5.	Site Details	
5.1	What name would you like the site to be known by? (Please note if the site is currently included within the ALDP2017 please use the OP site number)	Friarsfield - Woodley
5.2	Site Address	Woodley, Cults, Aberdeen
5.3	Postcode	AB15 9QH
5.4	Have you any information for the site on the internet? If so please provide the web address:	No Details:
5.5	Is the site currently being marketed?	No Details:
5.6	Site Location Map (Please include an OS Map with the Boundary of the site clearly marked)	Details: Contained within supporting documents Site Location Supporting Statement
5.7	Please provide the National Grid reference of the site.	388504 803572
5.8	What is the current use of the site?	Private vacant dwellinghouse
5.9	Has there been any previous development on the site? If yes please provide details	Yes Details: Dwellinghouse

6.	**Legal and Planning History**		
6.1	Please indicate the relationship to the Proposer or Person / Organisation they are working on behalf of, has with the site.	Sole owner	
		Part owner	
		Option to purchase	Yes
		No legal interest	
6.2	Is the site under option to a developer?	Yes Details: Stewart Milne Homes	
6.3	Is the proposed site included in the ALDP2017?	No Details: This site is currently identified as Green Belt, please see supporting statement for information on the purpose of the requested rezoning.	
6.4	Is the proposed site included in the Aberdeen City Centre Masterplan?	No Details:	
6.5	Has the site been subject of previous discussions with the Council or any agent there of?	Yes Details: Pre-application discussion.	
6.6	Has the site been subject of previous Planning Applications? (Please provide a planning reference)	No Details:	
6.7	Has the site been subject of a previous Bid to a previous LDP? (Please provide the bid reference number)	No	
6.8	Are there any legal restrictions on the title deeds such as rights of way, way leaves etc.	No Details:	
6.9	Are there any other legal factors that might prevent or restrict development? (e.g. ransom strips / issues with accessing the site etc.)	No Details:	

7.	**Your Proposal** (Please provide as much detail as possible on your site proposal)		
7.1	Proposed Use	Housing	
		Employment	
		Mixed Use	
		Retail	
		Other (Please Specify) Access link for wider residential development as described in supporting statement.	✓
7.2	Do you have a specific occupier in mind for the site?		
7.3	Site Area (hectares)	0.1	
	Housing		
7.4	Approx. no of units.	0	
7.5	Proposed Mix and Number (Number of Flats / Terraced / Semi-detached / detached etc.)	See supporting statement for reasons for rezoning.	
7.6	Affordable Housing Percentage	See supporting statement for reasons for rezoning.	
7.7	Affordable Housing Partner (Details of any partner organisation, Registered Social Landlord etc.)	See supporting statement for reasons for rezoning.	
7.8	Tenure (Details of tenure type, Private Rental Sector / private sale / Housing for the elderly etc.)	See supporting statement for reasons for rezoning.	
	Employment		
7.9	Business and Office	$0m^2$	
7.10	General Industrial	$0m^2$	
7.11	Storage and distribution	$0m^2$	

7.12	Other Please specify	0m^2
	Mixed Use (Please provide as much detail as possible on each use class)	
7.13	Housing	
7.14	Employment	m^2
7.15	Retail	m^2
	Retail	
7.16	Approx. floor area	m^2

	Other (Please Specify examples could include retailing, tourism, renewable energy, sports, leisure and recreation, institutions and education.)	
7.17	Details of proposal	
7.18	Approx. floor area	m^2

8.	**Engagement and Delivery**	
8.1	Has the local community been given the opportunity to influence/partake in the development proposal?	If there has been any community engagement please provide details of the way in which it was carried out and how it has influenced your proposals. If no consultation has yet taken place please detail how you will do so in the future.
		Yes Details: A proposal of application notice has been submitted for this site and engagement undertaken with the local community and Cults, Bieldside and Milltimber Community Council to discuss the proposed amendments to the development and the wider connectivity with the Development Framework area.
8.2	Will the proposed development be phased?	No
8.3	Expected development **start** post adoption of the plan in 2022	Anticipated start date in advance of the next Local Development Plan.
8.4	Expected development **completion**	The development at Friarsfield is programmed to be completed by 2021 in accordance with the Council's Action Programme.
8.5	Is finance in place and if so what form? (Secured Loan, Grant Funding etc.)	Yes Details: Proposals are at an advanced stage and funding is available to commit to the development.
8.6	Are there any other issues with the delivery of the site that we should be made aware of? (These should include any issues which may prevent or impact on the deliverability of the site.)	No Details:

9.	**Sustainable Development and Design**		
9.1	Have you applied principles of sustainable siting and design to your site? The City Council has produced a Sustainability Checklist which provides guidance on the principles of sustainable siting and design and other issues which can be found on www.aberdeencity.gov.uk. Please provide the following information:		
	Orientation		
9.2	Exposure:- (does the site currently have)	Little shelter from northerly winds	
		Some shelter from northerly winds	
		Good shelter from northerly winds	✓
9.3	Aspect:- (is the site mainly)	North facing	
		East or west facing	
		South, south west or south east facing	✓
9.4	Slope:- (do any parts of the site have a gradient greater than 1 in 12?)	Yes	
		If yes approx. what area (hectares or %)	
		No	✓
	Flooding & Drainage		
9.5	Flooding (is any part of the site at risk of flooding or has it previous flooded, if so provide detail You can view the SEPA flood maps at http://map.sepa.org.uk/floodmap/map.htm)	Yes (If yes please use the SEPA flood maps to determine the risk)	
		Little or No Risk	
		Low to Medium Risk	✓
		Medium to High Risk	
		If yes approx. what area (hectares or %)	
		No	
9.6	Has a flooding strategy been developed for the site?	Yes Details: Please see supporting statement section 5.3.	

9.7	Have discussions been had with the Council's flooding team?	Yes Details: Discussion with the Council's flood team have been held through the discussions on the wider detailed design.
9.8	Have discussion been had with Scottish Water?	This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal and will be addressed through the wider proposals for the site.
9.9	Is there **waste water** capacity for the proposed development? http://www.scottishwater.co.uk/business/Connections/Connecting-your-property/Asset-Capacity-Search)?	This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal and will be addressed through the wider proposals for the site.
9.10	Is there **water** capacity for the proposed development? http://www.scottishwater.co.uk/business/Connections/Connecting-your-property/Asset-Capacity-	This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal and will be addressed through the wider proposals for the site.

