TECHNICAL NOTE

Job Name: Lotmead Farm Villages

Job No: 27970

Note No: 27970/4003/TN001

Date: 22/08/19

Prepared By: R Laker

Subject: **Addendum to March 2019 Flood Risk Assessment**

1. Introduction

This Addendum to the March 2019 Flood Risk Assessment (FRA) has been prepared by Peter Brett Associates LLP, now part of Stantec, (PBA), on behalf of our client, Ainscough Strategic Land, to support a planning application for a 2,500 units residential development of the Lotmead Farm Villages site. This Addendum and the March 2019 FRA have been completed in accordance with national and local flood risk policy.

This addendum to the FRA addresses comments raised by Swindon Borough Council as Lead Local Flood Authority and the Environment Agency.

2. Background

Details relating to the proposed surface water drainage system were included in Section 7 of the FRA, with Sections 7.4 to 7.7 providing specific detail on design parameters and criteria. The FRA was submitted to Swindon Borough Council (SBC) in April 2019 and they requested additional information relating to the proposed surface water drainage system.

The surface water drainage strategy presented in the FRA is one potential solution, however, this was considered by SBCs drainage engineer to be overly reliant on tertiary drainage measures and as such, revised calculations and drawings have been provided which incorporate reasonable assumptions to the provision of on-plot source control measures.

Following on from the meeting and comments received from SBC's drainage engineers, changes have been made to the proposed surface water drainage system. These changes are detailed in Section 3 of this document, and therefore in effect Sections 7 and Appendices E and F of the March 2019 FRA are superseded by this Addendum.

The Environment Agency (EA) objected to the proposed development, in a letter dated 5th August 2019 (Ref. *WA/2019/126527/01-L01*). The EA objected based on the following points:

1) Address climate change
2) Provide enough detail on the proposed new bridge in the floodplain

The each point has been addressed in the technical note (Ref. 27970-TN201901) and letter by PBA and a summary is provided in Section 3 of this addendum.

This Addendum to the March 2019 FRA incorporates the following:

- Details of proposed changes to the surface water drainage strategy;
- Details in response to the Environment Agency's objections

- **Appendix A** includes the updated Illustrative Masterplan, Drawing No. *PL1461.1-PLA-00-XX-DR-U-0002-S4*
- **Appendix B** the updated surface water drainage strategy, Drawing *27970-4005-001 Rev B*

- **Appendix C** amended Green Infrastructure Parameter Plan (*Drawing No. PL1461.1-PLA-00-XX-DR-U-0005-S4*)
- **Appendix D** Response to EA model review ref 2018s0387 (TN201901)

3. Drainage

As part of the vision for Lotmead Villages, a Strategic Design Code will be included as part of the Design and Access Statement (DAS). This is to provide clarity over what constitutes acceptable design quality for the proposed development, and provide certainty that quality drainage design will be achieved. The strategic design code has been designed to provide an overarching development framework that can be expanded upon at detailed design stages (reserved matters). In terms of the drainage design, the design principles focus on establishing the key strategic infrastructure, rather than detail of the built form.

The bullet points below (as agreed with SBCs drainage engineer on 19th July 2019) set out the key parameters and criteria of the strategic design code for the proposed surface water drainage design.

Surface Water and SuDS Design

- SuDS are to be provided in accordance with CIRIA C753 and to be located outside of Post-development 1 in 100 plus climate change floodplain extents.
- Shallow above ground conveyance features will be prioritised throughout the development (where feasible), utilising natural drainage routes and existing drainage features which must be retained post-development.
- Plot scale 'source control' SuDS features such as raingardens, permeable paving, green roofs or swales, will be prioritised in the first instance. The exact features, including their locations, will be determined at the detailed design stage.
- SuDS drainage features will be prioritised in the following hierarchy:
    - Primary – plot scale 'source control' features such as raingardens, permeable paving etc;
    - Secondary – under drained swales providing conveyance and attenuation storage;
    - Tertiary – attenuation basins or ponds providing attenuation storage.
- All existing watercourses will be retained post-development.
- All strategic SuDS attenuation features will be design with a minimum freeboard of 300mm to allow for any residual risk related to blockage or an extreme rainfall event (in excess of the 1 in 100 plus climate change event).

Rainfall catchment areas have been determined and for each catchment a limiting discharge rate (mean annual greenfield rate) of 4.67 l/s/ha will be applied for all events up to and including the 1 in 100 plus climate change event. Each rainfall catchment will comprise a minimum of two SuDS components to attenuate and improve water quality prior to discharging into one of the adjacent watercourses.

The following assumptions have been used in the surface water management strategy design:

- No infiltration potential at site.
- Limiting discharge rate of 4.67 l/s/ha (mean annual greenfield rate) for all events up to and including 1 in 100 plus climate change event.
- Design undertaken in accordance with best practice and National Planning Policy Framework (NPPF).
- Additional ecological and biodiversity benefits to be provided within SuDS such as planting, reed beds, or varying permanent water depths where feasible.
- Exact detail of onsite drainage to be confirmed through detailed design. This can be achieved through provision of swales, ditches, permeable paving or other forms of SuDS and in accordance with the 'SuDS Vision for New Eastern Villages (NEV) Supplementary Planning Document' (SPD) – February 2017.
- All SuDS designs within the development shall be based above the 1 in 100 plus climate change flood level, including any outfalls.

- At the detailed design stage, the proposed drainage strategy will be tested with surcharged outfalls to confirm the adequate operation and performance of the system in the event of the receiving watercourse being in flood. Inline non-return valves shall be fitted to all outfall points subject to flooding.

Management and maintenance

- Adoption and maintenance is to be undertaken in line with the long term management plan set out in the March 2019 FRA.
- Long term management of SuDS components is essential to ensure they continue to function to their design standard. As such, a management and maintenance plan will need to be developed in order to ensure the systems continue to function effectively.
- The final strategy for adoption of SuDS and SuDS maintenance plan, including a maintenance schedule and details of easements and outfalls for the drainage system, will be produced at the detailed design phase, once details of any SuDS features to be incorporated into the site have been finalised.

Since the March 2019 FRA, the Surface Water Drainage Strategy has been revised, in this addendum, to address the concerns outlined by SBC.

The proposed development will incorporate a surface water drainage strategy in line with the strategic design code as outlined above. The illustrative Masterplan is included in **Appendix A** and details of the revised drainage strategy are provided in **Appendix B**.

The catchment areas have been amended as per PBA Drawing *27970-4005-001 Rev B*. It is expected that the intermediate discharge rates will vary as detailed designs are prepared at a later stage to suit evolving designs for SuDS features however, the overall discharge rate will still be limited to 4.67 l/s/ha, and is anticipated to be distributed across a number of catchment areas across the site through the indicative allowable discharge rates as per Table 1 below.

Catchment	Area (Ha)	Indicative Allowable Discharge Rate (Qbar = 4.67l/s/ha)
A1	3.99	18.6 l/s
A2	6.07	28.3 l/s
B1	1.56	7.3 l/s
B2	2.84	13.3 l/s
C1	7.40	34.6 l/s
C2	3.41	15.9 l/s
C3	5.05	23.6 l/s
C4	6.08	28.4 l/s
C5	2.89	13.5 l/s

D1	4.89	22.8 l/s
D2	6.61	30.9 l/s
E1	4.39	20.5 l/s
E2	4.59	21.4 l/s
F1	6.62	30.9 l/s
F2	6.72	31.4 l/s
G1	6.31	29.4 l/s
G2	8.43	39.4 l/s
H1	4.99	23.3 l/s

Table 1 Anticipated Surface Water catchments and greenfield discharge rates

SBC's drainage engineers approved the revised drainage strategy through email correspondence on 19th July 2019, stating that the revisions had gone a long way in addressing their comments, subject to a few minor outstanding amendments. All amendments have now been completed and incorporated into this addendum.

A detailed drainage strategy will be developed at the reserved matters stage, once the on-plot details are known. **Appendix B** provides details of the surface water drainage principles and parameters to be agreed at this stage and is considered sufficient for an outline planning application.

4. Environment Agency objection(s)

The Environment Agency (EA) objected to the proposed development, in a letter dated 5th August 2019 (Ref. *WA/2019/126527/01-L01*). Their letter outlines two main points, reproduced below for reference:

1) ***Address climate change***

   We have reviewed the Climate Change Technical Report. We have responded to flood risk modelling under a separate cover. Please note there are a number of issues which are highlighted in red and amber which need to be addressed.

2) ***Provide enough detail on the proposed new bridges in the floodplain***

   The proposal is for the new bridges to be modelled at a later date. We require additional information such as the proposed dimensions of these structures with sufficient detail to demonstrate that there is no effect below the 1 in 100 plus appropriate climate change level. We note that there are two options: 1. Open Span or 2. Culverts. We are opposed to culverting of watercourses because of the adverse ecological, flood risk, geomorphological, human safety and aesthetic impacts.

