Envision Battery Plant **07/07/2021**

Reference number TBC - R001

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

SYSTRA

ENVISION BATTERY PLANT

FLOOD RISK ASSESSMENT & DRAINAGE STRATEGY

IDENTIFICATION TABLE	
Client/Project owner	Envision
Project	Envision Battery Plant
Study	Flood risk assessment & drainage strategy
Date	07/07/2021
Reference number	TBC - R001

APPROVAL

Version	Name		Position	Date	Modifications
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2					
3					

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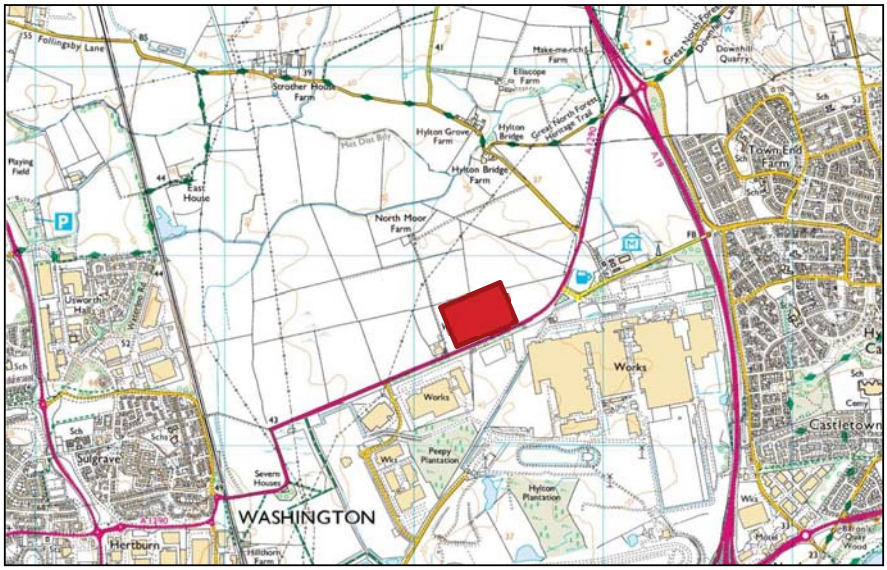
1. INTRODUCTION

1.1 Background

1.1.1 This is the Flood Risk Assessment (FRA) and Drainage Strategy (DS) for the Envision development which is located within the boundaries of the parcel known as "IAMP ONE Phase 2", which forms part of the International Advanced Manufacturing Park (IAMP) industrial development on land north of the Nissan UK's Sunderland Park.

1.1.2 SYSTRA Ltd was previously commissioned by IAMP LLP to undertake FRA and DS reports for both IAMP ONE Phase 1 and 2 developments to accompany their respective planning applications. IAMP ONE Phase 1 obtained planning permission in May 2018 and is currently under construction. The location of the Envision site is shown on below **Figure 1.**

Figure 1. Site location



Source: Ordnance Survey. Crown Copyright reserved.

1.2 Scope of Report

1.2.1 The purpose of this assessment is to develop a full appreciation of possible flood risks to the development and to other properties in the surrounding areas that may be affected as a result and to identify suitable strategies for managing the drainage needs of the proposed scheme in order to satisfy the requirements set out in *'National Planning Policy Framework'* [(1)] *and 'Planning Practice Guidance'* [(2)].

1.2.2 These assessments have been undertaken with reference to previous FRA and DS work by SYSTRA and others for the wider IAMP developments and related documents including:

- IAMP Area Action Plan [(3)]
- AAP Flood Risk and Water Management Technical Background Report [(4)]
- IAMP ONE Environmental Statement [(5)]

2. SITE INFORMATION

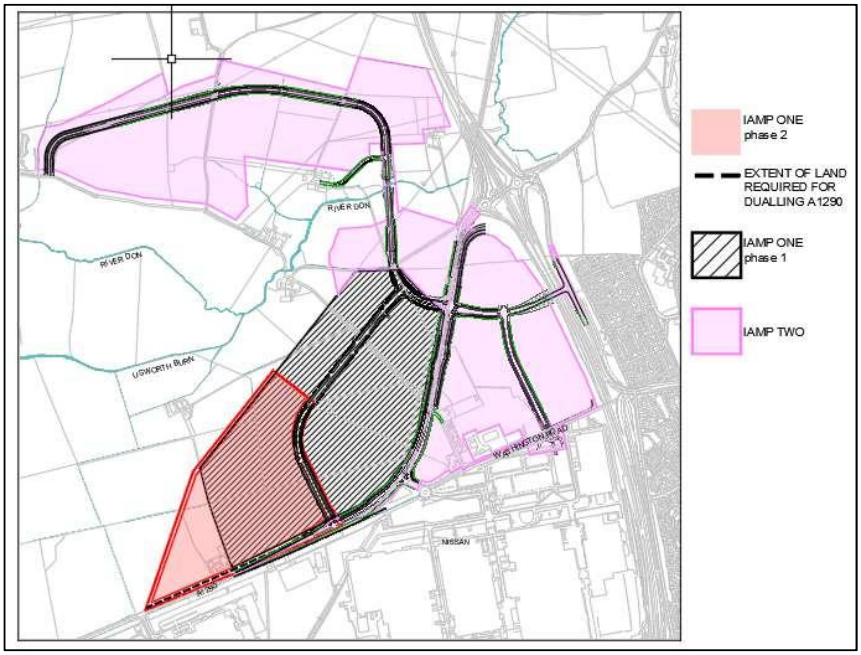
2.1 Site Description

2.1.1 The IAMP ONE phase 2 Envision site occupies approximately 25.1ha in size and is located 6.2km to the north-west of Sunderland at an Ordnance Survey grid reference of *NZ332586*.

2.1.2 The proposed development site comprises land from the original extent of IAMP ONE Phase 2 that has not yet been taken up for development, extending into the triangular-shaped plot of agricultural land towards West Moor Farm. The proposed development is wholly contained within the boundaries of IAMP ONE Phase 2 which is bounded to the east by a new access road serving the IAMP ONE parcels, to the south by the A1290 road and Nissan's factory and by farmlands to the north and west. The River Don and Usworth Burn both pass to the north of the site. A series of field-boundary ditches are currently draining the land. The site is shown below in **Figure 2** in relation to the IAMP area.

2.1.3 The site is accessed via International Drive which was constructed as part of the IAMP ONE infrastructure. The A1290 is due to be widened to a dual carriageway as part of the future IAMP TWO works and dictates the southern boundary of the site.

Figure 2. Site location related to the IAMP ONE and TWO extents



2.2 Site topography and land drainage

2.2.1 The majority of the land on which the development is proposed mainly falls in the north-east directions, whilst the south-west corner falls in the south-east direction

2.2.2 The proposed development site is relatively flat with the change in level across the site being approximately 3m over a distance of 0.8km and an average slope of 1:167.