	Land Use, Built and Cultural Heritage		
9.11	Built and Cultural Heritage (would the development of the site lead to the loss or disturbance of archaeological sites or vernacular or listed buildings?)	Significant loss or disturbance	
		Some potential loss or disturbance	
		No loss or disturbance	✓
9.12	Natural conservation (would the development of the site lead to the loss or disturbance of wildlife habitats or species?)	Significant loss or disturbance	
		Some potential loss or disturbance	
		No loss or disturbance	✓
9.13	Landscape features (would the development of the site lead to the loss or disturbance of linear and group features of woods, tree belts, hedges and stone walls?)	Significant loss or disturbance	
		Some potential loss or disturbance	✓
		No loss or disturbance	
9.14	Landscape fit (would the development be intrusive into the surrounding landscape?)	Significant intrusion	
		Slight intrusion	See supporting statements for further details. ✓
		No intrusion	
9.15	Relationship to existing settlements (how well related will the development be to existing settlements?)	Unrelated (essentially a new settlement)	
		Partially related	
		Well related to existing settlement	✓
9.16	Land use mix (will the development contribute to a balance of land uses, or provide the impetus for attracting new facilities?)	No contribution	✓
		Some contribution	
		Significant contribution	
9.17	Contamination (are there any contamination or waste tipping issues with the site?)	Significant contamination or tipping present	
		Some potential contamination or tipping present	
		No contamination or tipping present	✓

9.18	Will the site impact on any water courses?	Details: There will be a crossing of the Cults Burn as with other phases of development along Kirk Brae, although there is no proposal to physically alter the Cults burn.			
9.19	Does the development site contain carbon-rich soils or peatland? http://www.snh.gov.uk/planning-and-development/advice-for-planners-and-developers/soils-and-development/cpp/	No Details:			
9.20	Is the development site within the airport safety exclusion zone?	No Details:			
9.21	Is the development site within the airport 57dB LAeq noise contours?	No Details:			
9.22	Land use conflict (would the development conflict with adjoining land uses or have any air quality or noise issues?)	Significant conflict			
		Some potential conflict			
		No conflict	✓		
9.23	If there are significant conflicts, what mitigation measures are proposed?	Details:			
	Transport and Accessibility				
9.24	Has contact been made with the Council's transport team?	Yes Details: Discussions on Transport Statement in support of planning application reference 130663 and further discussions held with the Roads service in relation to the proposed vehicular access design.			
9.25	Is access required onto a Trunk road and if so has contact been made with Transport Scotland?	No Details:			
9.26	Accessibility (is the site currently accessible to bus, rail, or major road network?)		Bus Route	Rail Station	Major Road
		More than 800m			
		Between 400-800m			
		Within 400m			
	This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal.				

9.27	Proximity to services and facilities (How close are any of the following?)		400m	400-800m	>800m
		Community facilities			
		Local shops			
		Sports facilities			
		Public transport networks			
		Primary schools			
	This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal.				
9.28	Footpath and cycle connections (are there any existing direct footpath and cycle connections to community and recreation facilities or employment? Give the Core Path number if core path is present https://www.aberdeencity.gov.uk/services/environment/core-paths-plan)	No available connections			
		Limited range of connections			
		Good range of connections	✓ The site has a connection via the Core Path network and existing footpaths to the wider area. There will be improvements made as a part of the development		
9.29	Proximity to employment opportunities (are there any existing employment opportunities within 1.6km for people using or living in the development you propose?)	None			
		Limited	✓		
		Significant			
	Infrastructure				
9.30	Physical Infrastructure (does the site have connections to the following utilities?)	Electricity	Yes		
		Gas	Yes		
9.31	Does the development have access to high speed broadband?	No Details: Connection will require to be provided.			

9.32	Does the development include a Heat Network/District Heating Scheme?	No This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal.	
9.33	How is the development proposing to satisfy the Councils Low and Zero Carbon Policy?	Details: This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal.	
9.34	Are there any further physical or service infrastructure issues affecting the site?	No Details:	
	Public open space		
9.35	Will the site provide the required level of open space as per the current LDP (Please provide details of your calculations)	Yes This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal.	
9.36	What impact will the development have on the Green Space Network?	Enhance the Network	
		No impact on the Network	✓
		Negatively impact the Network	
		Please justify your response: Please see supporting statement.	

10.	**Education**		
10.1	Have discussions been had with the Council's Education Department?	Yes Details: Separate discussions in relation to the allocated residential development that has been factored into the school roll forecasts have been held in advance of a planning application. This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal.	

10.2	Is there currently education capacity for the proposed development? https://www.aberdeencity.gov.uk/ services/education-and- childcare/schools-and-education/schools-pupil-roll-forecasts	Details: This is a proposal for access only and relates to an existing allocation. These questions are not applicable to this proposal.

11.	**Community benefits** Community benefits can include new community facilities (such as local shops, health, education, leisure and community facilities), affordable housing, green transport links and open spaces. Include elements which you anticipate may be required as developer contributions from the development. (Please note, specific contributions will have to be negotiated with the Council on the basis of the proposal.)	
11.1	Does the development proposal give any benefits to the community? If so what benefits does the development bring, and how would they likely be delivered?	Yes Details: The proposed access will ensure that the residential allocation is delivered in accordance with the Council's plans and will provide new housing and new affordable housing to meet need and demand.

12.	**Masterplan Development Framework**	
12.1	If you have prepared a framework or masterplan showing a possible layout for the site, please include it with this form.	Yes Details: See supporting statement.

13.	**Additional attachments**		
	No site is going to be perfect and the checklist above will inevitably raise some potential negative impacts from any development. Where negative impacts are identified, please provide details of their nature and extent and of any mitigation that may be undertaken. Listed below are examples of further information that may be included in your submission;		
		Included	Not Applicable
13.1	Contamination Report		✓
13.2	Flood Risk Assessment	✓	
13.3	Drainage Impact Assessment		
13.4	Habitat/Biodiversity Assessment	✓	
13.5	Landscape Assessment		
13.6	Transport Assessment		
13.7	Other as applicable (e.g. trees, noise, dust, smell, retail impact assessment etc. please state)		

	Supporting Bid Statement	✓	
	Indicative Site Layout / Proposals	✓	

14.	**Development Viability**		
14.1	Taking into account all the information provided above, and the requirements of the Aberdeen Local Development Plan 2017 and supporting Supplementary Guidance, please confirm that you have assessed the financial viability of your proposed development and found it to be viable for development in the timeframe set out above.	I confirm that I consider the site to be viable as per the details provided above.	✓
		Please provide details of viability: The land for the proposed access is in the control of Stewart Milne Homes. An application for planning permission is currently being prepared for the development and it is confirmed that the development is viable and will proceed.	

