81.500	450				
S5	82.700	1.339	Open Manhole	1500	S2.001	81.361	450	S2.000	81.361	450	
S6	82.700	1.422	Open Manhole	1500	S1.004	81.278	450	S1.003	81.278	450	
								S2.001	81.279	450	1
S7	83.000	1.781	Open Manhole	1350	S1.005	81.219	450	S1.004	81.219	450	
S8	83.000	1.953	Open Manhole	1350	S1.006	81.047	450	S1.005	81.047	450	
S9	82.700	1.675	Open Manhole	1350	S1.007	81.025	450	S1.006	81.025	450	
S10	82.700	1.757	Open Manhole	1350	S1.008	80.943	450	S1.007	80.943	450	
S11	82.600	1.200	Open Manhole	1200	S3.000	81.400	300				
S12	82.600	1.518	Open Manhole	1500	S3.001	81.082	525	S3.000	81.307	300	
S13	82.700	1.913	Open Manhole	1500	S1.009	80.787	525	S1.008	80.862	450	
								S3.001	80.954	525	167
S14	82.600	1.995	Open Manhole	1500	S1.010	80.605	525	S1.009	80.605	525	
S15	82.600	1.200	Open Manhole	1200	S4.000	81.400	300				
S16	82.600	1.438	Open Manhole	1350	S4.001	81.162	450	S4.000	81.312	300	
S17	82.250	1.756	Open Manhole	1500	S1.011	80.494	600	S1.010	80.569	525	
								S4.001	81.014	450	370
S18	81.550	1.166	Open Manhole	1500	S1.012	80.384	600	S1.011	80.384	600	
S19	81.700	1.403	Open Manhole	1500	S1.013	80.297	600	S1.012	80.297	600	
S20	81.600	1.327	Open Manhole	1500	S1.014	80.273	600	S1.013	80.273	600	
S21	82.700	0.825	Open Manhole	1350	S5.000	81.875	450				
S22	82.700	1.200	Open Manhole	1350	S6.000	81.500	450				
S23	82.700	1.294	Open Manhole	1350	S5.001	81.406	450	S5.000	81.631	450	225
								S6.000	81.406	450	
S24	82.700	1.378	Open Manhole	1500	S5.002	81.322	500	S5.001	81.372	450	
S25	82.300	1.246	Open Manhole	1500	S5.003	81.054	500	S5.002	81.054	500	
S26	82.700	0.750	Open Manhole	1200	S7.000	81.950	225				
S27	82.700	1.000	Open Manhole	1350	S8.000	81.700	450				
S28	82.700	1.138	Open Manhole	1350	S8.001	81.562	450	S8.000	81.562	450	
S29	82.100	2.154	Open Manhole	1800	S1.015	79.946	750	S1.014	80.096	600	
								S5.003	80.815	500	619
								S7.000	81.350	225	879
								S8.001	81.025	450	779
SSwale	81.500	1.500	Open Manhole	1200	S9.000	80.000	150				
S30	82.000	2.116	Open Manhole	1800	S1.016	79.889	750	S1.015	79.889	750	
								S9.000	79.884	150	
S31	83.000	1.000	Open Manhole	1350	S10.000	82.000	375				
S31a	83.000	1.034	Open Manhole	1350	S10.001	81.966	375	S10.000	81.966	375	
S32	82.500	0.700	Open Manhole	1200	S11.000	81.800	225				
S32a	82.500	0.809	Open Manhole	1200	S11.001	81.691	225	S11.000	81.691	225	
S33	82.500	1.103	Open Manhole	1350	S10.002	81.397	375	S10.001	81.397	375	
								S11.001	81.547	225	

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam.,L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
S34	81.500	0.700	Open Manhole	1200	S12.000	80.800	225				
S34a	81.500	1.020	Open Manhole	1350	S12.001	80.480	450	S12.000	80.705	225	
S35	81.500	1.259	Open Manhole	1500	S10.003	80.241	525	S10.002	80.391	375	
								S12.001	80.441	450	125
S36	81.500	0.700	Open Manhole	1200	S13.000	80.800	225				
S36a	81.500	1.053	Open Manhole	1200	S13.001	80.447	350	S13.000	80.572	225	
S37	81.500	1.506	Open Manhole	1500	S10.004	79.994	600	S10.003	80.069	525	
								S13.001	80.369	350	125
S38	81.500	0.700	Open Manhole	1200	S14.000	80.800	225				
S39	81.500	1.005	Open Manhole	1350	S14.001	80.495	375	S14.000	80.645	225	
S40	81.500	1.617	Open Manhole	1500	S10.005	79.883	600	S10.004	79.883	600	
								S14.001	80.463	375	355
SRE	81.500	0.700	Open Manhole	1200	S15.000	80.800	225				
S41	81.500	1.017	Open Manhole	1350	S15.001	80.483	375	S15.000	80.633	225	
S42	81.500	1.780	Open Manhole	1500	S10.006	79.720	675	S10.005	79.795	600	
								S15.001	80.446	375	426
S43	81.500	1.810	Open Manhole	1500	S16.000	79.690	675				
S44	81.500	1.817	Open Manhole	2000	S1.017	79.683	40	S1.016	79.683	750	
								S10.006	79.683	675	
								S16.000	79.683	675	
S	80.884	1.284	Open Manhole	450		OUTFALL		S1.017	79.600	40	

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
S1.017	S	80.884	79.600	79.600	450	0

Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m³/ha Storage	2.000
Hot Start (mins)	0	Inlet Coeffiecient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	10	Number of Storage Structures	14	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Storm Duration (mins)	30
Ratio R	0.413		

Online Controls for Storm

Orifice Manhole: S12, DS/PN: S3.001, Volume (m³): 3.9

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 81.082

Orifice Manhole: S16, DS/PN: S4.001, Volume (m³): 3.2

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 81.162

Orifice Manhole: S24, DS/PN: S5.002, Volume (m³): 4.9

Diameter (m) 0.290 Discharge Coefficient 0.600 Invert Level (m) 81.322

Orifice Manhole: S31a, DS/PN: S10.001, Volume (m³): 3.0

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 81.966

Orifice Manhole: S32a, DS/PN: S11.001, Volume (m³): 1.4

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 81.691

Orifice Manhole: S34a, DS/PN: S12.001, Volume (m³): 1.9

Diameter (m) 0.060 Discharge Coefficient 0.600 Invert Level (m) 80.480

Orifice Manhole: S36a, DS/PN: S13.001, Volume (m³): 2.2

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 80.447

Orifice Manhole: S39, DS/PN: S14.001, Volume (m³): 2.1

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 80.495

Orifice Manhole: S41, DS/PN: S15.001, Volume (m³): 2.2

Diameter (m) 0.040 Discharge Coefficient 0.600 Invert Level (m) 80.483

Hydro-Brake® Optimum Manhole: S44, DS/PN: S1.017, Volume (m³): 58.7

Unit Reference	MD-SHE-0215-3130-2800-3130
Design Head (m)	2.800
Design Flow (l/s)	31.3
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	215
Invert Level (m)	79.683
Minimum Outlet Pipe Diameter (mm)	300
Suggested Manhole Diameter (mm)	2100

Control Points	**Head (m)**	**Flow (l/s)**	**Control Points**	**Head (m)**	**Flow (l/s)**
Design Point (Calculated)	2.800	31.3	Kick-Flo®	1.678	24.5
Flush-Flo™	0.801	31.3	Mean Flow over Head Range	-	27.3

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Hydro-Brake® Optimum Manhole: S44, DS/PN: S1.017, Volume (m^3): 58.7

Depth (m)	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**	**Depth (m)**	**Flow (l/s)**
0.100	7.3	0.800	31.3	2.000	26.6	4.000	37.1	7.000	48.6
0.200	21.0	1.000	31.0	2.200	27.9	4.500	39.3	7.500	50.3
0.300	26.8	1.200	30.2	2.400	29.0	5.000	41.3	8.000	51.9
0.400	28.8	1.400	28.7	2.600	30.2	5.500	43.3	8.500	53.4
0.500	30.1	1.600	26.1	3.000	32.3	6.000	45.1	9.000	54.9
0.600	30.8	1.800	25.3	3.500	34.8	6.500	46.9	9.500	56.4

Storage Structures for Storm

Tank or Pond Manhole: S3, DS/PN: S1.003

Invert Level (m) 81.468

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	200.0	0.500	200.0	0.501	0.0

Swale Manhole: S7, DS/PN: S1.005

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	90.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	82.400	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5	Include Swale Volume	Yes

Swale Manhole: S9, DS/PN: S1.007

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Length (m)	45.0
Infiltration Coefficient Side (m/hr)	0.00000	Side Slope (1:X)	4.0
Safety Factor	2.0	Slope (1:X)	1000.0
Porosity	1.00	Cap Volume Depth (m)	0.000
Invert Level (m)	82.100	Cap Infiltration Depth (m)	0.000
Base Width (m)	0.5	Include Swale Volume	Yes

Tank or Pond Manhole: S12, DS/PN: S3.001

Invert Level (m) 82.100

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	183.0	0.500	1184.0

Tank or Pond Manhole: S16, DS/PN: S4.001

Invert Level (m) 82.100

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	183.0	0.500	1184.0

Porous Car Park Manhole: S23, DS/PN: S5.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.0
Membrane Percolation (mm/hr)	1000	Length (m)	40.0
Max Percolation (l/s)	333.3	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	82.100	Cap Volume Depth (m)	0.600

Swale Manhole: SSwale, DS/PN: S9.000

Warning:- Volume should always be included unless the upstream pipe is being used for storage and/or as a carrier

Infiltration Coefficient Base (m/hr)	0.00000	Infiltration Coefficient Side (m/hr)	0.00000

Swale Manhole: SSwale, DS/PN: S9.000

Safety Factor	2.0	Side Slope (1:X)	4.0
Porosity	1.00	Slope (1:X)	500.0
Invert Level (m)	80.000	Cap Volume Depth (m)	0.000
Base Width (m)	1.0	Cap Infiltration Depth (m)	0.000
Length (m)	250.0	Include Swale Volume	Yes

Porous Car Park Manhole: S31a, DS/PN: S10.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	70.0
Membrane Percolation (mm/hr)	1000	Length (m)	70.0
Max Percolation (l/s)	1361.1	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	82.400	Cap Volume Depth (m)	0.600

Porous Car Park Manhole: S32a, DS/PN: S11.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	54.0
Membrane Percolation (mm/hr)	1000	Length (m)	54.0
Max Percolation (l/s)	810.0	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	81.900	Cap Volume Depth (m)	0.600

Porous Car Park Manhole: S34a, DS/PN: S12.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	50.0
Membrane Percolation (mm/hr)	1000	Length (m)	40.0
Max Percolation (l/s)	555.6	Slope (1:X)	0.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	80.900	Cap Volume Depth (m)	0.600

Porous Car Park Manhole: S36a, DS/PN: S13.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	30.0
Membrane Percolation (mm/hr)	1000	Length (m)	21.0
Max Percolation (l/s)	175.0	Slope (1:X)	400.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	80.900	Cap Volume Depth (m)	0.600

Porous Car Park Manhole: S39, DS/PN: S14.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	65.0
Membrane Percolation (mm/hr)	1000	Length (m)	64.0
Max Percolation (l/s)	1155.6	Slope (1:X)	300.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	80.900	Cap Volume Depth (m)	0.600

Porous Car Park Manhole: S41, DS/PN: S15.001

Infiltration Coefficient Base (m/hr)	0.00000	Width (m)	55.0
Membrane Percolation (mm/hr)	1000	Length (m)	55.0
Max Percolation (l/s)	840.3	Slope (1:X)	300.0
Safety Factor	2.0	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	80.900	Cap Volume Depth (m)	0.600

Tank or Pond Manhole: S43, DS/PN: S16.000

Invert Level (m) 79.690

Depth (m)	**Area (m²)**	**Depth (m)**	**Area (m²)**	**Depth (m)**	**Area (m²)**
0.000	2000.0	1.000	2000.0	1.001	0.0

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor	1.000	Additional Flow - % of Total Flow	0.000
Hot Start (mins)	0	MADD Factor * 10m³/ha Storage	2.000
Hot Start Level (mm)	0	Inlet Coeffiecient	0.800
Manhole Headloss Coeff (Global)	0.500	Flow per Person per Day (l/per/day)	0.000
Foul Sewage per hectare (l/s)	0.000		

Number of Input Hydrographs	0	Number of Offline Controls	0	Number of Time/Area Diagrams	0
Number of Online Controls	10	Number of Storage Structures	14	Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FEH	Site Location	GB 455172 221569	Cv (Summer)	0.750
FEH Rainfall Version	2013	Data Type	Point	Cv (Winter)	0.840

Margin for Flood Risk Warning (mm)	300.0
Analysis Timestep	2.5 Second Increment (Extended)
DTS Status	ON
DVD Status	ON
Inertia Status	ON

Profile(s)	Summer and Winter
Duration(s) (mins)	15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years)	2, 30, 100
Climate Change (%)	20, 20, 40

PN	**US/MH Name**	**Storm**	**Return Period**	**Climate Change**	**First (X) Surcharge**	**First (Y) Flood**	**First (Z) Overflow**	**Overflow Act.**	**Water Level (m)**	**Surcharged Depth (m)**	**Flooded Volume (m³)**
S1.000	S1	15 Winter	2	+20%	100/15 Winter				81.887	-0.384	0.000
S1.001	S1A	15 Winter	2	+20%	100/15 Winter				81.772	-0.370	0.000
S1.002	S2	15 Winter	2	+20%	100/15 Summer				81.730	-0.282	0.000
S1.003	S3	30 Winter	2	+20%	100/15 Summer				81.602	-0.316	0.000
S2.000	S4	15 Winter	2	+20%	30/15 Winter				81.630	-0.320	0.000
S2.001	S5	15 Winter	2	+20%	30/15 Summer				81.530	-0.281	0.000
S1.004	S6	30 Winter	2	+20%	30/15 Winter				81.523	-0.205	0.000
S1.005	S7	30 Winter	2	+20%	30/15 Summer				81.471	-0.198	0.000
S1.006	S8	30 Winter	2	+20%	30/15 Summer				81.386	-0.110	0.000
S1.007	S9	30 Winter	2	+20%	30/15 Summer				81.274	-0.201	0.000
S1.008	S10	30 Winter	2	+20%	30/15 Winter				81.185	-0.208	0.000
S3.000	S11	240 Winter	2	+20%	2/15 Summer				82.292	0.592	0.000
S3.001	S12	240 Winter	2	+20%	2/15 Summer				82.292	0.685	0.000
S1.009	S13	30 Winter	2	+20%	100/15 Summer				81.010	-0.301	0.000
S1.010	S14	30 Winter	2	+20%	100/15 Summer				80.877	-0.254	0.000
S4.000	S15	240 Winter	2	+20%	2/15 Summer				82.281	0.581	0.000
S4.001	S16	240 Winter	2	+20%	2/15 Summer				82.280	0.668	0.000
S1.011	S17	30 Winter	2	+20%	100/15 Summer				80.729	-0.365	0.000
S1.012	S18	30 Winter	2	+20%	100/15 Summer				80.653	-0.330	0.000
S1.013	S19	30 Winter	2	+20%	100/15 Summer				80.592	-0.305	0.000
S1.014	S20	30 Winter	2	+20%	100/15 Summer				80.526	-0.347	0.000
S5.000	S21	15 Winter	2	+20%	30/15 Summer				82.007	-0.318	0.000
S6.000	S22	15 Winter	2	+20%	30/15 Summer				81.950	0.000	0.000
S5.001	S23	15 Winter	2	+20%	2/15 Summer				81.925	0.069	0.000
S5.002	S24	15 Winter	2	+20%	2/15 Summer				81.909	0.087	0.000
S5.003	S25	15 Winter	2	+20%	30/15 Summer				81.415	-0.139	0.000
S7.000	S26	15 Winter	2	+20%	100/15 Summer				82.053	-0.122	0.000
S8.000	S27	15 Winter	2	+20%					81.820	-0.330	0.000
S8.001	S28	15 Winter	2	+20%					81.712	-0.300	0.000
S1.015	S29	30 Winter	2	+20%	30/15 Summer				80.455	-0.241	0.000
S9.000	SSwale	120 Winter	2	+20%	2/15 Summer				80.250	0.100	0.000
S1.016	S30	30 Winter	2	+20%	30/15 Summer				80.424	-0.215	0.000
S10.000	S31	480 Winter	2	+20%	2/15 Summer				82.561	0.186	0.000

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.05		9.9	OK	
S1.001	S1A	0.05		9.8	OK	
S1.002	S2	0.30		51.8	OK	
S1.003	S3	0.18		35.9	OK	
S2.000	S4	0.18		34.8	OK	
S2.001	S5	0.22		37.0	OK	
S1.004	S6	0.43		53.1	OK	
S1.005	S7	0.49		66.7	OK	
S1.006	S8	0.92		72.9	OK	
S1.007	S9	0.57		72.4	OK	
S1.008	S10	0.56		71.8	OK	
S3.000	S11	0.06		3.8	SURCHARGED	
S3.001	S12	0.01		3.6	SURCHARGED	
S1.009	S13	0.36		73.5	OK	
S1.010	S14	0.53		74.5	OK	
S4.000	S15	0.06		4.0	SURCHARGED	
S4.001	S16	0.02		3.5	SURCHARGED	
S1.011	S17	0.25		77.5	OK	
S1.012	S18	0.29		76.4	OK	
S1.013	S19	0.49		76.2	OK	
S1.014	S20	0.27		76.2	OK	
S5.000	S21	0.18		39.9	OK	
S6.000	S22	0.08		14.1	OK	
S5.001	S23	0.49		45.7	SURCHARGED	
S5.002	S24	0.40		105.4	SURCHARGED	
S5.003	S25	0.87		156.9	OK	
S7.000	S26	0.42		25.1	OK	
S8.000	S27	0.16		33.0	OK	
S8.001	S28	0.24		71.1	OK	
S1.015	S29	0.59		250.0	OK	
S9.000	SSwale	0.85		12.7	SURCHARGED	
S1.016	S30	0.40		226.3	OK	
S10.000	S31	0.00		0.1	SURCHARGED	

