Lidl Great Britain Limited

Proposed Development at Crieff Road, Perth

Flood Risk Assessment

November 2021

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SEPA CHECKLIST

Flood Risk Assessment (FRA) Checklist

(SS-NFR-F-001 - Version 14 - Last updated 28/05/2019

This document must be attached within the front cover of any Flood Risk Assessments issued to Local Planning Authorities (LPA) in support of a development proposal which may be at risk of flooding. The document will take only a few minutes to complete and will assist SEPA in reviewing FRAs, when consulted by LPAs. This document should not be a substitute for a FRA.

Development Proposal Summary							
Site Name:		Crieff Road, Perth					
Grid Reference:	Easting:						
Local Authority:		Perth and Kinross Council					
Planning Reference number (if known):							
Nature of the development:		Commercial	If residential, state type:	Supermarket			
Size of the development site:		~0.85	Ha				
Identified Flood Risk:	Source:	Fluvial	Source name:	Newton Burn (Culverted)			
Land Use Planning							
Is any of the site within the functional floodplain? (refer to SPP para 255)		No	If yes, what is the net loss of storage?		m^3		
Is the site identified within the local development plan?		Yes	Local Development Plan Name:	Adopted LDP 2019	Year of Publication:	2019	
			Allocation Number / Reference:	H71			
If yes, what is the proposed use for the site as identified in the local plan?		Residential	If Other please specify:				
Does the local development plan and/or any pre-application advice, identify any flood risk issues with or requirements for the site.		Yes	If so, please specify:	Request a Flood Risk Assessment			
What is the proposed land use vulnerability?		Least Vulnerable	Do the proposals represent an increase in land use vulnerability?	Yes			
Supporting Information							
Have clear maps / plans been provided within the FRA (including topographic and flood inundation plans)?		Yes					
Has sufficient supporting information, in line with our Technical Guidance, been provided? For example: site plans, photos, topographic information, structure information and other site specific information.		Yes					
Has a historic flood search been undertaken?		Select from List	If flood records in vicinity of the site please provide details:				
Is a formal flood prevention scheme present?		No	If known, state the standard of protection offered:				
Current / historical site use:		Greenfield.					
Is the site considered vacant or derelict?		No					
Development Requirements							
Freeboard on design water level:		NA	m				
Is safe / dry access and egress available?		Vehicular and Pedestrian	Min access/egress level:	NA	m AOD		
Design levels:	Ground level:	NA	m AOD	Min FFL:	NA	mAOD	
Mitigation							
Can development be designed to avoid all areas at risk of flooding?		Yes					
Is mitigation proposed?		Yes	*Surface water measures*				
If yes, is compenstory storage necessary?		No					
Demonstration of compensatory storage on a "like for like" basis?		Select from List					
Should water resistant materials and forms of construction be used?		Select from List					

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Flood Risk Assessment (FRA) Checklist

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Hydrology

Is there a requirement to consider fluvial flooding?	Yes	Based on Culvert Capacity	
Area of catchment:	NA	km^2	Is a map of catchment area included in FRA? Select from List
Estimation method(s) used (please select all that apply):	Pooled Analysis ☐		If Pooled analysis have group details been included? Select from List
	Single Site Analysis ☐		
	Enhanced Single Site ☐		
	ReFH2 ☐		
	FEH RRM ☐		
	Other ☑		If other (please specify methodology used): Culvert Modelling - Max conveyance
Estimate of 200 year design flood flow:	0.55 (MAX)	m^3/s	
Qmed estimate:	NA	m^3/s	Method: Other
Statistical Distribution Selected:	Select from List		Reasons for selection:

Hydraulics

Hydraulic modelling method:	Select from List		Software used: Select from List
			If other please specify: HEC-RAS 1D Culvert model - Flood Modeller 2D for flows in excess capacity
Number of cross sections:	LiDAR		
Source of data (i.e. topographic survey, LiDAR etc):	LiDAR & Culvert data		Date obtained / surveyed: ~2016
Modelled reach length:	800	m	
Any changes to default simulation parameters?	no		If yes please provide details:
Model timestep:	0.5 secs		
Model grid size:	1m		
Any structures within the modelled length?	Select from List		Specify, if combination: Culvert in 1D Model. Outputs from 1D go into 2D model
Maximum observed velocity:	1.65	m/s	
Brief summary of sensitivity tests, and range:			
variation on flow (%)	35	%	Please specify climate change scenario considered: "East" Rainfall Intensity 35%
variation on channel roughness (%)	20	%	
blockage of structure (range of % blocked)	100	%	
boundary conditions:	**Upstream**		**Downstream**
(1) type	Flow		Normal depth
Specify if other			Specify if other:
(2) does it influence water levels at the site?	No		No
Has model been calibrated (gauge data / flood records)?	No		
Is the hydraulic model available to SEPA?	No		
Design flood levels: 200 year	NA	m AOD	200 year plus climate change: NA m AOD
Cross section results provided?	Select from List	NA	
Long section results provided?	Select from List	NA	
Cross section ratings provided?	Select from List	NA	
Tabular output provided (i.e. levels, velocities)?		NA	
Mass balance error:	<5	%	

Coastal

Is there a requirement to consider coastal / tidal flooding?	No		
Estimate of 200 year design flood level:		m AOD	
Estimation method(s) used:	Select from List		If other please specify methodology used:
Allowance for climate change (m):		m	
Allowance for wave action etc (m):		m	
Overall design flood level:		m AOD	

Comments

Any additional comments:	The results of the assessment show that the entirety of the site lies over 35m from the 1 in 200-year flood extent assuming a 100% blockage of the Newton Burn culvert. The site is therefore not considered to be at fluvial flood risk in a 1 in 200-year event.

Approved by: Michael Stewart
Organisation: Kaya Consulting
Date: 03.11.2021

Note: Further details and guidance is provided in 'Technical Flood Risk Guidance for Stakeholders' which can be accesssed here:- CLICK HERE

1 Introduction

Kaya Consulting Ltd was commissioned by Lidl Great Britain Limited through Blyth and Blyth to carry out a flood risk assessment for a proposed development of a Lidl store off Crieff Road in Perth.

The site is undeveloped and located to the north-west of the junction of Crieff Road and the new A85 extension. Consultation of the SEPA flood maps shows no significant risk of flooding for the site, but there are surface water flood issues close to the site and Newton Burn flows to the north of the site.

The scope of work includes the following:

- Walkover site visit;
- Review of historical maps;
- Contact with local council and internet search to obtain information on historical flooding in the area;
- Assess risk from culverted watercourse to the north of the site;
- Assessment of surface water using rainfall-runoff modelling and available LiDAR and topographical data;
- Preparation of 200 year flood map;
- Assessment of risk from other sources, such as existing drainage systems and groundwater
- Liaison with Masterplanners and engineers to identify constraints at the site and options for development;
- Flood risk assessment report suitable for submission with planning application, assuming all risks can be mitigated.