The EA's letter also asked for further clarification on the proposed new modelled flood outlines, proposed development areas and the line of the Wilts & Berks Canal. The Green Infrastructure Parameter Plan (Drawing No. PL1461.1-PLA-00-XX-DR-U-0005-S4*)* in **Appendix C** has been

annotated to show the modelled flood outlines in relation to proposed development areas and line of the canal.

Flood risk modelling note

The EA model review of the simulation of the latest climate change allowances raised a few detailed technical questions and comments. These are addressed in a technical note in **Appendix D**.

Overall, it is shown that none of the comments raised would have a significant influence on the current model or impact on the results.

Bridges

The level of detail provided within the FRA (2019) is consistent with that of the FRA (2015) that accompanied the previous application, which was accepted by the EA. Further detail of recommendations is presented within this Addendum to address the EA's request.

Access bridges over Main Rivers will be designed in accordance with best practice and the latest EA guidance. Access bridges will also be designed in accordance with Swindon Borough Councils '*New Eastern Villages Island Bridge Vision – Supplementary Planning Document*' (June 2017), which provides guidance on the design expectations for all bridges located within the NEV.

Any bridge crossing will cross Main River channels in a clear single span. Construction methods and the effect on the watercourse will be considered at the detailed design stage. However, outline design principles considered sufficient at this stage of planning are outlined below.

Each bridge crossing over Main Rivers will be designed so there is no net loss of floodplain storage and therefore no increase in flood risk to internal or external receptors. Bridge soffits will be raised a minimum of 600mm above the modelled 1 in 100 year plus climate change flood event. Flood relief culverts will be constructed, if required, to maintain flood conveyance flows.

We will liaise with the EA Ecology team in order to provide for mammal passage as required, at the detailed design stage.

Proposed works in, over, under or near a Main River or a flood defence require a 'Flood Risk Activity Permit' (FRAP) application to be made to the EA (this replaced the previous 'Flood Defence Consent' (FDC) procedure). This is required to demonstrate any new development does not have a detrimental impact on flood risk, either through impacting the integrity of the existing defence or through preventing maintenance access to the defence.

The proposed new access bridges crossing the River Cole will require FRAPs. Separate consent from SBC, as LLFA, is required for new crossings or development that may impact on minor and ordinary watercourses within and adjacent to the site.

Further details of proposed bridge crossings will be included in FRAPs and set out as part of any Reserved Matter Application and the Council is able to include suitable planning conditions which require crossings to have no effect below the 1 in 100 plus climate change flood level.

Canal

SBC's Local Plan seeks the re-instatement of the Wilts & Berks Canal and identifies an indicative alignment which crosses the southern and eastern edge of the Masterplan Site, as described in the Design and Access Statement.

The proposed route for the Wilts & Berks Canal, as set out on SBC's Local Policies Map will be safeguard and protected from development, in line with *Policy EN11: Heritage Transport*. A significant corridor width for the Canal has been allowed to ensure that this application does not constrain the Wilts &Berks Canal proposals as and when they come forward.

The proposals will not prejudice the future alignment of the Canal and, indeed, the proposed floodplain reinstatement within the eastern part of the site will help support its delivery, as described in the Design and Access Statement. The proposed line of the canal is shown in **Appendix A** on the updated Illustrative Masterplan, *Drawing No. PL1461.1-PLA-00-XX-DR-U-0002-S4.*

No surface water outfalls will drain into the Canal.

5. Conclusion

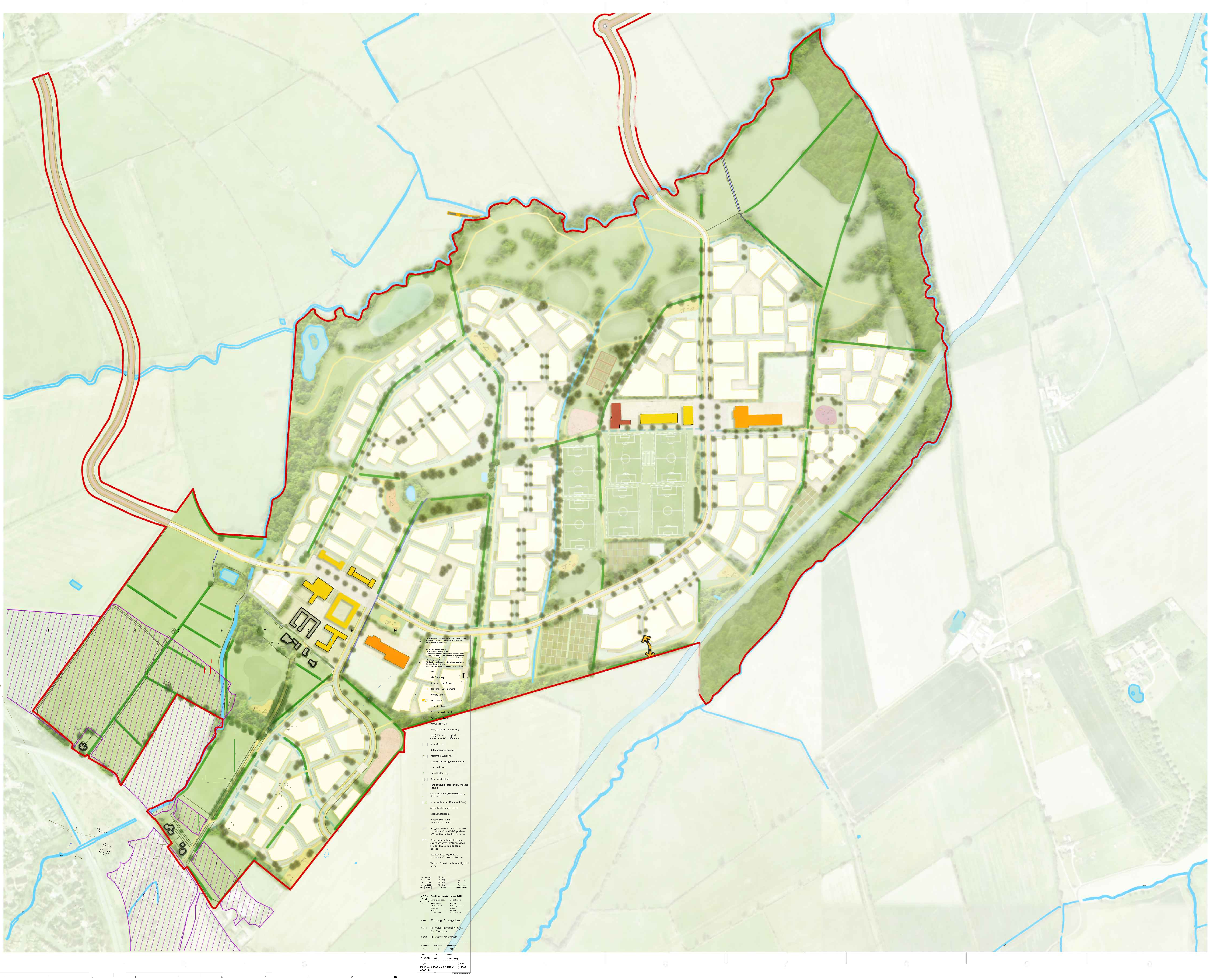
This FRA Addendum incorporates further details to support the Lotmead Farm Villages planning application and addresses concerns raised by SBC's drainage engineers in relation to the proposed surface water drainage strategy.

Bridge crossings will be designed so there is no loss of floodplain storage and no increase in flood risk to internal or external receptors. Bridge soffits will be raised a minimum of 600mm above the modelled 1 in 100 year plus climate change flood event. Flood relief culverts will be constructed, if required, to maintain flood conveyance flows.

Further details of proposed bridge crossings will be included in FRAPs and set out as part of any Reserved Matter Application and the Council is able to include suitable planning conditions which require crossings to have no effect below the 1 in 100 plus climate change flood level.

This FRA Addendum demonstrates that the findings of the Flood Risk Assessment (March 2019), and accompanying ES chapters and conclusions, remain valid including consideration of the changes to the proposed surface water drainage system.