2.2.3 Part of the land drains via an existing field ditch running approximately northwards towards the Usworth Burn and which discharges into the Burn about 140m upstream of the Burn's

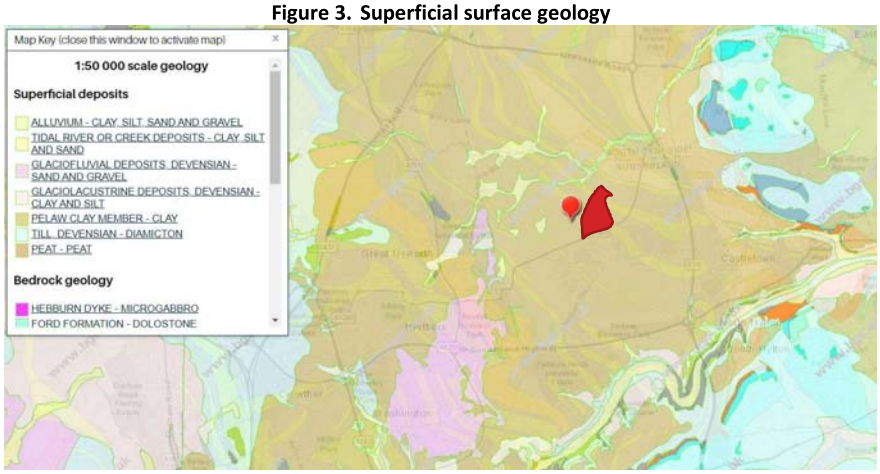
confluence with the River Don. The south-western section of land ostensibly drains to a low point north-west of West Moor Farm. The wider drainage pattern in this part of the site sees the land drain to an open drain that runs along the southern side of Washington Road. The drain appears to reach a summit opposite the Farm and flows away both eastwards and westwards from this point.

2.2.4 A plan showing the site's contour pattern is in more detail is included as SYSTRA drawing nr 107671/FRA/02 in **Appendix A**.

2.3 Ground conditions

2.3.1 Publicly-available records from the British Geological Survey indicate the superficial geology to be Pelaw Clay as shown in **Figure 3**. Site-investigations [6] in 2017 on the eastern part of the site within the original IAMP ONE extent recorded the ground as slightly sandy or gravelly clay or silty clay over mudstone or sandstone: the corresponding borehole logs are included for information in **Appendix B**. Where granular material (gravel) was present, this was at depths below which soakaway structures would be practicable and which were below such groundwater levels as were recorded.

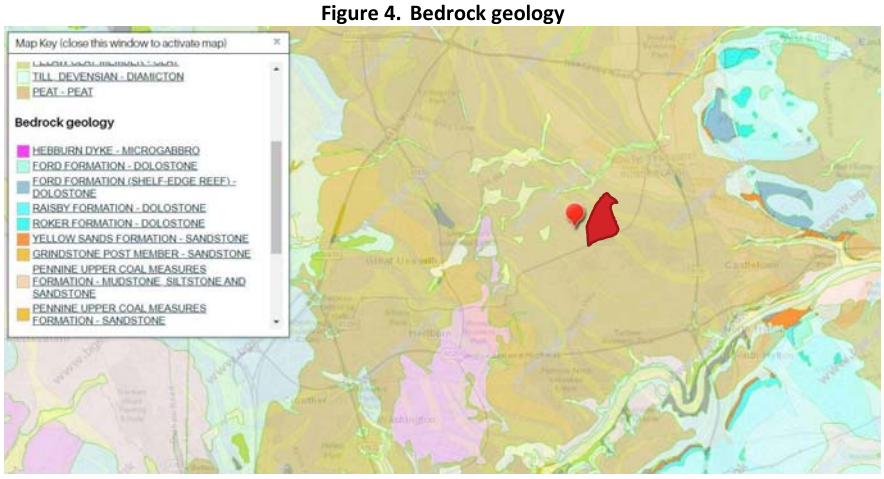
Figure 3. Superficial surface geology



Source: British Geological Society website, 2019

2.3.2 The bedrock geology is mainly a combination of Pennine Middle Coal Measures (mudstone, siltstone) and a band crossing northeast the site of Sandstone, and Pennine Middle Coal Measures, as shown in the borehole logs.

Figure 4. Bedrock geology



Source: British Geological Society website, 2019

2.3.3 This suggests that the superficial material is relatively impermeable. Soakaway tests across the IAMP ONE area returned permeability factors no higher than $5x10^{-7}$m/s. This is reflected in observations of the area's behavior during and after prolonged wet weather where surface ponding is a frequent result.

2.4 Surface Water Features

2.4.1 Usworth Burn runs eastwards to the north of the site, joining the River Don approximately 230m from the northern corner of the site. The River Don continues to the east passing through Hylton Bridge nearby, eventually discharging to the River Tyne in Jarrow.

2.4.2 The A1290 along the site's southern boundary is drained by an open drain which runs easterly into a piped culvert along Washington Road or westwards to eventually discharge to a small tributary stream to Usworth Burn west of Cherry Blossom Way.

2.4.3 The site is crossed by a number of ditches which convey flows in different directions; the main falls across the site are toward the northern-east boundary towards the River Don or, for the southern part, eastwards toward International Drive. There is a small ditch flowing towards the north which continues beyond the site's northern edge and discharges into Usworth Burn. The south-west corner of the site drains toward the eastern edges. There are no other surface water-features of note within or close to the proposed development site.

2.4.4 JBA Consultants had undertaken a modelling exercise [(7)] for the wider IAMP scheme to determine the extent of fluvial flooding associated with the River Don and its tributaries. This identified that "*... although the southern block of the proposed IAMP development area would be largely safe from a present day 1% AEP event, some parts of this block would be at risk from both future 1% AEP (with climate change; +20%, +25%, and +50%) and present day 0.1% AEP events.*"

2.4.5 The flood behavior of the Don and Usworth Burn is addressed in detail in Section 4.

2.5 Drainage Infrastructure

2.5.1 Records obtained from Northumbrian Water (NWL) for the IAMP scheme indicate that there are no public surface water sewers within the site.

2.5.2 The nearest public sewers relating to surface water are recorded on NWL's sewer plans as a combined sewer around a former PH and Usworth Cottages east of the main Nissan entrance. It flows eastwards along Washington Road before turning south down the western side of the A19 before turning east and crossing beneath the A-road into the urban area (Hylton Castle) beyond. There are no sewers on or close to the site other than those laid for the IAMP ONE scheme. Those comprise a trunk storm sewer running northwards under the new access road (International Drive) directly east of the site and a new trunk foul sewer following the same route. Connection points into these sewers have been located towards the mid-point of the site's eastern boundary.

2.5.3 Highway drainage serving the A1290 discharges into an open drain along the south side of the road which flows away from a high point opposite West Moor Farm, eastwards towards the culverted watercourse along Washington Road or westwards towards Washington and Cherry Blossom Way.

2.5.4 This scheme will drain via two new surface water networks laid to drain the IAMP ONE scheme. The main network conveys run-off from the majority of IAMP ONE via balancing ponds in the centre of that phase and an outfall sewer eastwards beneath the A1290 and passing north of the air museum. The outfall then turns south and then east again at Washington Road, after which it connects into the Washington Road culverted watercourse. The IAMP ONE parcels already built have removed a land drain as part of the construction footprint that previously drained land north-west of the A1290 and which discharged into the culverted watercourse west of the Three Horseshoes Pub.