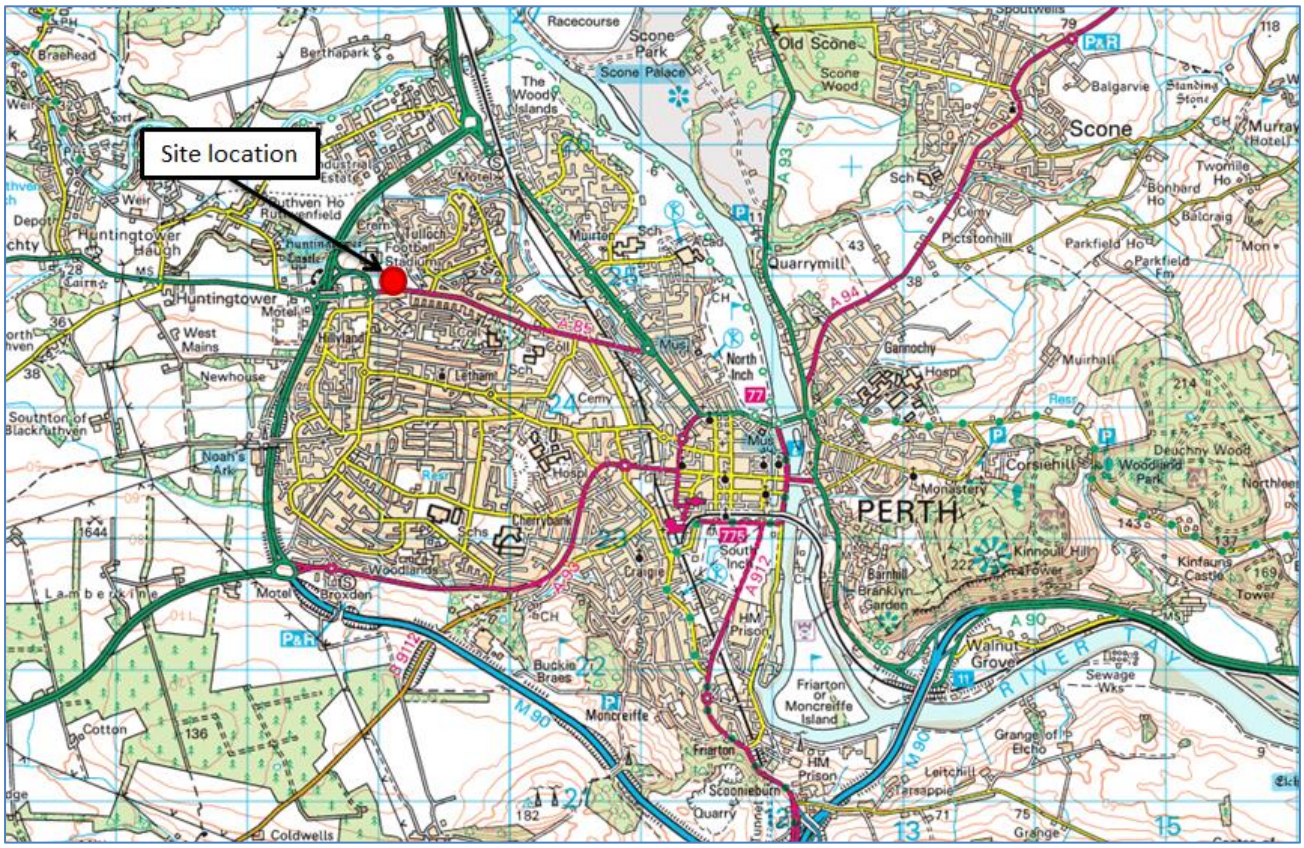
Information made available to Kaya Consulting Ltd for the study includes the following:

- Drawing of the proposed site layout;
- Topographic survey data of the site;
- LiDAR topographical data; and
- Scottish Water service drawings.

A general location map of the site is shown in Figure 1.

The work carried out to assess the flooding risk of the site and main findings of the study are summarised in the following sections.

Figure 1: General site location



2 Legislative and Policy Aspects

2.1 National Planning Policy

The current version of the Scottish Planning Policy (SPP) was published in June 2014 https://www.gov.scot/publications/scottish-planning-policy/

The SPP sets out national planning policies that includes policies related to the management of flood risk. The key principles of SPP with respect to flooding are that the planning system should promote (Paragraph 255):

- *a precautionary approach to flood risk from all sources, including coastal, water course (fluvial), surface water (pluvial), groundwater, reservoirs and drainage systems (sewers and culverts), taking account of the predicted effects of climate change;*
- *flood avoidance: by safeguarding flood storage and conveying capacity, and locating development away from functional flood plains and medium to high risk areas;*
- *flood reduction: assessing flood risk and, where appropriate, undertaking natural and structural flood management measures, including flood protection, restoring natural features and characteristics, enhancing flood storage capacity, avoiding the construction of new culverts and opening existing culverts where possible; and*
- *avoidance of increased surface water flooding through requirements for Sustainable Drainage Systems (SuDS) and minimising the area of impermeable surface.*

SPP requires that most types of development are not located within the functional floodplain of a watercourse or the coast, defined as an area flooded during a 1 in 200 year event. Development should also take account of the effects of future climate change. Types of development allowed in floodplains are those that are water compatible (e.g., sports pitch) or where there is a small extension or similar development on an existing footprint.

Civil infrastructure may not be suitable for areas at risk of flooding up to a 1 in 1000 year event and some other types of development (e.g., care homes, lodges and camp sites) may need to be protected for a 1 in 1000 year event, depending on the vulnerability of the land use.

SPP requires infrastructure and buildings to be generally designed to be free from surface water flooding for rainfall events greater than the 1 in 200 year event. SPP does not require surface water flooding risk to be considered for events higher than the 1 in 200 year event.

There is a general principle that development should not increase flood risk to others.

There is a presumption against land raising within floodplains. SPP allows this under exceptional circumstances only, where it is shown to have a neutral or better impact on flood risk outside the raised area (with provision of compensatory flood storage). SPP does not specific exceptional circumstances and provides local authorities some interpretation in this area.

2.2 Local Authority Policy and Guidance with Respect to Flood Risk

Perth and Kinross Flood Risk and Flood Risk Assessment: Developer's guidance note on flooding and drainage, June 2014. *https://www.pkc.gov.uk/media/24772/Flood-Risk-and-FRA/pdf/Flood_Risk_and_FRA_-_June_2014.pdf?m=635379146904000000*

The council guidance references the need to follow relevant SEPA guidance

PKC require the following in addition to the SEPA guidance

- Climate change increase of 35% on the 200 year event
- Finished Floor Levels set a minimum of 600mm above the 200 year flood level + climate change
- Lowest garden level set a minimum of 300mm above the 200 year flood level + climate change, although there is flexibility in the application of the garden level requirement
- Critical infrastructure to be out with the 1 in 1000 year floodplain
- There is a requirement for a sensitivity analysis for model assessments with the analysis to consider the impact of uncertainties in peak flow, manning n roughness, blockage to all obstructions and upstream and downstream boundary conditions
- New development must incorporate safe access/egress for pedestrians and vehicular traffic within the development site, based on assessment of flooding from all sources including the 200 year + climate change floodplain and overland flood routes from within and external to the site
- New bridges should be designed with a soffit at the 1 in 200 year + 35% flood level plus 600mm. If this requirement cannot be met for small crossings the requirements can be discussed with the council flooding team.
- A 5m stand off from any watercourse is required for maintenance.
- If there is development close to a flood prevention scheme the council flooding team should be contacted as early as possible.

The guidance provides additional information with respect to the design of the site drainage system, that is discussed within the outline Drainage Strategy.

The council operates a self-certification and independent check process.

It is noted that PKC are consulting on an updated version of their 2014 guidance https://www.pkc.gov.uk/media/43640/Supplementary-Guidance-Flood-Risk-Flood-Risk-Assessments/pdf/Flood_Risk___Flood_Risk_Assessmentsforweb.pdf?m=636844406973270000
The key change to the 2014 guidance are;

- PKC note recent updates to climate change guidance and recommend that developers contact the flooding team to confirm the most appropriate climate change increase to be considered in any assessment.

2.3 SEPA Technical Flood Risk Guidance

SEPA are a statutory consultee to the planning process with respect to flood risk. To support its role and to give guidance to practitioners and local authorities SEPA have published a series of guidance documents. The key documents with direct relevance to flood risk assessment are;

1. SEPA (2018a), Flood Risk and Land Use Vulnerability Guidance, July 2018. https://www.sepa.org.uk/media/143416/land-use-vulnerability-guidance.pdf
2. SEPA (2019a), *Technical Flood Risk Guidance for Stakeholders - SEPA requirements for undertaking a Flood Risk Assessment*, May 2019. https://www.sepa.org.uk/media/162602/ss-nfr-p-002-technical-flood-risk-guidance-for-stakeholders.pdf
3. SEPA (2019b), *Climate change allowances for flood risk assessment in land use planning*, April 2019. https://www.sepa.org.uk/media/426913/lups_cc1.pdf
4. SEPA (2018b), *Land Use Planning System, SEPA Development Plan Guidance Note 2a*, July 2018. https://www.sepa.org.uk/media/306609/lups-dm-gu2a-development-management-guidance-on-flood-risk.pdf

Reference 1 provides SEPA's assessment of land use vulnerability which allows the identification of the appropriate return period to be considered in any flood risk assessment, based on the type of development proposed.