Appendix A Indicative Masterplan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E
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3. All setting out, levels and dimensions to be agreed on site.
4. The dimensions of all materials must be checked on site before being laid out.
5. This drawing must be read with the relevant specification clauses and detail drawings.
6. Order of construction and setting out to be agreed on site.
KEY
Site Boundary
Buildings to be Retained
Residential Development
Primary School
Local Centre
Sports Pavilion
Community Allotments
Play Space (LEAP)
Play Space (NEAP)
Play (combined NEAP / LEAP)
Play (LEAP with ecological enhancements in buffer zone)
Sports Pitches
Outdoor Sports Facilities
Pedestrian/Cycle Links
Existing Trees/Hedgerows Retained
Proposed Trees
Indicative Planting
Road Infrastructure
Land safeguarded for Tertiary Drainage Feature
Canal Alignment (to be delivered by third party
Scheduled Ancient Monument (SAM)
Secondary Drainage Feature
Existing Watercourse
Proposed Woodland Total Area = 17.14 Ha
Bridges to Great Stall East (to ensure aspirations of the NEV Bridge Vision SPD and Nev Masterplan can be met)
Road Link to Redlands (to ensure aspirations of the NEV Bridge Vision SPD and NEV Masterplan can be realised)
Recreational Lake (to ensure aspirations of GI SPD can be met)
Vehicular Route to be delivered by third parties
S4 06.08.19 Planning CJ LF
S4 17.07.19 Planning EO LF
S4 12.07.19 Planning EO LF
S4 28.03.19 Planning JTO AR
Issue Date Status Drawn Apprvd.
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Client Ainscough Strategic Land
Project PL1461.1 Lotmead Villages East Swindon
Drg Title Illustrative Masterplan
Created on 17.01.19 Created by LF Approved by AR
Scale 1:5000 Size A2 Status Planning
Drg No. PL1461.1-PLA-00-XX-DR-U-0002-S4 Issue P02
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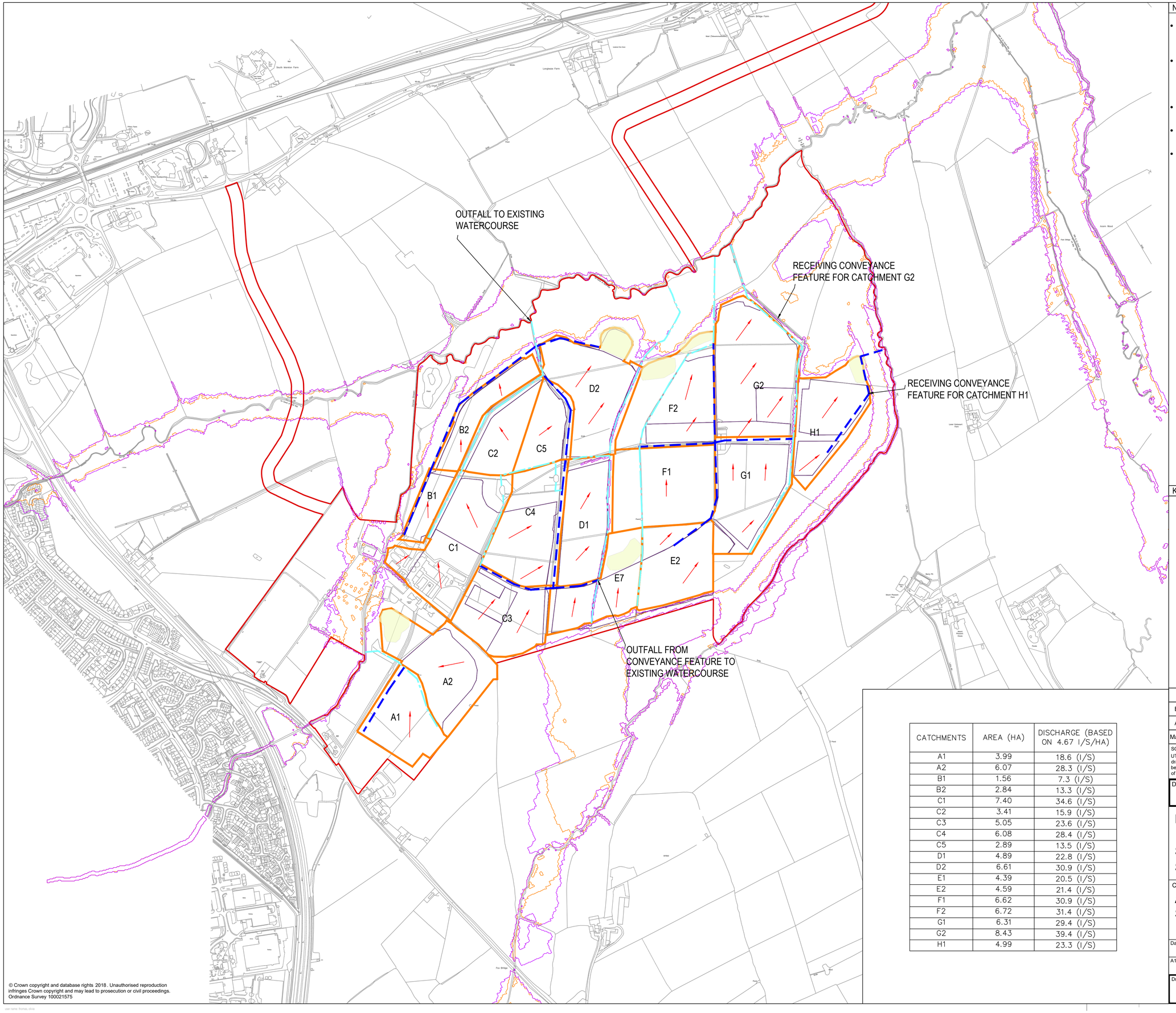
Appendix B Surface Water Drainage Strategy



NOTES:

- THIS SURFACE WATER MANAGEMENT STRATEGY (SWMS) SETS OUT THE KEY ASSUMPTIONS AND CONSIDERATIONS THAT HAVE BEEN USED IN THE DESIGN AND INTEGRATION OF SUSTAINABLE DRAINAGE SYSTEMS (SUDS) WITHIN THE DEVELOPMENT PROPOSALS.
- THE FOLLOWING SITE CONSIDERATIONS HAVE BEEN USED TO PROVIDE THIS PRELIMINARY STRATEGY:
  1. TOPOGRAPHICAL SURVEY- GREENHATCH GROUP DRAWING 18422_OGL
  2. MASTERPLAN - PLANIT - IE LLP DRAWING PL1461.1-PLA-00-XX-DR-U-0008-S3-PO3
- SUDS ARE TO BE PROVIDED IN ACCORDANCE WITH CIRIA C753 AND TO BE LOCATED OUTSIDE OF POST DEVELOPMENT 1% +CC FLOODPLAIN EXTENTS.
- ADOPTION AND MAINTENANCE TO BE UNDERTAKEN IN LINE WITH THE LONG TERM MANAGEMENT PLAN SET OUT IN THE FRA.
- THE FOLLOWING ASSUMPTIONS HAVE BEEN USED IN THE SWMS DESIGN
  1. EACH DEVELOPMENT PARCEL HAS BEEN ASSUMED TO BE 60% IMPERMEABLE FOR RESIDENTIAL AREAS AND 80% IMPERMEABLE FOR COMMERCIAL AREAS, WITH A TOTAL IMPERMEABLE AREA OF 39.3 HA
  2. NO INFILTRATION POTENTIAL AT SITE
  3. LIMITING DISCHARGE RATE OF 4.67l/s/ha (MEAN ANNUAL GREENFIELD RUNOFF RATE) FOR ALL EVENTS UP TO 1% AEP + CLIMATE CHANGE EVENT
  4. DESIGN UNDERTAKEN IN ACCORDANCE WITH BEST PRACTICE & NPPF
  5. ADDITIONAL ECOLOGICAL & BIODIVERSITY BENEFITS TO BE PROVIDED WITHIN SUDS SUCH AS PLANTING, REED BEDS, OR VARYING PERMANENT WATER DEPTHS WHERE FEASIBLE
  6. ADEQUATE ATTENUATION IS TO BE PROVIDED WITHIN EACH CATCHMENT TO MEET ALLOWABLE DISCHARGE RATES; FINAL FORM AND LOCATION OF ATTENUATION TO BE CONFIRMED AT RESERVED MATTER APPLICATION STAGE FOR EACH CATCHMENT..
  7. EXACT DETAIL OF ONSITE DRAINAGE TO BE CONFIRMED THROUGH DETAILED DESIGN. THIS CAN BE ACHIEVED THROUGH PROVISION OF SWALES, DITCHES, PERMEABLE PAVING OR OTHER FORMS OF SUDS AND IN ACCORDANCE WITH THE SUDS VISION FOR NEW EASTERN VILLAGES (NEV) SUPPLEMENTARY PLANNING DOCUMENT (SPD) - FEBRUARY 2017
  8. INLINE NON RETURN CHAMBER SHALL BE FITTED TO ALL OUTFALLS POINTS TO THE RECEIVING WATERCOURSE TO PREVENT BACKFLOW INTO THE SWALE.
  9. ALL SUDS FEATURES WITHIN THE SITE SHALL BE LOCATED ABOVE THE 1:100 YEAR +CC FLOOD LEVEL.
  10. CATCHMENTS TO OUTFALL TO EXISTING FIELD DRAINS AND WATERCOURSES LOCATED WITHIN THE SITE BOUNDARY. INDICATIVE LOCATION OF ADDITIONAL CHANNELS OR SWALES REQUIRED FOR CONVEYANCE OF SURFACE WATER RUNOFF TO EXISTING FEATURES SHOWN.
  11. FINAL SIZE OF NEW FEATURES TO BE CONFIRMED AT RESERVED MATTER APPLICATION STAGE, IN ACCORDANCE WITH THE SUDS VISION FOR NEW EASTERN VILLAGES (NEV) SUPPLEMENTARY PLANNING DOCUMENT (SPD) - FEBRUARY 2017.