2.5.5 The second network uses an existing land drain flowing northwards from the western side of IAMP ONE to convey run-off from that edge of the wider development to a series of scrapes and flood compensation features prior to discharge to the Burn. This split of the two networks was done to reflect the split in natural catchment within the IAMP ONE area.

2.5.6 The nearest parts of the first system to the Envision site comprise a trunk storm sewer running under the new IAMP ONE access road fronting the eastern edge of the site, with connection points close to the middle of that boundary, and the cluster of flood-compensation scrapes near North Moor Farm. A layout plan showing these works is included in **Appendix A**.

2.5.7 A new trunk foul sewer runs alongside the storm sewer under the IAMP ONE access road with connections to serve the Envision site. This discharges into a new sewage pumping station located central to the wider IAMP ONE area and located close to the north-east corner of this site. This in turn transfers sewage off-site to discharge into a trunk combined sewer near Washington.

3. REGULATORY REQUIREMENTS

3.1 Environment Agency

3.1.1 The Environment Agency (EA) is the drainage authority for the River Don and Usworth Burn which are both designated 'main river'. Their main interest is in the fluvial flood-risk management for the development and compliance with the Water Framework Directive (WFD) [9] alongside habitat enhancements to the river corridors and wider floodplain as part of the overall IAMP project, though these latter aspects are not part of this scheme and have been addressed by others elsewhere.

3.1.2 With regard to the WFD, the Northumbria River Basin Management Plan [10] deems the site to be split between the Don and the Wear Lower & Estuary surface-water units. There is no local groundwater unit. The policy approach for this is at low to moderate flood risk and will be applied where the risks are currently appropriately managed and where the risk of flooding is not expected to increase significantly.

3.1.3 A Water Framework Assessment [11] produced for the overall IAMP development did not record any additional constraints upon the scheme that impact specifically upon this scheme.

3.2 Lead Local Flood and Planning Authorities requirements.

3.2.1 SCC is the LLFA and LPA for this site as it sits entirely south of the River Don (the boundary with South Tyneside Council). The most recent version [12] of their Strategic Flood Risk Assessment (SFRA) was published in 2017 and replaced a previous version from 2010.

3.2.2 The SFRA mentions the IAMP development, principally referring to it in respect of the 2016 Flood Risk and Water Management Report [4] produced as part of the IAMP AAP as noted earlier. The SFRA highlighted four key objectives for drainage strategy and flood-risk management for the IAMP project drawn from this document, of which three are pertinent to this particular site:

- Managing flood risk from large paved areas.
- Controlling run-off from new development.
- Managing water quality of development run-off.

3.2.3 SCC, in its role as LLFA, maintains a Local Flood Risk Management Strategy [13]. This sets out a series of measures to manage flood risk of which the following are pertinent to this site:

- Development drainage on greenfield sites should be designed to discharge at greenfield run-off rates for the 1 in 1-year and 1 in 100-year rainfall events.
- Greenfield (and brownfield) sites should be checked on a 6-hour rainfall duration and any flooding constrained within the development site, causing no flooding to any buildings. Such flood water must be able to enter back into the system.
- Major Planning Application schemes should include some form of SuDS attenuation and source control.

3.2.4 The LFRMS identifies part of IAMP TWO area as land where development potentially conflicts with known flood risk but the area concerned is outside the extent of this particular site.

3.2.5 The Local Plan includes two key documents in relation to this appraisal:

- The Core Strategy and Development Plan (CSDP) [14] which sets out the overarching spatial strategy for development within the city from 2015-2033, adopted in 2020.

- The IAMP AAP [3] which was prepared jointly by SCC and STC and adopted in 2017.

3.2.6 The CSDP includes a series of policies relating to drainage and flood risk:

- WWE2 Flood Risk and Coastal Management.
- WWE3 Water Management
- WWE4 Water Quality
- WWE5 Disposal of Foul Water

3.2.7 Policy WWE2 broadly restates principal elements of the general thread for flood-risk management from NPPF [1]. It also requires development to contribute to the objectives of the local river basin management plan and to utilise SuDS measures as part of wider 'green infrastructure' systems. Policy WWE3 requires development to demonstrate that it passes the Sequential Test for flooding, to match greenfield run-off rates for surface drainage at the 1-year and 100-year return periods and to apply suitable provision for climate-change effects.

3.2.8 Policy WWE4 obliges development discharging to a watercourse to make appropriate pollution control measures. Policy WWE5 sets out a hierarchy of preference for sewage disposal from new development. The full text of all four policies is included in **Appendix C** for reference.

3.3 Northumbrian Water

3.3.1 NWL is the incumbent sewer authority. New trunk foul sewers serving the IAMP ONE site are to be adopted and will be used as a discharge location for the proposed foul water sewer serving the Envision development.

3.4 Other

3.4.1 FRA and DS reports have been produced for the overall IAMP ONE and TWO developments to inform the earlier stages of the planning and design process. Amongst these, the following documents set out the strategic approach to be taken for this site:

- AAP Flood Risk and Water Management Technical Background Report [4].
- IAMP ONE: Environmental Statement: Chapter I: Water resources & flood risk [5].
- IAMP TWO Flood risk assessment & Drainage strategy [19].

4. PROPOSED DEVELOPMENT

4.1 Introduction

4.1.1 IAMP is a flagship project for the North East, linked to the safeguarding and growth of employment within the automotive and advanced manufacturing sectors. The North East plays a key national role in these sectors and IAMP is required to provide land and buildings to deliver growth to support the sectors.

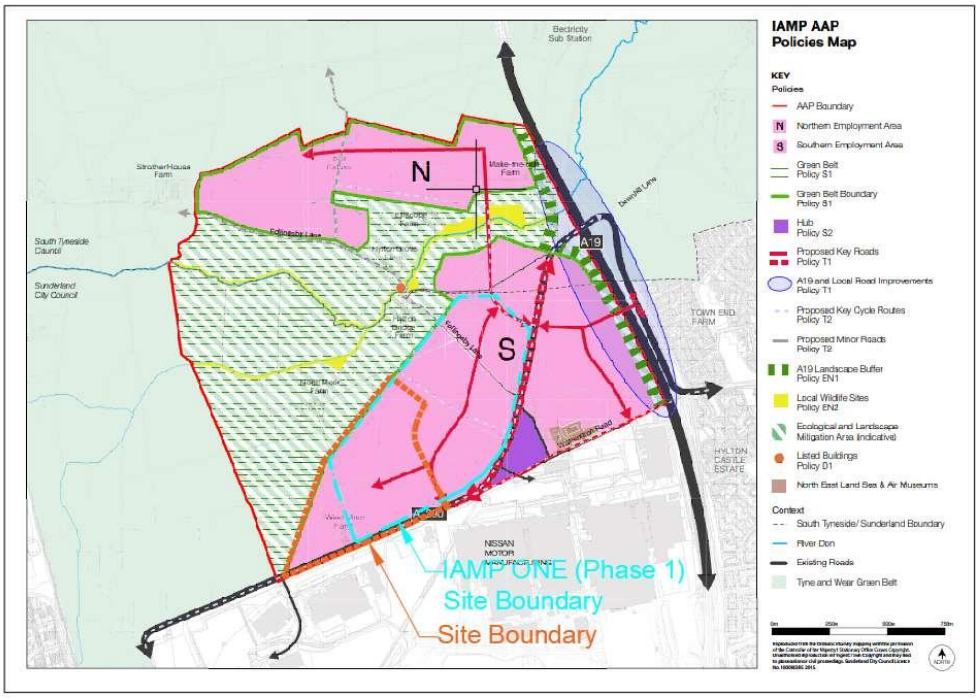
4.1.2 IAMP ONE (phase 1) planning application was submitted in January 2018 and was approved in May 2018. It is currently under construction with some parcels already complete and establishing operations.