2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S10.001	S31a	480 Winter	2	+20%	2/15 Summer				82.561	0.220	0.000
S11.000	S32	360 Winter	2	+20%	30/30 Summer				82.020	-0.005	0.000
S11.001	S32a	360 Winter	2	+20%	2/15 Summer				82.020	0.104	0.000
S10.002	S33	15 Winter	2	+20%					81.453	-0.319	0.000
S12.000	S34	240 Winter	2	+20%	30/30 Summer				80.977	-0.048	0.000
S12.001	S34a	240 Winter	2	+20%	2/15 Winter				80.978	0.048	0.000
S10.003	S35	30 Winter	2	+20%	100/15 Summer				80.405	-0.360	0.000
S13.000	S36	120 Winter	2	+20%	30/15 Summer				80.992	-0.033	0.000
S13.001	S36a	120 Winter	2	+20%	2/15 Summer				80.992	0.195	0.000
S10.004	S37	30 Winter	2	+20%	100/15 Summer				80.401	-0.192	0.000
S14.000	S38	360 Winter	2	+20%	2/120 Summer				81.074	0.049	0.000
S14.001	S39	360 Winter	2	+20%	2/15 Summer				81.075	0.205	0.000
S10.005	S40	30 Winter	2	+20%	30/15 Summer				80.387	-0.097	0.000
S15.000	SRE	360 Winter	2	+20%	2/60 Winter				81.080	0.055	0.000
S15.001	S41	360 Winter	2	+20%	2/15 Summer				81.080	0.222	0.000
S10.006	S42	30 Winter	2	+20%	30/15 Summer				80.363	-0.032	0.000
S16.000	S43	960 Winter	2	+20%	30/360 Winter				80.126	-0.239	0.000
S1.017	S44	30 Winter	2	+20%	100/15 Summer				80.348	-0.606	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S10.001	S31a	0.01		2.5	SURCHARGED	
S11.000	S32	0.00		0.0	OK	
S11.001	S32a	0.03		1.9	SURCHARGED	
S10.002	S33	0.05		20.7	OK	
S12.000	S34	0.01		0.3	OK	
S12.001	S34a	0.05		5.1	SURCHARGED	
S10.003	S35	0.10		24.6	OK	
S13.000	S36	0.01		0.3	OK	
S13.001	S36a	0.03		2.4	SURCHARGED	
S10.004	S37	0.09		24.3	OK	
S14.000	S38	0.00		0.0	SURCHARGED	
S14.001	S39	0.04		2.5	SURCHARGED	
S10.005	S40	0.12		31.9	OK	
S15.000	SRE	0.00		0.0	SURCHARGED	
S15.001	S41	0.04		2.5	SURCHARGED	
S10.006	S42	0.16		42.3	OK	
S16.000	S43	0.08		16.6	OK	
S1.017	S44	0.01		30.8	OK	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000
Hot Start (mins) 0
Hot Start Level (mm) 0
Manhole Headloss Coeff (Global) 0.500
Foul Sewage per hectare (l/s) 0.000
Additional Flow - % of Total Flow 0.000
MADD Factor * 10m³/ha Storage 2.000
Inlet Coeffiecient 0.800
Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0
Number of Online Controls 10
Number of Offline Controls 0
Number of Storage Structures 14
Number of Time/Area Diagrams 0
Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH
FEH Rainfall Version 2013
Site Location GB 455172 221569
Data Type Point
Cv (Summer) 0.750
Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	15 Winter	30	+20%	100/15 Winter				81.941	-0.330	0.000
S1.001	S1A	15 Winter	30	+20%	100/15 Winter				81.892	-0.250	0.000
S1.002	S2	15 Winter	30	+20%	100/15 Summer				81.876	-0.136	0.000
S1.003	S3	30 Winter	30	+20%	100/15 Summer				81.822	-0.096	0.000
S2.000	S4	30 Winter	30	+20%	30/15 Winter				81.983	0.033	0.000
S2.001	S5	30 Winter	30	+20%	30/15 Summer				81.868	0.057	0.000
S1.004	S6	30 Winter	30	+20%	30/15 Winter				81.782	0.054	0.000
S1.005	S7	30 Winter	30	+20%	30/15 Summer				81.735	0.067	0.000
S1.006	S8	30 Winter	30	+20%	30/15 Summer				81.563	0.066	0.000
S1.007	S9	30 Winter	30	+20%	30/15 Summer				81.515	0.040	0.000
S1.008	S10	30 Winter	30	+20%	30/15 Winter				81.402	0.008	0.000
S3.000	S11	240 Winter	30	+20%	2/15 Summer				82.457	0.757	0.000
S3.001	S12	240 Winter	30	+20%	2/15 Summer				82.456	0.849	0.000
S1.009	S13	30 Winter	30	+20%	100/15 Summer				81.169	-0.143	0.000
S1.010	S14	30 Winter	30	+20%	100/15 Summer				81.088	-0.042	0.000
S4.000	S15	240 Winter	30	+20%	2/15 Summer				82.440	0.740	0.000
S4.001	S16	240 Winter	30	+20%	2/15 Summer				82.439	0.827	0.000
S1.011	S17	30 Winter	30	+20%	100/15 Summer				80.993	-0.100	0.000
S1.012	S18	30 Winter	30	+20%	100/15 Summer				80.911	-0.072	0.000
S1.013	S19	30 Winter	30	+20%	100/15 Summer				80.843	-0.054	0.000
S1.014	S20	30 Winter	30	+20%	100/15 Summer				80.817	-0.056	0.000
S5.000	S21	15 Winter	30	+20%	30/15 Summer				82.449	0.124	0.000
S6.000	S22	15 Winter	30	+20%	30/15 Summer				82.405	0.455	0.000
S5.001	S23	15 Winter	30	+20%	2/15 Summer				82.321	0.465	0.000
S5.002	S24	15 Winter	30	+20%	2/15 Summer				82.351	0.529	0.000
S5.003	S25	15 Winter	30	+20%	30/15 Summer				81.936	0.382	0.000
S7.000	S26	15 Winter	30	+20%	100/15 Summer				82.129	-0.046	0.000
S8.000	S27	15 Winter	30	+20%					81.889	-0.261	0.000
S8.001	S28	15 Winter	30	+20%					81.824	-0.188	0.000
S1.015	S29	15 Winter	30	+20%	30/15 Summer				80.822	0.126	0.000
S9.000	SSwale	960 Winter	30	+20%	2/15 Summer				80.487	0.337	0.000
S1.016	S30	15 Winter	30	+20%	30/15 Summer				80.773	0.135	0.000
S10.000	S31	480 Winter	30	+20%	2/15 Summer				82.669	0.294	0.000

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.12		22.8	OK	
S1.001	S1A	0.14		27.0	OK	
S1.002	S2	0.80		138.3	OK	
S1.003	S3	0.36		73.6	OK	
S2.000	S4	0.30		58.2	SURCHARGED	
S2.001	S5	0.35		58.7	SURCHARGED	
S1.004	S6	0.83		102.5	SURCHARGED	
S1.005	S7	0.99		134.8	SURCHARGED	
S1.006	S8	1.93		152.0	SURCHARGED	
S1.007	S9	1.17		150.2	SURCHARGED	
S1.008	S10	1.16		148.9	SURCHARGED	
S3.000	S11	0.11		7.6	FLOOD RISK	
S3.001	S12	0.01		3.9	FLOOD RISK	
S1.009	S13	0.72		145.2	OK	
S1.010	S14	1.00		141.0	OK	
S4.000	S15	0.12		7.9	FLOOD RISK	
S4.001	S16	0.02		3.7	FLOOD RISK	
S1.011	S17	0.48		147.8	OK	
S1.012	S18	0.58		152.4	OK	
S1.013	S19	1.00		156.6	OK	
S1.014	S20	0.54		153.1	OK	
S5.000	S21	0.39		85.0	FLOOD RISK	
S6.000	S22	0.23		40.0	FLOOD RISK	
S5.001	S23	0.85		79.2	SURCHARGED	
S5.002	S24	0.50		133.7	SURCHARGED	
S5.003	S25	1.60		289.1	SURCHARGED	
S7.000	S26	0.97		58.1	OK	
S8.000	S27	0.37		76.6	OK	
S8.001	S28	0.62		184.2	OK	
S1.015	S29	1.30		548.2	SURCHARGED	
S9.000	SSwale	0.36		5.3	SURCHARGED	
S1.016	S30	0.84		478.3	SURCHARGED	
S10.000	S31	0.00		0.1	SURCHARGED	

30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m^3)
S10.001	S31a	480 Winter	30	+20%	2/15 Summer				82.669	0.328	0.000
S11.000	S32	360 Winter	30	+20%	30/30 Summer				82.105	0.080	0.000
S11.001	S32a	360 Winter	30	+20%	2/15 Summer				82.105	0.189	0.000
S10.002	S33	15 Winter	30	+20%					81.497	-0.275	0.000
S12.000	S34	240 Winter	30	+20%	30/30 Summer				81.140	0.115	0.000
S12.001	S34a	240 Winter	30	+20%	2/15 Winter				81.140	0.210	0.000
S10.003	S35	30 Winter	30	+20%	100/15 Summer				80.655	-0.110	0.000
S13.000	S36	120 Winter	30	+20%	30/15 Summer				81.153	0.128	0.000
S13.001	S36a	120 Winter	30	+20%	2/15 Summer				81.153	0.356	0.000
S10.004	S37	60 Winter	30	+20%	100/15 Summer				80.594	0.000	0.000
S14.000	S38	480 Winter	30	+20%	2/120 Summer				81.184	0.159	0.000
S14.001	S39	480 Winter	30	+20%	2/15 Summer				81.184	0.314	0.000
S10.005	S40	15 Winter	30	+20%	30/15 Summer				80.525	0.042	0.000
S15.000	SRE	360 Winter	30	+20%	2/60 Winter				81.210	0.185	0.000
S15.001	S41	360 Winter	30	+20%	2/15 Summer				81.210	0.352	0.000
S10.006	S42	15 Winter	30	+20%	30/15 Summer				80.621	0.226	0.000
S16.000	S43	960 Winter	30	+20%	30/360 Winter				80.455	0.090	0.000
S1.017	S44	15 Winter	30	+20%	100/15 Summer				80.667	-0.287	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S10.001	S31a	0.01		2.8	SURCHARGED	
S11.000	S32	0.00		0.0	SURCHARGED	
S11.001	S32a	0.04		2.1	SURCHARGED	
S10.002	S33	0.16		63.0	OK	
S12.000	S34	0.00		0.0	SURCHARGED	
S12.001	S34a	0.05		6.0	SURCHARGED	
S10.003	S35	0.21		51.7	OK	
S13.000	S36	0.00		0.0	SURCHARGED	
S13.001	S36a	0.03		2.7	SURCHARGED	
S10.004	S37	0.11		28.6	OK	
S14.000	S38	0.00		0.0	SURCHARGED	
S14.001	S39	0.05		2.7	SURCHARGED	
S10.005	S40	0.14		35.7	SURCHARGED	
S15.000	SRE	0.00		0.0	FLOOD RISK	
S15.001	S41	0.04		2.8	FLOOD RISK	
S10.006	S42	0.17		44.6	SURCHARGED	
S16.000	S43	0.10		22.2	SURCHARGED	
S1.017	S44	0.01		31.1	OK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000
Hot Start (mins) 0
Hot Start Level (mm) 0
Manhole Headloss Coeff (Global) 0.500
Foul Sewage per hectare (l/s) 0.000
Additional Flow - % of Total Flow 0.000
MADD Factor * 10m³/ha Storage 2.000
Inlet Coeffiecient 0.800
Flow per Person per Day (l/per/day) 0.000

Number of Input Hydrographs 0
Number of Online Controls 10
Number of Offline Controls 0
Number of Storage Structures 14
Number of Time/Area Diagrams 0
Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FEH
FEH Rainfall Version 2013
Site Location GB 455172 221569
Data Type Point
Cv (Summer) 0.750
Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
Analysis Timestep 2.5 Second Increment (Extended)
DTS Status ON
DVD Status ON
Inertia Status ON

Profile(s) Summer and Winter
Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
Return Period(s) (years) 2, 30, 100
Climate Change (%) 20, 20, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S1.000	S1	30 Winter	100	+40%	100/15 Winter				82.691	0.420	0.000
S1.001	S1A	30 Winter	100	+40%	100/15 Winter				82.687	0.545	0.000
S1.002	S2	30 Winter	100	+40%	100/15 Summer				82.683	0.671	0.000
S1.003	S3	30 Winter	100	+40%	100/15 Summer				82.598	0.680	0.000
S2.000	S4	30 Winter	100	+40%	30/15 Winter				82.662	0.712	0.000
S2.001	S5	30 Winter	100	+40%	30/15 Summer				82.552	0.741	0.000
S1.004	S6	30 Winter	100	+40%	30/15 Winter				82.486	0.758	0.000
S1.005	S7	30 Winter	100	+40%	30/15 Summer				82.390	0.722	0.000
S1.006	S8	30 Winter	100	+40%	30/15 Summer				82.020	0.524	0.000
S1.007	S9	30 Winter	100	+40%	30/15 Summer				81.873	0.397	0.000
S1.008	S10	15 Winter	100	+40%	30/15 Winter				81.661	0.268	0.000
S3.000	S11	360 Winter	100	+40%	2/15 Summer				82.571	0.871	0.000
S3.001	S12	360 Winter	100	+40%	2/15 Summer				82.570	0.963	0.000
S1.009	S13	15 Winter	100	+40%	100/15 Summer				81.502	0.191	0.000
S1.010	S14	15 Winter	100	+40%	100/15 Summer				81.312	0.182	0.000
S4.000	S15	360 Winter	100	+40%	2/15 Summer				82.550	0.850	0.000
S4.001	S16	360 Winter	100	+40%	2/15 Summer				82.549	0.937	0.000
S1.011	S17	15 Winter	100	+40%	100/15 Summer				81.284	0.190	0.000
S1.012	S18	15 Winter	100	+40%	100/15 Summer				81.212	0.229	0.000
S1.013	S19	15 Winter	100	+40%	100/15 Summer				81.251	0.354	0.000
S1.014	S20	15 Winter	100	+40%	100/15 Summer				81.258	0.385	0.000
S5.000	S21	30 Winter	100	+40%	30/15 Summer				82.673	0.348	0.000
S6.000	S22	30 Winter	100	+40%	30/15 Summer				82.630	0.680	0.000
S5.001	S23	30 Winter	100	+40%	2/15 Summer				82.543	0.687	0.000
S5.002	S24	15 Winter	100	+40%	2/15 Summer				82.593	0.771	0.000
S5.003	S25	15 Winter	100	+40%	30/15 Summer				82.289	0.735	0.000
S7.000	S26	15 Winter	100	+40%	100/15 Summer				82.619	0.444	0.000
S8.000	S27	15 Winter	100	+40%					81.950	-0.200	0.000
S8.001	S28	15 Winter	100	+40%					81.910	-0.102	0.000
S1.015	S29	15 Winter	100	+40%	30/15 Summer				81.300	0.604	0.000
S9.000	SSwale	960 Winter	100	+40%	2/15 Summer				80.834	0.684	0.000
S1.016	S30	15 Summer	100	+40%	30/15 Summer				81.273	0.635	0.000
S10.000	S31	480 Winter	100	+40%	2/15 Summer				82.780	0.405	0.000

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S1.000	S1	0.13		25.8	FLOOD RISK	
S1.001	S1A	0.11		20.5	FLOOD RISK	
S1.002	S2	0.90		155.0	FLOOD RISK	
S1.003	S3	0.49		98.9	FLOOD RISK	
S2.000	S4	0.47		91.4	FLOOD RISK	
S2.001	S5	0.60		101.2	FLOOD RISK	
S1.004	S6	1.31		161.8	FLOOD RISK	
S1.005	S7	1.44		195.1	SURCHARGED	
S1.006	S8	2.74		216.7	SURCHARGED	
S1.007	S9	1.67		213.8	SURCHARGED	
S1.008	S10	1.47		187.7	SURCHARGED	
S3.000	S11	0.12		8.2	FLOOD RISK	
S3.001	S12	0.01		4.0	FLOOD RISK	
S1.009	S13	0.97		195.1	SURCHARGED	
S1.010	S14	1.51		213.0	SURCHARGED	
S4.000	S15	0.13		8.5	FLOOD RISK	
S4.001	S16	0.02		3.9	FLOOD RISK	
S1.011	S17	0.72		219.2	SURCHARGED	
S1.012	S18	0.80		209.6	SURCHARGED	
S1.013	S19	1.34		209.7	SURCHARGED	
S1.014	S20	0.70		198.5	SURCHARGED	
S5.000	S21	0.47		102.2	FLOOD RISK	
S6.000	S22	0.27		45.9	FLOOD RISK	
S5.001	S23	0.99		92.1	FLOOD RISK	
S5.002	S24	0.56		149.6	FLOOD RISK	
S5.003	S25	1.96		353.2	FLOOD RISK	
S7.000	S26	1.31		78.6	FLOOD RISK	
S8.000	S27	0.55		114.6	OK	
S8.001	S28	0.93		275.0	OK	
S1.015	S29	1.90		803.3	SURCHARGED	
S9.000	SSwale	0.57		8.5	SURCHARGED	
S1.016	S30	1.13		640.6	SURCHARGED	
S10.000	S31	0.00		0.0	FLOOD RISK	

100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)	Flooded Volume (m³)
S10.001	S31a	480 Winter	100	+40%	2/15 Summer				82.780	0.439	0.000
S11.000	S32	480 Winter	100	+40%	30/30 Summer				82.193	0.168	0.000
S11.001	S32a	480 Winter	100	+40%	2/15 Summer				82.193	0.277	0.000
S10.002	S33	15 Winter	100	+40%					81.519	-0.252	0.000
S12.000	S34	240 Winter	100	+40%	30/30 Summer				81.294	0.269	0.000
S12.001	S34a	240 Winter	100	+40%	2/15 Winter				81.294	0.364	0.000
S10.003	S35	15 Winter	100	+40%	100/15 Summer				81.016	0.250	0.000
S13.000	S36	240 Winter	100	+40%	30/15 Summer				81.315	0.290	0.000
S13.001	S36a	240 Winter	100	+40%	2/15 Summer				81.315	0.518	0.000
S10.004	S37	480 Winter	100	+40%	100/15 Summer				81.010	0.417	0.000
S14.000	S38	480 Winter	100	+40%	2/120 Summer				81.302	0.277	0.000
S14.001	S39	480 Winter	100	+40%	2/15 Summer				81.302	0.432	0.000
S10.005	S40	15 Summer	100	+40%	30/15 Summer				81.231	0.747	0.000
S15.000	SRE	480 Winter	100	+40%	2/60 Winter				81.356	0.331	0.000
S15.001	S41	480 Winter	100	+40%	2/15 Summer				81.356	0.498	0.000
S10.006	S42	15 Summer	100	+40%	30/15 Summer				81.137	0.742	0.000
S16.000	S43	480 Winter	100	+40%	30/360 Winter				81.001	0.636	0.000
S1.017	S44	15 Summer	100	+40%	100/15 Summer				81.161	0.207	0.000

PN	US/MH Name	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
S10.001	S31a	0.02		3.0	FLOOD RISK	
S11.000	S32	0.00		0.0	SURCHARGED	
S11.001	S32a	0.04		2.3	SURCHARGED	
S10.002	S33	0.24		92.6	OK	
S12.000	S34	0.00		0.0	FLOOD RISK	
S12.001	S34a	0.05		5.3	FLOOD RISK	
S10.003	S35	0.37		94.0	SURCHARGED	
S13.000	S36	0.00		0.0	FLOOD RISK	
S13.001	S36a	0.03		2.6	FLOOD RISK	
S10.004	S37	0.07		19.5	SURCHARGED	
S14.000	S38	0.00		0.0	FLOOD RISK	
S14.001	S39	0.05		2.8	FLOOD RISK	
S10.005	S40	0.16		41.2	FLOOD RISK	
S15.000	SRE	0.00		0.0	FLOOD RISK	
S15.001	S41	0.05		2.9	FLOOD RISK	
S10.006	S42	0.18		45.4	SURCHARGED	
S16.000	S43	0.04		7.7	SURCHARGED	
S1.017	S44	0.01		31.1	SURCHARGED	

From:	Richard Bettridge
Sent:	11 January 2021 12:34
To:	Bennett, Richard - Communities; Michael Smith; Littler, Adam - Communities
Cc:	Neil Jaques; Peter Twemlow; Farmer, Chanika - Communities; Andy Bateson
Subject:	RE: Great Wolf Lodge - Hydrogeological Report - JH Groundwater Ltd
Attachments:	1194_GtWolf_GWPoESupp_Rev1.pdf
Importance:	High

Dear Richard,
Further to our discussions I have now been able to procure a report from Julian Hatherall of JH Groundwater Ltd regarding the concern you expressed about groundwater impact.
I have asked him to address the question of the likely impact, if any, that the drainage proposals for Great Wolf including the tank may have on the groundwater regime.
Having read his report I am happy that any impact would be negligible, and temporary and the groundwater regime would return to normal after completion of the works.
I take his point entirely that it would be usual good civil engineering practice for the groundwater to be monitored before, during and following completion of the works and I am sure that this obligation could be secured by a suitable condition.
Once you have considered the report could we speak again and see if we can come up with a likely condition which could allay your concerns regarding groundwater impact.