KEY:

- SITE BOUNDARY
- FLOOD PLAIN EXTENTS 1 IN 100 YEAR + 70% CC
- FLOOD PLAIN EXTENTS 1 IN 100 YEAR + 35% CC
- PROPOSED CATCHMENT AREAS
- INDICATIVE OVERLAND FLOW ROUTES
- OVERLAND CHANNEL FOR COLLECTION AND CONVEYANCE
- RETAINED WATERCOURSES
- CATCHMENT BOUNDARIES

XREFS:
x-OS Data
x-sw_drainage_strategy
x-red_line_boundary
x-Site Topo Survey
x-pba-100yr-35cc-floodplain
x-pba-100yr-70cc-floodplain
x-sw_catchments

CATCHMENTS	AREA (HA)	DISCHARGE (BASED ON 4.67 l/S/HA)
A1	3.99	18.6 (l/S)
A2	6.07	28.3 (l/S)
B1	1.56	7.3 (l/S)
B2	2.84	13.3 (l/S)
C1	7.40	34.6 (l/S)
C2	3.41	15.9 (l/S)
C3	5.05	23.6 (l/S)
C4	6.08	28.4 (l/S)
C5	2.89	13.5 (l/S)
D1	4.89	22.8 (l/S)
D2	6.61	30.9 (l/S)
E1	4.39	20.5 (l/S)
E2	4.59	21.4 (l/S)
F1	6.62	30.9 (l/S)
F2	6.72	31.4 (l/S)
G1	6.31	29.4 (l/S)
G2	8.43	39.4 (l/S)
H1	4.99	23.3 (l/S)

Mark	Revision	Date	Drawn	Chkd	Appd
B	DRAWING AMENDMENTS	17.07.19	OT	RL	ET
A	DRAWING AMENDMENTS	11.07.19	OT	RL	ET

SCALING NOTE: Do not scale from this drawing. If in doubt, ask.

UTILITIES NOTE: The position of any existing public or private sewers, utility services, plant or apparatus shown on this drawing is believed to be correct, but no warranty to this is expressed or implied. Other such plant or apparatus may also be present but not shown. The Contractor is therefore advised to undertake their own investigation where the presence of any existing sewers, services, plant or apparatus may affect their operations.

Drawing Issue Status

FOR INFORMATION

LOTMEAD FARM VILLAGES, SWINDON

SURFACE WATER MANAGEMENT STRATEGY

Client

AINSCOUGH STRATEGIC LAND

Date of 1st Issue	Designed	Drawn
01.02.19	RP	RP
A1 Scale	Checked	Approved
1:5000	ET	ET

Drawing Number: 27970/4005/001

Revision: B

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now part of Stantec
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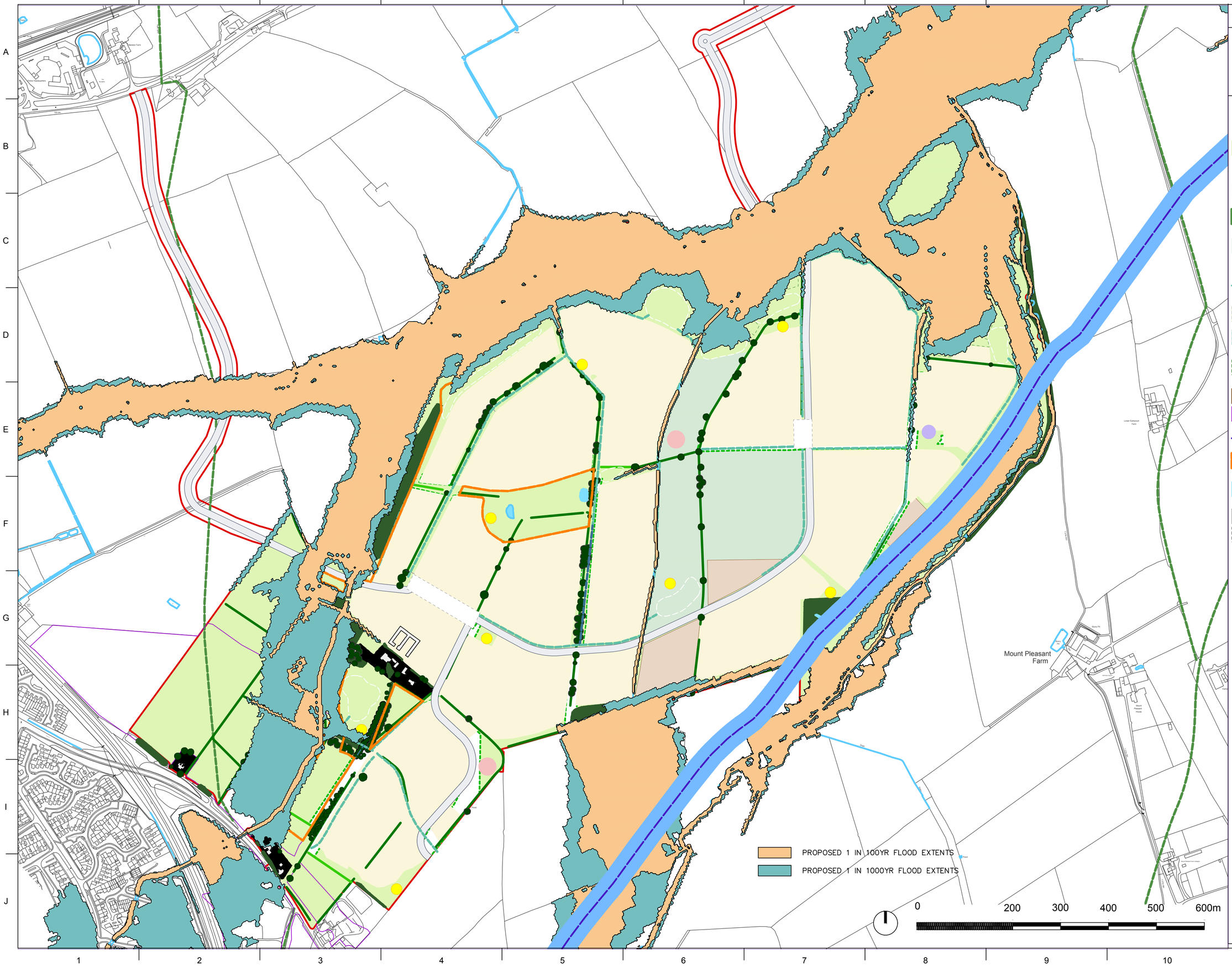
Appendix C Green Infrastructure Parameter Plan (Drawing No. PL1461.1-PLA-00-XX-DR-U-0005-S4)



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4. The dimensions of all materials must be checked on site before being laid out.
5. This drawing must be read with the relevant specification clauses and detail drawings.
6. Order of construction and setting out to be agreed on site.