4.1.3 The Envision development is located within the IAMP ONE Phase2 boundaries. The proposed development consists of an industrial unit (Class B2) that is to house a 9 GWh capacity

electrode and battery manufacturing facility, comprising of two battery manufacturing plants separated by a central spine of offices.

4.1.4 The proposed facility will manufacture lithium-ion battery pouch cells and modules. The facility will employ approximately 1,000 jobs, consisting of 150 office staff and 850 shift staff. There will be 4 shifts. . The proposed development will be set within a landscaped plot, supported by necessary vehicle parking, loading/unloading bays and maneuvering aryteas.

Figure 5. Site Boundary IAMP ONE Phases 1 and 2



Source: IAMP AAP

4.2 Planning Context

4.2.1 As described in more detail in the following section, the river modelling carried out by JBA Consultants for the River Don and Usworth Burn shows that the Envision development mainly sits within Flood Zone 1 with the exception of a small portion to the northern-east end of the site, that is currently located within Zone 2 and falling into Zone 3 over time as climate-change affects the flood patterns over the development lifetime. It is proposed to set the open space between the development and the sewage pump station at levels sufficient to block the overland flow route that arises within Flood Zone 3, in tandem with similar steps for the land around the western end of the attenuation basin north of this site, but a residual flood path will remain in Flood Zone 2 towards the end of the development's lifetime.

4.2.2 The proposed development will comprise of manufacturing facilities which, due to requiring hazardous substances consent in relation to some of the materials used, are classed as '*highly Vulnerable*' according to Table 2 from the flood management section of the PPG website.

4.2.3 The paved proportion of the site is approximately equivalent to 60% of the IAMP ONE Ph 2 area.

4.2.4 The proposed development is almost wholly situated within Flood Zone 1 for its lifetime. Only part of the site entrance off International Drive sits within Flood Zone 2. In view of this the proposed factory is considered to be compatible with the prevailing risk of flooding

throughout the development's lifetime According to Table 3 of the PPG section and an Exceptions Test is not considered necessary for the proposed scheme.

5. FLOOD RISK ASSESMENT

5.1 Existing flood risk

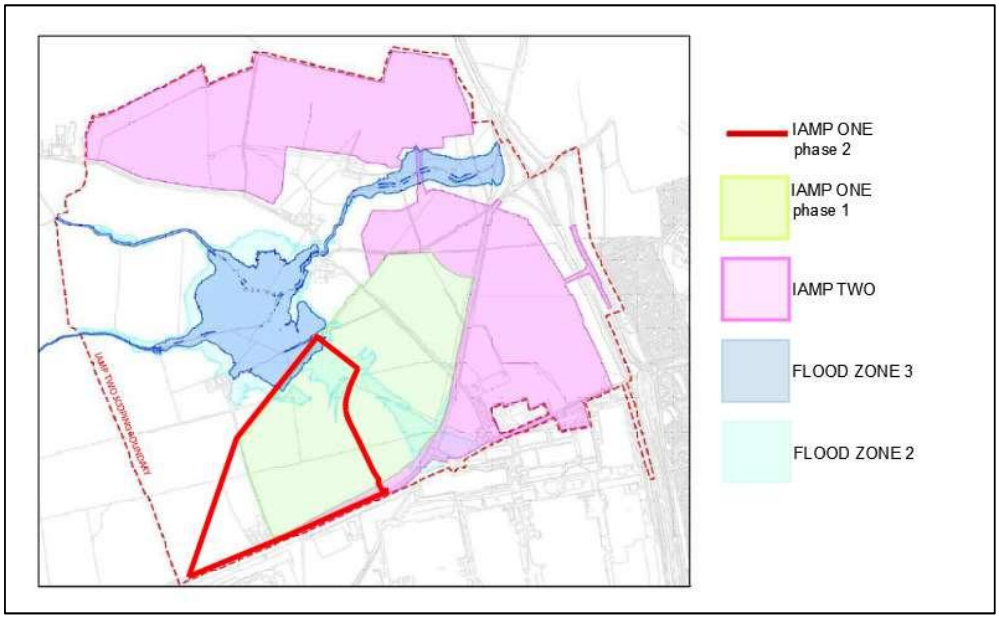
Fluvial Flooding

5.1.1 The River Don and its major tributary, known as Usworth Burn run to the north of the site flowing eastwards. The two channels converge west of Hylton Bridge farm. The river is bridged by Follingsby Lane at Hylton Bridge and passes beneath the A19 and former railway, the latter's structure being subsumed into the dual-carriageway culvert.

5.1.2 The EA's indicative flood mapping of the Don and the Burn was too coarse to be relied upon for the purposes of flood risk assessment for the project. A detailed river model was compiled and used to provide detailed forecasts of the design flood extents in order to inform the flood risk assessment process. JBA's report [8] contains full details of the modelling work and results.

5.1.3 The present-day flood zones across the IAMP ONE Phase 2 site in relation to the proposed development boundary are shown below in **Figure 6**. This shows that the design flood (100-year return period, Flood Zone 3) does not encroach into the proposed development area. Almost all the proposed development sits within the low-risk category of Flood Zone 1. Flood Zone 2 encroaches onto the northern end of the proposed development and affects part of the site entrance off International Drive.

Figure 6. Fluvial Flood Zones



Source: SYSTRA FRA for IAMP TWO, 2019

5.1.4 The flooding on the wider IAMP ONE Phase 2 site is driven mainly by the restriction to flow at Hylton Bridge. The constraints imposed by the A19 culvert do not overly influence flood levels this far upstream: peak flood levels at the design-flood level of severity are about 1m lower upstream of the A19 than upstream of Hylton Bridge. Key river levels are shown in Table 1 below.

5.1.5 The effects of future climate change were also tested, adding between 20 – 50% to existing flood flows. These values were taken from Table 1 of the prevailing guidance [20] for climate-change allowances for flood and drainage management (see extract in **Figure 7**). This directs

that the '*higher central*' and '*upper end*' values should be considered in respect of '*essential infrastructure*' or '*highly* vulnerable' assets when in Flood Zone 2.

Figure 7. Climate change allowance for Northumbria river basin

Table 1 peak river flow allowances by river basin district (use 1961 to 1990 baseline)

River basin district	Allowance category	Total potential change anticipated for the '2020s' (2015 to 2039)	Total potential change anticipated for the '2050s' (2040 to 2069)	Total potential change anticipated for the '2080s' (2070 to 2115)
Northumbria	Upper end	20%	30%	50%
	Higher central	15%	20%	25%
	Central	10%	15%	20%

Source: EA update to FRA climate-change allowances, 2016

5.1.6 The design life of the development exceeds 50 years so allowances from the 2080s column have been used.

5.1.7 The combined flood envelopes for current and future events are shown in **Figure 8** over the page (Figure 5.2 from JBA's 2017 report). The corresponding modelling included the existing flood defences within the model: a comparison was made omitting those defences but showed no meaningful difference in results. This is due to the low standard of protection afforded by those features: they are overwhelmed at the design flood conditions.