I shall be in contact again to agree a further teams meeting so that we can continue discussions with the aim of resolving outstanding matters.
With that in mind could you suggest a suitable date or let me know your availability over say the next couple of weeks please?

Kind Regards

Richard Bettridge | Director
BSc(Hons) BA CEng CEnv MICE FCIHT MCIWEM

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From: Bennett, Richard - Communities <Richard.Bennett@Oxfordshire.gov.uk>
Sent: 08 January 2021 10:57
To: Richard Bettridge <rbettridge@motion.co.uk>; Michael Smith <Michael.Smith@curtins.com>; Littler, Adam - Communities <Adam.Littler@Oxfordshire.gov.uk>
Cc: Neil Jaques <NJaques@motion.co.uk>; Peter Twemlow <Peter.Twemlow@dp9.co.uk>; Farmer, Chanika - Communities <Chanika.Farmer@Oxfordshire.gov.uk>; Andy Bateson <Andy.Bateson@cherwellandsouthnorthants.gov.uk>
Subject: RE: Great Wolf Lodge - LLFA Response

Dear Richard,

Happy New Year and thank you for your letter and calculations. Would it be possible to get an updated plan with the invert and cover levels on to help with our review?

Appendix C

2011013-SK-01 – Schematic SuDS Layout

Legend

▨	Existing pond/basin
▪▪▪▪▪	Existing swale/ditch
■	Proposed pond/basin and wetland areas
▪▪▪▪▪	Proposed swale/ditch
☐	Proposed green roof
▨	Proposed permeable paving
▦	Proposed rainwater harvesting/attenuation tank

A	First Issue	MH	NJ	NJ	08-01-2021
Revision Notes:		Drn	Chk	App	Date

Drawing Status:
FOR INFORMATION
NOT FOR CONSTRUCTION

motion

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Client:
Great Lakes UK Ltd

Project:
Great Wolf Lodge, Bicester

Title:
Schematic SuDS Layout

Scale: 1:1000
Size: A1
Project No: 2011013

Drawing:
2011013-SK-01

Revision:
A

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Appendix D

Policy Framework

1.0 Policy Framework

National Planning Policy Framework

1.1 In recent years, the Government and local authorities have placed increased priority on the need for developers to take full account of the flood and drainage risks of development at all stages of the planning process. The National Planning Policy Framework (NPPF) and Planning Practice Guidance (PPG) identifies how the issue of flooding is dealt with through the planning process and with the creation of a site-specific Flood Risk Assessment (FRA) for sites over 1ha in area or in Flood Zones 2 & 3.

Planning Practice Guidance

1.2 The Government's Planning Practice Guidance (PPG) provides additional information to be read alongside the NPPF. The online guidance sets out the definitions for the flood zones and defines the permitted uses of development that can be proposed in them. The tables below provide a summary of this guidance and refer to Table 1 (Paragraph 065), 2 (Paragraph (066) and 3 (Paragraph 067) in the PPG.

Flood Zone	**Annual Probability of Flooding (%)**	**Corresponding Annual Chance of Flooding (1 in x)**
Zone 1 Low Probability	Fluvial <0.1% Tidal <0.1%	>1,000 >1,000
Zone 2 Medium Probability	Fluvial 0.1 – 1.0% Tidal 0.1 – 0.5%	1,000 – 100 1,000 – 200
Zone 3a High Probability	Fluvial >1.0% Tidal >0.5%	<100 <200
Zone 3b The Functional Floodplain	Fluvial >5.0%* Tidal >5.0%* *Starting point for consideration. LPAs should identify Functional Floodplain, which should not be defined solely by rigid probability parameters.	<20 <20

Table 3.1 Flood Zones

Essential Infrastructure

- Essential transport infrastructure (including mass evacuation routes) which has to cross the area at risk.
- Essential utility infrastructure which must be located in a flood risk area for operational reasons, including electricity generating power stations and grid and primary substations; and water treatment works that need to remain operational in times of flood.
- Wind turbines.

Highly vulnerable

- Police and ambulance stations; fire stations and command centres; telecommunications installations required to be operational during flooding.
- Emergency dispersal points.
- Basement dwellings.
- Caravans, mobile homes and park homes intended for permanent residential use.

- Installations requiring hazardous substances consent. (Where there is a demonstrable need to locate such installations for bulk storage of materials with port or other similar facilities, or such installations with energy infrastructure or carbon capture and storage installations, that require coastal or water-side locations, or need to be located in other high flood risk areas, in these instances the facilities should be classified as 'Essential Infrastructure').

More vulnerable

- Hospitals
- Residential institutions such as residential care homes, children's homes, social services homes, prisons and hostels.
- Buildings used for dwelling houses, student halls of residence, drinking establishments, nightclubs and hotels.
- Non–residential uses for health services, nurseries and educational establishments.
- Landfill* and sites used for waste management facilities for hazardous waste.
- Sites used for holiday or short-let caravans and camping, subject to a specific warning and evacuation plan.

Less vulnerable

- Police, ambulance and fire stations which are not required to be operational during flooding.
- Buildings used for shops; financial, professional and other services; restaurants, cafes and hot food takeaways; offices; general industry, storage and distribution; non-residential institutions not included in the 'more vulnerable' class; and assembly and leisure.
- Land and buildings used for agriculture and forestry.
- Waste treatment (except landfill* and hazardous waste facilities).
- Minerals working and processing (except for sand and gravel working).
- Water treatment works which do not need to remain operational during times of flood.
- Sewage treatment works, if adequate measures to control pollution and manage sewage during flooding events are in place.

Water-compatible development

- Flood control infrastructure.
- Water transmission infrastructure and pumping stations.
- Sewage transmission infrastructure and pumping stations.
- Sand and gravel working.
- Docks, marinas and wharves.
- Navigation facilities.
- Ministry of Defence installations.
- Ship building, repairing and dismantling, dockside fish processing and refrigeration and compatible activities requiring a waterside location.

- Water-based recreation (excluding sleeping accommodation).
- Lifeguard and coastguard stations.
- Amenity open space, nature conservation and biodiversity, outdoor sports and recreation and essential facilities such as changing rooms.
- Essential ancillary sleeping or residential accommodation for staff required by uses in this category, subject to a specific warning and evacuation plan.

Table 3.2 Flood risk vulnerability classification

Flood Zone	**Essential Infrastructure**	**Water Compatible**	**Highly Vulnerable**	**More Vulnerable**	**Less Vulnerable**
Zone 1			✓	✓	✓
Zone 2			Exception test required	✓	✓
Zone 3a	Exception test required		✗	Exception test required	✓
Zone 3b	Exception test required				

Key:
✓ Development is appropriate
✗ Development should not be permitted

Table 3.3 Flood risk vulnerability and flood zone ‘compatibility

Local Planning Policy Requirements

The Cherwell Local Plan 2011-2031

1.3 The Cherwell Local Plan seeks to support and guide developments in the area between 2011-2031. It includes the following policies relating to drainage and flooding.

Policy ESD 6: Sustainable Flood Risk Management

1.4 This policy aims to reinforce the guidance set out in the NPPF and outlines Cherwell District’s requirements for new developments in respect to flooding. As with the requirements of the NPPF, ESD 6 outlines the requirements of site-specific flood risk assessment. The policy states that:

"The Council will manage and reduce flood risk in the District through using a sequential approach to development; locating vulnerable developments in areas at lower risk of flooding. Development proposals will be assessed according to the sequential approach and where necessary the exceptions test as set out in the NPPF and NPPG. Development will only be permitted in areas of flood risk when there are no reasonably available sites in areas of lower flood risk and the benefits of the development outweigh the risks from flooding.

In addition to safeguarding floodplains from development, opportunities will be sought to restore natural river flows and floodplains, increasing their amenity and biodiversity value. Building over or culverting watercourses should be avoided and the removal of existing culverts will be encouraged.

Existing flood defences will be protected from damaging development and where development is considered appropriate in areas protected by such defences it must allow for the maintenance and management of the defences and be designed to be resilient to flooding.

Site specific flood risk assessments will be required to accompany development proposals in the following situations:

- All development proposals located in flood zones 2 or 3
- Development proposals of 1 hectare or more located in flood zone 1
- Development sites located in an area known to have experienced flooding problems
- Development sites located within 9m of any watercourses.

Flood risk assessments should assess all sources of flood risk and demonstrate that:

- There will be increase in surface water discharge rates or volumes during storm events up to and including the 1 in 100 year storm event with an allowance for climate change (the design storm event)
- Developments will not flood from surface water up to and including the design storm event or any surface water flooding beyond the 1 in 30 year storm event, up to and including the designs storm event will be safely contained on site.

Development should be safe and remain operational (where necessary) and proposals should demonstrate that surface water will be managed effectively on site and that development will not increase flood risk elsewhere, including sewer flooding."

Policy ESD 7: Sustainable Drainage Systems (SuDS)

1.5 This policy aims to promote the use of SuDS for all new developments in the management of surface water runoff. The policy states that;

"All development will be required to use sustainable drainage systems (SuDS) for the management of surface water run-off.

Where site specific Flood Risk Assessments are required in association with development proposals, they should be used to determine how SuDS can be used on particular sites and to design appropriate systems. In considering SuDS solutions, the need to protect ground water quality must be taken into account, especially where infiltration techniques are proposed. Where possible, SuDS should seek to reduce flood risk, reduce pollution and provide landscape and wildlife benefits. SuDS will require the approval of Oxfordshire County Council as LLFA and SuDS Approval Body, and proposals must include an agreement on the future management, maintenance, and replacement of the SuDS features"

Strategic Flood Risk Assessment

1.6 CDC produced a Strategic Flood Risk Assessment (SFRA) in May 2017 which provides an update on a previous version dealing with new policy and a summary of flood risk in Cherwell. The document provides guidelines on use of SuDS and guidance for FRAs.

1.7 The document requires consideration of groundwater emergence as part of the decision-making process on the type of the SuDS techniques. The list of items to be provided within a site drainage strategy is included below:

1. SuDS proposals
2. Outfall locations and levels, including confirmation from relevant authorities that the proposed outfall location will be accepted
3. Rates of discharge including confirmation from relevant authorities that the proposed discharge rate will be accepted
4. On-site storage requirements including storage location indicated within the proposed development plan, confirmation that is it is to be located outside the existing 1% AEP+CC flood extent, and evidence that sufficient space is available
5. Maintenance, funding and operation proposals for the SuDS.

Oxfordshire Flood Risk Management Plan

1.8 Oxfordshire County Council (OCC) acts as the Lead Local Flood Authority (LLFA) for the county. A Flood Risk Management Strategy has been produced by the LLFA as part of this role, with an aim to:

1. Setting out a long-term programme for flood risk reduction.
2. Setting out procedures for identifying relative priorities of measures for flood risk reduction.
3. Establish how to find area where a holistic approach to flood risk reduction will achieve multiple benefits.
4. Establish how to identify affordable measures for implementation to agreed time frames.
5. Facilitate engagement and consultation with community and strategic partners.
6. Encourage public awareness and self-help where appropriate.

Appendix E

Rainwater Harvesting System

SDS Intellistorm

Introduction

This document outlines the controls specification for the Intellistorm Attenuation Control system as required. The following outlines the key control arrangements for the system.

Summary

The Intellistorm system is designed to manage and control stormwater attenuation systems in an intelligent, responsive manner, enabling local stormwater re-use. Intellistorm is coupled with a range of assets, including pumps, tanks, water treatment and instrumentation to achieve total stormwater management and re-use.

The system operates two parallel sub-systems. These systems are designed to operate separately thus ensuring a simple and secure control methodology of the most important function, stormwater attenuation.

1. Attenuation Control - All rainwater falling upon a site, building or hardstanding is directed to the attenuation storage tank. This tank’s level is monitored in real time by the main Intellistorm control system by way of level switches, sensors, and a remote relay panel.

The Intellistorm system receives a daily update of rainfall forecast via a gsm connection covered by a contract connection managed by SDS Ltd. A daily SMS informs the system of the incoming rainfall for the following 24-hour period in a mm rainfall format.

Intellistorm uses this information, combined with the known site surface rainfall collection area to calculate an incoming rainfall volume. This is then actioned as a required tank void and thus a target tank level (available capacity within the attenuation tank).

Connected attenuation pumps / Valves are activated to empty the tank to the correct level and thereafter monitor the tank level, ensuring the void is maintained.

2. Water Reuse - A transfer pump is connected to the attenuation to transfer water to the collection tank. This pump delivers water for treatment and re-use. This pump cannot interact with tank level and simply receives data from the control system indicating “water is available for reuse”.

The delivery path for water reuse in this instance, delivers water untreated, direct to the untreated greywater tank, thereafter, all treatment and control is undertaken by the greywater system, using the submersible macerator supply pump interconnected to the GWOD system.

Design

Key Attributes

1. Reliability

Due to the nature of the system, reliability is the most important factor of any design and must be considered at every stage of the design process. Beginning with component selection and future availability, through to longevity of materials and overall control theory incorporating failsafe redundancy.

2. Ease of installation

Systems are installed in partnership by SDS Ltd and several mechanical and electrical companies. Simple steps, ranging from superior labelling through to common sense arrangement of system connections will enable a more fluid and overall more cost effective onsite installation process both for SDS ltd and its clients.

3. Ease of Operation

Due to the end user nature (Facilities Management) any system must ultimately present itself to the client in an easy to understand manner, this will in turn benefit the client through simple onsite rectification of minor issues and benefit SDS Ltd through the ability to provide telephone support where historically a site visit may have been required.

4. Low Maintenance

The system is designed in line with two maintenance visits per annum per site.
In this instance, consumables have been requested to add additional filtration capabilities, these will require routine checking during the inter-maintenance period.

System Design

For clarity, the equipment concerned is separated into two unique physical locations, with attenuation and pumping equipment located in the tank area and the main body of Intellistorm controls located within the greywater treatment plant room.

Whilst pumps will contain on board control panels including variable speed drive, all start/stop control is derived from the Intellistorm system

A safety level has been agreed, the system will provide a fixed level top out at this point, ensuring tank volume never increases beyond this (except during 100yr rainfall events)

The attenuation tank system contains a single 4-20ma hydrostatic level sensor providing real time tank volume to the Intellistorm control system. The Intellistorm panel will accept both a calibration of the sensor and an adjustment of the tank volume by input of tank dimensions (all tanks are cuboid), combining to provide tank volume indication on HMI.

The level sensor is the primary point of level measurement, however in the event of a level sensor failure, the system will automatically empty the tank, using 4 x Tilt level switches which are present within the attenuation tank and continue in this fashion indefinitely.

1. Pump dry run protection – 10% (subject to calculation of outlet height)
2. Tank empty (stop pumps) - 15%
3. Tank full (start pumps) – 35%
4. Tank overflow alarm (start pumps and alarm) – 90%

Thus allowing the system to function in attenuation only status, maintaining an empty tank until level sensor remediation.

Rainwater Reclaim Pumps - Location: Tank Area

Each pumpset consists a single pump with integrated variable speed drive supplied by Xylem water (albeit mounted on the same baseplate as the above attenuation pumpset). These pumps receive constant power from the Intellistorm system, receive a dedicated run/stop signal and provide a fault signal back to the Intellistorm system.

These pumps supply water to the untreated greywater tank via a single outlet with demand signal received by the main Intellistorm control panel based on the operation of the demand level switch located within the untreated greywater tank. The HMI allows the user to manually operate the pump through a manual/off/auto switch function.

Controls Design

All programming is created in industry standard language and full ladder logic will be made available on demand.

Main Intellistorm Control Panel (1 of) – Location: Greywater Plant Area

The main Intellistorm Control Panel provides all user function and control of assets related to the Intellistorm System. This panel is designated Intellistorm Controller 2018-1.

A local power supply (240vac 32a) is provided to this control panel. The panel includes a rotary isolator enabling complete power shutdown of the panel and all connected assets. All other control is achieved via the Siemens HMI. The Siemens HMI (appendix 12) requires password access and allows 2 tiers of user;

1. Admin (full control)

2. Engineer (access only, no setpoint changes)

The system contains a dedicated GSM sim card and aerial allowing the system to receive daily sms input. The HMI is P&ID based in design, whereby a user can follow the overall system schematic, selecting components where appropriate.

Default Screen

The default screen resides on a simplified P&ID of the system whereby individual assets may be selected. The system defaults to screensaver mode if no activity within 5 minutes.

Attenuation Tanks Screen

This screen displays the attenuation tank and their respective volumes, in percentage capacity figures. Graphics are intuitive whereby a full tank is denoted by a tank filled with water and, an empty one devoid of water.

Pressing on an individual tank enables the user to enter a settings screen for that specific tank. The settings screen enables the user to input the following settings attributable to that tank including;

Tank dimensions, length x height x width in metres. Autocalculation of max tank volume based on above calculation (429.95M3) Level Sensor Depth range in metres 3/5/10, Surface area of site attributed to that tank in m2. An arrow from the main tank screen allows the user to move on to the Pumps Screen.

Pumps

This page displays all system pumps. When a pump is running (in so far as the system has signalled it to run and no fault is present) a pump will indicate as green, when in fault as red and if manually switched off, as grey.