KEY

- Green Space – 65.7ha
  includes: retained green spaces and habitats, new biodiversity zones, open space and general recreation and play areas, grassland, structural planting and SUDS
- Existing Vegetation
  includes: woodland, hedgerows and trees
- Proposed Woodland – 13.73 ha
  includes: woodland, hedgerows and trees
- Sports Hub – 9.74 ha
  includes: playing pitches (7.4 ha) and additional formal sports facilities (0.4 ha)
- Proposed Secondary Drainage Feature
- Land Safeguarded for Tertiary Drainage Feature
- Recreational Lakes
- Area of Indicative Planting not included in 'Proposed Woodland' calculation
- Allotments – 2.59 ha
- Scheduled Monument
- Safeguarded Canal Alignment includes 50m buffer zone
- Biodiversity Zones – 15.4 ha
- Existing Waterbodies
  includes streams, ponds and drainage ditches
- Existing Plot to be retained
- Pedestrian Priority Zone
- Safeguarded Play Space
- Neighbourhood Equipped Area for Play (NEAP) – indicative location
- Neighbourhood/ Locally Equipped Area for Play (NLEAP) – indicative location
- Locally Equipped Area for Play (LEAP) – indicative location

Overall Green Infrastructure Quantum
91.76 ha

Issue	Date	Status	Drawn	Apprvd.
P02	28.03.19	Planning	CJ	AR
P01	28.03.19	Planning	CJ	AR

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Client	Ainscough Strategic Land
Project	PL1461.1 East Swindon Lotmead Villages
Drg Title	Parameter Plan Green Infrastructure

Created on	Created by	Approved by
28.03.19	CJ	AR

Scale	Size	Status
1:5000	A2	Planning

Drg No.	Suitability	Revision
PL1461.1-PLA-00-XX-DR-U-0005	S4	P02

Appendix D Response to EA model review ref 2018s0387 (TN201901)

TECHNICAL NOTE

Job Name: Lotmead Villages, Swindon

Job No: 27970/4008

Note No: TN201901

Date: 14/08/19

Prepared By: S Bari

Subject: **Response to EA model review ref 2018s0387**

1. Introduction

1.1. PBA has previously submitted hydraulic modelling pertaining to the proposed development of the Lotmead Villages site, to the east of Swindon, Wiltshire. The hydraulic modelling for the site has previously been reviewed and approved by the EA. This model was subsequently updated to address the updated climate change allowances and the EA has undertaken a review of these additional scenarios following the submission of the updated climate change modelling.

1.2. The EA response to the modelling was provided on the 5th of August 2019 and raised a number of additional queries regarding the modelling.

1.3. This technical note details PBA's further investigations and responses to the comments raised.

1.4. We have copied the relevant comments from the review into this letter along with our responses.

1.5. The EA comments were defined as either red, amber or green comments based their potential significance on the outcomes of the modelling.

1.6. The EA definition of the comments is as follows;

Red – omission that could make the findings subject to challenge and which requires correction/further work.

Amber – non-standard method or method not following guidance but unlikely to have impacted on results

Green – suggestion for improved / good practice but which is unlikely to change the project outcomes.

2. EA Comment on 1d Boundary Condition

2.1. The first comment from the review was highlighted as a 'Red' comment;

DOCUMENT ISSUE RECORD

Technical Note No	Rev	Date	Prepared	Checked	Reviewed (Discipline Lead)	Approved (Project Director)
27970/4008/TN201901	-	14/08/19	S Bari	T Hughes	A Hensler	A Hensler

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'Coincidently whilst checking the HQ was sufficient for the +70% CC flows it has been noted it has been applied incorrectly. Flow should be in the first column of the curve and stage in the second. See output from the 1d_bc check file. As such, the stage at the downstream node of the model is set at the bed level of cross section.'

2.2. The reviewer's comments are correct. This error was present in the original EA hydraulic modelling and unfortunately, was not identified during our update. Our modelling did not look to alter the downstream boundary conditions from the original calibrated EA model so we were not alerted to this discrepancy at the time.

2.3. As the downstream boundary condition in the model is set to the bed level of the channel rather than using the HQ rating curve, this would lead to a local drawdown in the modelled flood level at the downstream of the model.

2.4. However, having reviewed the model, the 1d downstream boundary condition has only a negligible impact on the modelled water levels at the site for the following reasons.

- The downstream boundary is located over 1 km downstream of the site – it is unlikely that any drawdown effect would extend this far upstream.

- The boundary is located behind two significant flow control structures across the floodplain – the A420 road and the railway line. These would act as a downstream control and prevent any artificial drawdown of flood levels at the downstream boundary extending further upstream to the site.

2.5. **Figure 1.** below indicates that location of the site and the downstream boundary and shows the downstream boundary is over 1 km away from the site.

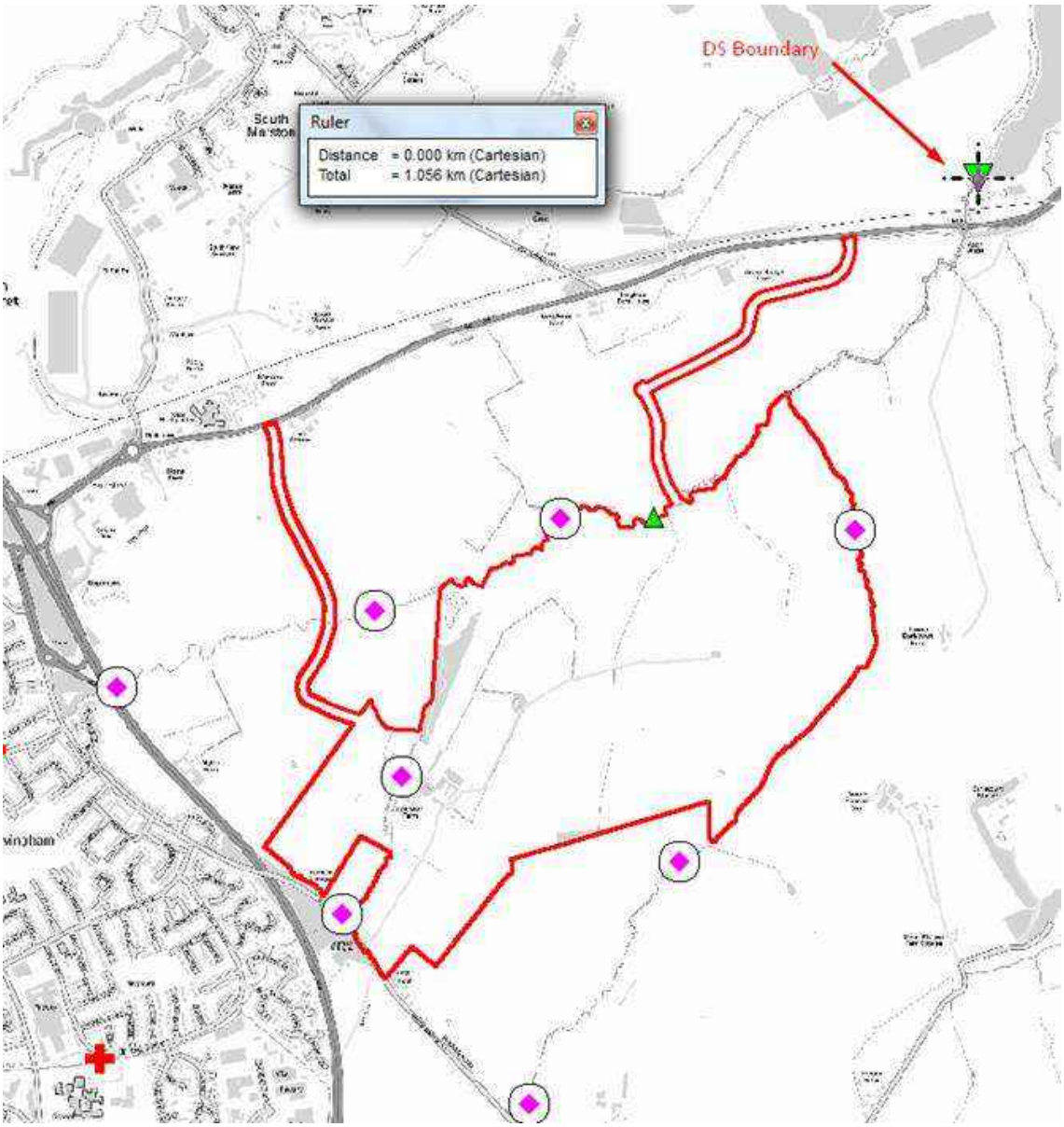

Figure 1) Downstream boundary location

2.6. **Figure 2.** shows an extract of the modelled flood extents at the downstream boundary with significant backing up at the road and railway lines.