Reference 2 is a technical guidance document intended to outline methodologies that may be appropriate for hydrological and hydraulic modelling and sets out what information SEPA requires to be submitted as part of a Flood Risk Assessment.

Reference 3 outlines the most recent SEPA guidance in terms of flow, rainfall and sea level uplifts for climate change.

Reference 4 provides additional planning guidance with respect to flood risk.

In addition, The Water Environment (Controlled Activities) (Scotland) Amended Regulations 2013 (CAR) describes requirements for any works at or near watercourses that require licensing. SEPA are responsible for the implementation of the Act, see https://www.sepa.org.uk/media/34800/introduction-to-the-controlled-activities-regulations.pdf for an outline of the regulations.

With relevance to all developments the Regulations include a requirement that surface water discharge must not result in pollution of the water environment. It also makes Sustainable Drainage Systems (SuDS) a requirement for new development, with the exception of runoff from a single dwelling and discharges to coastal waters.

In addition, SEPA (2017) Background Paper on the Water Environment, LUPS-BP-GU2b requires that "*A buffer strip of a minimum of 6m on either side of the watercourse is recommended and should be proportional to the bank width, with wider rivers having a larger buffer strip than a narrow burn*."

The table with recommended buffer strip widths is provided below. It is also noted that *"a buffer strip is still required for ditches, however, there is some discretion to reduce the buffer strip to a minimum of 3m depending on requirements for access for maintenance"*

Width to watercourse (top of bank)	Width of buffer strip (either side)
Less than 1m	6m
1-5m	6-12m
5-15m	12-20m
15m+	20m+

2.4 Guidance and Policy Constraints with Relevance to Current Site

Based on relevant policies and guidance the following sections outlines the principles and constraints under which the flood risk assessment is undertaken.

2.4.1 Land Use Vulnerability and Design Event

The proposed development is for a supermarket. Based on SEPA (2018a), shops are considered as a 'Least Vulnerable" use and considered suitable for land outside the 1 in 200-year floodplain.

The design event for this development is the 1 in 200-year event.

2.4.2 Constraints on Developable Area

2.4.2.1 Surface Water Flooding

Land affected by surface water flooding can generally be developed assuming the surface water flood risk can be managed through the development of the site drainage system and land drainage to manage surface water entering the site from outside its boundaries. However, in some cases, where sites currently act to store surface water, development could displace surface water and increase flood risk elsewhere. In these cases, there may be a need to leave areas of surface water storage undeveloped and/or provide storage of equivalent volumes of surface water elsewhere in the site.

The assessment will consider surface water flooding risks for the 1 in 200-year event.

2.4.3 Climate Change Considerations

The development should be resilient against the impacts of climate change, such that properties are not predicted to flood for the design event plus climate change.

Based on current PKC council guidance the impact of climate change should be considered by increasing 1 in 200 year flood flows by 35%. However, draft council guidance indicates that consideration should be given to increased climate change allowances based on UKCP18 climate change predictions.

SEPA (2019a) considers predictions based on UKCP09. For the study area the impact of climate change is a 35% increase in rainfall totals.

The assessment will consider increases in flow due to climate change of 35%. It will assess the resilience of the site to the impact of climate change on flows. It is noted that these increases may not be consistent with increases considered by Scottish Water for drainage design.

2.4.4 Development Levels and Finished Floor Levels

SEPA (2019a and 2019b) notes that adequate freeboard should be provided for developments involving the erection of new buildings and in the majority of cases an adequate freeboard allowance would be 600mm above the design flood level (separate to any climate change allowance that may be applied). It is noted that other freeboards can be recommended if supported by appropriate modelling. For re-developments of existing buildings, the freeboard allowance is considered a recommendation and should be applied as far as practicable.

The assessment will consider Finished Floor Levels based on the 1 in 200-year design flood level. Account of climate change flood will also be included.

2.4.5 Site Access Considerations

It is important that developments can be accessed and left during flood events, so that developments do not form islands within flooded areas.

PKC guidance requires any new development to incorporate safe access/egress for pedestrians and vehicle access within the development site. This should take into account the 200 year + climate change floodplain and overland flood routes within and external from the site.

SEPA (2019b) requires that provision of a safe and flood free route during the design event for any development that introduces overnight accommodation onto a site, which enables the free movement of people of all abilities (on foot or with assistance) both to and from a secure place that is connected to ground above the design flood level and/or wider area. This refers to river or coastal flooding.

Therefore, for river and coastal flooding PKC require safe access for pedestrians and vehicles, which allows for some flooding as long as the depths and velocities are low enough to allow safe access. In contrast SEPA require flood free pedestrian access/egress to a site during a river or coastal flood event.

During extreme events there will be surface water flooding on most roads if the event is higher than design conditions. SEPA do not provide guidance for surface water flooding. When considering surface water flooding, local councils generally look for ‘safe’ access to a site, where flood depths are less than approx. 0.3m. However, these requirements vary depending on the size and nature of the site, and the type of development.

Access requirements with respect to surface water flooding will be considered in this assessment.

It is noted that this assessment can only consider the local access restrictions to the site and cannot consider wider, regional access issues, e.g., access to hospitals remote to the site. These wider access issues need to be considered by the appropriate local authority within local plans.

2.4.6 Other Flooding Risks

2.4.6.1 Coastal Flooding

This site is not at risk of coastal flooding.

2.4.6.2 Reservoir Flooding

Reservoir flood maps extracted from SEPA interactive dashboard (SEPA, 2015) suggests that there is a risk of inundation due to a breach/failure of nearby reservoirs which may enter the site boundary. Scottish reservoirs are subject to strict safety guidelines with many larger reservoirs bracketed as high risk despite the probability of failure remaining very low.

2.4.6.3 Site Drainage and Sewer Flooding

The design of the site drainage system will be undertaken by others.

2.4.6.4 Existing Flood Defences

SEPA (2019b) provides guidance with respect to development behind flood prevention schemes.

This site is not protected by any existing formal flood defences.

2.4.6.5 Canal Flooding

Canals are operated and managed by Scottish Canals. Failures and overtopping of canals is rare and areas at risk are generally known by Scottish Canals who should be consulted for developments located close to any canal.

The site is not at risk from canal flooding.

2.4.6.6 CAR Licensing

Any crossings or changes to watercourses within the site may require CAR licensing. CAR licenses are not required as part of a planning application and are generally conditioned as part of a planning consent. However, during the planning process sufficient information should be provided in a planning application so SEPA can identify whether it is likely that a CAR license would be granted.

3 Site Location and Description

The proposed development site is an area of undeveloped land in the west of Perth. The site is located at the corner of Crieff Road and the new A85 extension. The site is bounded by these roads (with a buffer strip between the site and roads) on the south and east; with open ground to the north and west. The site is currently in dense vegetation.

The general site topography was derived from LiDAR data with topographical survey of the new roads along the edges of the site. The LiDAR data is shown in Figure 3, it is noted that the LiDAR pre-dates the new road and junction to the east and south-east of the site. Land generally slopes from south to north close to the site, rising to a local high point at Letham Primary School to the south of the site and falling to a local low north of the site, see Figure 4 for a cross-section through the site.

The local low to the north of the site contains a culverted section of Newton Burn. The burn flows as an open channel to the east of the site, eventually entering the Town's Lade. The line of Newton Burn is shown in Figure 5, based on a CCTV survey that pre-dates the new road. The culvert was CCTV surveyed as part of the A9/A85 improvement works and details of the culverted section were provided by Perth and Kinross Council. The line and size of the culvert is shown in Figure 5. The culvert does not pass through the site. The inflowing culvert upstream of McDiarmid Park is 375mm in diameter. Within the football stadium the original culvert has been replaced and upgraded to a 600mm culvert. There are also two large inflowing culverts within this section (350mm and 200mm). Downstream of the stadium the culvert reverts to a 375mm culvert, which the CCTV survey indicated was in poor condition, with the CCTV camera unable to pass through the culvert. Under the access road to the crematorium the culvert is 675mm in diameter. A Scottish Water surface water sewer (750mm) then enters the culvert downstream of the track, with the main culvert increasing in size to 900mm from this point to its outlet to the east of the site.