5.1.8 The river modelling found that the flood limits upstream of Hylton Bridge were relatively sensitive to the climate-change factors, as can be seen from the differences between the series of flood conditions in the flood-mapping. Key peak flood levels are listed below based on the modelling work.

Table 1. Key flood levels on River Don / Usworth Burn - pre-development

LOCATION	1% AEP	1% AEP + 20%	1% AEP + 50%	0.1% AEP
U/S Hylton Br.	35.35mAOD	35.58mAOD	35.62mAOD	35.89mAOD
North Moor Fm.	35.35mAOD	35.58mAOD	35.62mAOD	35.89mAOD

Source: JBA Consulting, 2017

5.1.9 The flooding crossing the northern end of the site is not static but represents a sheet flow following the land's natural fall south-eastwards. It is backed up locally by the A1290 road which sits slightly higher than the adjacent ground but eventually overtops this, as well as driving increased flows through the culvert that conveys the land-drain beneath the A1290.

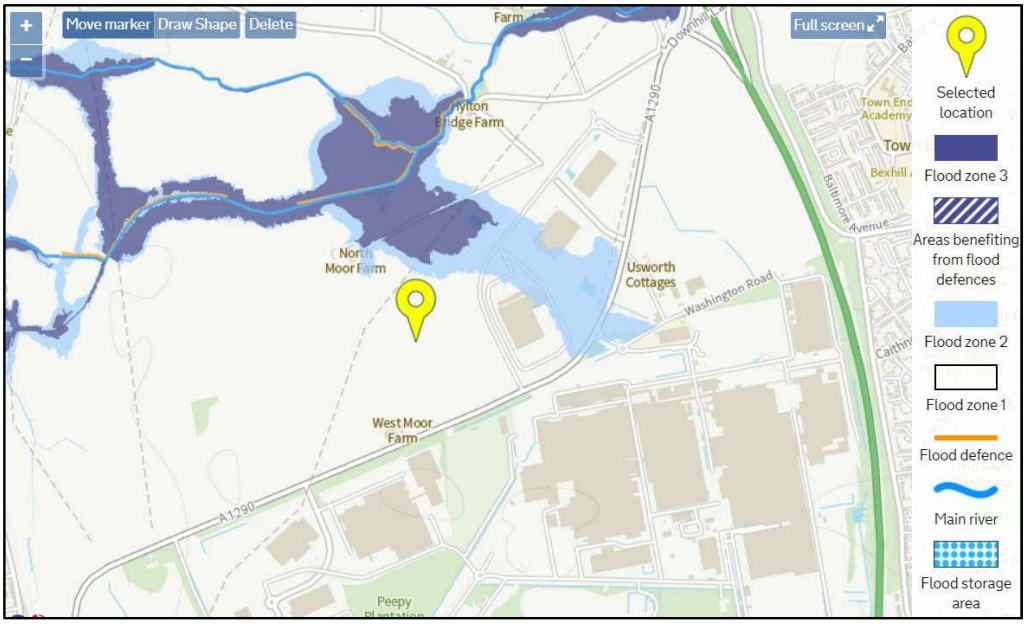
5.1.10 Overall, there is only a **VERY LOW** risk of fluvial flooding at present with all but a small area of the proposed development located in Flood Zone 1. There is a very low residual risk of flood flows crossing the north end of the site and continuing down to the A1290 and across to Washington Road and towards the Nissan factory.

Surface Water Flooding

5.1.11 The risk categories for surface flooding align with those for fluvial flooding. **Figure 9** below shows the EA's indicative mapping for surface flooding across the IAMP scheme. The maps

show that the site is not Only a small area within this site's boundary is at anything other than a very low risk of surface water flooding.

Figure 8. Flood risk from surface water



Source: EA website, 2019

5.1.12 The surface water flooding identified at the northern corner of the site correlates with the fluvial flooding extents and does not affect the proposed development to any greater degree.

5.1.13 An isolated low area close to West Moor Farm is classed as being at low to medium risk and corresponds with local low-lying areas prone to waterlogging and to surface ponding during prolonged wet weather. The proposed development site is located approximately 50m to the east and is not affected.

5.1.14 Surface flooding is considered to present a very **LOW** risk of flooding overall, with isolated low areas of the site known to be prone to ponding or waterlogging in prolonged wet weather at present.

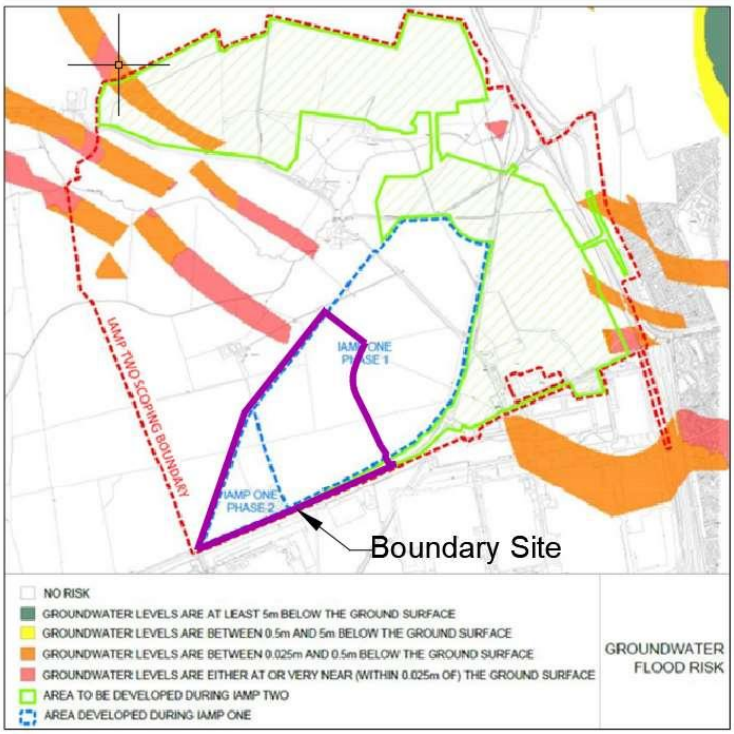
Artificial sources

5.1.15 There are no records of flooding from reservoirs affecting the site or the Don and its tributaries. There are no other nearby artificial water bodies beyond those created specifically for the IAMP scheme. This potential source is irrelevant at this site.

Groundwater flooding

5.1.16 The SCC DSFRA only covers part of the site and therefore flood risk information has been obtained from JBA. **Figure 10** shows the groundwater risk areas, with expected groundwater depths, in relation to the parts of the site that will be developed in IAMP TWO.

Figure 9. Groundwater flood-risk



5.1.17 There is no material risk from groundwater identified within the wider IAMP ONE Phase 2 site boundaries. There is a risk of shallow groundwater on land close to the north-west boundary of it associated with the underlying geology, which is characterised by sub-crops of permeable sandstone bedrock and are shaded green in **Figure 4**.