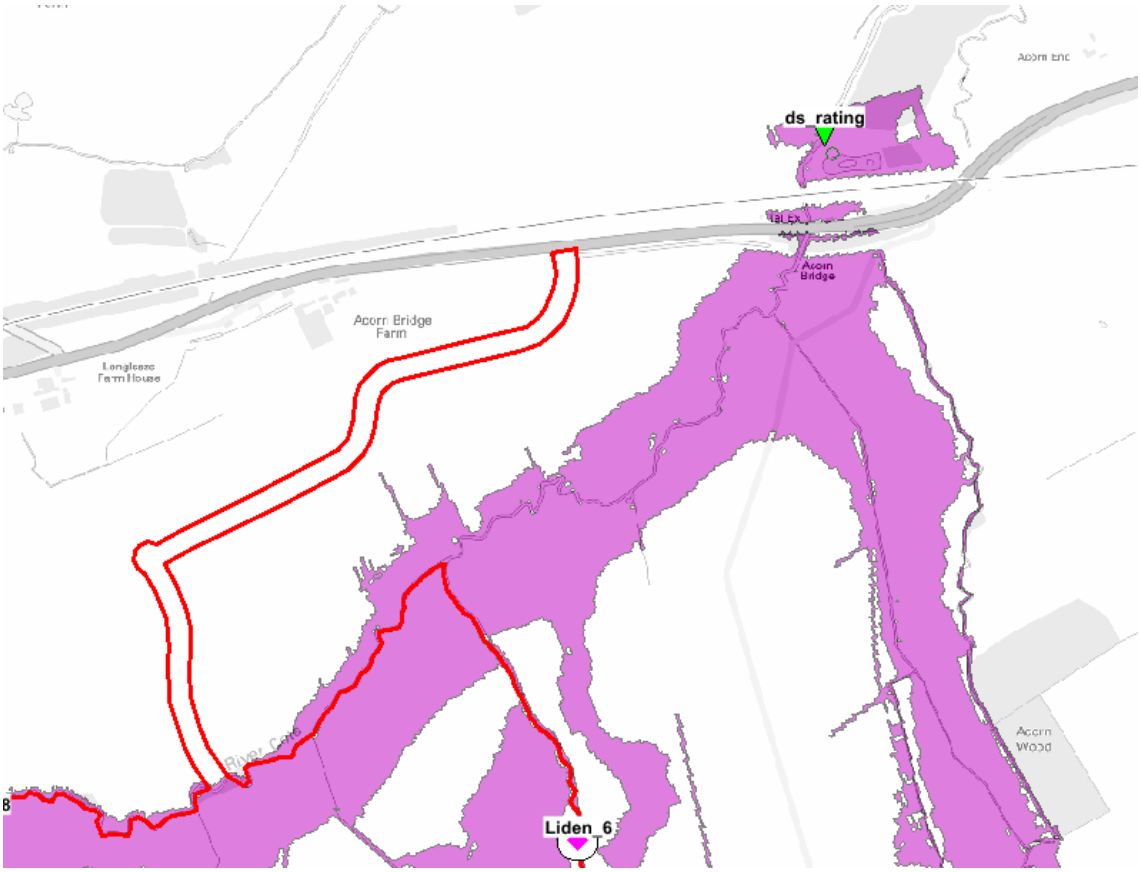

Figure 2) flood extents at downstream boundary showing backing up at road and railway

2.7. **Figure 3.** shows the maximum stage within the downstream reach for the 1:1000 annual probability event for the EA and PBA models.

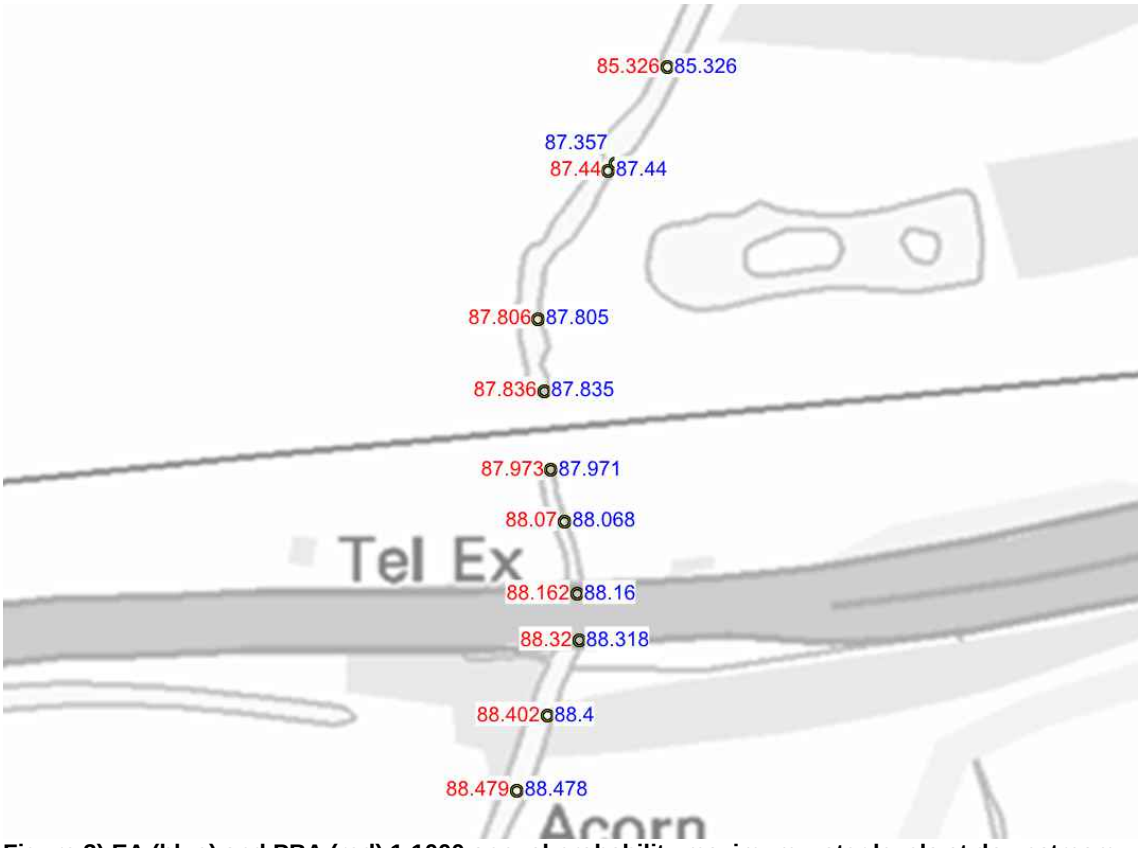

Figure 3) EA (blue) and PBA (red) 1:1000 annual probability maximum water levels at downstream

2.8. This shows a significant local drawdown in water levels at the very downstream due to error in the downstream 1d HQ boundary. However, this impact is present in both the EA calibrated model and PBA's model and the drawdown is localised at the very downstream channel sections. The water levels immediately upstream of the A420 road and the railway line are not significantly impacted.

2.9. As such, the actual impact of this error to the model is likely to be negligible given the location and greater impact of control structures.

3. EA Comment on omitted inflow boundaries

3.1. The following comments from the model review were Amber comments;

'It should be noted that in the bc_dbase an inflow named "ditchA" is present for both the 100-year + 35% climate change and 100-year +70% climate change events bc_dbases but isn't in the inflow CSV's. Additionally, "Input_G_Lta" is noted in the inflows CSV but not in the 1D QT boundaries. Should these flows be applied?'

3.2. PBA has reviewed this comment. The flow for DitchA was created during the model build stage to allow for a sweetening flow to be added to a dry drainage ditch, which was added to the model by PBA to capture a potential flow route. However, the ESTRY drainage ditch was ultimately stable enough with no flows such that a sweetening flow was not necessary.

3.3. The flow data for this channel was located in a different inflow csv (Swindon_112b_PBA.csv) but was set to 0 in any event **(Figure 4).**

	Name	Source	Column1_or_Time	Column2_or_Value_or_ID	TimeAdd
2	Cole_8	Swindon_112b.csv	Time_Col8	Flow_Col8	
3	Cole_7	Swindon_112b.csv	Time_Col7	Flow_Col7	
4	Cole_5a	Swindon_112b.csv	Time_Col5a	Flow_Col5a	
5	Stratton	Swindon_112b.csv	Time_Strat	Flow_Strat	
6	Dorcan_8	Swindon_112b.csv	Time_Dor8	Flow_Dor8	
7	Dorcan_7a	Swindon_112b.csv	Time_Dor7a	Flow_Dor7a	
8	Kestrel	Swindon_112b.csv	Time_Kes	Flow_Kes	
9	Liden_6	Swindon_112b.csv	Time_Lid6	Flow_Lid6	
10	Liden_5	Swindon_112b.csv	Time_Lid5	Flow_Lid5	
11	Liden_3a	Swindon_112b.csv	Time_Lid3a	Flow_Lid3a	
12	Lid_G	Swindon_112b.csv	Time_G_Lid	Flow_G_Lid	
13	Fox	Swindon_112b.csv	Time_Fox	Flow_Fox	
14	Lenta	Swindon_112b.csv	Time_Len	Flow_Len	
15	Input_G_Lta	Swindon_112b.csv	Time_G_Lta	Flow_G_Lta	
16	ds_rating	Swindon_038.csv	head_ds_rating	Flow_ds_rating	
17	ditchA	Swindon_112b_PBA.csv	Time_ditchA_PBA	ditchA_PBA	

	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
1	Time_Lid6	Flow_Lid6		Time_Len	Flow_Len		Time_G_L	Flow_G_Lta		Time_ditchA_PBA	ditchA_PBA		
2	0	0.015528		0	0.272		0	0.068		0	0		
3	0.5	0.015528		0.5	0.272		0.5	0.068		50	0		
4	1	0.015839		1	0.28		1	0.07					
5	1.5	0.01677		1.5	0.296		1.5	0.074					
6	2	0.018323		2	0.336		2	0.084					
7	2.5	0.021118		2.5	0.4		2.5	0.1					
8	3	0.025466		3	0.504		3	0.126					
9	3.5	0.032609		3.5	0.664		3.5	0.166					
10	4	0.043168		4	0.912		4	0.228					

Figure 4) inflow data for DitchA

3.4. Input_G_Lta was included in the flow data .csv file from the EA model however it was not used in the their final model. **Figure 5.** shows the inflow labels from the EA model (1d_bc_swin_077), which does not include Input_G_Lta. Therefore the omission of this inflow is consistent with the existing EA model.