With the construction of the new road there are the following additional features;

- Swale to the north-east of the site (following line of 'Drain' shown in Figures 2 and 3) that takes road runoff;
- SuDS basin to the east of the A85 which takes road runoff and discharges it to Newton Burn;
- Pipe work connecting the various road drainage features.

An overview of the road design and drainage components are shown in Figure 6, with details in Figure 7. It is noted that these drawings do not show the Newton Burn, but the road and SuDS basin are on the line of the burn. It is assumed that works have been undertaken to maintain the burn across the road and SuDS basin. Ground levels along the line of the road have been raised compared to levels in the LiDAR data, with the low point of the new road, over the culverted watercourse at approximately 25.4 m AOD, based on drawings associated with the planning application for road construction. These levels are around 1.2m above the natural ground level at the low point.

Photo 1 shows the new A85 road, with the site to the right, with Photo 2 looking to the north along the swale. It is notable that the swale and road is located at a lower level than the site. Photo 3 is a close up of the northern end of the swale where it passes under the access to the sports pitches. It is noted that the construction of the swale has resulted in an area of surface water ponding to the west of the swale, but this area is located north of the site on lower ground. Photo 4 shows the SuDS basin to the east of the road.

Scottish Water service drawings indicate no existing sewer network on the site. There is a foul and surface water sewer running to the south of Crieff Road to the south of the site and a surface water sewer to the west of the new A85.

Consultation of the SEPA online flood maps indicate risks of pluvial (surface water) flooding to the west and north of the site. The area to the north is consistent with low lying land visible in Figure 3 and the flooding to the west is likely associated with issues with LiDAR interpretation associated with old buildings on the neighbouring site (now cleared). The site is not shown at risk of flooding.

A review of historical Ordnance Survey mapping for the area around the site indicates that the Newton Burn, which at present is an open watercourse 300m to the east of the site, was originally an open watercourse where it ran approximately 100m to the north of the site.

Perth & Kinross Council were consulted to support this Flood Risk Assessment.

Figure 2: Detailed site location

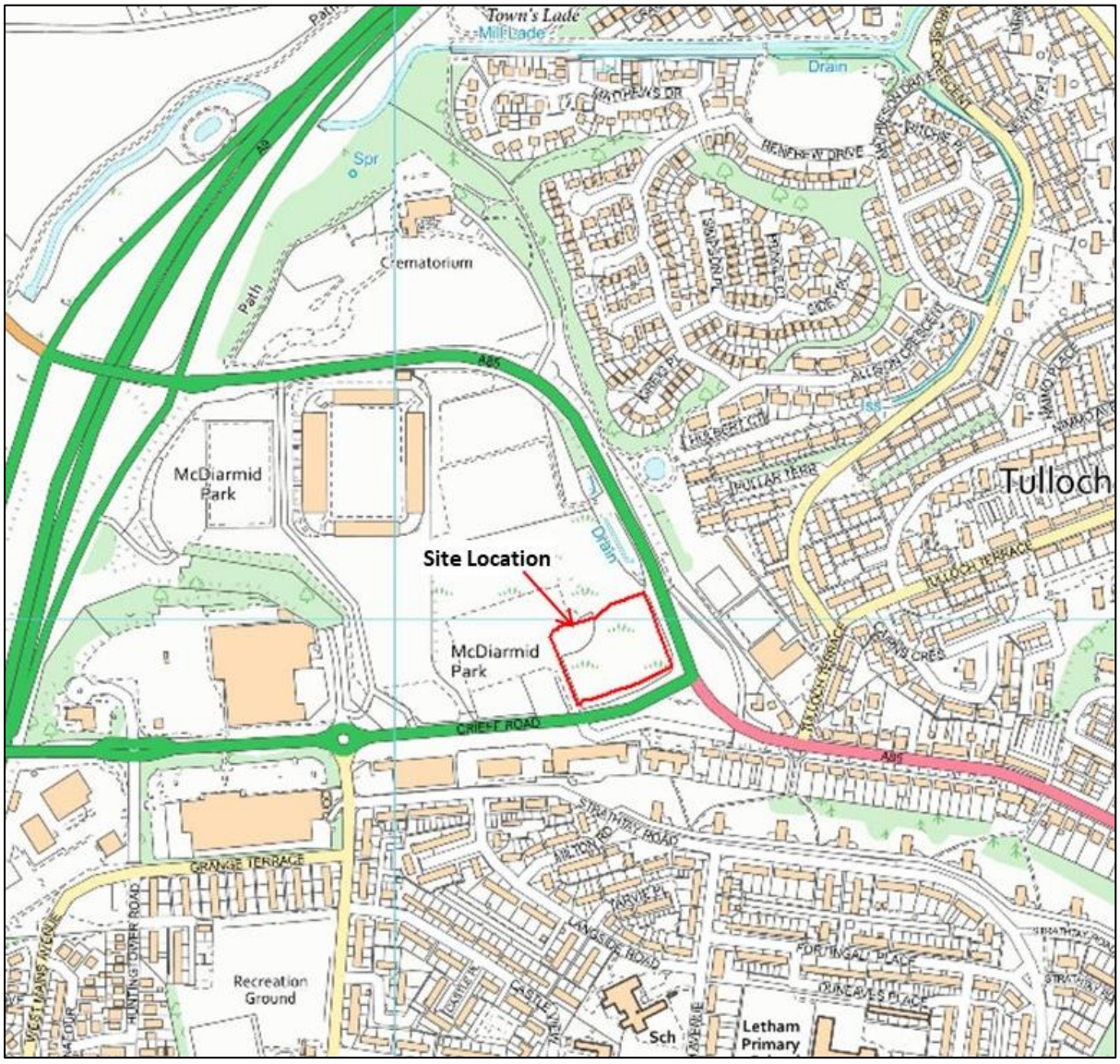


Figure 3: Site topography created from the LiDAR data with 1m contour lines added and selected heights labelled (m AOD).

Figure 4: Cross-section through site showing site location well above low-lying land to the north