5.1.18 Groundwater is not considered to pose any meaningful risk of flooding to the site in light of this information. The physical nature of the soils locally does not permit ready movement of groundwater and there is no underlying mobile water table that would be expected to rise to the surface.

5.1.19 The risk of flooding to the site from groundwater is considered **LOW**.

Sewers flooding

5.1.20 The closest location of known sewer flooding issues was on Washington Road adjacent to the former Three Horse Shoes PH opposite the air museum. This was understood to be caused by or exacerbated by land-drainage flows that were culverted west of the pub and discharged into piped drains running along Washington Road, as well as local deficiencies in the pipe works themselves. Such flooding would pose no direct risk to the site or cause any significant interference with off-site access.

5.1.21 The main surface water sewer in proximity of the site is the outfall installed to drain IAMP ONE to the culverted watercourse along Washington Road at the north-east corner of the Nissan boundary. This relieves demand locally upon the culvert and an overflow into a combined drain partway along Washington Road. The new drain is designed to convey flows up to and including the 1 in 100-year event with a 40% climate change allowance.

5.1.22 The watercourse which runs through the south-eastern portion of the wider IAMP ONE development site, connects into a 450mm culvert before connecting into the culverted watercourse. Modelling carried out for the IAMP ONE shows that this 450mm culvert is undersized for its current purpose but the proposed development will divert the surface runoff toward the existing sewer running beneath International Drive, reducing further any localized risks of flooding.

5.1.23 There are no recorded instances of flooding on the A1290 from the highway drainage network.

5.2 Post-development flood risk

Fluvial flooding

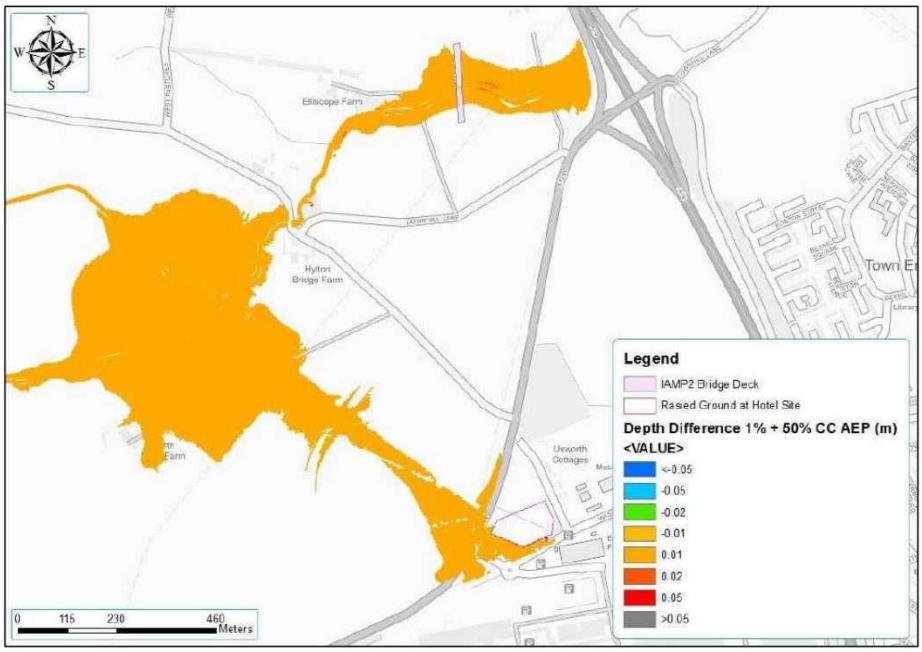
5.2.1 The proposed development does not encroach onto the margins of the current Flood Zone 3. When future climate-changes are included, the Flood Zone 3 elevations are still lower than the proposed development site, therefore the development is not at risk of flooding from the watercourse at the design standard.

5.2.2 In view of the potential consequences of the future changes in the River Don's flood regime, it is proposed to set levels across this development higher than existing ones in order to block this flow-path at the design standard flood and to protect existing and future development beyond the A1290. This change was tested with the River Don model which showed that, even in the future 100-year flood with 50% climate-change (the 'upper end' category), the difference in water levels across the IAMP scheme was no more than 0.01m, as shown in **Figure 11** over the page.

5.2.3 Such a small change in water level has minimal effect upon other properties: the nearest such is North Moor Farm which is marginally affected by such extreme flood conditions. The flood outlines shown in **Figures 8 & 11** both show the flood extents surrounding the farmstead on the northern, eastern and southern sides. Such a small change is of only small significance in terms of the river-model's accuracy.

5.2.4 In addition to general land-raising for this purpose, the floor levels for the new development are to be set a minimum of **0.6m** above the design flood level (1% + CC). The climate-change figure is 50% (see para 5.1.5), giving a minimum floor level of **36.25mAOD** on this site in relation to the post-IAMP flood behaviour (see Table 2 below). Proposed development floor levels are set upwards of 38mOD respectively so are clearly sufficient.

Figure 10. Depth-difference for peak flood levels (overland flow-path blocked)



Source: JBA Consulting, 2017

5.2.5 The post-development peak flood levels predicted by the model are shown in Table 2 below.

Table 2. Key flood levels on River Don / Usworth Burn – post-development

LOCATION	1% AEP	1% AEP + 20%	1% AEP + 50%	0.1% AEP
U/s Hylton Br.	34.99mAOD	35.27	35.65	35.77
North Moor Fm.	34.99	35.27	35.65	35.77

Source: JBA Consulting, 2017

Surface Water Flooding

5.2.6 The risk of external surface flooding affecting the site is minimal due to the absence of large paved areas surrounding the proposed development that would shed run-off quickly onto the site.

5.2.7 The proposed development creates significant areas of paved surface and building roofs. This significantly increases the rate of run-off from the site but the provision of a new surface drainage system as part of the development will collect and manage that run-off and setting of floor levels higher than external surfaces will prevent the risk of internal flooding in such conditions. There is a residual risk of increased run-off and surface flooding at storm conditions above the drainage design standards but the levels of such risk are **LOW**.

5.2.8 Surface flooding is considered to continue to pose a **LOW RISK** of flooding overall for the site's developed form given the provision of a new drainage system to drain the scheme.

Groundwater Flooding

5.2.9 The proposed development will harden the majority of the site surface and divert rainfall away from soaking into the ground and into the new surface drainage system. This is not

considered to materially alter the local groundwater behaviour given how poorly permeable is the superficial material. Any water ponding on adjacent waterlogged ground that spills onto the development, if ground levels permit, will be collected by the drainage system.

5.2.10 Any use of piled foundations may intrude into lower strata (e.g. sandstone) which may be more porous but are not considered to cause any material interference with the movement of groundwater in those layers as the likely spacing of such elements will be widely spread.

5.2.11 Groundwater is considered to continue to pose a **VERY LOW** risk of flooding overall for the site's developed form.