In all cases, pumps are selectable as manually on/off/auto to enable maintenance works. In the case of the twin pump duplex pumpsets, selecting manually on serves to activate only the duty pump as controlled by the pumpset onboard controller. An arrow allows the user to select the next screen as below.

Intellistorm Settings Screen

This screen enables the user to adjust the following settings,

Intelligent/Attenuation Operation

A button enables the user to terminate intelligent operation, this will default the system to operate on the level switches only, maintaining the tank at empty status. This may be selected if the end user declines to renew subscription.

Hydrostatic Levels

Active when the system is operating in intelligent mode using the hydrostatic level sensor for control of attenuation pumps and attenuation tank level.

1. Dry Run Protection Level (%) – This is the level at which pumps will not operate due to tank low level and cause alarm output.

2. Tank Empty Level (%) – This is the level at which both the attenuation pumps and rainwater reuse pump will cease operating due to lack of water.

3. Tank Full Level (%) – This is the level at which the tank is designated full. This will be at approximately 80% of overflow level and pumping will initiate regardless of intelligent input.

4. Tank Emergency Level (%)– This is the level at which the tank has reached its maximum capacity prior to overflow and at which point it has been deemed that outlet pumping has failed and user intervention is required. This will be at approximately 90% of tank overflow level.

5. Safety Factor (%) – This is effectively the hysteresis of pump operation during intelligent control as described further later.

Details Screen

This screen displays the following details which cannot be adjusted and are for reference only;

System address: (Phone no of sim card) System postcode: Site Postcode

System Model No: Intellistorm 2019-1-CWT3 Manufacturer name: SDS Ltd

Fault Screen

A record of all faults as described later are collated within the fault area, all faults history must be manually cleared. Where a fault has not been acknowledged, it is highlighted. All fault history is downloadable via USB.

Data and Background Program

Both the system’s internal SIM card and the data input stream are covered by contract with SDS ltd for year 1 from practical completion of build (PC) continuing as part of a maintenance agreement with SDS ltd thereafter. An SMS input format has been agreed for the site based on the postcode.

This postcode ensures Intellistorm receives daily SMS weather alerts specific to the geographical area applicable to this Intellistorm System.

Daily, an SMS is automatically generated and sent to the system, received on number xxxxxxxxxxxx. SMS will be in the following format: 06-07-07-2020

Where 06 denotes the mm of rainfall received by the site and 07-07-2020 denotes the 24 hr period for which the forecast pertains to.

Texts will be received the preceding day at 9am. Example. Monday 1st May at 9am, an SMS will be received as above pertaining to the 24hr period commencing 00:00 2nd may and finishing 23:59 2nd may.

Intellistorm uses the above data to interpret the sites volumetric rainfall catchment using the total surface area attributed to the attenuation tanks multiplied by the received mm of rainfall.

Example Only - During setup, input that RWH5 is a tank measuring 10m x 5m x 4m, therefore 200m3 capacity tank.

During setup, input that RWH5 is linked to a collection area of 500m2. During setup, tank full setpoint is input as 80%.

During setup, safety factor is input at 5%

At 9am on the 1st May, the system receives an SMS of 06

2/5/18

Based on the received SMS of 06mm, Intellistorm will convert the received SMS from millimetres to meters by dividing by 1000

ie. 06/1000 = 0.06m.

The system will now calculate the volume of rainfall received based on the surface area multiplied by the rainfall depth ie;

500m2 x 0.06m = 30m3

This is in turn factored into a percentage of total tank capacity required as a void. Ie. (30m3/200m3)*100 = 15%

And inverted to a target capacity. The target capacity is the “tank full setpoint” minus the percentage void required.

Ie. 80%-15% = 65% target capacity

The system will, 12 hours following SMS receipt (9pm), interrogate the tank volume of RWH5. Should this already be below target capacity ie at <65%, no action will be taken.

Should the tank be at a level higher than this, ie. >65%, then the tank will commence emptying until the tank volume is realised lower than 65%.

There is a minimum run duration of 3 minutes (with the exception of dry run protection) to prevent pump burnout.

Tank level is then continuously monitored for the next 24 hours and should tank level exceed the safety factor+ target capacity.

Ie. 65% +5% = 70%

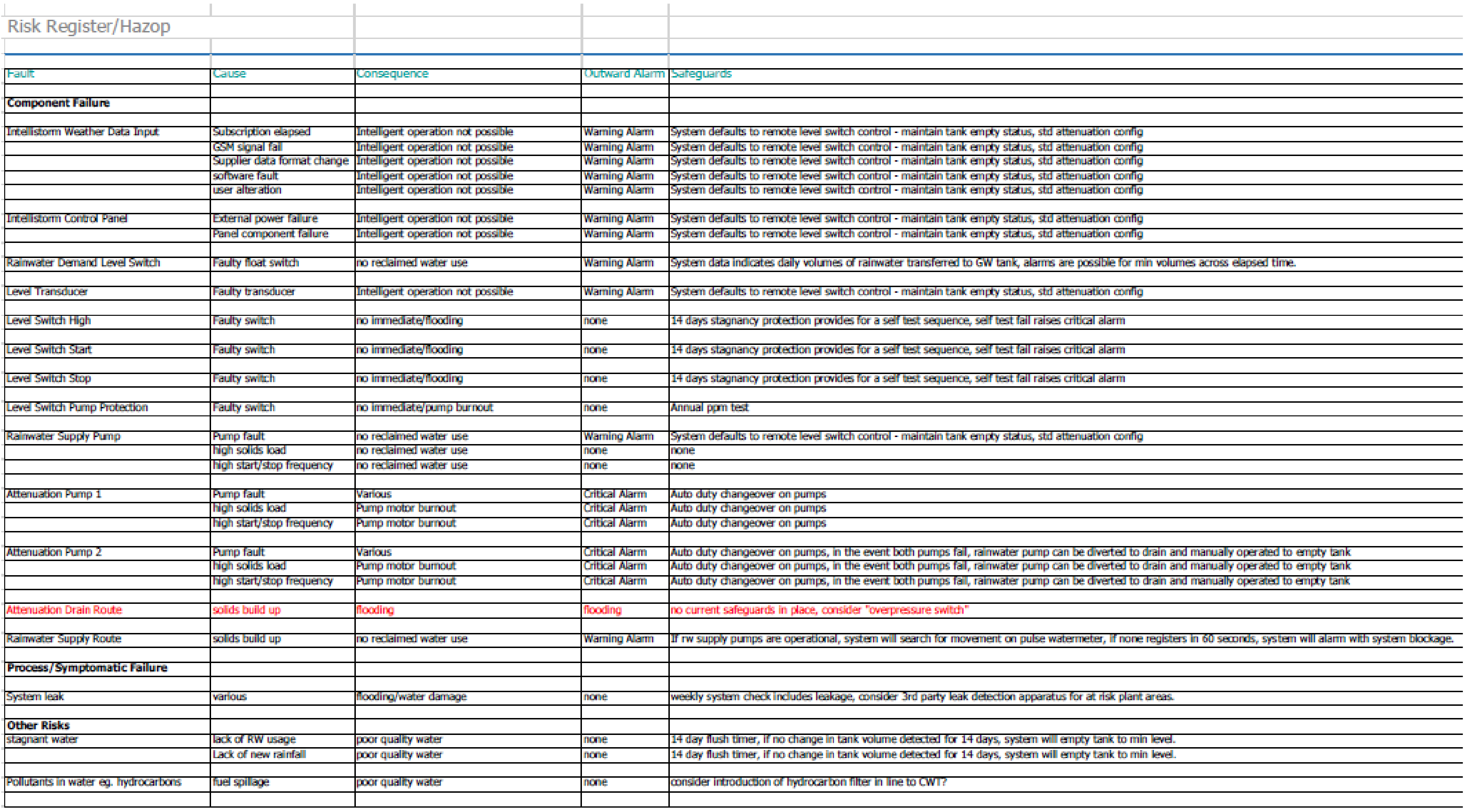
Then the pumps / Valves will be re-operated to achieve a tank volume less than target capacity. This process continues through to re-evaluation at 9pm the following day where the next target capacity is applied.

Stagnancy protection sequence inc level switch test

Every 14 days (adjustable 0-30 days on the HMI, the system performs a self-test and anti-stagnancy sequence. Whereby, a drain down of the attenuation tank will occur, taking level to the "tank empty level" on hydrostatic level sensor, which should be located below the backup L2-RWH level switch.

During this sequence, if level switch L2 fails to operate, an alarm will be reported as a warning alarm.

Faults



Risk Register/Hazop

Fault	Cause	Consequence	Outward Alarm	Safeguards
Component Failure				
Intellistorm Weather Data Input	Subscription elapsed	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
	GSM signal fail	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
	Supplier data format change	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
	software fault	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
	user alteration	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
Intellistorm Control Panel	External power failure	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
	Panel component failure	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
Rainwater Demand Level Switch	Faulty float switch	no reclaimed water use	Warning Alarm	System data indicates daily volumes of rainwater transferred to GW tank, alarms are possible for min volumes across elapsed time.
Level Transducer	Faulty transducer	Intelligent operation not possible	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
Level Switch High	Faulty switch	no immediate/flooding	none	14 days stagnancy protection provides for a self test sequence, self test fail raises critical alarm
Level Switch Start	Faulty switch	no immediate/flooding	none	14 days stagnancy protection provides for a self test sequence, self test fail raises critical alarm
Level Switch Stop	Faulty switch	no immediate/flooding	none	14 days stagnancy protection provides for a self test sequence, self test fail raises critical alarm
Level Switch Pump Protection	Faulty switch	no immediate/pump burnout	none	Annual ppm test
Rainwater Supply Pump	Pump fault	no reclaimed water use	Warning Alarm	System defaults to remote level switch control - maintain tank empty status, std attenuation config
	high solids load	no reclaimed water use	none	none
	high start/stop frequency	no reclaimed water use	none	none
Attenuation Pump 1	Pump fault	Various	Critical Alarm	Auto duty changeover on pumps
	high solids load	Pump motor burnout	Critical Alarm	Auto duty changeover on pumps
	high start/stop frequency	Pump motor burnout	Critical Alarm	Auto duty changeover on pumps
Attenuation Pump 2	Pump fault	Various	Critical Alarm	Auto duty changeover on pumps, in the event both pumps fail, rainwater pump can be diverted to drain and manually operated to empty tank
	high solids load	Pump motor burnout	Critical Alarm	Auto duty changeover on pumps, in the event both pumps fail, rainwater pump can be diverted to drain and manually operated to empty tank
	high start/stop frequency	Pump motor burnout	Critical Alarm	Auto duty changeover on pumps, in the event both pumps fail, rainwater pump can be diverted to drain and manually operated to empty tank
Attenuation Drain Route	solids build up	flooding	flooding	no current safeguards in place, consider "overpressure switch"
Rainwater Supply Route	solids build up	no reclaimed water use	Warning Alarm	If rw supply pumps are operational, system will search for movement on pulse watermeter, if none registers in 60 seconds, system will alarm with system blockage.
Process/Symptomatic Failure				
System leak	various	flooding/water damage	none	weekly system check includes leakage, consider 3rd party leak detection apparatus for at risk plant areas.
Other Risks				
stagnant water	lack of RW usage	poor quality water	none	14 day flush timer, if no change in tank volume detected for 14 days, system will empty tank to min level.
	Lack of new rainfall	poor quality water	none	14 day flush timer, if no change in tank volume detected for 14 days, system will empty tank to min level.
Pollutants in water eg. hydrocarbons	fuel spillage	poor quality water	none	consider introduction of hydrocarbon filter in line to CWT?

Intellistorm Calculation Operational Theory

Typical operation - Attenuation

At 9am, Intellistorm Control System receives update text message detailing the following days predicted rainfall in mm for the specific postcode

eg. on 1st september, system receives sms “E1 1BB, 20” (20mm of rainfall predicted at E1 1BB between 9am on the 2nd sept and 9am on the 3rd).

The system will be programmed with the roof area associated with each connected attenuation system eg 4560m2 for attenuation tank 1.

The system then calculates, based on collection areas and 20mm of rainfall, approximately 2m3 of rainfall will travel to tank. The system then monitors current tank volume within the attenuation tank and where necessary, commencing 9am, activates attenuation valve to reduce and maintain tank level to appropriate void. If tank level is already below desired level, system does not activate.

EG Tank1. Full level is 429.95m3, tank level at 9am on 2nd sept is 429.95m3. System activates attenuation valve to reduce level to 427.95m3, creating 2m3 void.

Using appropriate hysteresis, system continues to operate valves to maintain max tank level of 429.95m3 at all times until 9am on 3rd, where system will default to newly received data and new tank void requirement. In the event of panel failure or lack of input data, system defaults to normal attenuation, ie. complete empty of tank using normal level switches.

Typical operation – Rainwater Reclaim

The rainwater system does not communicate with the attenuation system operating as a standalone system although sharing some resource such as level switches. The rainwater system searches for available rainwater volume within attenuation tank. If water is present, and demand within the untreated greywater water tank calls for rainwater, the system will supply rainwater to meet demand.

Requirements

Intellistorm requires a continuous GSM signal. This can be achieved in-situ where plant rooms are above ground and receive sufficient coverage, or through the use of a small remote aerial mounted externally (supplied) and connected to the main control panel. Where this cannot be achieved, an option exists to reconfigure the system to utilise local network or wifi signal. This requires factory configuration and may require component changeout if performed onsite.

Intellistorm Limitations

The Intellistorm system requires a continuous GSM connection. This is received by way of an Aerial. This must be mounted in a location with signal. To this end, SDS Ltd will provide an aerial box with 20m of extension cable (Ethernet+7 core 1mm). It is the responsibility of site to both provide a continuous containment route and install this cable within said route, reaching from Intellistorm panel to signal location. Any extension to this distance is chargeable. It is important to note that the Intellistorm system has been designed for NON green/blue roof areas, inclusion of these items will negatively impact water quality and may affect system performance.

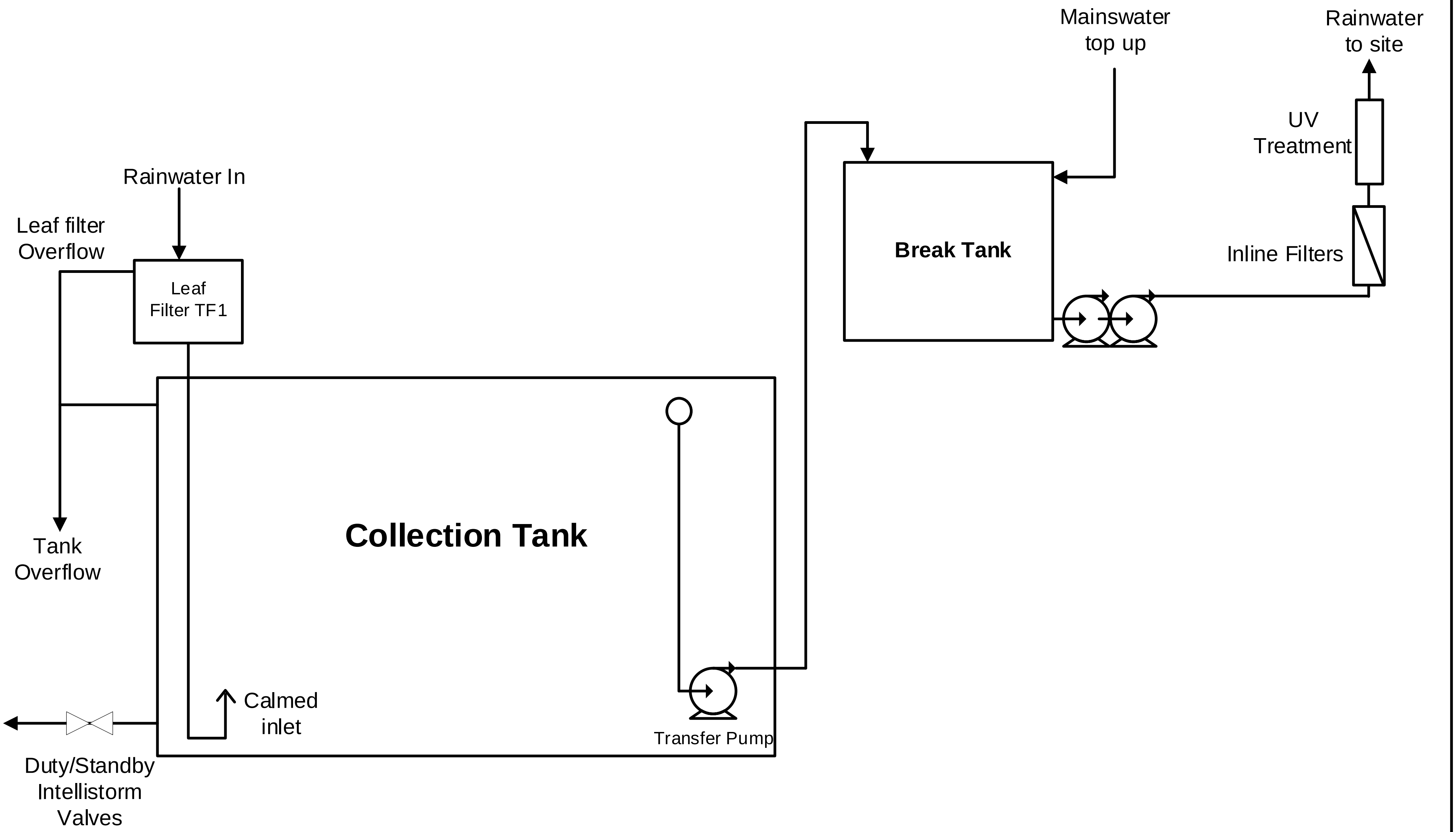
Other

1. On power failure, the system will automatically reboot without user intervention to normal operation

2. All supplied material will meet all applicable legislation relevant to the supply of electrical equipment suitable for end user market.

3. System will be supplied with all necessary wiring diagrams, and PLC ladder diagrams and full copy of programming.

The following datasheets comprise the component materials of the Intellistorm System.



Client	SDS	Details
Project Name	Standard Detail	
Type	Intellistorm RWH Layout	
Date	14.10.20	
Drawing no.	-	
Revision	A	

Notes:

This Drawing is to be read in conjunction with all relevant Architect, Engineers and Specialists drawings and specifications.

Do not scale from the drawing in either paper or digital form. Use written dimensions only.

SDS
Water
Infrastructure
Systems

Planning your wastewater

We’ve put together some information on sewerage to help you plan your new development.

How long does it take to get consent to connect to a sewer?

If you’re applying for consent to connect to a sewer under Section 106 of the Water Industry Act 1991, you’ll need to give us 21 days’ notice.

I think I’ll need to connect to a trunk sewer – is that possible?

Connecting directly to trunk sewers can be complex and dangerous, and we won’t permit this at all in London. If you’re considering a trunk sewer as a point of connection, please contact us as soon as possible to discuss.