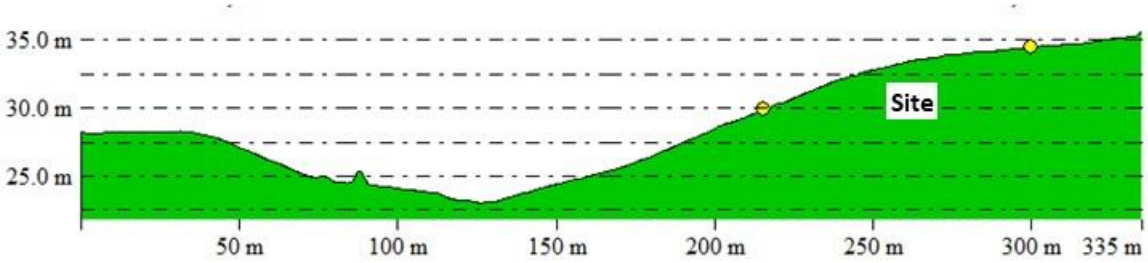


Figure 5: Newton Burn culvert to north of site

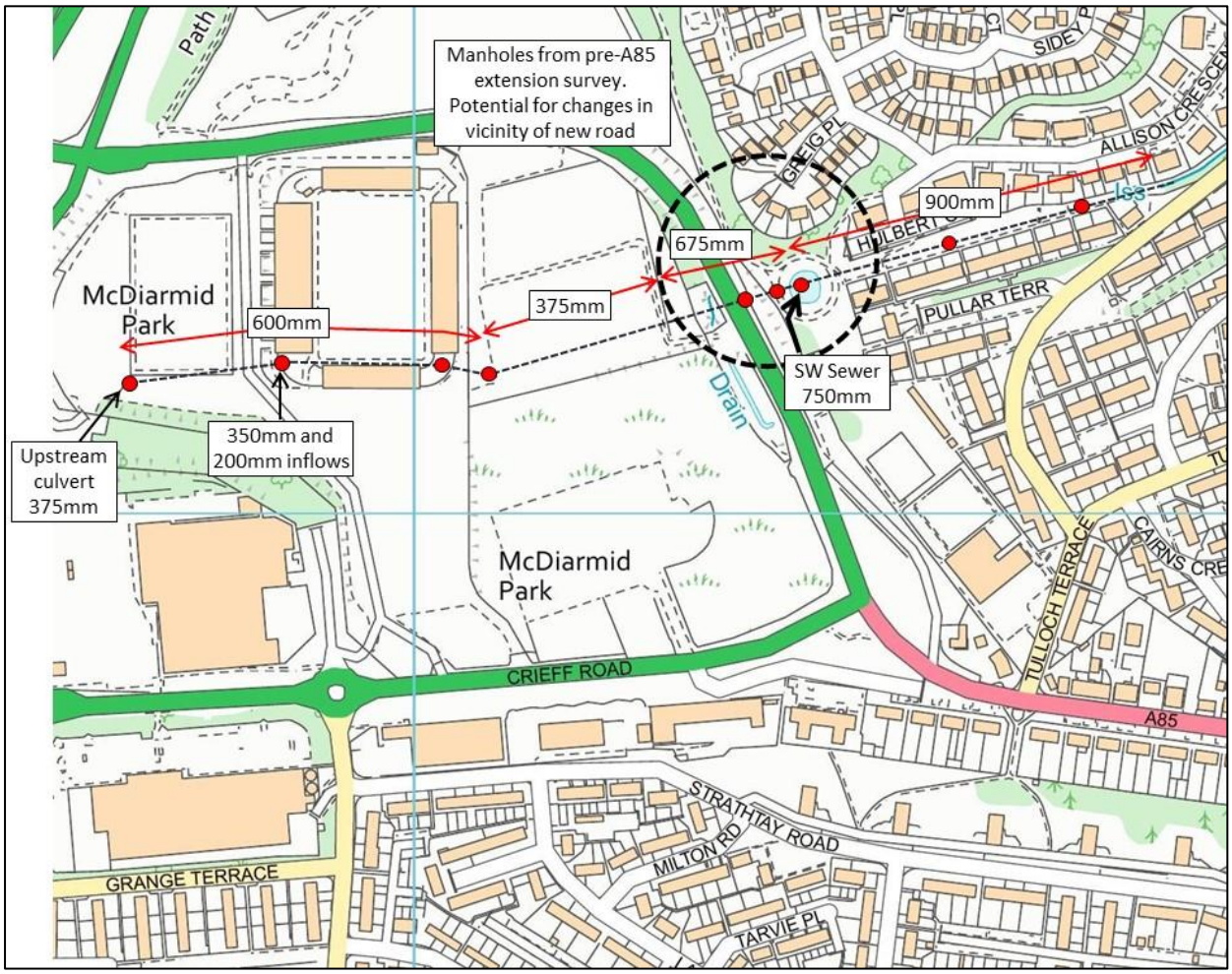


Figure 6: Outline drainage proposals associated with A85 extension. From drawings on Perth and Kinross Council planning portal for 16/01290/FLL

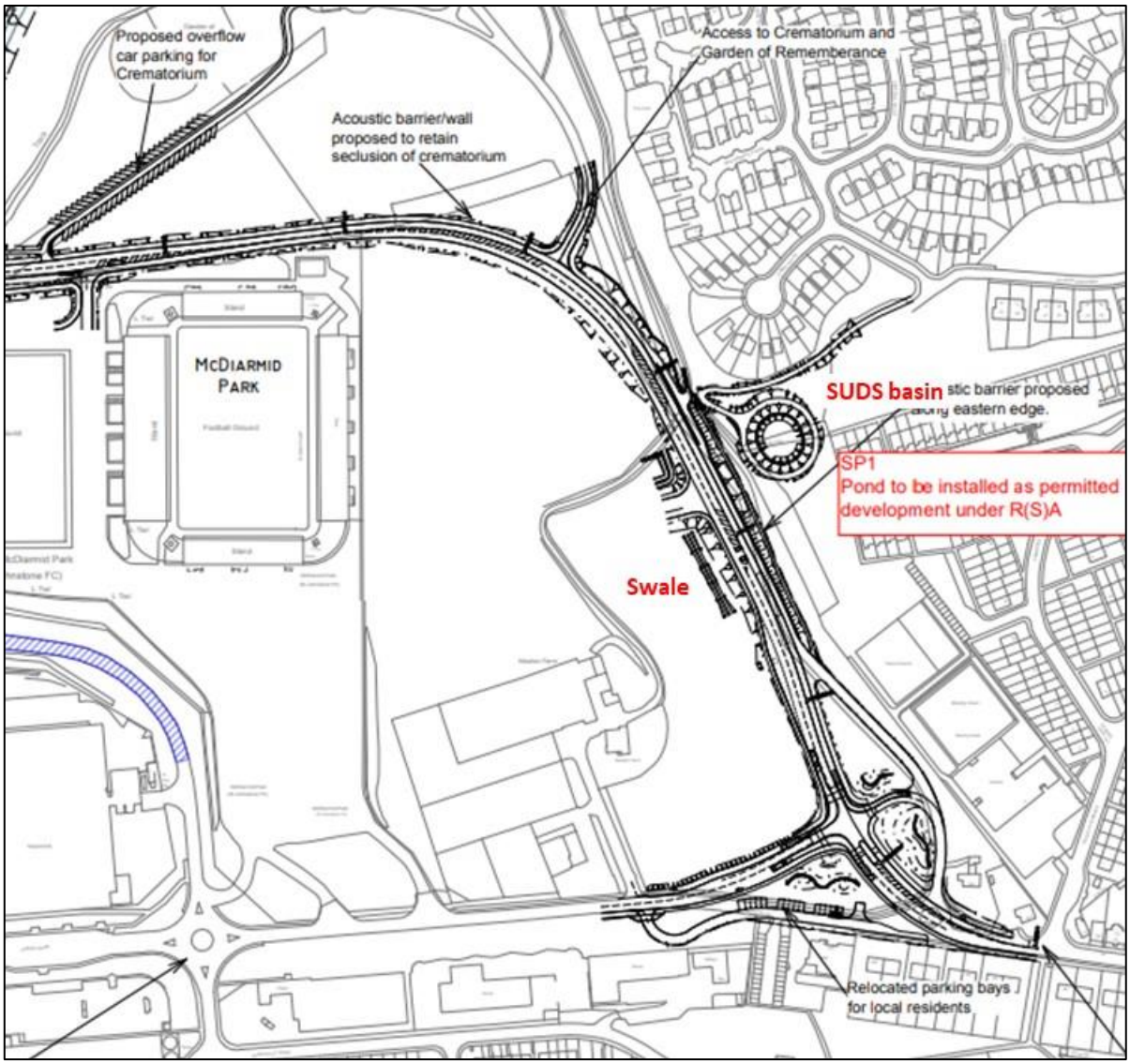


Figure 7: Detailed drainage proposals associated with A85 extension. From drawings on Perth and Kinross Council planning portal for 16/01290/FLL