Artificial Flooding

5.2.12 As noted earlier, this potential source is not relevant here.

Sewer flooding

5.2.13 The risk of external sewer flooding from existing sewers remains immaterial. The new drainage systems provided as part of the overall IAMP scheme has been designed to serve the new development and will therefore pose no risk of overflowing up to the relevant design standards for drainage – 100-year return period plus 40% allowance for future climate change. The details of the new drainage systems are described in more detail in Section 6.

5.2.14 The drainage network serving the proposed Envision development, following the overall IAMP design philosophy, has been designed not to flood for up to and including the 1 in 100 year storm with 40% climate change allowance and reduce any pressure on the existing drainage system running beneath International Drive; therefore the proposed development is not considered to increase any material risk of flood to the adjacent sites.

5.2.15 There is a residual risk of sewer flooding at storm conditions above the drainage design standards but the levels of such risk are **VERY LOW**.

5.3 Sequential Test

5.3.1 The proposed development site lies within Flood Zone 1, therefore there are no requirements for the Sequential Test to be carried out.

5.4 Summary of flood risk

Table 3. Existing and post-development flood risk summary

FLOOD RISK SOURCE	CURRENT WORST RISK LEVEL	CURRENT RISK	MITIGATION MEASURES	RISK LEVEL FOLLOWING MITIGATION
Fluvial	High	Site is almost wholly within flood zone 1. Medium to high flood risks are identified to the northern corner of the IAMP ONE Phase2 , away	Development platform level to be set to block overland flood route to protect new and existing development to south-east. Floor levels set 600mm above design flood level (35.65mOD)	Very low

FLOOD RISK SOURCE	CURRENT WORST RISK LEVEL	CURRENT RISK	MITIGATION MEASURES	RISK LEVEL FOLLOWING MITIGATION
		from the proposed development site.	based on vulnerability classification.	
Surface Water	High	Substantial majority of site at low risk of surface flooding. Small isolated areas with a medium to high risk of surface water flooding within the development boundary.	Install cut-off ditches where land falls toward the development to re-direct flows around site. New floor levels should be min. 150mm above external ground level. Any land drainage found during construction to be diverted where needed.	Low
Artificial resources	No risk	None	None	No risk
Groundwater	Low	There is no groundwater risk identified within the site boundary. Isolated areas north-west of the site are shown to be prone to groundwater at shallow depths.	Groundwater monitoring to be undertaken prior to detailed design. Floor levels to be min. of 150mm above external ground level. Land drainage to be installed if necessary.	Very low
Sewers	Low	No material risk onsite. Drainage flooding on Washington Road is distant from site.	New surface drainage to be designed to 100-year return period + 40%cc standard. New foul drainage sized for whole development.	Very low

6. SURFACE DRAINAGE STRATEGY

6.1 Existing site surface water run-off

6.1.1 The existing topography of the Envision site splits into two catchments that drain in different directions. The proposed development lies on the boundary of the two catchments, therefore it is proposed to drain the site via two independent systems with separate outfalls. Part of the site naturally drains to Usworth Burn via a land-drain network running northward (Outfall 1) whilst the remainder drains toward Washington Road and/or the land drain that flows south-eastwards towards the former Three Horseshoes PH (Outall2).

6.1.2 The IAMP scheme greenfield run-off rate has previously been agreed as a $\mathbf{Q_{BAR}}$ value of **3.8l/s/ha**, as recorded in the wider IAMP TWO FRA [18]. This corresponds to values of **3.3**, **6.7** and **8.0l/s/ha** for the 1-year, 30-year and 100-year storm return periods respectively.

6.2 Proposed drainage strategy

Storm Water

6.2.1 The surface drainage approach for this scheme will rely upon underground storage tanks, porous paving for parking areas, filter drains for internal roads and proprietary oil separators in order to achieve the required train of treatments for the proposed outfalls. The soil character locally is predominantly clayey and poorly permeable, as described earlier in Section 2.3. Those conditions do not support use of infiltration drainage for development drainage purposes: permeability factors were recorded as no greater than **5 x 10^{-7}m/s**. Such residual infiltration as may occur from un-lined drainage features will be minimal and has not been allowed for in design of the trunk surface-drainage system at this stage.

6.2.2 The higher permeability values recorded from the site tests ranged from '*no result*' to between **2x10^{-7}** to **5x10^{-7}m/s**. The latter values would class the ground as '*very poor infiltration*' (Table 25.1, SuDS Manual) in tandem with the logged descriptions of the sub-soil as clay. The Manual suggests that residual infiltration from attenuation structures (e.g. permeable pavements, cellular tanks) can be considered for levels of permeability as low as 1x10^{-8}m/s: detailed ground investigations of the Phase 2 parcel will clarify the site's condition and whether the potential for such allowance for residual infiltration can be relied upon in detailed design of the parcel drainage.

6.2.3 Discharge of surface run-off to watercourse is the next in order of preference for the manner of surface drainage and the Envision scheme takes this as the solution to the development's needs. Run-off is directed variously to the River Don, Usworth Burn or Hylton Dene Burn, in the latter case via the IAMP ONE storm drainage system.

6.2.4 As stated in the IAMP ONE Ph 2 DS: "*The drainage approach devised for IAMP is to split management of run-off of the development plots from that for the communal areas and access roads. Plot drainage is managed within the plot limits by the individual parcels' own surface drainage systems, discharging only greenfield-equivalent flows and providing sufficient water-quality treatment within those systems as appropriate to the parcels' respective uses.*" The Ph 2 area was split in two with part of the area set to discharge to the River Don and part to the trunk storm sewer under International Drive that in turn fees the Hylton Dene Burn headwaters. The respective areas are shown in Table x below, as per the Ph 2 catchment.

Table 4. **IAMP ONE Ph 2 Sub-catchment areas**

SUB-CATCHMENT	AREA (HA)	MODELLED DISCHARGE POINT & WATERCOURSE
NE	6.30	Outfall 1, R. Don
NW	3.98	Outfall 2, R. Don
SE	7.38	Storm Connection Point 1, Hylton Dene Burn
SW	6.65	Storm Connection Point 2, Hylton Dene Burn

6.2.5 The net drained area for the Envision scheme is approximately 14ha, comprising 9.0ha building roofs, 4.6ha of access roads and parking and 0.5ha of the site entrance roads and gatehouse. This total is too great to be wholly directed to the River Don so the areas will be partially separated according to their origin and the discharge rates controlled according to the destination:

- Roof area directed to R. Don via Outfalls 1 & 2 north of the Envision development with staged flow limits of 29.7 / 60.3 / 72.0 l/s at the 1 / 30 / 100CC return periods respectively.
- Access roads and parking directed to the connection points into the trunk storm sewer in International Drive with a net limit of 16.8 l/s up to and including the 100CC return period.
- Climate-change allowance to be 40% in accordance with PPG.

6.2.6 The attenuation storage required to hold the excess run-off in each system pending storage will be provided via cellular storage tanks located beneath the car-parking area. The dense layout used for the scheme does not leave sufficient un-used space to use basins or similar surface features. The order of scale of these features is shown in Table 5 below.