How do I handle trade effluent and groundwater discharges?

You mustn’t discharge non-domestic waste to our sewers without a valid trade effluent consent - doing this is an offence under Section 109(1) of the Water Industry Act 1991. You can call our trade effluent team on 0203 577 9200 to get help with trade effluent consents and ground water discharge permits.

Where can I discharge surface water?

The Lead Local Flood Authority, or if you are in a London Borough, ‘The London Plan’, advises that your development should utilise sustainable drainage systems (SuDS) unless there are practical reasons for not doing so. You should aim to achieve greenfield run-off rates and ensure you manage surface water run-off as close to its source as possible in line with the following drainage hierarchy:

1. Store rainwater for later use.
2. Use infiltration techniques, such as porous surfaces in non-clay areas.
3. Attenuate rainwater in ponds or open water features for gradual release.
4. Attenuate rainwater by storing in tanks or sealed water features for gradual release.
5. Discharge rainwater direct to a watercourse.
6. Discharge rainwater to a surface water sewer or drain.
7. Discharge rainwater to a combined sewer.

Please note that if you’re discharging surface water anywhere other than to a public sewer – such as to a watercourse – you’ll need approval from the relevant authority, for example the Environment Agency, the local authority or the Canals and Rivers Trust.

If you don’t follow the surface water hierarchy you may not be granted planning permission, and Thames Water may seek to put conditions on the planning application.

There’s no right of discharge of highway drainage into the public sewerage system, and we’d need to agree this with the relevant highway authority under Section 115 of the Water Industry Act 1991. You can contact us to discuss this further.

What can I do about redundant sewers and rising mains on my site?

On brownfield sites where existing sewers or rising mains need to be made redundant or diverted, the developer will need to fund the work, as set out in Section 185 of the Water Industry Act. If there’s no practical way of making a diversion, we’ll apply the standoff distances in Sewers for Adoption 7th edition to assess the width of easement required.

Appendix F

Permitted Drainage Schemes for Other Local Developments

COUNTY COUNCIL'S RESPONSE TO CONSULTATION ON THE FOLLOWING DEVELOPMENT PROPOSAL

District: Cherwell
Application No: 18/01253/F-2
Proposal: Erection of hotel and conference facility with associated access, parking, and landscaping.
Location: Bicester Heritage, Buckingham Road, Bicester.

Response date: ***24th October 2018***

This report sets out the officer views of Oxfordshire County Council (OCC) on the above proposal. These are set out by individual service area/technical discipline and include details of any planning conditions or informatives that should be attached in the event that permission is granted and any obligations to be secured by way of a S106 agreement. Where considered appropriate, an overarching strategic commentary is also included. If the local County Council member has provided comments on the application these are provided as a separate attachment.

Application no: 18/01253/F-2
Location: Bicester Heritage, Buckingham Road, Bicester.

Strategic Comments

The road network in the vicinity of this site plays a key role in the area transport strategy. It is therefore to see that the issues raised have been resolved.

Officer's Name: Jacqui Cox
Officer's Title: Infrastructure Locality Lead Cherwell & West
Date: 24 October 2018

Application no: 18/01253/F-2
Location: Bicester Heritage, Buckingham Road, Bicester.

General Information and Advice

Recommendations for approval contrary to OCC objection:
IF within this response an OCC officer has raised an objection but the Local Planning Authority are still minded to recommend approval, OCC would be grateful for notification (via planningconsultations@oxfordshire.gov.uk) as to why material consideration outweigh OCC's objections, and given an opportunity to make further representations.

Outline applications and contributions
The number and type of dwellings and/or the floor space may be set by the developer at the time of application, or if not stated in the application, a policy compliant mix will be used for assessment of the impact and mitigation in the form of s106 contributions. These are set out on the first page of this response.

In the case of outline applications, once the unit mix/floor space is confirmed by the developer a matrix (if appropriate) will be applied to assess any increase in contributions payable. The matrix will be based on an assumed policy compliant mix as if not agreed during the s106 negotiations.

Where unit mix is established prior to commencement of development, the matrix sum can be fixed based on the supplied mix (with scope for higher contribution if there is a revised reserved matters approval).

Where a S106/Planning Obligation is required:

- **Index Linked** – in order to maintain the real value of s106 contributions, contributions will be index linked. Base values and the index to be applied are set out in the Schedules to this response.

- **Security of payment for deferred contributions** – An approved **bond** will be required to secure payments where the payment of S106 contributions (in aggregate) have been agreed to be deferred to post implementation and the total County contributions for the development exceed £1m (after indexation).

- **Administration and Monitoring Fee -** £0
  This is an estimate of the amount required to cover the extra monitoring and administration associated with the S106 agreement. The final amount will be based on the OCC's scale of fees and will adjusted to take account of the number of obligations and the complexity of the S106 agreement.

- **OCC Legal Fees** The applicant will be required to pay OCC's legal fees in relation to legal agreements. Please note the fees apply whether an s106 agreement is completed or not.

CIL Regulation 123

Due to pooling constraints for local authorities set out in Regulation 123 of the Community Infrastructure Levy Regulations 2010 (as amended), OCC may choose not to seek contributions set out in this response during the s106 drafting and negotiation.

That decision is taken either because:

- OCC considers that to do so it would breach the limit of 5 obligations to that infrastructure type or that infrastructure project or
- OCC considers that it is appropriate to reserve the ability to seek contributions to that infrastructure type or that infrastructure project in relation to the impacts of another proposal.

The district planning authority should however, take into account the whole impact of the proposed development on the county infrastructure, and the lack of mitigation in making its decision.

Application no: 18/01253/F-2
Location: Bicester Heritage, Buckingham Road, Bicester.

Transport Schedule

Recommendation:

No objection subject to:

- **S106 Contributions** as set out and justified in the county council's previous response dated 7 September 2018:

- **An obligation to enter into a S278** agreement as detailed below.

- **Planning Conditions** as detailed below.

Key Points

This updated response should be read in conjunction with the county council's previous response dated 7 September 2018.

In that response the county council set out an objection to the application for the following reasons:

- *An amendment to the layout of the site access is required in order to accommodate the movements of the largest vehicles anticipated to require access to the site.*
- *It is not clear from the drawings submitted whether the proposed mitigation schemes can be delivered within the highway boundary and without detriment to existing pedestrian and cycle infrastructure. Further details of these schemes are therefore required.*

To address these reasons for objection amended plans for the site access and junction mitigation schemes have been provided.

The county council is satisfied with the proposed arrangements for the site access and junction mitigation schemes and therefore these objections can be removed.

Comments:

Site Access

The site access has been amended and a new swept path analysis has been submitted which demonstrates that the largest vehicles anticipated to require access to the site can safely and easily enter and exit via the site access. The county council is satisfied with the plans submitted and can withdraw the previous objection related to the layout of the site access. The site access highway works will be subject to a full technical audit as part of the S278 Agreement.

Junction Mitigation Schemes

The county council previously objected to the proposed scheme as it was unclear whether the proposed junction improvements could be accommodated within the highway boundary and without detriment to existing footways and cycleways.

Amended plans have since been submitted which include the extent of the highway boundary and which also address some points identified since the county council's previous response.

A4421 / Launton Road / Skimmingdish Lane / Care home access roundabout
The scheme proposed for the A4421 / Launton Road / Skimmingdish Lane / Care home access roundabout junction has been amended to take account of recently completed improvements at that junction. The proposed arrangement set out in Drawing No: J32-3569-PS-112 Rev D is acceptable and will be subject to a full technical audit as part of the S278 Agreement.

Skimmingdish Lane / Buckingham Road / A4095 roundabout
The proposed improvement scheme at the Skimmingdish Lane / Buckingham Road / A4095 roundabout junction has also been amended to ensure that minimum lane widths of 3m at the point of each lane's marked separation can be accommodated on all arms. The proposed arrangement set out in Drawing No: J32-3569-PS-110 Rev D is acceptable and will be subject to a full technical audit as part of the S278 Agreement.

The county council can therefore remove the second reason for objection.

A4095 / B4100 / Banbury Road junction

The Transport Assessment submitted with the application sets out that a scheme to mitigate the impact of development traffic at this junction is required.

The county council has made a bid for Garden Town funding towards a wider capacity improvement scheme at this junction, however no announcement has yet been made as to whether that bid has been successful.

The county council has also sought developer contributions towards wider improvements at this junction from other developments in this area. Any such improvements would make the mitigation scheme proposed by the applicant in Drawing No: J32-3569-PS-111 Rev: B abortive.

Therefore, rather than implement the mitigation scheme proposed by the applicant, the county council would usually seek a financial contribution towards a wider improvement scheme at this junction - to the same equivalent value of the cost of the proposed mitigation scheme.

However, due to CIL regulation 123 pooling restrictions, no such contribution towards improvements at this junction is sought from this application.

S278 Highway Works:

An obligation to enter into a S278 Agreement will be required to secure mitigation/improvement works, including:

- Site access junction as indicated in Drawing No: J32-3569-PS-100 Rev B
- Widening of Buckingham Road at the site access in order to form a ghost island right-turn lane as indicated in Drawing No: J32-3569-PS-100 Rev B
- Informal tactile pedestrian / cycle crossing adjacent to the site access to include a pedestrian refuge island on Buckingham Road
- Hardstanding for a pair of bus stops adjacent to the site access and informal tactile crossing
- Toucan crossing to the south of the Buckingham Road / Skimmingdish Lane priority junction as indicated in Drawing No: J32-3569-PS-100 Rev B
- 3m wide shared use footway / cycleway from the site access to the proposed toucan crossing outlined above, as indicated in Drawing No: J32-3569-PS-100 Rev B
- Junction capacity enhancement scheme at the A4421 / A4095 roundabout junction as indicated in Drawing No: J32-3569-PS-110 Rev D
- Junction capacity enhancement scheme at the A4421 / Launton Road / Care Home Access roundabout junction as indicated in Drawing No: J32-3569-PS-112 Rev D

Notes:
This is secured by means of S106 restriction not to implement development (or occasionally other trigger point) until S278 agreement has been entered into.
The trigger by which time S278 works are to be completed shall also be included in the S106 agreement.

Identification of areas required to be dedicated as public highway and agreement of all relevant landowners will be necessary in order to enter into the S278 agreements.

S278 agreements include certain payments that apply to all S278 agreements however the S278 agreement may also include an additional payment(s) relating to specific works.

Planning Conditions:
In the event that permission is to be given, the following planning conditions should be attached:

Access
Prior to the commencement of the development hereby approved, full details of the means of access between the land and the highway, including, position, layout, construction, drainage and vision splays shall be submitted to and approved in writing by the Local Planning Authority. This shall include details of an informal pedestrian crossing with pedestrian refuge island on Buckingham Road and a pair of bus stops adjacent to the site access and pedestrian crossing. Thereafter, the means of access shall be constructed and retained in accordance with the approved details.

Reason: In the interest of highway safety.

Travel Plan

Prior to the first occupation of the development hereby approved, a Travel Plan, prepared in accordance with Oxfordshire County Council's approved Travel Plan guidance shall be submitted to and approved in writing by the Local Planning Authority. Thereafter, the approved Travel Plan shall be implemented and operated in accordance with the approved details.

Reason: In the interests of sustainability and to ensure a satisfactory form of development, in accordance with the Government guidance contained within the National Planning Policy Framework.

CTMP

A Construction Travel Management Plan (CTMP) will be needed for this development, given the traffic sensitive nature of the potential approach routes on the wider strategic road network in and around Bicester. We would expect the CTMP to incorporate the following in detail:

- The CTMP must be appropriately titled, include the site and planning permission number.
- Routing of construction traffic and delivery vehicles is required to be shown and signed appropriately to the necessary standards/requirements. This includes means of access into the site.
- Details of and approval of any road closures needed during construction.
- Details of and approval of any traffic management needed during construction.
- Details of wheel cleaning/wash facilities – to prevent mud etc, in vehicle tyres/wheels, from migrating onto adjacent highway.
- Details of appropriate signing, to accord with the necessary standards/requirements, for pedestrians during construction works, including any footpath diversions.
- The erection and maintenance of security hoarding / scaffolding if required.
- A regime to inspect and maintain all signing, barriers etc.
- Contact details of the Project Manager and Site Supervisor responsible for on-site works to be provided.
- The use of appropriately trained, qualified and certificated banksmen for guiding vehicles/unloading etc.
- No unnecessary parking of site related vehicles (worker transport etc) in the vicinity – details of where these will be parked and occupiers transported to/from site to be submitted for consideration and approval. Areas to be shown on a plan not less than 1:500.
- Layout plan of the site that shows structures, roads, site storage, compound, pedestrian routes etc.
- A before-work commencement highway condition survey and agreement with a representative of the Highways Depot – contact 0845 310 1111. Final correspondence is required to be submitted.
- Local residents to be kept informed of significant deliveries and liaised with through the project. Contact details for person to whom issues should be raised with in first instance to be provided and a record kept of these and subsequent resolution.
- Any temporary access arrangements to be agreed with and approved by Highways Depot.

- Details of times for construction traffic and delivery vehicles, which must be outside network peak and school peak hours.

Reason: In the interests of highway safety and to mitigate the impact of construction vehicles on the surrounding network, road infrastructure and local residents, particularly at peak traffic times.

Drainage
Development shall not begin until a surface water drainage scheme for the site, based on sustainable drainage principles and an assessment of the hydrological and hydro-geological context of the development, has been submitted to and approved in writing by the local planning authority. The scheme shall subsequently be implemented in accordance with the approved details before the development is completed. The scheme shall also include:

- Discharge Rates
- Discharge Volumes
- Infiltration in accordance with BRE365 (To include infiltration testing; seasonal monitoring and recording of groundwater levels)
- SuDS (Underground geo-cellular soakaway, Swale, Permeable Paving)
- Maintenance and management of SuDS features (To include provision of a SuDS Management and Maintenance Plan)
- Detailed drainage layout with pipe numbers
- Network drainage calculations
- Phasing
- Flood Flow Routing in exceedance conditions (To include provision of a flood exceedance route plan)

Officer’s Name: Tim Peart
Officer’s Title: Senior Transport Planner
Date: 24 October 2018

GENERAL NOTES

1. All setting out to be in accordance with the Architects drawings. Any discrepancies between the Engineers and the Architects drawings to be referred to the Architect before proceeding. Dimensions must not be scaled.
2. All drainage to be installed in accordance with relevant Building Regulations documents and Current Sewers for Adoption where applicable.
3. Connections to Public sewers to be agreed and inspected by Water Authority.
4. Invert level, size and cover levels to existing manholes and sewers to be checked prior to any construction. Any discrepancies to be reported immediately.
5. Invert to base of soil stack bends to be 450mm below lowest branch connection for up to 3 storeys buildings. For buildings up to 5 storeys the invert to base of soil stack bends should be not less than 750mm.
6. All RWP and Foul Water drain point setting out is to be confirmed by Architect.
7. All RWP & SVP sizes & setting out by Architect / M&E Engineer. All below ground connections to match above ground outlet size, Min 100/110mm diameter.
8. Foul drains to project 100mm above finished floor level.
9. All internal Manholes and Inspection Chambers to have double sealed recessed covers to suit floor finishes by Architect.
10. All external covers in footpaths and roads in non tarmac areas to have recessed trays to suit the paving material.
11. Refer to drainage specification for pipe materials.
12. All pipework to be 100/110Ø UNO. Refer to note 7 connection sizes.
13. All foul and surface water drainage stacks to have above ground rodding access, refer to above ground drainage layout by others.
14. This drawing has been produced in colour and should be reproduced in colour for clarity.
15. A CCTV Survey and report in WINCAN format for all new drainage will be required before the "As Built" drawings will be issued.

Key

■	Road Gully
○	Storm Polypropylene Inspection Chamber
▭	Storm Concrete Inspection Chamber
◎	Storm Concrete Manhole
▨	Permeable Sub-base
▨	Permeable Paving
▨	Grasscrete Paving
●	Foul Polypropylene Inspection Chamber
■	Foul Concrete Inspection Chamber
●	Foul Concrete Manhole
— - — FW —	New Foul Sewer
— — — — — —	New Foul Rising Main
— — SW —	New Surface Water Sewer
▬ ▬ ▬ ▬ ▬ ▬	New Linear Drainage System
	Existing Drainage
□ □	Existing Manholes
—— Ex FW ——	Existing Foul Sewer
—— Ex SW ——	Existing Surface Water Sewer
—✕— Ex FW —✕— —✕— Ex SW —✕—	Existing Sewers to be abandoned and grouted up either end

🟦	Flooded Area max. 50mm deep.

Rev.	Amendment	Drn	Chkd	Date
P03	Drainage updated to suit revised entrance	NJ	GT	11.07.18
P02	Preliminary Issue	NJ	GT	29.06.18
P01	Preliminary Issue	NJ	GT	21.06.18

Drg. Status
Preliminary
Suitability

AKSWard②
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☐ London
☐ Hitchin
■ Oxford
☐ Southampton
☐ Birmingham

Client Bicester Heritage Ltd.

Project Bicester Heritage Hotel

Title
Flooded Areas
1 in 100 Year + 40% CC
Critical Storm

Reviewed Scheme GT Date 21.06.18

Reviewed Final Date

Scales at A1 1:250 Project No. X162034

Project Ref.	Originator	Zone	Level	Type	Role	Drg No.	Rev.
BHH	AKSW	XX	GF	DR	C	9209	P03

District: Cherwell
Application No: 20/01031/DISC
Proposal: Discharge of Condition 4 (Arboricultural Impact assessment, Tree Protection and Method Statement), 5 (Construction Traffic Management Plan), 6 and 7 (Archaeology), 8 (Sustainable urban drainage) and 10 (Landscape and Ecology Management Plan) of 19/00617/F.
Location: Land Adj To Warriner Game Court, The Warriner School, Banbury Road, Bloxham.

Lead Local Flood Authority

Recommendation:

Condition 8 not discharged

Detailed comments:

We are broadly happy in principle with the strategy however there are a couple of minor points to be addressed.

- Inline with our guidance FEH data should be used in rainfall models instead of FSR.
- Network details haven't been included in the model which include invert and cover levels of pipe runs. Cover levels also need to be included in the simulation results.

Although it looks ok in principle, we need this information to complete the review to ensure the design is fully compliant.

Officer's Name: Richard Bennett
Officer's Title: Flood Risk Engineer
Date: 18 May 2020

District: Cherwell
Application No: 20/01031/DISC-2
Proposal: Discharge of Condition 4 (Arboricultural Impact assessment, Tree Protection and Method Statement), 5 (Construction Traffic Management Plan), 6 and 7 (Archaeology), 8 (Sustainable urban drainage) and 10 (Landscape and Ecology Management Plan) of 19/00617/F.
Location: Land Adj To Warriner Game Court, The Warriner School, Banbury Road, Bloxham.