Supporting Bid Statement

Friarsfield - Woodley

IAAB170057

Stewart Milne Homes

24 May 2018

NORR

Table of Contents

1 INTRODUCTION AND BACKGROUND

This statement has been prepared in support of a proposal for the rezoning of a residential property at Woodley, Friarsfield from Green Belt to residential, location marked in Figure 1. The proposed site is linked to the current allocation and development that is progressing at Friarsfield, Cluts., OP41 as shown in Figure 2. This request for rezoning has been prepared as a part of the participation process for the review of the Aberdeenshire Local Development Plan and is promoted by Stewart Milne Homes.

The site at Friarsfield is located to the west of the City of Aberdeen, on the northern edge of Cults. The Development Framework boundary covers an area of approximately 29.6 hectares. The land is in various ownerships, with current developer involvement from CALA Homes and Stewart Milne Homes. A further area of land, under the control of Scotia Homes, lies within the Development Framework site to the east, now complete. A number of other properties, including Greenridge, Dove Cottage, Bramble House, Craigbank House, East Craigbank and South Craigbank are included within the Framework area simply owing to the allocation status in the adopted Local Development Plan 2017.

Figure 1: Site Location

Friarsfield is identified in the 2017 Aberdeen Local Development Plan for residential development (OP41). A Development Framework has been prepared for the site and was approved as supplementary guidance in 2012. Public consultation was undertaken as a part of preparing the original framework.

Planning permissions have been granted for development of parcels of the site totalling 210 dwellings. There have been changes to the framework given the time that has elapsed and these changes will influence the final phases of the development. Application reference 170307 for the development of 19 residential units and part of the link road to the east of the development, at Morkeu, Craigton Road, Aberdeen was granted willingness to approve subject to a legal agreement at the Council's Development Management Committee on 26 April 2018. Part of the link road provides a new junction arrangement with Friarsfield Road, Craigton Road and the new link road. The section of road improvement to the north east of Dove Cottage is currently Green Belt and the principle of the development was considered to be compliant with the provisions of the Development Plan.

Figure 2: Extent of Friarsfield Development

Detailed proposals are being finalised for the development of the final phase of the development by Stewart Milne Homes. In finalising these details the Development Framework is being updated to ensure that the development is coordinated with the changes to the design as a result of planning permissions granted by the Council. An application will be advanced for the development including the land identified within this submission, and it is requested that the Council amend the allocation within the Local Development Plan to reflect the current proposals for the development at Friarsfield.

This bid relates to the residential property at Woodley and the site includes a house with overgrown garden grounds as shown in Figure 3 and 4. The building remains in very sound structural condition. The Cults Burn runs along the northern boundary of the property in an embanked and realigned channel.

Figure 4: View of Northern Boundary

Figure 3: View of Southern Boundary

2 DEVELOPMENT PROPOSAL

Within the site identified at Woodley it is proposed that the existing house is demolished and a new vehicular access formed onto Kirk Brae. The layout of the junction is identified within Fairhurst Drawing 92673/0115. The full detail design of this junction is subject to detailed planning permission and further engagement with the Council's Roads Service.

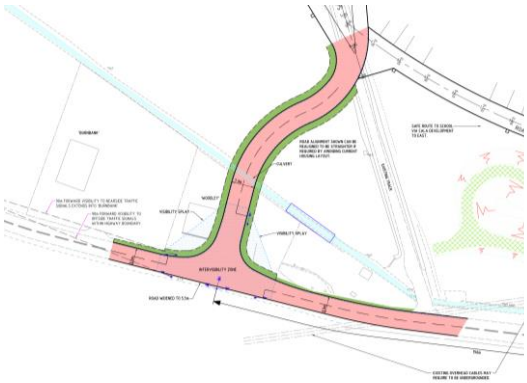


Figure 5: New Access Road

The development of this phase by Stewart Milne Homes has been designed to connect with the layout of the CALA development to the east to ensure that there is good connectivity, and in particular access to the link road, as shown in Figure 5. The purpose of the link road is to divert existing traffic flows away from Friarsfield Road and the southern Section of Kirk Brae. The link road has formed an important part of the strategy for the development. This proposal does not alter this strategy and contributions towards the completion of the link road from this development will be necessary. Design proposals for this phase continue the wider strategy of creating a park along Kirk Brae, which will create opportunities for the existing and new communities to interact, providing a sense of place and help encourage active lifestyles will still be provided.

The additional point of access proposed will increase permeability in the development leading to a more even spread of vehicular traffic through the area and greater connectivity with the existing development. The proposal will also involve changes to the speed limits entering Cults, extending the 30mph zone further west. In combination with the changes to the character of this area will help to reduce traffic speeds entering Cults and make this a more attractive environment for pedestrians.

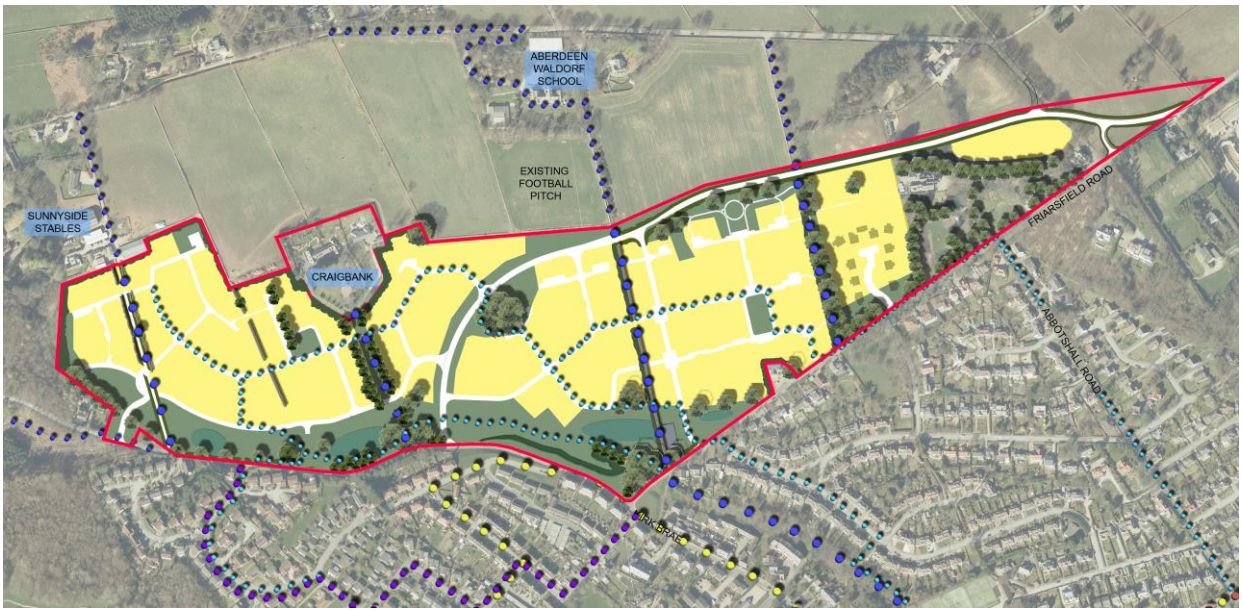


Figure 6: Overall Revised Framework

3 FIT WITH DEVELOPMENT PLAN STRATEGY

The delivery of the link road relies on all developments making contributions towards the cost of this infrastructure. Within the draft 2018 Housing Land Audit the portion of Friarsfield in control of Stewart Milne Homes is identified as reference A/PC/R/061a and it anticipates that completions will start on-site from 2019. Access to Stewart Milne Homes' site will not be provided until completion of the development to the east and this is not forecast for completion until 2022. Access to this site and completion of the link road are separate as the link road does not provide direct access to this phase of the development.