6.2.7 Storage volumes have been provided in the form of underground storage tank, porous paving. The following **Table 6** shows the provided volume required to store surface water for storm even up to 100 year+40%CC

Table 5. **Storage volumes for each sub-catchment**

RETURN PERIOD	SITE ENTRANCE	HIGHWAY&CARPARK	BUILDING
Porous paving	-	3500m^3	-
Underground Tank	300m^3	4200m^3	5600m^3
Total	300m^3	7700m^3	5600m^3

6.2.8 The proposed drainage layout drawing and the associated MicroDrainage network details and results tables for the main sewer network are included in **Appendix D.**

6.2.9 The flows from the section of the site that drains to Usworth Burn via the flood-compensation/habitat area have been modelled as a single outfall. The effects of the Don and Burn flooding have also been tested based on the 25% 'higher central' climate-change allowance with a surcharged outfall. The modelled outflows take this into account, based on the avoidance of overflow from the drain systems as represented in these models.

6.2.10 The water-quality management for the site run-off is provided according to the run-off source and associated risk of pollution.

6.2.11 Roof run-off is at least risk of pollution and a proprietary vortex separator (e.g. Hydro Defender) is proposed prior to the storage feature for this system, principally to manage silt flushed from the roof.

6.2.12 The parking areas will use permeable paving with a porous sub-base and a network of collector drains in the sub-base to transfer the water percolating through the fill into the drain network that conveys the water to the storage block. Access roads will be drained by filter drains at the roads' edges where layout permits or by gullies or kerb-drains where it does not. The combined flows will pass through a bypass oil separator prior to the storage. A similar arrangement will apply for the site entrance but on a smaller scale.

Foul Water

6.2.13 The preferred drainage option for the foul water from Envision's site is to discharge into the existing 225**mm** dia foul sewer beneath International Drive. This leads to a sewage pumping station that transfers sewage from IAMP ONE to a NWL public sewer west of Nissan near Seven Cottages on the old A1290 route.

6.3 Maintenance and responsibility

6.3.1 The plot owner and operator are to be responsible for constructing, owning and maintaining both the foul and surface water systems within the boundary of each plot and to off-site connections with strategic drainage links.

6.3.2 Highway drainage serving the new access road will remain private and maintained by Envision.

7. CONCLUSION

7.1.1 It is proposed to develop a new battery factory on part of a parcel wholly contained within the boundaries of the farmland at West Moor Farm and north of the Nissan factory outside Sunderland as part of the International Advance Manufacturing Park project. The proposed scheme has an approximate area of 15ha within a planning boundary of 25ha circa.

7.1.2 The scheme comprises extensive buildings and access/parking/loading yards. A high paved or built proportion is planned and the surface drainage provisions have been designed based on the proposed impermeable drained areas.

Flood risk

7.1.3 The site straddles two catchments. The Usworth Burn passes the site to the north-west, about 220m from the site edge at its closest. The north-western side of the site drains to this watercourse, which joins the River Don north of the site. The Don flows off eastwards, passing beneath the A19 on the eastern side of the overall IAMP scheme. The greater part of the site drains in a south-easterly direction towards the A1290 and the Nissan plant via a network of field ditches and land drains which in turn form part of the headwaters of Hylton Dene Burn. This too flows off eastwards but crosses beneath the A19 east of the Nissan plant.

7.1.4 The site currently lies almost entirely within Flood Zone 1 but the floodplain of Usworth Burn and the Don encroaches onto the north-western edge of the site at the entrance off International Drive in Zones 2 and in 3 once significant climate change takes effect. Future changes in flood behavior caused by climate changes are predicted to raise flood levels and extend the floodplain for Zones 2 and 3 such that the design flood would eventually rise high enough to overtop the ridge between the Usworth Burn and Hylton Dene Burn catchments and feed an overland flow route towards the Nissan plant across the site.

7.1.5 The ground conditions across the site are dominated by poorly-permeable clayey and silty soils (Pelaw Clay) as evidenced by regular waterlogging of the farmland following wet weather and ponding in local depressions. Surface flooding is not otherwise a material risk to the land or surrounding areas as the field-ditch network drains the area. Groundwater flooding is not considered to be a material risk as the ground conditions do not support a mobile water table.

7.1.6 There are no nearby sewers other than those laid for the IAMP One scheme. The A1290 road which passes the southern edge of the site drains to a land-drain and culvert system along the A-road and Washington Road eastwards or, west of West Moor Farm, westwards alongside the A-road. A new access road serving the IAMP ONE scheme runs along the site's eastern side and is served by road-side swales that in turn feed into the new IAMP ONE surface drainage system. Sewer flooding is not considered to be a material risk.

7.1.7 The proposed development is to be elevated compared with existing ground levels across its (lower) northern section so that the predicted overland flow-route from increasing fluvial flood risk is impeded or blocked outright to protect the Nissan plant and this development. To do so makes only a very small increase in predicted flood levels on the Usworth Burn and River Don of no more than about 1cm at the design flood condition.

7.1.8 The greater part of the proposed development site lies within Flood Zone 1 both now and throughout the scheme's intended lifetime. The predicted design flood level reaches 36.25mOD at the north end of the Envision site whereas development levels are set above 37moD and the building floor level at over 38mOD.

7.1.9 The proposed development location has previously been compared with alternative site options in respect of flood risk and was found to be similar in that respect to those alternatives. The land is allocated for development under the AAP and Local Plan and its selection is considered to have satisfied the sequential test for flood-risk purposes within the wider constraints of the IAMP scheme.

Drainage strategy

7.1.10 The site's development run-off is to be managed according to the natural catchment to which it drains. Run-off from areas draining towards the Usworth Burn will be attenuated on site before passing into a flood-compensation area with a series of shallow basins or scrapes as part of the wider IAMP habitat mitigation works north of the site. Flow rates are to be restricted to the greenfield equivalent for the corresponding return periods. These equate to **3.3**, **6.7** and **8.0l/s/ha** at the 1-year, 30-year and 100-year storm condition respectively.

7.1.11 Run-off from areas draining into the Hylton Dene Burn system are to be drained into the new IAMP ONE surface-drainage system and restricted to the existing Q_1 Greenfield rate for storm conditions up to and including the 100-year+40% condition. This attenuation and flow control are to be provided within the development site limits, discharging only the attenuated flow to the IAMP ONE system or to the river as appropriate.

7.1.12 The proposed development's internal layout does not directly align with the natural catchment boundary, however the internal surface drainage systems have been managed to apportion the drained areas between the two receiving watercourses matching the pre-development condition.

7.1.13 The design for the wider IAMP ONE and IAMP TWO surface-drainage system has been adapted to include the increased development area for this site. The outflows remain within the target limits as required at the three key return periods (1, 30 and 100-years) with a Climate Change allowance of 40% over the 1 in 100yrs storm events.

7.1.14 The development's foul drainage needs will be met by connecting the site into the IAMP ONE trunk foul sewer system. This drains to a nearby sewage pumping station which transfers foul flows to a large combined sewer some distance west of the site near Washington. This in turn conveys flows to NWL's sewage treatment works near Barmston.

7.1.15 The future development site owner(s) and operator(s) are to be responsible for constructing, owning and maintaining both foul and surface water systems within the site boundary.

7.1.16 IAMP LLP and their site development partner will own and maintain the surface drainage system outside the development plot. NWL will adopt and maintain the trunk foul sewerage outside of the development site.

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