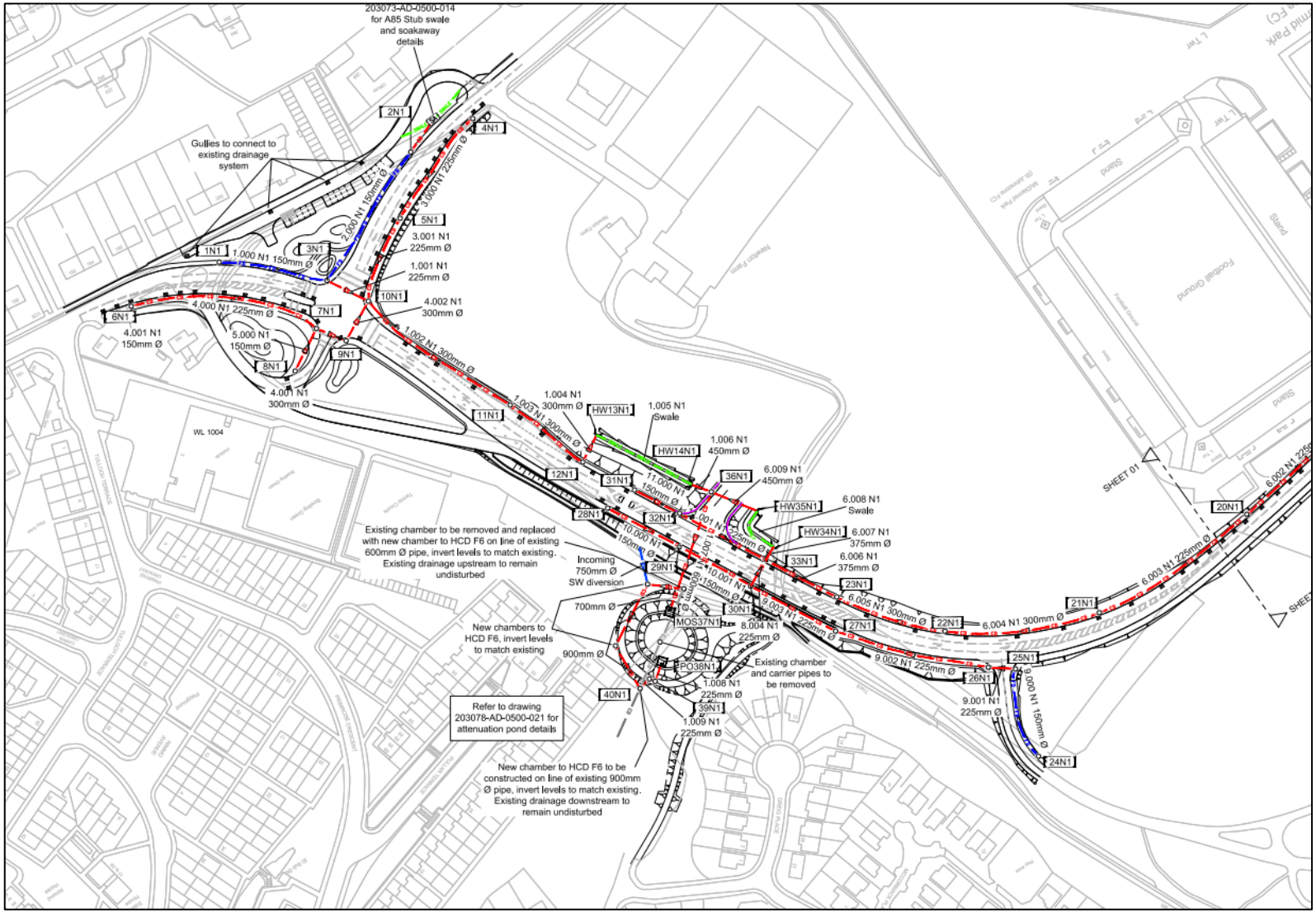


Photo 1: View south along new road, with site in distance

Photo 2: View looking north along edge of new road, showing swale and low point on road near to access to sports centre

Photo 3: North end of swale showing culvert under access to sports centre and ponding of surface water to west of swale

4 Flood Risk Assessment

The flood risk assessment considers flooding from:

- Newton Burn;
- Surface water runoff;
- Groundwater;
- Site drainage system; and
- The proposed site access.

4.1 Risk of Flooding from Newton Burn

The Newton Burn is culverted to the north of the site. The route of the culvert is shown in Figure 5. The catchment draining to the burn is likely limited to land to the north of Crieff Road, with some inflows from the A9 at the upstream end. Flows entering the culvert will be limited by the upstream culvert capacity, with the upstream culvert at 375mm diameter, indicating the limited inflows.

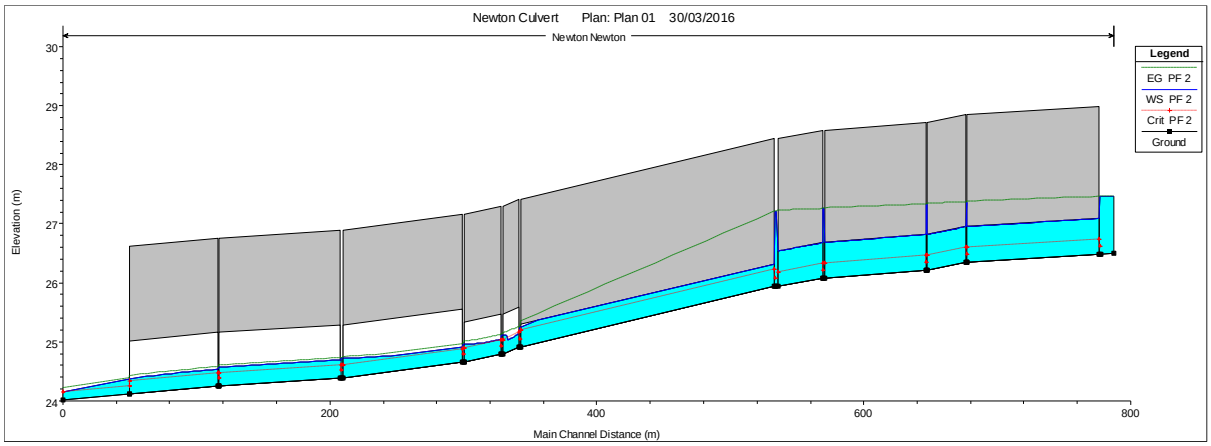
Information on the Newton Burn culvert was provided by Perth and Kinross Council and included the culvert size and gradients. Depth to invert was not provided, but the information provided was sufficient to build a HEC-RAS model of the culvert to assess the flow capacity of the culvert.

Based on the upstream culvert section and two inflowing pipes from McDiarmid Park the maximum flow able to reach the 375 mm diameter section upstream of the site was calculated to be 0.55 m^3/s, based on upstream pipes flowing full;

- 375 mm pipe upstream of McDiarmid Park = 0.25 m^3/s
- 350 mm and 200 mm pipes inflowing from McDiarmid Park = 0.14 and 0.03 m^3/s, respectively

The HEC-RAS model was run for a range of flows to assess the peak flow able to pass through the culvert. The long-profile of the model is shown in Figure 6, for a flow of 0.15 m^3/s, which is predicted to be the maximum flow that can be passed through the 375 mm diameter section north of the site. Based on the upstream flow of 0.55 m^3/s, this suggests a flow of around 0.4 m^3/s could spill from the manholes upstream of the site and flow overland towards the site. There are likely to be changes in the manholes close to the new road, but the constraining section of the culvert is upstream of the A85 and changes to the A85 would not affect the capacity estimates above.

Figure 8: HEC-RAS long profile of Newton Burn culvert (0.15 m^3/s flow)



A Flood Modeller Pro 2D simulation was run based on LiDAR data and was run with a 1m grid size. The grid was adjusted to take into account the new road elevation, with the road elevations based on drawings associated with the planning application for the road, available on the Perth and Kinross Council planning portal (16_01290_FLL-SITE_PLAN_-_2_OF_7__16_01290_5_-845077). A default Manning's *n* of 0.1 was applied to the model domain. A flow hydrograph based on the FEH Rainfall-Runoff hydrograph for the full catchment for Newton Burn, but constrained to 0.4 m^3/s was applied to the 2D domain upstream of the site. This gave a critical storm duration of 4.9 hours. The flood extent is shown in Figure 9.

The model was then run assuming full blockage of the culvert adjacent to the site with a peak flow of 0.6 m^3/s flowing overland. The flood extent for this scenario is shown in Figure 10.

The two flood maps show ponding of flood waters north of the site, behind the road. The flood extent is constrained by the overtopping level of the road to the north-east of the site, which is significantly lower than the northern end of the site (25.4m AOD versus 31.0m AOD). In the event of blockage or surcharging of the Newton Burn Culvert flows would build up against the new A85 road and overtop this embankment once water levels reach approximately 25.4m AOD. The predicted flooding remains over 35m from the northern site boundary. Based on this the site is not considered to be at risk of flooding from the Newton Burn in 1 in 200-year event.