The phasing is also reflected in the current Action Programme with the expectation that the entire development is completed by 2021. The Action Programme identifies the infrastructure necessary to support this development and the consent for the remaining phase of the development will be the final step in the planning process to ensure that this allocation can be delivered in accordance with the Local Development Plan and Action Programme.

Scottish Planning Policy Paragraph 20 expects that Development Plans should positively seek opportunities to meet the development needs of the plan area in a way which is flexible enough to adapt to changing circumstances over time. It is considered that the Development Plan, Policy NE2 – Green Belt does make provision for these instances and the approach adopted by the Council in allowing access through areas of Green Belt to deliver allocated development is to be supported and is consistent with the expectations of Scottish Planning Policy.

Paragraph 110 of Scottish Planning Policy states that *"the planning system should have a sharp focus on the delivery of allocated sites embedded in action programmes, informed by strong engagement with stakeholders."*

In achieving the Council's targets of increased housing delivery in accordance with housing need and demand assessment and in ensuring that the proposals within the Local Development Plan and Action Programme are delivered there will be a requirement for an alternative access to enable development of phase 3 to commence.

4 ASSESSMENT OF EFFECTS OF ADDITIONAL LAND

5.1 Loss of Green Belt

The site is located within the Green Belt within the extant Local Development Plan. However, in undertaking a review of the Local Development Plan this designation also requires to be reviewed in light of a need for any new allocations for development. With the exception of urban areas and existing development allocations all land within the city boundary is designated as Green Belt.

Scottish Planning Policy identifies that the purpose of a Green Belt is to direct development to the most appropriate locations, protect and enhance the character, landscape setting and identity of the settlement; and protect and provide access to open space.

Scottish Planning Policy states that the Green Belt should give consideration to *"the need for development in smaller settlements within the green belt, where appropriate leaving room for expansion"*

Scottish Planning Policy identifies that the Purpose of the Green Belt is to support the spatial strategy by:

- directing development to the most appropriate locations and supporting regeneration;
- protecting and enhancing the character, landscape setting and identity of the settlement; and
- protecting and providing access to open space.

The development at Friarsfield has already been identified as a location for greenfield development and early phases of the development have commenced. This proposal extends to an area covering 1,000sqm, or 0.3% of the overall 29.6 hectare site. The site is a residential curtilage and does not currently fulfill a role in providing access to open space. The site is overgrown with some trees, but with the surrounding woodland this property would have minimal effect on the landscape setting of the surrounding area and the character of the settlement.

5.2 Greenspace Network and Ecological Effects

An Ecological Impact Assessment for the development of the site at Friarsfield was updated in January 2018 by Northern Ecological Services to take account of the additional land identified within this development bid.

There are no designations on the site. The Cults Burn runs along the northern boundary of Woodley and the Local Nature Conservation designation starts further to the east as shown in Figure 7. The LNCS is identified as providing a linear habitat through the built up area of Cults. The habitats referenced within the designation are willow scrub, marshy grassland, mature woodland, improved pasture and amenity grassland.

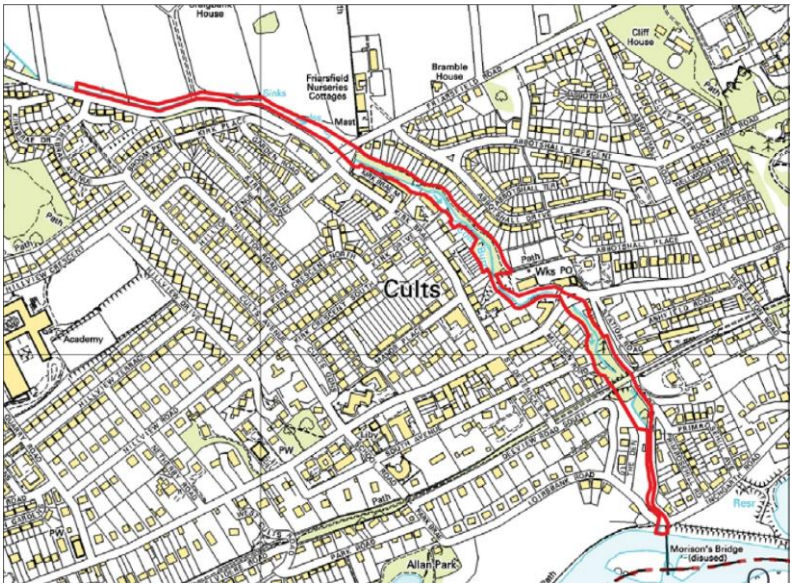


Figure 7: Cults Burn LNCS

The Ecological Impact Assessment identifies that the burn is shallow, approx. 10cm deep and fast flowing over a substrate of angular cobbles and coarse gravels along the southern edge of the site. The Assessment identified that the burn supports little aquatic or emergent macrophyte (higher plant species) vegetation. apart from locally occurring brooklime and watercress.

There could be the potential for pollution associated with construction works on the site that could affect the water quality in the Cults Burn. This is applicable to the entire development and not something unique to the additional area of land proposed. All construction activity will be undertaken following best practice and precautionary measures as guided by SEPA. A method statement shall be submitted and agreed with SEPA to identify measures to avoid and mitigate any pollution entering the burn.

In demolishing the property at Woodley was subject to a "preliminary roost assessment" for bats. None of the trees on or on the edge of the site were considered to have bat roost potential. The existing property, scheduled for demolition was also investigated. There was some potential identified and an activity survey for bats is currently being undertaken.

The Local Development Plan identifies that Aberdeen's Green Space Network is made up of multiple components and is mainly comprised of:

- Formally designated natural heritage sites;
- A diversity of habitats and their connectivity;
- Water bodies of all types including lochs, ponds, wetlands and watercourses;
- Woodland, hedgerows and individual trees, especially veteran trees;
- Open Spaces defined in Aberdeen's Open Space Audit 2010;
- Spaces for physical activity and access to the outdoors; and
- Paths and links for pedestrians and cycling.