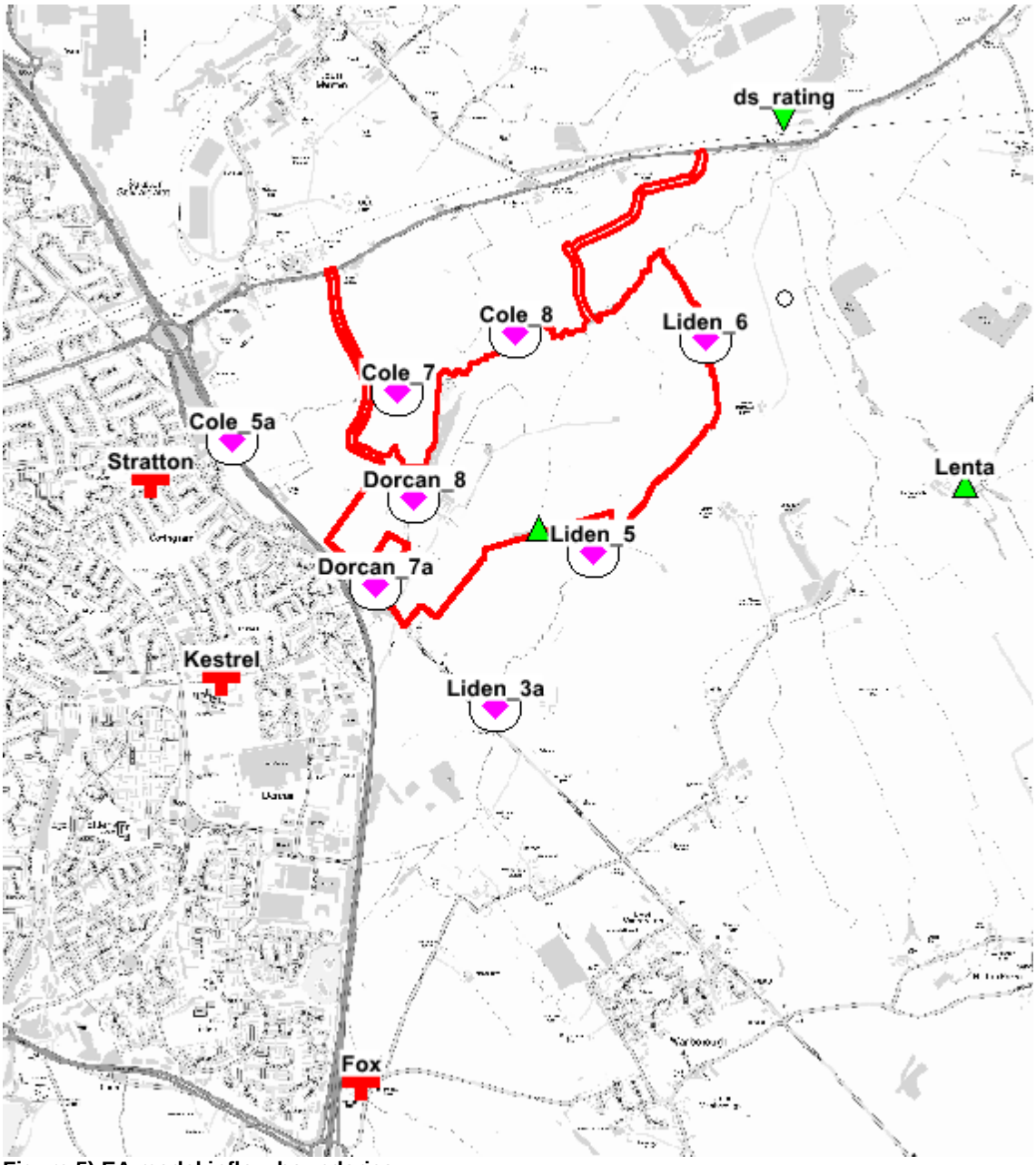

Figure 5) EA model inflow boundaries

3.5. As such the comments on the inflow boundaries do not need to be considered further.

4. EA Comment on TUFLOW version used

4.1. The next comment from the model review is also an Amber comment;

'The models appear to be run in TUFLOW version 2007-07-DB. This is significantly dated and therefore should be rerun in the latest version of the software to conform with best practice.'

4.2. The EA model was calibrated using an older version of TUFLOW – with different default parameters – using a newer version of the software would invalidate the calibration work done on the model. This approach is generally recommended for calibrated models.

5. EA Comments on TUFLOW Warning messages

5.1. The final comments from the model review were Green comments;

5.2. By definition these comments are not considered significant in terms of influencing the model results.

- *"WARNING - Unused 1d_ta line with attributes: ..\model\xs\Lenta_xs_076.csv"*
- *"WARNING - Unused 1d_ta line with attributes: ..\model\xs\Gully_Lid_W_007_PBA.csv"*
- *"WARNING 2079 - 3D breakline failed to modify any Zpts. Check elevations"*
- *"WARNING 2079 - 3D breakline failed to modify any Zpts. Check elevations"*

5.3. PBA has investigated the locations of these messages. **Figure 6.** shows the locations of these messages.

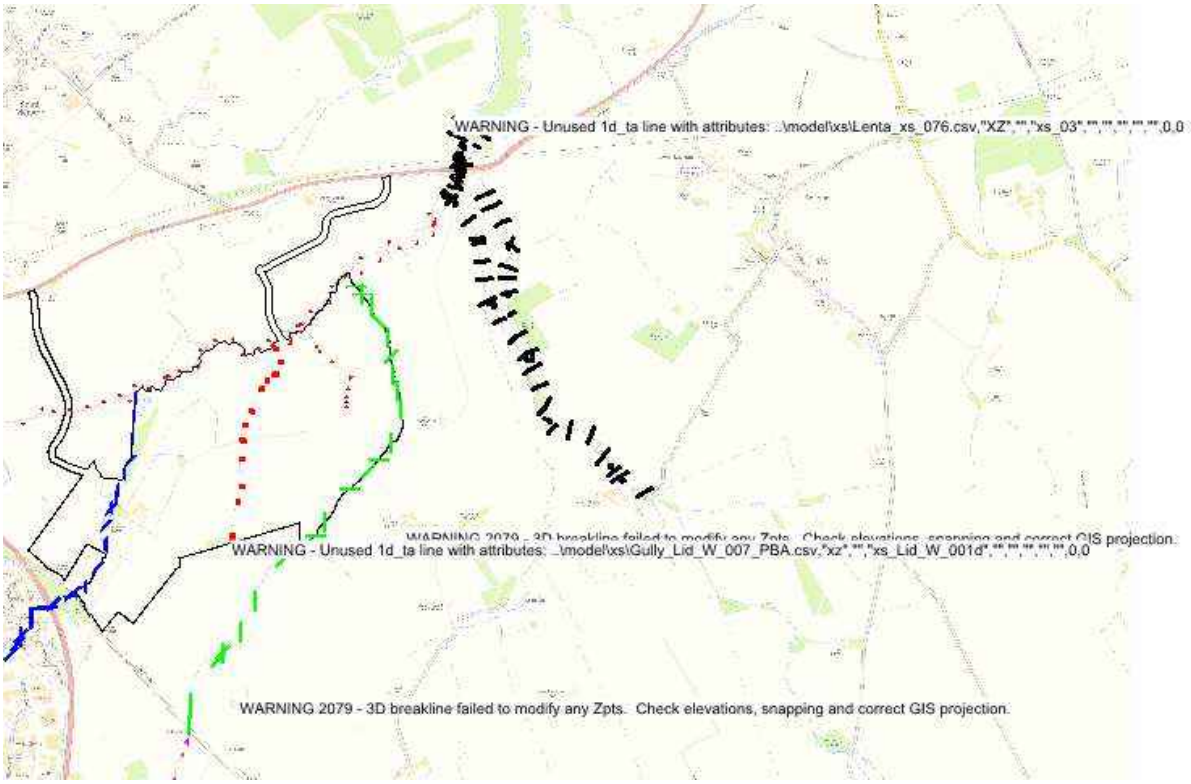

Figure 6) Location of messages

5.4. One of the unused 1d_ta lines was located at the upstream end of a minor drainage channel (**Figure 7**). This section helped define a short reach of channel, with another cross section profile located approximately 20 m downstream. The impact of this unused 1d_ta line is therefore considered to be minimal.