Both of these runs were re-run with flows increased to allow for climate change. These runs show very minor increases in flood extents and water levels of no more than 0.03m. This is because flooding is controlled by the A85 in this area, and climate change will have limited bearing on flood risk to the site.

Figure 9: The 200 year return period flooding extent if the culverted Newton Burn overtopped upstream.

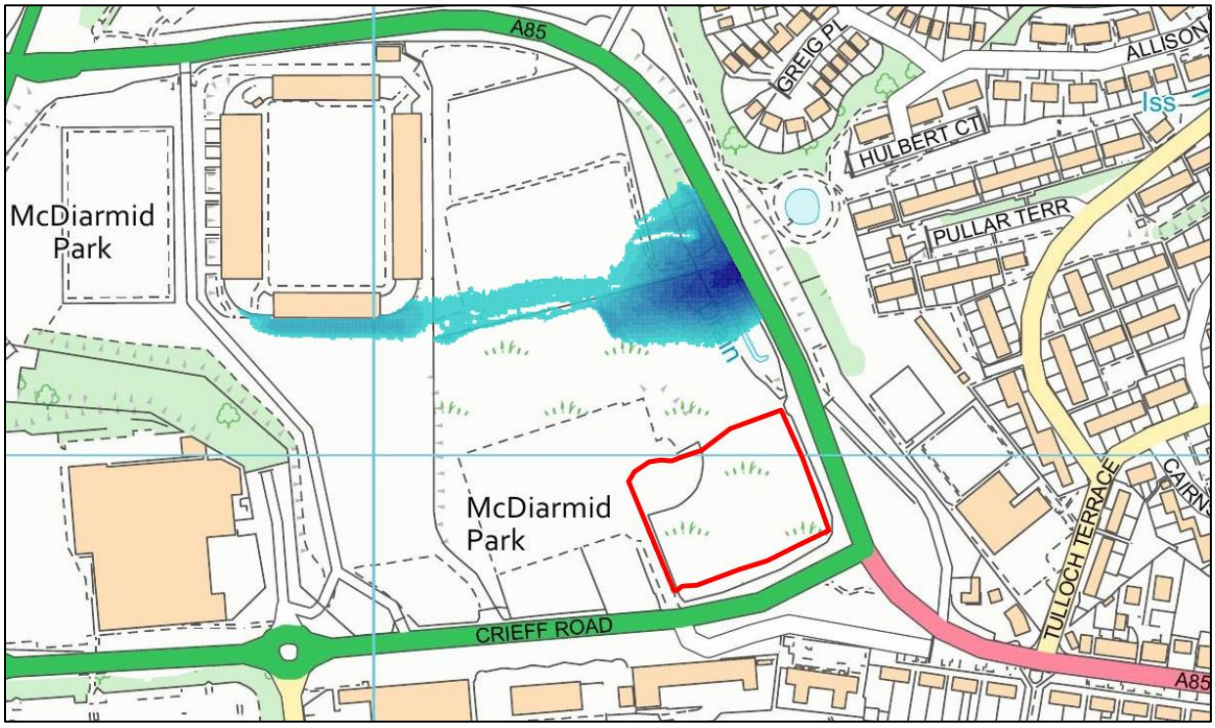
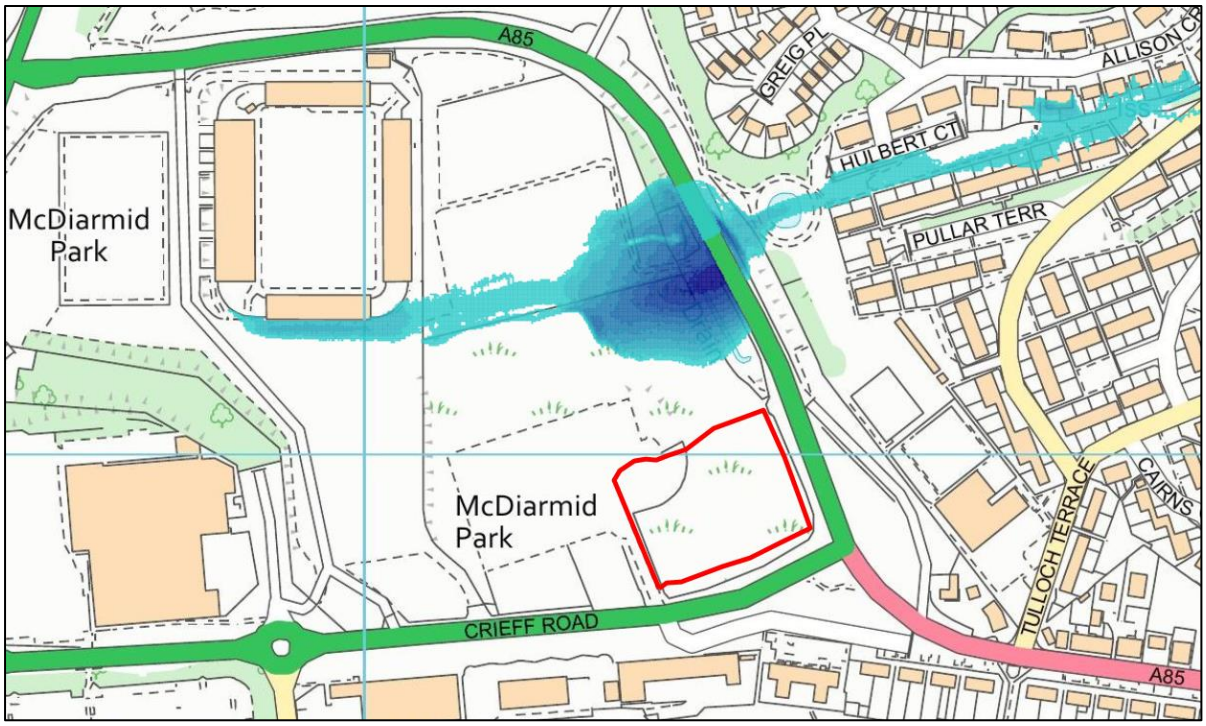


Figure 10: The 200 year return period flooding extent if the culverted Newton Burn experienced a full blockage and overtopped upstream.



Sensitivity runs were undertaken to confirm the impact of Manning's roughness and the downstream boundary on the flood extent. The results suggest that adjusting these parameters has an insignificant impact on water levels in the reach to the north of the site.

4.2 Risk of Flooding from Surface Water

Ground levels rise to the south of the site, but the Crieff Road is set at a higher level than land to the south, so a LiDAR flow pathway analysis, presented in Figure 11 (See Section 4.6), shows that surface water would tend to flow either to the west or east of the site. Direct flow into the site from the south would be prevented by Crieff Road. Land to the south is also served by a Scottish Water drainage system.

Crieff Road itself is located at a higher elevation than the site, so care will need to be taken in the design of the site that any surface water from Crieff Road is routed around the edges of the site (as at present) and access points from the road are not designed in a manner that would direct runoff into the site towards properties.

Overall, there is not expected to be a significant risk to the site from surface water runoff, assuming simple mitigation measures are undertaken to mitigate against any residual risk from surface water from south of the site.

4.3 Risk of Flooding from Groundwater

At the time of preparing this report there was no information on groundwater levels in the area available to us. As the majority of the site sits at a higher level than surrounding land with a watercourse to the north of the site at a significantly lower elevation, the site is not considered to be at significant risk of groundwater flooding. However, there may be elevated groundwater levels along the route of the Newton Burn culvert, to the north of the site.

If elevated groundwater levels were encountered during site investigations and construction, then appropriate measures would need to be taken in the design of the site and SuDS measures will need to take account of ground water conditions (e.g., changes to foundations in the case of elevated groundwater levels).

4.4 Risk of Flooding from the Site Drainage System

Design of the site drainage system is not part of this commission. The requirements of SuDS should be discussed and agreed with Perth and Kinross Council, SEPA and Scottish Water.

Ground levels within the site generally slope towards the north and the site currently drains towards the Newton Burn culvert, although connections from the site to the culvert will need to be proved.