The Local Development Plan Policy NE1 also identifies that *"where major infrastructure projects or other developments necessitate crossing the Green Space Network, such developments should maintain and enhance the coherence of the network. In doing so, provision should be made for access across roads for wildlife and outdoor recreation. Masterplans will determine the location, extent and configuration of the Green Space Network within the area, and its connectivity with the wider network."*

Figure 8: Extent of Green Space Network

In this case the Green Space Network follows the Cults Burn along the south of the allocation and this is respected in the open space created where the site is bound by the Cults Burn. This proposal does not depart from this strategy. The only exception to this is the vehicular links which do not detract from the coherence of the network in this location.

The proposals to the east have created a new access from Kirk Brae bridging over the Cults Burn. The assessment of this proposal (140272) considered that the habitat value is low and there will be negligible direct impact on the burn. This was confirmed in the report of handling that stated *"In terms of the Cults Burn, which is a tributary of the River Dee Special Area of Conservation (SAC) and a Local Nature Conservation Site (LNCS), it is not anticipated that there will be any adverse impact and as such the corridor quality of the Cults Burn will be unaffected by the proposals."* Along Kirk Brae the Cults Burn has been culverted in 3 locations now at Sunnyside, Craigbank and the new access to the development to the east. Based on the Ecological Appraisal Assessment undertaken it also considered that this proposal will not have any adverse impact.

Figure 9: Existing Crossing at Sunnyside

Figure 10: View of Woodland Surrounding the Site From Sunnyside Access

5.3 Flooding and Drainage

Appendix 3 provides a copy of the Flood Risk Assessment for the site. There are some areas of the site at risk from flooding. The 200 year flood envelope predicted by this report is entirely contained within the 'Structural Landscaping' area that forms part of the development framework for the area ensuring there is an acceptable freeboard above the 200 year peak water level.

Surface water drainage designs have been designed to treat and attenuate surface water and working with the levels of the site these will be located along the south of the site, creating a feature to the development to ensure that the development does not increase the risk of flooding elsewhere.

5.4 Road Safety and Transportation

A meeting was held with the Councils Roads team on 15 February 2018 to discuss the suitability of the arrangements for the access taken at Woodley. In conclusion it was identified that there would require to be three points addressed through the detailed design for this to be an acceptable proposal:

1. Both the 30mph and 40 mph speed zones will require to be moved further north west along Kirk Brae.
2. Due to the proximity of this signalized junction to the new crossing to be constructed as a part of the CALA development these will require to be tied in such a way as to maximize the free flow of traffic.
3. An alternative safe route to school will be required.

A review of the Transport Assessment that was submitted in support of the residential approvals at Friarsfield has been undertaken by WSP. There are currently conditions requiring that the link road is required on the completion of 160 units. At this point in the development it is the Friarsfield Road/Kirk Brae junction that is shown to experience capacity constraints. A review of the assumptions based on the HGV percentage would indicate that there is not a constraint until 200 units have been completed. The alternative point of access up to the point that the link road is completed would provide for access to the development without placing additional right turn movements onto Friarsfield Road.

There is a legal agreement in place that currently limits development on the larger development area to 160 units prior to the completion of the link road. The link road in the location approved does not provide access to the land in control of Stewart Milne Homes. The larger development area refers to the wider OP51 allocation with the exception of the 10 units completed by Scotia Homes. The total approval on the allocation totals 200 units with 19 units granted willingness to approve in addition to this. Whilst the trigger point for the completion of the link road requires further discussion there is no dispute from Stewart Milne Homes to the contribution towards the completion of the link road that will mitigate the wider traffic impact of the development on the road network.

5 CONCLUSIONS

This submission has been prepared in support of a request a residential property at Woodley, Kirk Brae from Green Belt to Residential to support the delivery of the wider development at Friarsfield. The detail design for the development of this phase of the development are being progressed by Stewart Milne Homes and an application will be submitted in advance of the review of the Local Development Plan. In focussing on the delivery of housing and the actions identified within the Action Programme it will be necessary for consent to be granted for the development in advance of a review of the Local Development Plan. On completion of the wider development there will be connections provided throughout the development and a link road from Kirk Brae to Craigton Road relieving pressure from the existing junction.

The site provides little contribution towards the objectives of the Green Belt and the access in this location will have no greater impact on the environment than the wider development proposals. The main ecological concern regarding the development in this location is potential for pollution of the Cults Burn and ultimately the River Dee SAC resulting from the construction phase of the development. Appropriate mitigation measures can be implemented through the construction and environmental management plans for the development in accordance with best practice, as has been the case for the current developments progressing.

The provision of an access at this location will allow for the full delivery of the site allocated in the Local Development Plan, OP51 Friarsfield in accordance with the current Local Development Plan and Action Programme and the Council's support in ensuring the delivery of this allocation within these timescales is requested.

APPENDIX 1 ECOLOGICAL IMPACT ASSESSMENT

APPENDIX 2 TRANSPORT ASSESSMENT REVIEW

APPENDIX 3 FLOOD EXTENT

Our ref: 50401039/PW/let140320

20 March 2014

Marianne McGowan
Area Director - Strategic Land Division
Stewart Milne Group
Osprey House, Mosscroft Avenue
Westhill
Aberdeen
AB32 6JQ

WSP UK Ltd
7 Lochside View
Edinburgh Park
Edinburgh
EH12 9DH
Tel: +44 (0)131 344 2300
Fax: +44 (0)131 344 2301
http://www.wspgroup.com

WSP Group plc
Offices worldwide
www.wspgroup.com

Dear Marianne

Friarsfield, Cults, Transport Assessment Review

WSP has carried out a technical review of the Transport Assessment (TA) dated February 2012, carried out by Fairhurst in support of a proposed residential development at Friarsfield Road, Cults, Aberdeen.

General
In general, the Transport Assessment methodology follows standard industry practice, as it was at the time of submission, with scoping discussions having taken place with Aberdeen City Council. The TA states that the proposed development site has a potential capacity of approximately 420 units, which the TA acknowledges is well beyond the 280 unit Local Plan Allocation.

Trips Generation & Distribution
The trip generation was estimated the using TRICS database in accordance with industry standard, and the resultant residual vehicular trips are reasonable for a site within a large City. The trip distribution was based on 2001 census data, which was also the industry standard methodology. As the 2011 census data is now available, the distribution assumptions could be re-visited, but are unlikely to change significantly from those in the TA.

Sustainable Travel
The TA discusses the sustainability of the site in terms of its accessibility by walking, cycling and public transport. Enhancements to public transport are limited to the potential extension of existing services through the development site via a new 'Link Road', connecting Kirk Brae to Craigton Road. Pedestrian and cycle enhancement focuses on reducing vehicle speeds through the use traffic calming and Designing Streets features. The TA states that the level of sustainable travel opportunities is consistent with current Policy, which would seem to be a reasonable conclusion to reach given the location of the site.