Lead Local Flood Authority

Recommendation:

Condition 8 not discharged

Detailed comments:

The information requested previously has now been provided and we have now been able to carry out a full review. There are a few minor issues that need addressing;

Imp Area in report and on Proforma = 0.780ha however, Imp Area in calculations = 0.682ha

Exceedance plan demonstrates the 100y+cc flood volumes will be contained within the site and not affect the proposed school building, however, the flood flow routes for storms in excess of the 100y+cc of system failure have not been shown on this plan.

A SuDS maintenance schedule has been provided however, it does not include maintenance activities for the First Defence treatment chamber.

No detailed sections of the SuDS features have been provided.

Officer’s Name: Richard Bennett
Officer’s Title: Flood Risk Engineer
Date: 03 August 2020

District: Cherwell
Application No: 20/01031/DISC-3
Proposal: Discharge of Condition 4 (Arboricultural Impact assessment, Tree Protection and Method Statement), 5 (Construction Traffic Management Plan), 6 and 7 (Archaeology), 8 (Sustainable urban drainage) and 10 (Landscape and Ecology Management Plan) of 19/00617/F.
Location: Land Adj To Warriner Game Court, The Warriner School, Banbury Road, Bloxham.

Lead Local Flood Authority

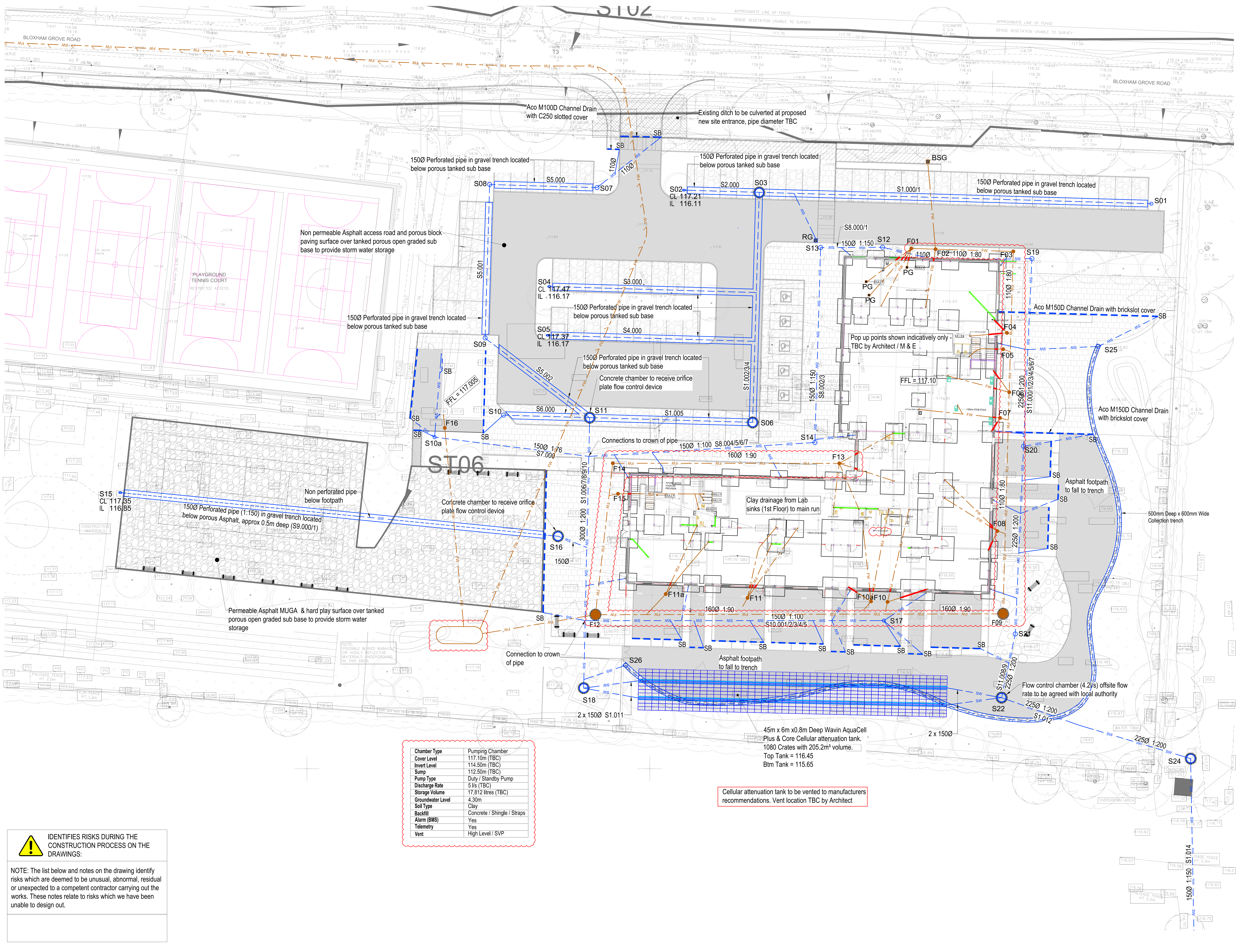
Recommendation:

No objection

Detailed comments:

The updated strategy addresses our previous comments and therefore we have no further concerns with the discharge of condition 8.

Officer's Name: Richard Bennett
Officer's Title: Flood Risk Engineer
Date: 03 September 2020



Chamber Type	Pumping Chamber
Cover Level	117.10m (TBC)
Invert Level	114.50m (TBC)
Sump	112.50m (TBC)
Pump Type	Duty / Standby Pump
Discharge Rate	5 l/s (TBC)
Storage Volume	17,812 litres (TBC)
Groundwater Level	4.30m
Soil Type	Clay
Backfill	Concrete / Shingle / Straps
Alarm (BMS)	Yes
Telemetry	Yes
Vent	High Level / SVP

IDENTIFIES RISKS DURING THE CONSTRUCTION PROCESS ON THE DRAWINGS:

NOTE: The list below and notes on the drawing identify risks which are deemed to be unusual, abnormal, residual or unexpected to a competent contractor carrying out the works. These notes relate to risks which we have been unable to design out.

GENERAL NOTES

1. All setting out to be in accordance with the Architects drawings. Any discrepancies between the Engineers and the Architects drawings to be referred to the Architect before proceeding. Dimensions must not be scaled.
2. All drainage to be installed in accordance with relevant Building Regulations documents and Current Sewers for Adoption where applicable.
3. Connections to Public sewers to be agreed and inspected by Water Authority.
4. Invert level, size and cover levels to existing manholes and sewers to be checked prior to any construction. Any discrepancies to be reported immediately.
5. Invert to base of soil stack bends to be 450mm below lowest branch connection for up to 3 storeys buildings. For buildings up to 5 storeys the invert to base of soil stack bends should be not less than 750mm.
6. All RWP and Foul Water drain point setting out is to be confirmed by Architect.
7. All RWP & SVP sizes & setting out by Architect / M&E Engineer. All below ground connections to match above ground outlet size, Min 100/110mm diameter.
8. Foul drains to project 100mm above finished floor level.
9. All internal Manholes and Inspection Chambers to have double sealed recessed covers to suit floor finishes by Architect.
10. All external covers in footpaths and roads in non tarmac areas to have recessed trays to suit the paving material.
11. Refer to drainage specification for pipe materials.
12. All pipework to be 100/110Ø UNO. Refer to note 7 connection sizes.
13. All foul and surface water drainage stacks to have above ground rodding access, refer to above ground drainage layout by others.
14. This drawing has been produced in colour and should be reproduced in colour for clarity.
15. A CCTV Survey and report in WINCAN format for all new drainage will be required before the "As Built" drawings will be issued.

Key

RG ■	Road Gully
BSG ■	Bin Store Gully
PG ■	Plantroom Gully
○	Storm Rodding Point
○	Storm Polypropylene Inspection Chamber
○	Storm Concrete Manhole
▭	Cellular Attenuation system
●	Foul Polypropylene Inspection Chamber
●	Foul Concrete Manhole
SB	New Linear Drainage System with Sump Box
— FW —	New Foul Sewer
— SW —	New Surface Water Sewer
— FW —	New Foul Rising Main

Rev.	Amendment	Drn	Chkd	Date
P05	Preliminary Issue	AB	DD	12.08.20
P04	Contractors Proposals - Treatment Plant Added, FW Amended to suit	DH	GT	28.06.19
P03	Contractors Proposals	DH	GT	13.06.19
P02	Preliminary issue	DH	GT	01.05.19
P01	Preliminary issue	DH	GT	12.03.19

Drg. Status **CP's**
Suitability **S3**

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☐ Hitchin
■ Oxford
☐ Southampton
☐ Birmingham

Client **Galliford Try**

Project

Bloxham Grove Academy

Title **Drainage Layout**
Sheet 1

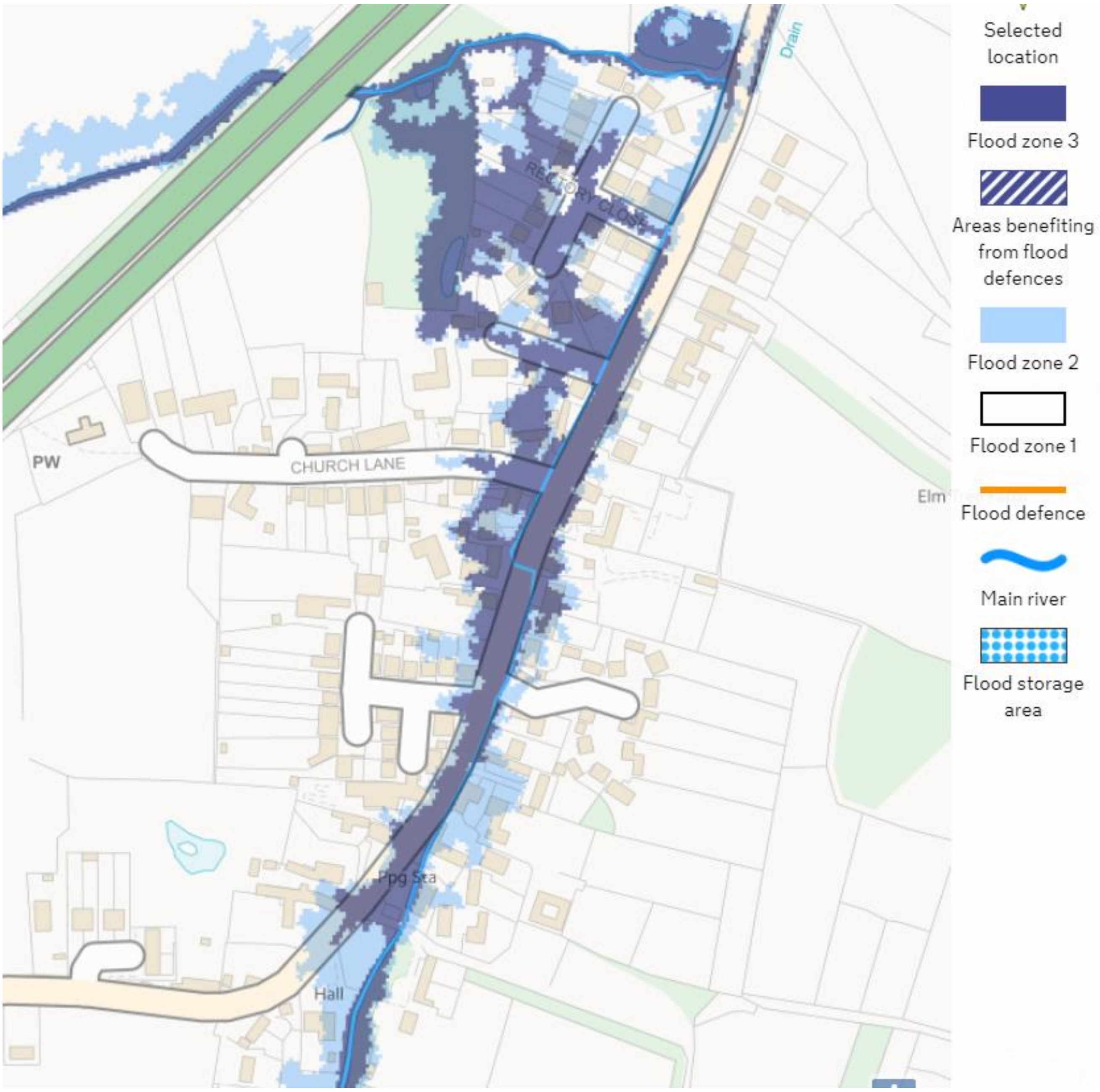
Reviewed Scheme GT Date 28.01.19
Reviewed Final Date
Scales at A1 1:250 Project No. **X182068**

Project Ref.	Originator	Zone	Level	Type	Role	Drg No.	Rev.
BGA	**AKSW**	**XX**	**XX**	**SH**	**C**	**9201**	**P05**

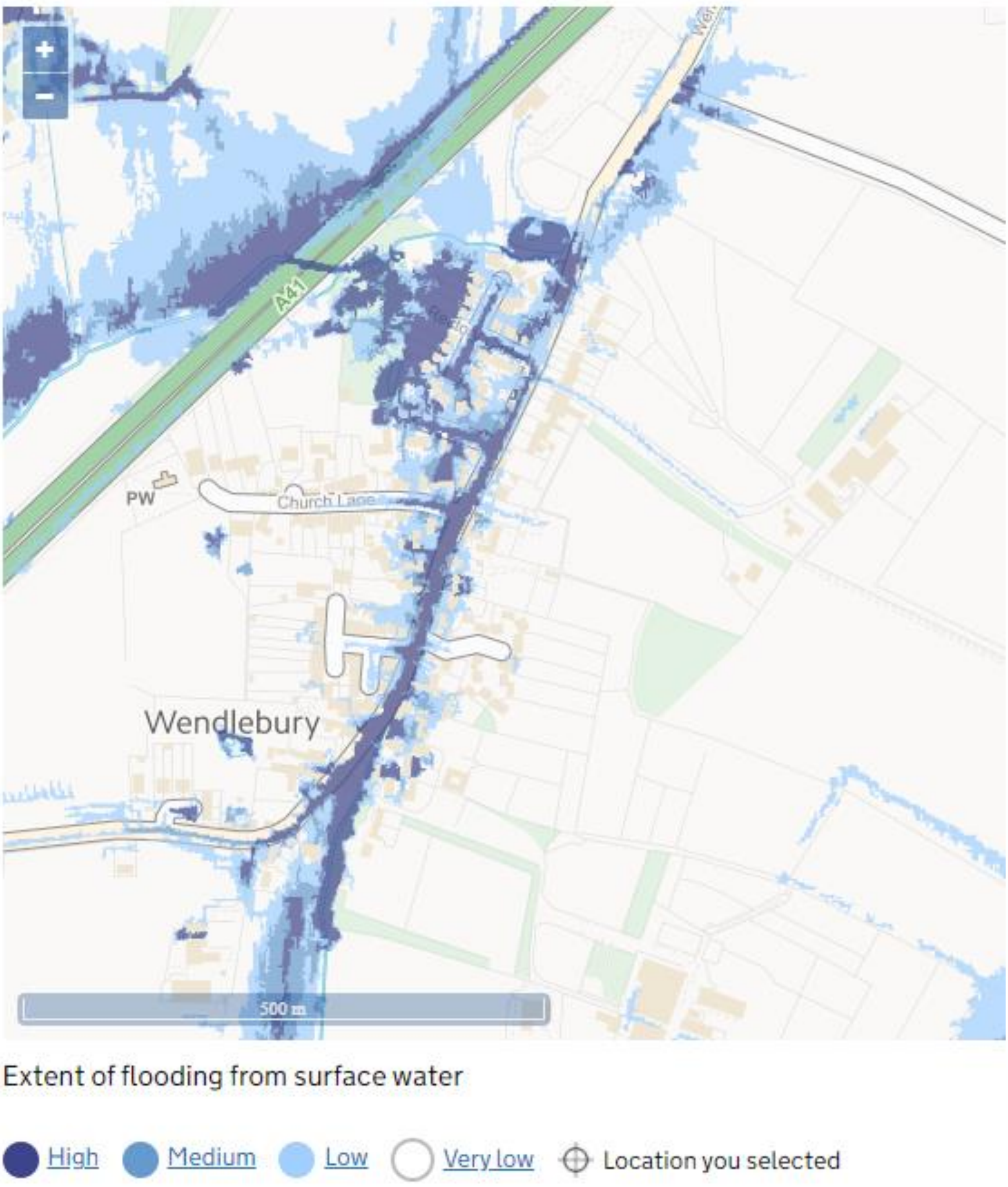
Appendix G

Environment Agency Flood Maps for Wendlebury

Fluvial Flood Map for Wendlebury

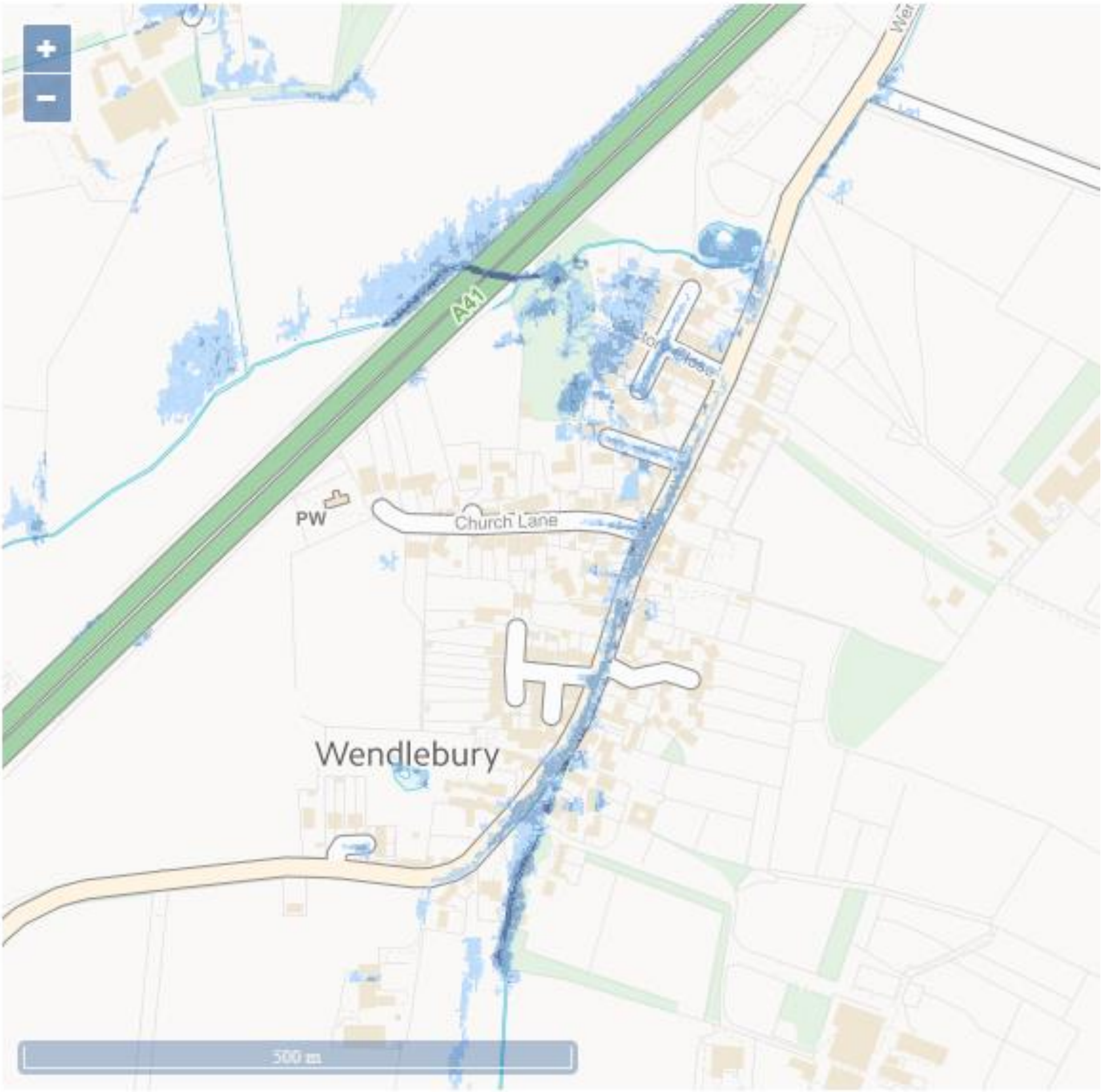


Surface Water Flood Map for Wendlebury



Extent of flooding from surface water

Surface Flood Map 1:30 year Event for Wendlebury showing flood depths



Surface water flood risk: water depth in a high risk scenario

Flood depth (millimetres)

● Over 900mm ● 300 to 900mm ● Below 300mm ⌖ Location you selected

Appendix H

Hydrogeological Report by JH Groundwater

TECHNICAL NOTE

T: 07765 255 197
E: julian@jhgroundwater.co.uk
W: www.jhgroundwater.co.uk

From: Julian Hatherall

To: Richard Betteridge / Neil Jaques, Motion
Date: 11/01/21

GREAT WOLF LODGE – FRA PLANNING APPEAL. COMMENTARY ON GROUNDWATER IN RELATION TO THE PROPOSED DRAINAGE STRATEGY.