5.5. The second unused 1d_ta line was at the downstream of the model and was inherited from the base EA model. The downstream of the model does not have a significant influence on the flooding further upstream (**Figure 3**) so this unused 1d_ta line is also considered to be insignificant.

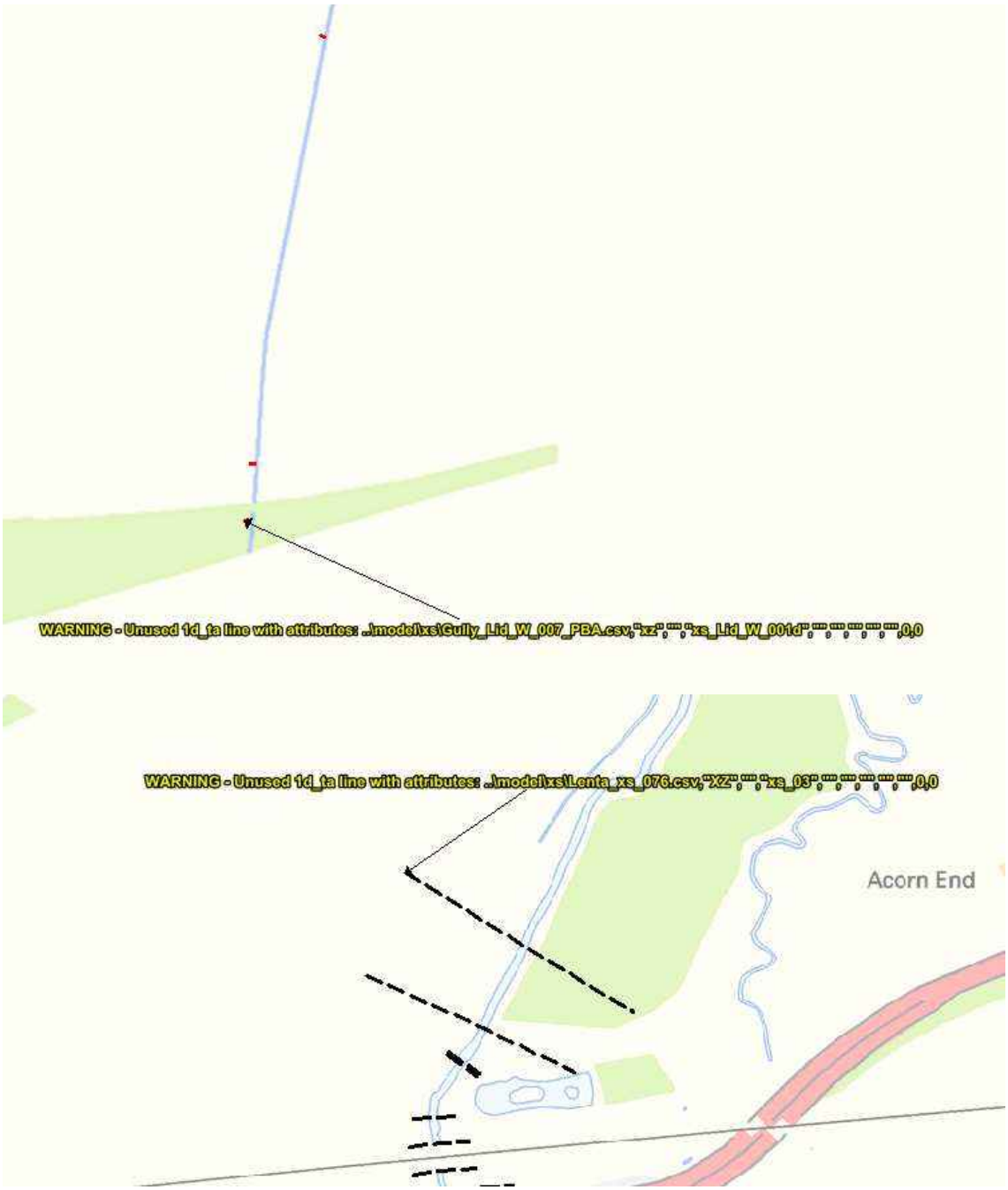

Figure 7) location of 1d_ta messages showing nearby sections (red and black dashed lines)

5.6. The 3d breakline messages indicated some features are not modifying any zpts. This is usually a consequence of using the Max or Min commands to raise or lower existing ground levels. They are usually only ignored where the underlying DTM is set above or below the Max/Min ground level. In this instance the messages indicated individual nodes along zlines which were being used as gullies so any discrepancy would be localised (**Figure 8**), as such it is considered that these messages can be ignored.

Figure 8) location of zpt messages

6. EA Comment on Model dVol and Mass Balance Oscillations

6.1. This comment was raised as a green comment;

'DVol for both runs has a sensible profile but notable oscillations. The reviewer has looked at the results in the 1D domain in the vicinity of the site and from a random inspection there does not appear to be any significant oscillations in either flow or stage within the vicinity of the proposed development. Potentially, this is an issue with another part of the model. Without model results from the original model the reviewer cannot determine if this is something caused by the climate change inflows or the original model.'

6.2. This comment is not considered significant, the reviewer indicates that this is likely to be a legacy issue within the EA model and does not influence the model at the site. **Figure 9.** shows the EA dVol and cumulative ME for the 1000 year results, which indicates similar profiles and oscillations as PBA's models.

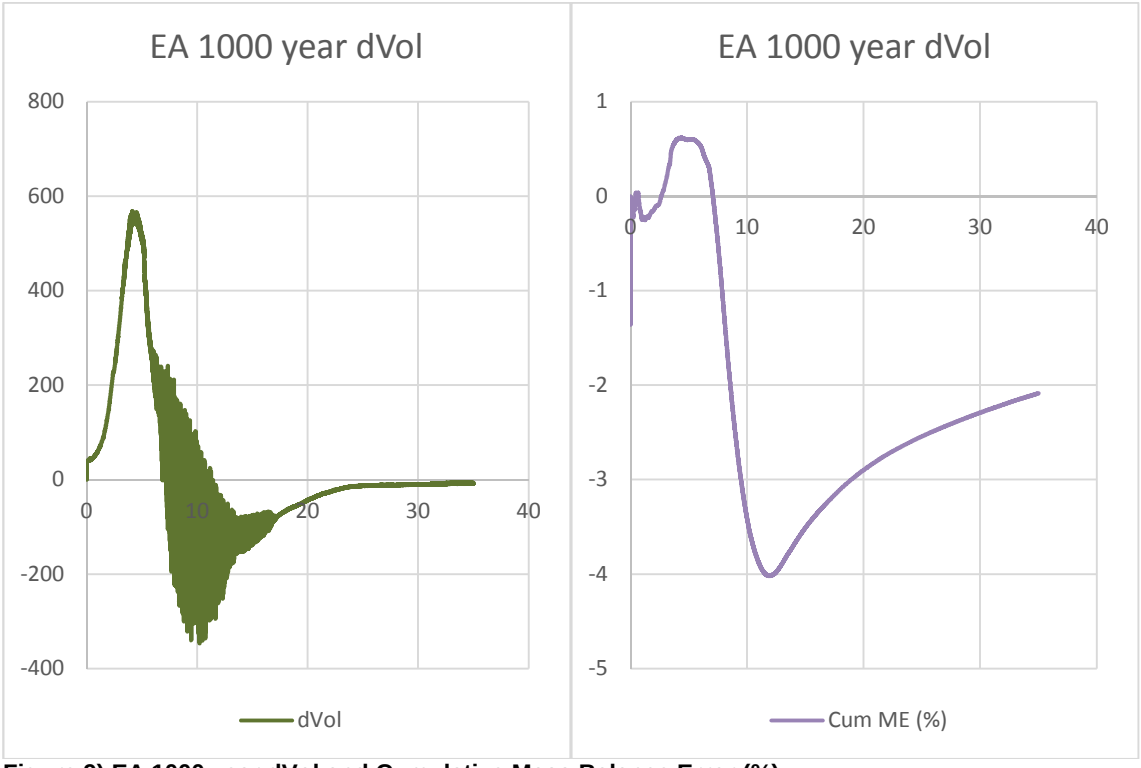

Figure 9) EA 1000 year dVol and Cumulative Mass Balance Error (%)

6.3. The oscillations in dVol and the cumulative Mass Balance Error (%) in the PBA modelling have been inherited from the EA model, consequently, it is considered that this comment does not need to be addressed further.

7. Conclusion

7.1. In conclusion, the comments raised in the review have been investigated by PBA. It is considered that none of the comments raised would have a significant influence on the current model or impact on the results.