Development Impact
Despite the increased political and social emphasis on sustainable travel, with increased focus on pedestrian/cycle/public transport access to the site, the TA focuses primarily on the vehicular impact of the development proposals on the surrounding local road network.

The TA presents the results of the capacity assessments of the study network, when development traffic is added incrementally, in five scenarios:

1. Existing Road Network with 2016 traffic flows
2. Existing Road Network with 2016 traffic flows + 160 residential units
3. Existing Road Network with 2016 traffic flows + new Link Road + 200 units

4. Existing Road Network with 2016 traffic flows + Link Road + AWPR + 200 units
5. Existing Road Network with 2016 traffic flows + Link Road + AWPR + 420 units

The choice of 160 units as the point at which the 'Link Road' is required, appears to be rather arbitrary, as one of the junctions is shown to be above the capacity limits which are quoted in the TA. In reality, the results show that there are three junctions which are close to capacity, namely:

- North Deeside Road/Abbotshall Road Westerton road junction
- Kirk Brae/North Deeside Road/St Devenick junction
- Friarsfield Road/Kirk Brae/Kirk Terrace junction

Only the Friarsfield Road/Kirk Brae junction is shown to be potentially experiencing capacity issues for 160 units, with the other two junctions not reaching capacity until over 200 units are added (with or without the Link road).

However on closer inspection of the actual junction analysis work on the Friarsfield Road/Kirk Brae junction, a fundamental error was discovered, which significantly effects the conclusions of the Transport Assessment. The TA has used PCU's (Passenger Car units) rather than vehicles throughout the analysis, which already take account of HGV's (i.e. 1 HGV = 2.3 PCU's) and consequently the HGV percentage must be set to zero when using PCU's rather than vehicles. However, the PICADY analysis for the Friarsfield Road/Kirk Brae junction has incorrectly used the 'Default HGV proportions', which is 10%, which significantly under-estimates the capacity of the junction.

On repeating the PICADY analysis, using the correct settings for HGV's, the following results were realised:

Table 1 - Friarsfield Road/Kirk Brae junction Capacity results

Scenario	2106 Base	2016 160 units	2016 200 units	2016 200 units + Link Road	2016 200 units + AWPR + Link Road	2023 420 units + AWPR + Link Road
	AM Peak Hour					
2012 TA Results	55.8 %	57.8%	n/a	14.6%	14.6%	20.2%
WSP Results	48.9%	50.5%	51.0%	13.2%	13.4%	18.4%
	PM Peak Hour					
2012 TA Results	76.2%	85.9%	n/a	24.8%	16.3%	25.9%
WSP Results	57.3%	61.6%	62.7%	24.3%	20.6%	24.0%

It can be clearly seen from Table 1 above, that the Friarsfield Road/Kirk Brae junction is comfortably below the 85% threshold with the additional of 200 residential units, without the Link Road being in place.

However, at 200 units, the TA correctly confirms that the Kirk Brae/North Deeside Road/St Devenick junction and the North Deeside Road/Abbotshall Road Westerton road junctions are reaching their practical capacity, and consequently the Link Road is considered to be required when the development reaches 200 units, rather than 160 units as stated in the TA.

Notwithstanding this, as there are two parts to the proposed development site, with different points of access. The majority of vehicles using the Cala entrance from Friarsfield Road are shown to be using **all three** of the critical junctions stated above, and are required to turn right at the critical junction number 3, whereas the majority of vehicles accessing the site via The Stewart Milne entrance, only travel through **one** of the critical junctions, and travel straight through this junction, rather than turning right, which therefore has no significant impact on junction capacity.

Conclusion
WSP has carried out a technical review of the Transport Assessment (TA) dated February 2012, carried out by Fairhurst in support of a proposed residential development at Friarsfield Road, Cults, Aberdeen.

The review of the TA has concluded that, due to an error in the junction analysis presented in the TA, 200 units can in fact be accommodated on the proposed site, prior to the Link Road being completed, with no significant impact compared to the proposed 160 units considered in the TA, particularly if the additional 40 units are accessed from the Stewart Milne access from Kirk Brae.

Should you have any queries regarding the enclosed, or any other matter, please contact me on 0131 344 2339.

Kind regards.

Yours sincerely

Paul White
Technical Director

Proposed Residential Development at Friarsfield

Flood Risk Assessment

April 2013

FAIRHURST

FAIRHURST

CONTROL SHEET

CLIENT:	**Stewart Milne Homes**
PROJECT TITLE:	**Friarsfield, Aberdeen**
REPORT TITLE:	**Flood Risk Assessment**
PROJECT REFERENCE:	**92673/GL/W/01**

Issue and Approval Schedule:

ISSUE 2 **Final**	Name	Signature	Date
Prepared by	James McNaughton	[redacted]	03/04/13
Reviewed by	Ed Clarke		3/4/13.
Approved by	Kenneth Barr		3/04/13.

Revision Record:

Issue	Date	Status	Description	By	Chk.	App.
1	11/03/13	Draft	Initial draft for comment	JMcN	EJC	KMHB
2	03/04/13	Final	Updated to Final status	JMcN	EJC	KMHB
3						
4						
5						

This report has been prepared in accordance with procedure OP/P02 of Fairhurst's integrated Quality and Environmental Management System (QEMS)

CONTENTS

1 INTRODUCTION

Fairhurst was appointed by Stewart Milne Homes to produce a Flood Risk Assessment for a potential residential development site in Friarsfield, Aberdeen. The site is located on greenfield land on the northern edge of Cults to the west of Aberdeen (NGR NJ886036). A plan of the site location in relation to the local and regional area is provided in Figure 1.

The site forms part of the overall Friarsfield Masterplan Zone, identified as Opportunity Site OP51 in the 2010 Aberdeen Local Development Plan. This Flood Risk Assessment applies only to the Stewart Milne Homes development situated to the west of the Friarsfield Masterplan.

The Cults Burn flows along the southern boundary of the site. Flood risk has been assessed in relation to this watercourse. Other potential sources of flooding have also been considered.