Development has the potential to increase surface water runoff rates and as a result, site runoff will need to be attenuated to greenfield rates before being discharged towards Newton Burn. An appropriate greenfield rate should be discussed and agreed with Perth and Kinross Council.

The site drainage system needs to be designed according to Perth and Kinross Council guidance for drainage systems.

In the case of blockage of the site drainage system or events in excess of design conditions, we would recommend that surface water flow pathways are provided within the site to route any surface water through the site to the watercourse, without flooding properties.

4.5 Risk of Flooding from Existing Drainage Systems

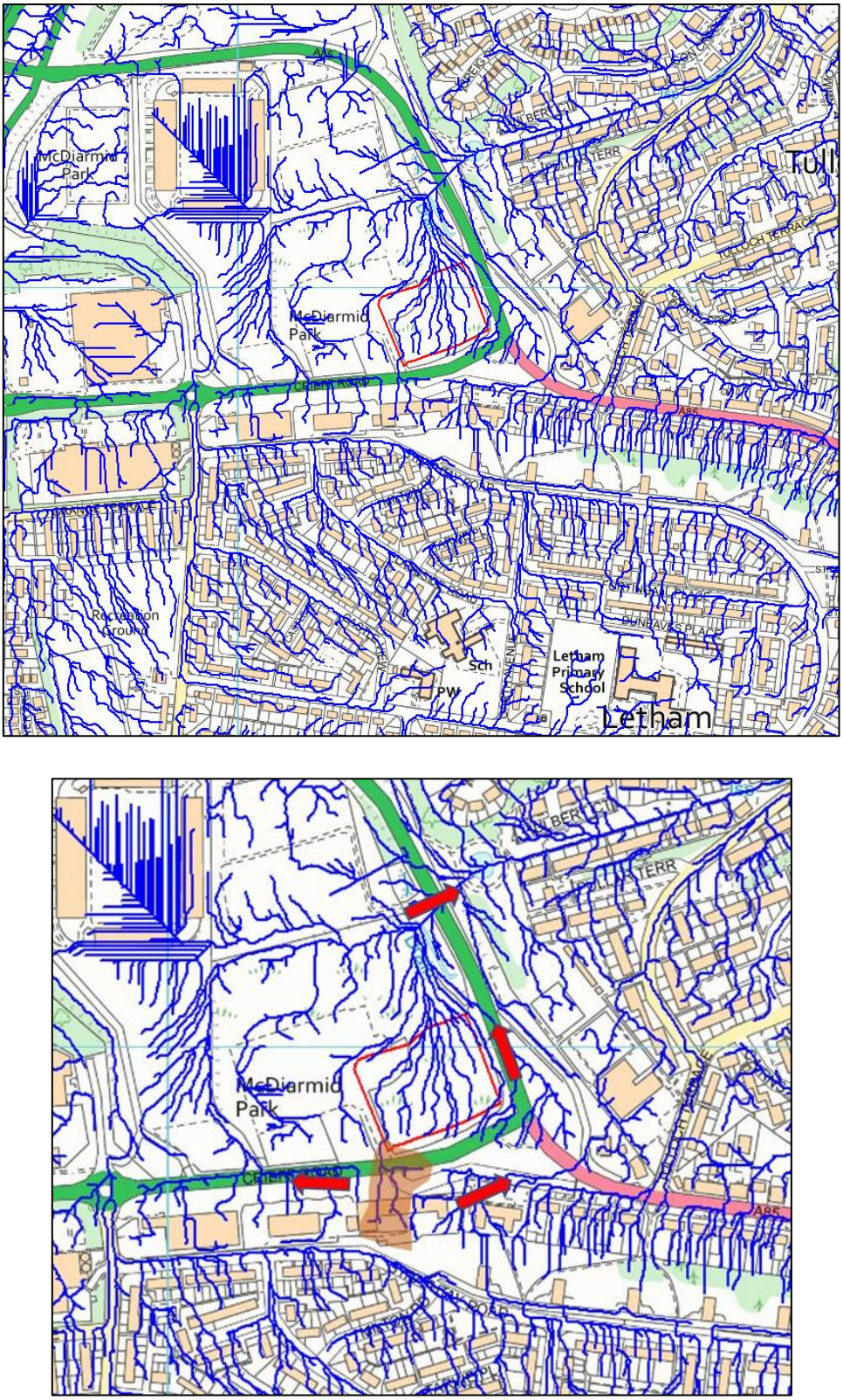
There is existing sewer infrastructure to the south and east of Crieff Road and the A85 extension. As such any excess water from the sewers would be expected to follow flow pathways outlined in Figure 11, with Crieff Road and the A85 raised compared to land on either side and providing a barrier to surface water generated on the opposite sides of the roads flowing directly to the site. Therefore, mitigation measures described above would be expected to manage excess surface water in the event of sewer flooding.

4.6 Site Access Considerations

The site access is not known at present. However, as the site is lower than the roads to the south and east, care will need to be taken so that the access points do not act as flow pathways routing surface water from the road into the site. The access points do not lie within any fluvial or surface water floodplain, so access to the site should not be prevented during flooding. It is noted that if access is

proposed from the north of the site, further assessment of the Newton Burn in this area would be required.

Figure 11: Overland flow pathways within the area surrounding the site



4.7 Flood Management Measures

The site is not considered to be at significant risk of flooding from any assessed sources up to a 1 in 200-year event. However, there are still general precautions that can be put in place to help mitigate against flood risk;

- Maintain appropriate flow pathways so that surface water that naturally enters the site can be managed and conveyed to a suitable drainage outlet or landscaped area so as not to pose a flood risk to the site or third parties;
- Design ground levels around buildings to shed away from buildings and towards roads, drainage measures and landscaped areas;
- The site is not considered to be at significant risk of flooding from fluvial sources in a 1 in 200-year event, with any fluvial flooding from Newton Burn limited to land to the north of the site and at levels well below the site. This means there are no minimum finished floor level requirements related to fluvial flood risk. However, it is generally recommended that finished floor levels are raised a suitable threshold above surrounding ground levels, with consideration of the risk of surface water flooding within the site.

Design of the site drainage system (including SuDS) was not part of this commission. Issues related to site drainage are outlined in Section 5.4. As with any design, maintenance is an important requirement for an effective drainage system. Regular maintenance programs need to be implemented for all components of the drainage system.

Irrespective of advice noted above, it is good practice to design Finished Floor Levels an appropriate height above surrounding ground levels and arrange finished ground levels sloping away from buildings. General ground levels should be finished in a way not to allow ponding of surface water within the site where it could increase the risk of flooding of properties. It is also good practice to provide, within the development site, an appropriate overland flow route through which flood waters could escape in the event of the site being flooded during floods exceeding the design flows or if site drainage features are blocked. Flow pathways should guide runoff through the site, avoiding both ponding on-site and increasing the risk of flooding to properties.

5 Summary and Conclusions

Kaya Consulting Ltd was commissioned by Lidl Great Britain Limited through Blyth and Blyth to carry out a flood risk assessment for a proposed development of a Lidl store off Crieff Road in Perth.

The Newton Burn is culverted approximately 110m to the north the development site. Hydraulic calculations suggest that this culvert has a capacity of approximately 0.15 m^3/s, with around 0.4 m^3/s anticipated to spill out from manholes upstream of the A85 and flow overland in an easterly direction. A 2D overland flow model predicts that flows would back up against the new, raised A85 embankment, building up until approximately 25.4m AOD before overtopping and spilling east away from the site. Based on this the site is not considered to be at risk of flooding from the Newton Burn in 1 in 200-year event.

Overall, there is not expected to be a significant risk to the site from surface water runoff, assuming simple mitigation measures are undertaken to mitigate against any residual risk from surface water from south of the site. Refer to Section 4.2 for more details.

There is no significant risk of flooding predicted from any other sources considered.

Flood management measures are summarised in Section 4.7.

Design of the site drainage system (including SuDS) was not part of this commission, but some guidance is provided in Section 4.5.

It should be noted that risk of flooding can be reduced but not totally eliminated, given the potential for events exceeding design conditions and the inherent uncertainty associated with estimating hydrological parameters for any given site.