Dear Richard / Neil

Following instruction, and in light of a planning appeal for this proposed development, please find below commentary on several aspects of the drainage strategy and groundwater environment. This note outlines a succinct conceptual model including geology, hydrology and hydrogeology which is in turn used to evaluate the nature of the proposals and address concerns raised by the LLFA. To this end, the note provides comments on the following four specific areas.

1. Comment on the historical nature of groundwater and surface water before development of the golf course;
2. Comment on the nature of the golf course water features and the linkage between surface water and groundwater in a man-made environment;
3. Discussion of the nature of the proposed scheme and how this relates to groundwater including potential issues and mitigation; and
4. Comment on the proposed retention tank and how, or if, this could have an influence on the local groundwater regime.

CONCEPTUALISATION

The following section outlines the geological and hydrogeological conditions and summarises a salient conceptual model related to the development and the drainage strategy.

Site geology

Artificial Geology

Based on geological mapping[1] (see also Figure 1), there are no significant mapped areas of identified ground at the proposed development location that has been modified by human

---

[1] http://mapapps2.bgs.ac.uk/geoindex/home.html?layer=BGSBoreholes Accessed 5/1/21

activity. This includes Made Ground, Worked Ground or Disturbed Ground. However, given that the site has been developed as a golf course it is likely that there will be some degree of Made Ground associated with buildings and/or areas of the golf course.

Superficial Geology

Based on geological mapping, no significant Superficial Geological formations have been identified beneath the footprint of the proposed development.

Solid Geology

The strata and thickness of each solid geological unit has been estimated based on available BGS data. No field data is available to verify these observations.

System	Group	Strata	Geological Description (British Geological Survey - BGS)	Estimated Thickness (m)
Middle Jurassic	Great Oolite Group	Cornbrash	Limestone, medium- to fine-grained. Generally, and characteristically intensely bioturbated and consequently poorly bedded. Generally bluish grey when fresh, but weathers to olive or yellowish brown. Thin argillaceous partings or interbeds of calcareous mudstone may occur.	1-4m from BGS (2002)[2]. Locally this is estimated to be 2-4m from borehole logs but is unproven.
		Forest Marble	Silicate-mudstone, greenish grey, variably calcareous, with lenticular typically cross-bedded limestone units that form banks and channel-fills, especially in lower part.	2-7m from BGS (2002). Locally this is estimated to be 3-5m from borehole logs, averaging 4m across the development, although this is unproven.
		White Limestone	A pale grey to off-white or yellowish limestone, with recrystallised limestone and/or hardgrounds at some levels with rare sandy limestone, muddy limestone, calcareous mudstone and silicate mudstone/clay. Coralliferous units occur at or close to the top.	7-18m from BGS (2002).

The thickness of the Cornbrash has been estimated by GWP (2019)[3] and this is shown in Figure 2. The presence of Cornbrash is interpreted to be across the whole of the development footprint

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[2] BGS, 2002. Buckingham. England and Wales Sheet 219. Solid and Drift Geology. 1:50 000. (Keyworth, Nottingham: British Geological Survey)

[3] GWP, 2019. Proposed Great Wolf Lodge resort, Bicester Golf Course geology and water desk studies. Client: Curtins. GTWOLF Report Number: 190411 Version: v.02. Issue Status: Final.

and suggests that outcrop of Forest Marble may not be present as indicated in Figure 1. This will be confirmed as part of the design process.

Structural Geology

The strata have a shallow dip regionally to the southeast but is essentially sub-horizontal at the scale of interest. No mapped faults have been identified within 1km of the target location.

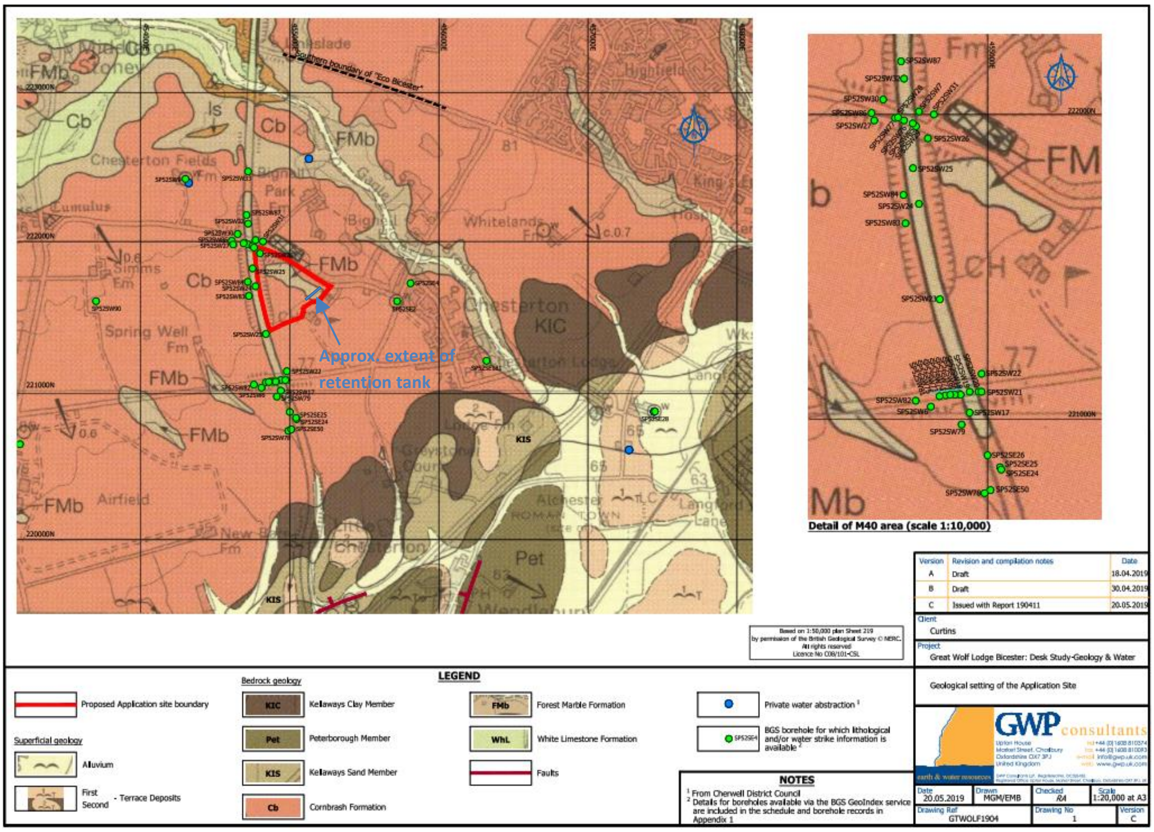


Figure 1 – Geological map showing extent of outcrops and development footprint, GWP (2019).

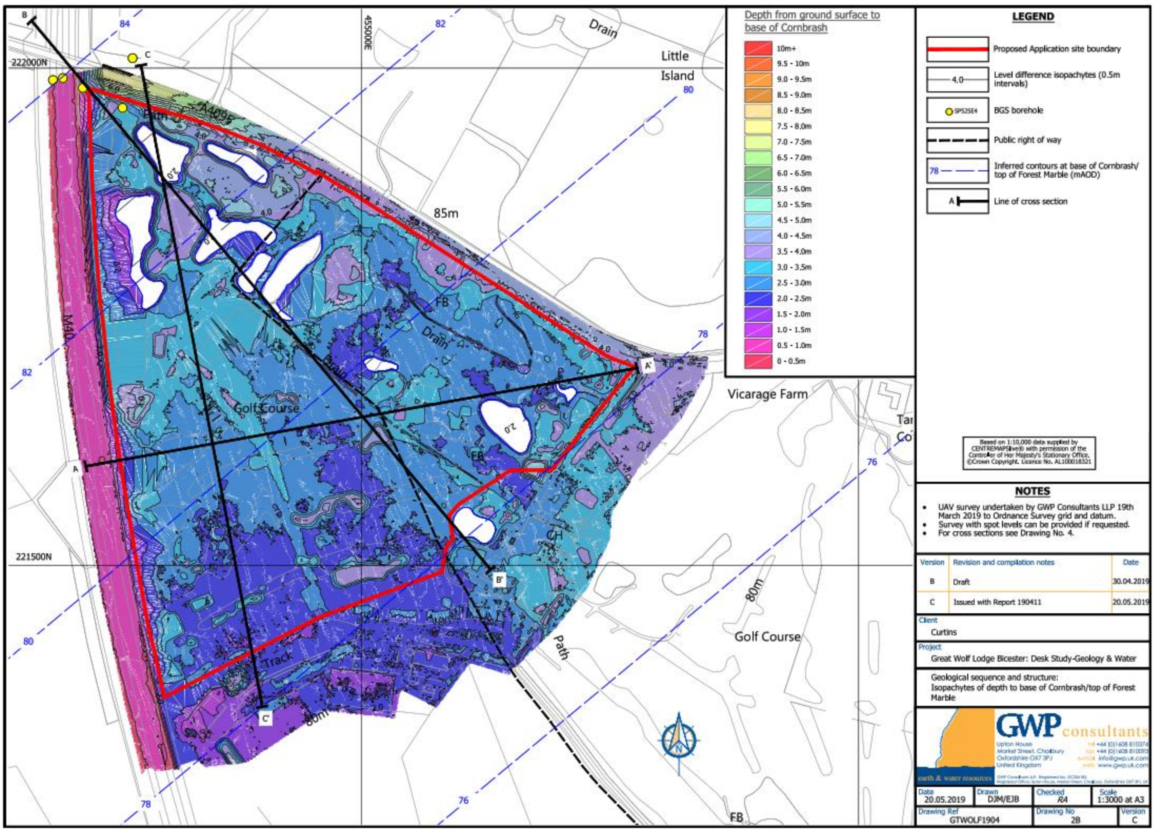


Figure 2 – Geological map showing interpreted thickness of Cornbrash, GWP (2019).

Hydrogeology

General Hydrogeological Conditions

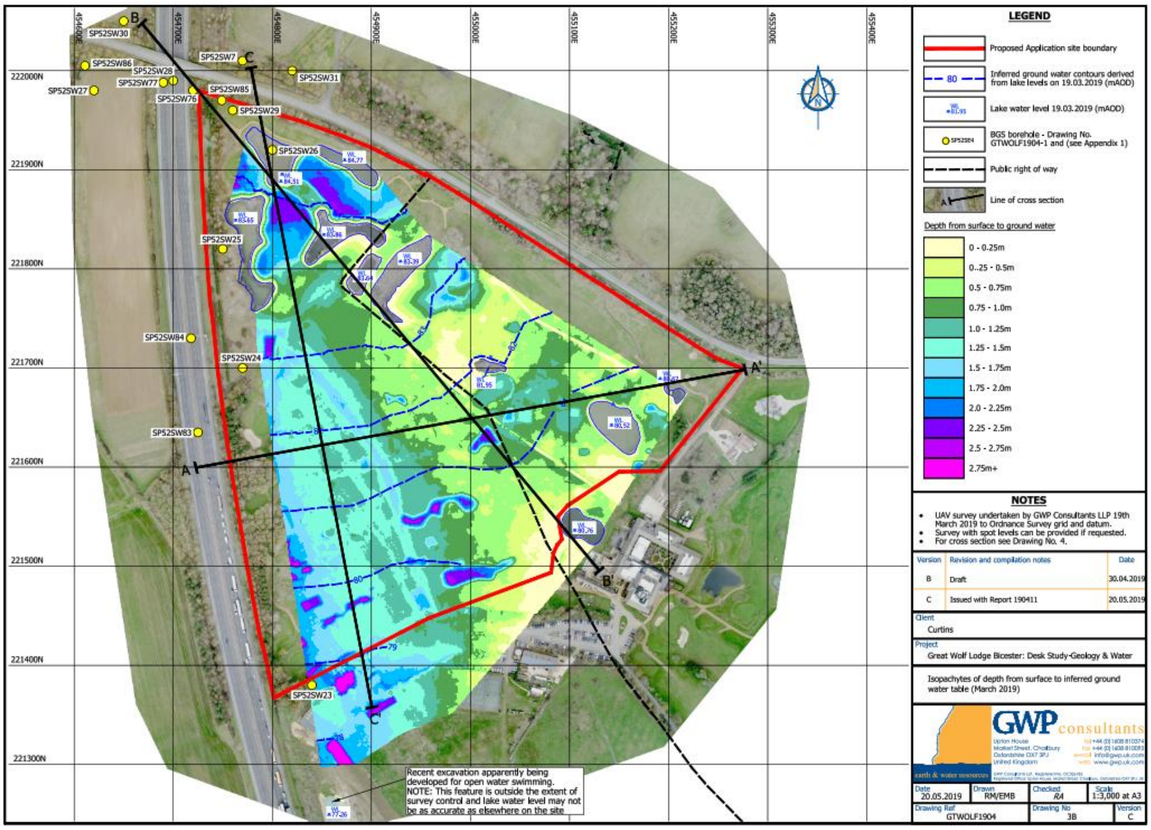
Summary hydrogeological conditions have been identified from published data and reports, together with referenced literature sources.

System	Group	Strata	Aquifer Status
Middle Jurassic	Great Oolite Group	Cornbrash	Secondary A Aquifer. Dominantly fracture flow. A shallow aquifer "perched" above the Forest Marble; it is of significance for private water supplies which achieve reasonable yields locally. Groundwater levels are generally shallow, being less than 1.25m below ground level and significantly shallower in places, close to ground level in the east of the development footprint.
		Forest Marble	Classified as a Secondary A Aquifer although has an overall low permeability as a result of the presence of interbedded clay layers and was previously classified as a Non-Aquifer. Dominantly fracture flow. The clay facilities hydraulic separation of the Cornbrash aquifer from the underlying aquifer in the White Limestone.
		White Limestone	Principal Aquifer. Dominantly fracture flow. Significant abstraction for Public Water Supply (PWS). Locally confined beneath the Forest Marble. Some records suggest that the aquifer is artesian in places. This will depend on the elevation of the borehole relative to the groundwater level.

Groundwater levels

Groundwater levels are shallow in the Cornbrash being less than 1.25m below ground level and significantly shallower in places, being at or close to ground level. Depth to groundwater depends on ground elevation across the site, shallowing where elevations are lower. This is particularly evident in eastern areas of the site as interpreted by GWP (2019) (Figure 3).

Groundwater in the White Limestone is interpreted to be confined and the piezometric surface close to and/or potentially slightly above ground level locally. The nearest groundwater monitoring borehole (EA reference SP52_19b, BGS reference SP52 SE/29) is 2.9km to the north-east of the proposed development. The levels recorded since 1971 are shown on Figure 4 and these have been taken from GWP (2019). The piezometric head in this aquifer has been between 84mAOD and 86mAOD since February 2004. Whilst this is above existing ground levels across the development, the elevation at the borehole location is approximately 86mAOD. It is therefore not possible to say whether the piezometric head would be above ground level across the development.



Recent excavation apparently being developed for open water swimming.
NOTE: This feature is outside the extent of survey control and lake water level may not be as accurate as elsewhere on the site

NOTES

- UAV survey undertaken by GWP Consultants LLP 19th March 2019 to Ordnance Survey grid and datum.
- Survey with spot levels can be provided if requested.
- For cross section see Drawing No. 4.