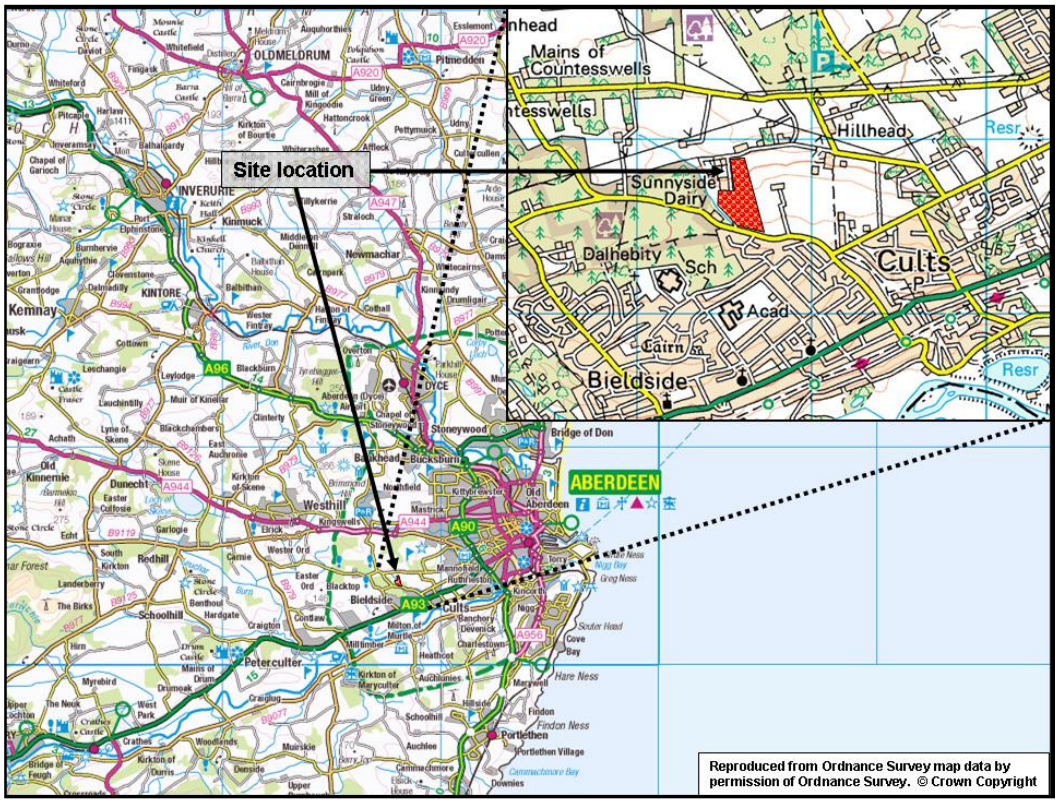


Figure 1: General location map

2 PLANNING POLICY

2.1 National planning policy

In consideration of planning applications, planning authorities require to be satisfied that due account has been taken of Scottish Planning Policy (SPP) and Planning Advice Note 69 (PAN69): Planning and Building Standards Advice on Flooding. It is necessary to show that adequate protection against flooding exists or can be provided for the proposed development and that the development does not increase any existing flood risk to persons or property upstream and downstream.

Flood risk has been categorised as High, Medium and Low based on the probability of inundation. Extracts from the Flood Risk Matrix set out in the SPP document highlight the likely planning response in the context of flood risk (Figure 2).

RISK FRAMEWORK

Little or No Risk – annual probability of watercourse, tidal or coastal flooding is less than 0.1% (1:1000)

- No constraints due to watercourse, tidal or coastal flooding.

Low to Medium Risk Area – annual probability of watercourse, tidal or coastal flooding in the range 0.1% - 0.5% (1:1000 – 1:200)

- These areas will be suitable for most development. A flood risk assessment may be required at the upper end of the probability range (i.e. close to 0.5%) or where the nature of the development or local circumstances indicate heightened risk. Water resistant materials and construction may be required depending on the flood risk assessment. Subject to operational requirements, including response times, these areas are generally not suitable for essential civil infrastructure such as hospitals, fire stations, emergency depots etc. Where such infrastructure must be located in these areas or is being substantially extended it should be capable of remaining operational and accessible during extreme flooding events.

Medium to High Risk – annual probability of watercourse, tidal or coastal flooding greater than 0.5% (1:200)

- Generally not suitable for essential civil infrastructure such as hospitals, fire stations, emergency depots etc., schools, care homes, ground-based electrical and telecommunications equipment unless subject to an appropriate long term flood risk management strategy. The policy for development on functional flood plains applies. Land raising may be acceptable.
- If built development is permitted, appropriate measures to manage flood risk will be required and the loss of flood storage capacity mitigated to produce a neutral or better outcome.
- Within built up areas, medium to high risk areas may be suitable for residential, institutional, commercial and industrial development provided flood prevention measures to the appropriate standard already exist, are under construction or are planned as part of a long term development strategy. In allocating sites, preference should be given to those areas already defended to required standards. Water resistant materials and construction should be used where appropriate.
- In undeveloped and sparsely developed areas, medium to high risk areas are generally not suitable for additional development. Exceptions may arise if a location is essential for operational reasons, e.g. for navigation and water based recreation uses, agriculture, transport or some utilities infrastructure and an alternative lower risk location is not achievable. Such infrastructure should be designed and constructed to remain operational during floods. These areas may also be suitable for some recreation, sport, amenity and nature conservation uses provided adequate evacuation procedures are in place. Job-related accommodation (e.g. caretakers and operational staff) may be acceptable. New caravan and camping sites should not be located in these areas. If built development is permitted, measures to manage flood risk are likely to be required and the loss of flood storage capacity minimised. Water resistant materials and construction should be used where appropriate.

Figure 2: Extract from the SPP Flood Risk Framework

SPP states that new development should not take place if it would be at significant risk of flooding from any source or would materially increase the probability of flooding elsewhere. In general, the storage capacity of floodplains should be safeguarded and works to elevate the level of the site by landraising should not lead to a loss of floodwater storage capacity.

The Scottish Environment Protection Agency (SEPA) has a duty to give advice to planning authorities as to flood risk under the Flood Risk Management Act 2009, Section 72. SEPA considers this to include professional and expert interpretation of data or records.

The Secretary of State for Scotland's guidance requires SEPA to take a holistic approach to the protection and enhancement of the environment. Planning authorities must consider SEPA's views on the merits of any proposals involving carrying out works or operations in the bed or on the banks of rivers and streams.

The SEPA/Planning Authority Protocol on Development at Risk of Flooding: Advice and Consultation issued in 2011 provides principles to be followed by the authorities regarding advice and consultation on flood risk issues. It also gives generic guidance on the requirements for undertaking flood risk assessments.

2.2 Local planning policy

Aberdeen City Council adopted the new authority-wide Local Development Plan (LDP) on 29th February 2012. This replaces the previous Local Plan for Aberdeen City, and sets out the statements and policies which are used to assess planning applications.

Policy NE6 addresses flooding and drainage issues. This evolved from the Aberdeen Local Plan Policy 24 and it reinforces the provisions of SPP. Policy NE6 states that development will not be permitted if it would increase the risk of flooding or be at risk of flooding itself. It is noted that:

"Applicants will be required to provide an assessment of flood risk where a development is likely to result in a material increase in the number of buildings at risk of flooding or where it has been indicated in the opportunity sites schedule that one will be prepared."