Version	Revision and compilation notes	Date
B	Draft	30.04.2019
C	Issued with Report 190411	20.05.2019

Client: Curtins

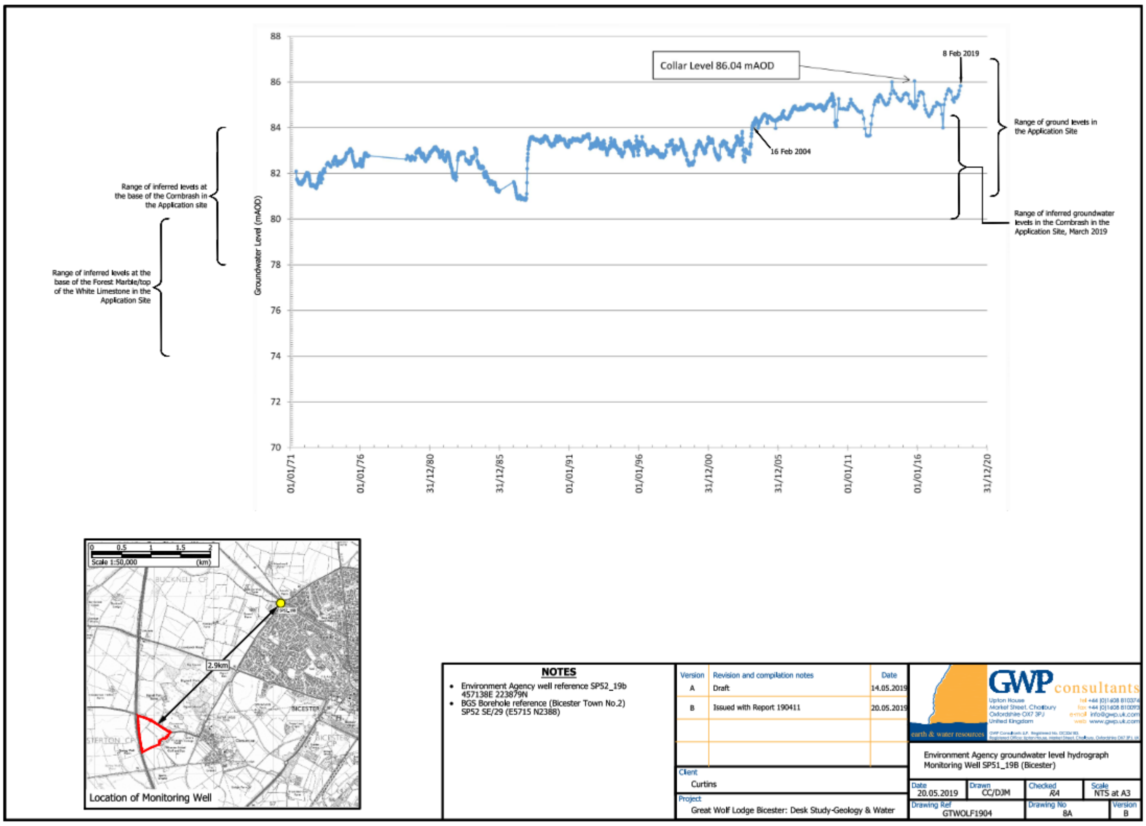
Project: Great Wolf Lodge Bicester: Desk Study-Geology & Water

Isopachytes of depth from surface to inferred ground water table (March 2019)

Date	Drawn	Checked	Scale
20.05.2019	RM/EMB	RA	1:3,000 at A3

Drawing Ref	Drawing No	Version
GTWOLF1904	3B	C

Figure 3 – Depth to and groundwater flow direction in the Cornbrash. From GWP (2019).



NOTES

- Environment Agency well reference SP52_19b 457138E 223879N
- BGS Borehole reference (Bicester Town No.2) SP52 SE/29 (E5715 N2388)

Version	Revision and compilation notes	Date
A	Draft	14.05.2019
B	Issued with Report 190411	20.05.2019

Client: Curtins

Project: Great Wolf Lodge Bicester: Desk Study-Geology & Water

Environment Agency groundwater level hydrograph
Monitoring Well SP51_19B (Bicester)

Date	Drawn	Checked	Scale
20.05.2019	CC/DJM	RA	NTS at A3

Drawing Ref	Drawing No	Version
GTWOLF1904	8A	B

Figure 4 – Groundwater levels in the White Limestone aquifer monitoring borehole (EA reference SP52_19b, BGS reference SP52 SE/29), GWP (2019).

Direction of groundwater flow

The direction of groundwater flow in the Cornbrash has previously been established by GWP (2019) using elevation data and the assumption of groundwater expression within lakes across the golf course (Figure 5). Flow is interpreted to be towards the southeast at a gradient of approximately 0.013, roughly coincident with the geological dip.

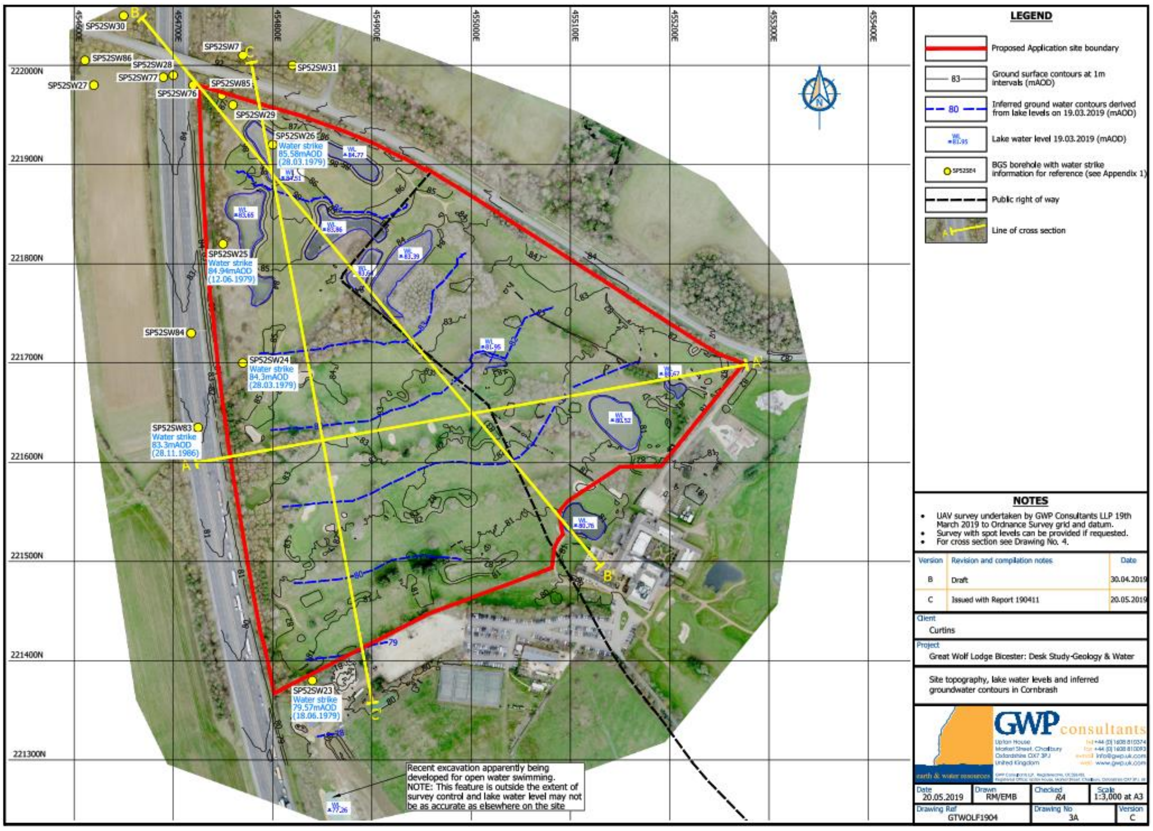


Figure 5 – Groundwater flow direction in the Cornbrash together with lines of section shown in Figure 6. GWP (2019).

The lines of section (Figure 6) show the depth to groundwater in the Cornbrash across the development footprint together with the elevation of groundwater in the White Limestone at the nearest groundwater monitoring borehole (EA reference SP52_19b, BGS reference SP52 SE/29), 2.9km to the north-east of the proposed development.

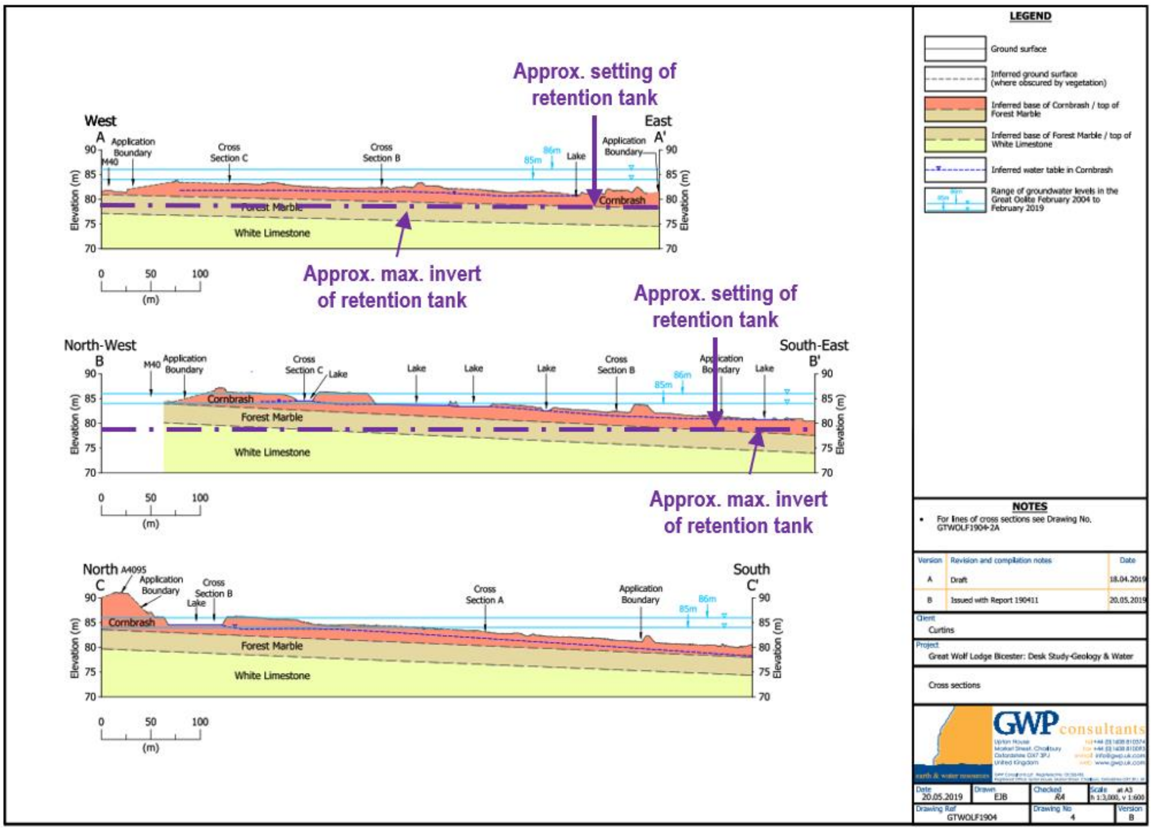


Figure 5 – Lines of section shown in Figure 4. The approximate setting and maximum depth of the invert level of the tank is also shown on the section, GWP (2019).

Outline conceptual model

The following points related to the groundwater and surface water conceptual model are considered relevant to the drainage strategy and development:

- There are two aquifers present, the upper aquifer of the Cornbrash and the lower aquifer of the White Limestone.
- The two aquifer units are separated by the low permeability Forest Marble. This is an interbedded mudstone and limestone unit, interpreted to locally contain two significant clay units which act as an aquitard to groundwater flow.
- The Forest Marble is shown to be present within the east of the development footprint on geological mapping, although this is unproven and would need to be considered as part of future engineering design. The mapping from GWP (2019) suggests that this may not be present.
- Groundwater in the Cornbrash is shallow and "perched" above the Forest Marble. It is generally shallow across the footprint of the development but is particularly shallow towards the south and east where it is close to ground level. The magnitude of seasonal fluctuations in groundwater levels are unknown.
- Groundwater levels in the Cornbrash are controlled by the rate of infiltration and discharge. The former is primarily as a result of precipitation, the latter is a result of several natural and anthropogenic activities including baseflow to rivers and streams,

spring discharges and groundwater abstractions. No features such as springs or resurgences acting as points of discharge have been identified across the footprint of the development.

- Surface water levels in ponds are an expression of groundwater in the Cornbrash. They will be influenced locally by surface water runoff, although these changes will be short term and levels would be expected to re-equilibrate quickly to groundwater levels.
- Groundwater in the Cornbrash is interpreted to flow to the southeast. The consistency of the groundwater contours suggests that there are no boundary effects associated with the local geology.
- Groundwater in the White Limestone is confined below the Forest Marble. The piezometric head, that being the level to which the water would rise if the aquifer were "tapped" is anticipated to be close to or just above ground level across the footprint of the development.

DISCUSSION

Nature of the groundwater environment in relation to the development proposals

The nature of the groundwater environment and the development proposals are considered in relation to the four specific points outlined in the introduction to this note. These are addressed in the following sections, with cross refence to comments made in the Oxfordshire County Council (OCC) letter dated 15th December 2020 where appropriate.

1. ***The nature of groundwater and surface water historically before development of the golf course.***

According to historical mapping reproduced within WSP (2018[4]) there are no surface water bodies, springs or resurgences within the footprint of the proposed development prior to 1981.

Ordnance Survey (OS) topographic mapping in 1970 shows that the area remained undeveloped until the golf course was shown to be present in OS mapping dated 1981. A single liner northeast-southwest trending surface water feature is then evident on the northeastern margins of the golf course. This is supplemented by an additional pond or small lake to the north of the club house by 1999. By 2006 a number of additional water features have been added in the northern area, presumably as manmade golf course hazards.

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[4] WSP, February 2018. GWR Bicester Preliminary Risk Assessment. Report reference 70042711_PRA.

2. ***The nature of the golf course water features and the linkage between surface water and groundwater in a man-made environment.***

Natural surface water bodies have not historically been present across the development footprint. As noted above the ponds and lakes are considered to be man-made features associated with the golf course.

The depth to groundwater strikes recorded in a number of local boreholes drilled on the western edge of the development footprint have been correlated with topographic and surface water surface elevation data from an unmanned aerial vehicle (UAV) survey reported by GWP (2019). Based on these observations it is considered reasonable to conclude that surface water currently represents a general expression of groundwater levels.

Surface water elevations from the UAV survey are however representative of a snapshot in time and will vary both relatively quickly as localised surface runoff enters ponds and lakes following periods of precipitation, and more slowly in response to longer term changes in groundwater levels within the wider aquifer. Large volumes of groundwater are contained within the aquifer and this provides a significant storage buffer resulting in slower changes to groundwater levels.

Groundwater levels and flows within the wider aquifer are controlled by recharge, primarily from precipitation or discharge from surface water courses to the ground and discharges in the form of groundwater baseflow to surface water, flow from springs and groundwater abstractions. Whilst pond levels may react to large volumes of surface runoff, surface water features are not considered to be controlling groundwater and it could be more correctly stated that, as these features represent an expression of groundwater, groundwater manages the levels of surface water features.

Contrary to the statements made on page 4 of the OCC letter, the existing surface water features, nor the proposed drainage strategy are not considered to be a major factor in controlling groundwater levels. The existing surface water features provide a degree of short-term storage capacity for surface water runoff but where this is in hydraulic connection with groundwater, water levels will relatively quickly re-equilibrate to the aquifer groundwater levels.

3. ***The nature of the proposed scheme and how this relates to groundwater including potential issues and mitigation.***

The proposed drainage scheme outlines the proposals for management of surface water runoff. Based on known geological and hydrogeological conditions, the presence of shallow groundwater levels limits the use of infiltration as the primary SuDS measure. It is for this reason that alternative drainage solutions have been proposed. These measures include shallow and deeper storage of runoff prior to discharge from the site at an agreed rate.

As stated above, the existing surface water features are an expression of groundwater rather than being features which manage groundwater.

The proposed retention tank will provide temporary runoff storage. It is anticipated that the tank will be constructed in the Cornbrash partially below the groundwater table based on data reported by GWP (2019), although this is subject to confirmation as part of the design process. It is feasible to design such structures in such a way that this should not suffer from groundwater inundation and prevent surcharging from groundwater flooding. Furthermore, subject to appropriate testing and design, the tank can be protected against floatation and other structural damage. Such engineering measures would normally consider a worst-case scenario of groundwater at ground level.

Furthermore, any tank would be designed in accordance with best engineering practice such that it would not adversely impact existing hydrogeological conditions.

4. *The proposed retention tank and how or if this could have an influence on the local groundwater regime.*

This section provides a response to groundwater related comments made in the OCC letter dated 15th December 2020 in relation to loss of groundwater storage.

The approximate setting and depth of the retention tank has been shown in Figures 2 and 6. The depth of the tank invert is not expected to be greater than 79mAOD. Based on Figure 2, the tank is expected to be constructed within the Cornbrash, although this will be subject to confirmation during design.

It is possible that the proposed retention tank could have an impact on groundwater levels, through both changes to flow patterns and loss of groundwater storage. The effect on groundwater is much like the impact from basement development for which guidance has been developed (e.g., Arup (2010)[5]). The proposed retention tank is a solitary, isolated structure which intersects the groundwater table.

It is not anticipated that the retention tank adversely will affect groundwater flows in the wider aquifer, since water will simply flow around the obstruction. Locally, changes in groundwater levels could potential occur although these are likely to be small and less significant than seasonal or other existing variations in the groundwater table. The magnitude of any change in water level will be dependent on the aquifer geology. However, installation of drainage measures around the tank can further reducing any risk of backing up of groundwater.

Temporary dewatering may be required in order to construct the tank. This would temporarily change local groundwater levels but these would re-equilibrate following completion of works. All dewatering would be undertaken in line with Environment Agency licensing requirements and in accordance with best practices.

In terms of aquifer storage loss, this needs to be considered not only within the local area but in relation to the wider aquifer. The footprint of the tank is insignificant in relation to the area and volume of the wider aquifer and groundwater levels would be anticipated to equilibrate rapidly after installation.

No significant permanent changes to groundwater conditions are therefore anticipated.

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[5] Arup, 2010. London Borough of Camden. Camden geological, hydrogeological and hydrological study. Guidance for subterranean development.

Summary

- The current surface water features within the development footprint are not natural. They were developed over time as water features and hazards within the golf course.
- The surface water features are not considered to control groundwater levels, contrary to the statement made in the OCC letter dated 15/12/20.
- The installation of the proposed retention tank is not considered likely to result in an adverse impact of the local hydrogeological environment.
- Temporary dewatering may be required in order to construct the tank, resulting in temporary localised changes to groundwater levels. These should re-equilibrate to the baseline condition following completion of works.
- The volume of groundwater storage beneath the footprint of the tank is insignificant relative to the volume of wider aquifer. No significant changes to groundwater conditions are there expected as a result of the installation and groundwater levels would be anticipated to re-equilibrate rapidly after construction.
- No significant changes to local hydrogeological conditions are anticipated.

Mitigation

The use of appropriate geological, hydrogeological monitoring and engineering design should be undertaken during the design of the retention tank to prove ground conditions and inform the design. It is suggested that this could be conditioned as necessary.

We trust that this assessment provides an appropriate response to the points raised in relation to groundwater, but we would be very happy to discuss should you require.

Yours sincerely

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About the Author

Julian Hatherall is a Chartered Geologist with over 23 years of experience providing advice on groundwater and hydrogeological issues and has significant knowledge of the assessment and management of groundwater and water resources. His experience encompasses both contaminant and water resource hydrogeology and includes baseline groundwater studies, groundwater risk assessment, groundwater advice in relation to the development of infrastructure and buildings including drainage, groundwater in the extractive industry, waste management and the development and management of groundwater abstractions. He has regularly contributed to Impact Assessments, has previously provided specialist hydrogeological support to regulators and has experience in the field of groundwater flooding and SuDS.

Julian works across a range of sectors, both within the UK and overseas and has experience of diverse geological and hydrogeological environments.

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