The development site is identified as Opportunity Site OP51 in the proposed Aberdeen Local Development Plan, Proposal Plan. It is also identified as in the Friarsfield Masterplan Zone. The Development Framework itself notes that a *"Flood Risk Assessment (FRA) will accompany any planning application relative to that part* [presence of the Cults Burn] *of the Development Framework and will identify the exact area at risk of flooding".* The proximity of the Cults Burn necessitates consideration of flood risk to confirm that the proposals will not increase flood risk elsewhere and will not lead to a material increase in the number of buildings at risk of flooding from the burn.

3 DEVELOPMENT SITE

3.1 Existing Site Conditions

3.1.1 General Background

The site extends across approximately 7ha of undeveloped land on the northern outskirts of Cults, Aberdeen. It is bounded to the north by Craigton Road, the buildings around Denwood and agricultural land beyond; to the east by the agricultural land forming the remaining Friarsfield development area; to the south by the Cults Burn, Kirk Brae road and the outskirts of Cults beyond; and to the west by forested land. An indicative site boundary and key features in the vicinity of the site are highlighted in Figure 3 below.

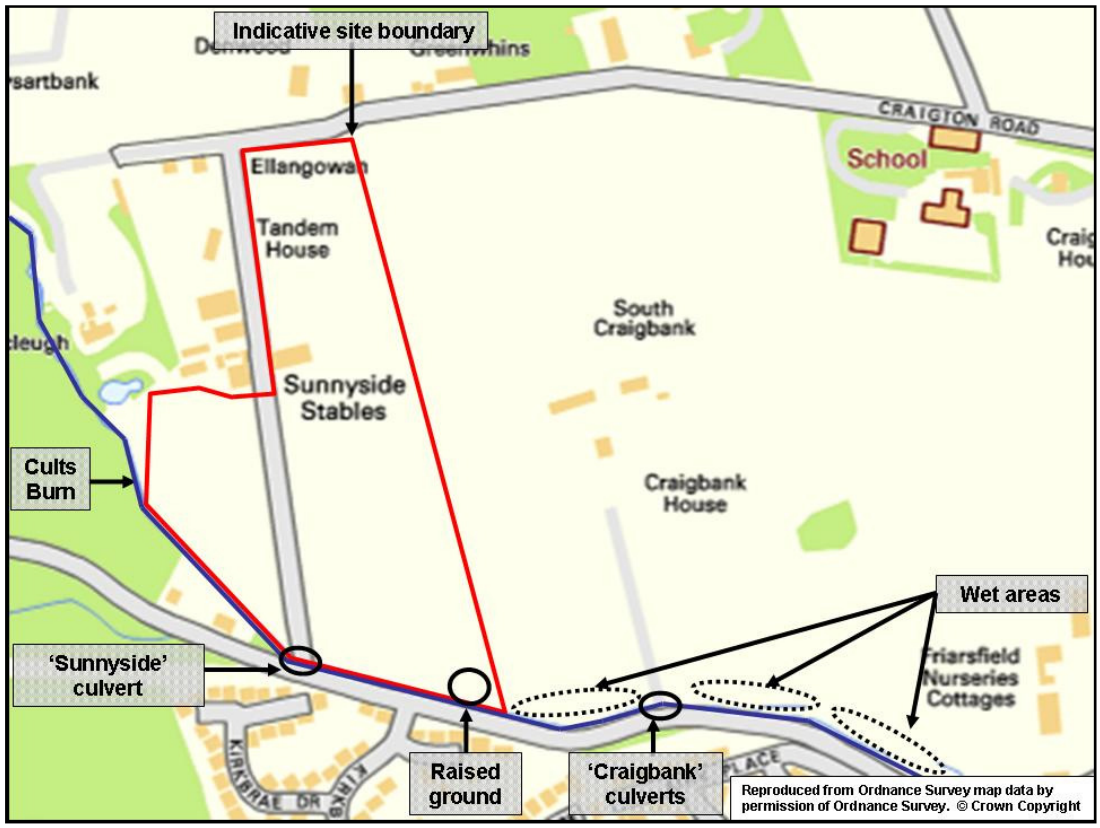


Figure 3: Site location plan

The site itself slopes from north to south, broadly following the gradient of the surrounding land falling from a local summit at the corner of Den Wood, 300m to the north of the site, to the Cults Burn along the southern boundary.

The Cults Burn rises on agricultural land to the north west of the proposed development site. It flows in a south easterly direction past the site before flowing through Cults to discharging to the River Dee. The catchment area of the Cults Burn at the site is approximately 2.5km² and predominantly agricultural.

Adjacent to the site the Cults Burn passes beneath the access road to Sunnyside Stables in a culvert. The rectangular opening of the Sunnyside culvert was measured by the site survey as 1440mm wide by 525mm deep. The site walkover survey noted that it was a simple roadway on top

of the channel. A photograph of this structure taken during the site walkover is provided in Appendix D.

Roughly 120m downstream of the site the Cults Burn is crossed by the access to the buildings around Craigbank House. The watercourse passes under this access road in a dual culvert structure. These Craigbank culverts were noted as modern on the site walkover survey, with a concrete culvert 600mm in diameter and a plastic culvert of 750mm diameter. A photograph of the structure is provided in Appendix D.

A drain is shown on the 1:25,000 OS Explorer map approaching Kirk Brae road from the south. Although the site walkover found no evidence of a culvert beneath Kirk Brae road discharging to the Cults Burn, it is believed that this is the case. The ditch is therefore considered in the catchment area of the Cults Burn.

The Friarsfield Development Framework identifies various surface water drainage discharges to the Cults Burn from Kirk Brae road.

3.1.2 Historic Features

Readily available historic mapping for the area has been examined from 1866 to the present day in order to identify changes in land use on the site and throughout the local burn catchment which may be relevant to flood risk.

The Cults Burn channel adjacent to the site is marked on all OS maps consulted for this research, including both the 1843-82 Ordnance Survey (OS) 6 inch '1st Edition' (surveyed 1866) and the OS 1892-1960 25 inch '2nd Edition and later' (surveyed 1923/38). It is also shown on the 1:10,000 and 1:25,000 scale present day OS mapping. On all the historical mapping consulted it is shown as an open watercourse to the west and south of the site.

The buildings around Sunnyside Stables and Ellengowan on the north of the site are marked on all the historical mapping consulted.

The 1843-82 OS 6 inch shows a triplet of wells and footbridges around the burn channel to the west of the site. One of these wells, immediately west of the buildings at Sunnyside, has a pond marked alongside it. This pond is also marked on the OS 2nd Edition 6 inch map and, though the wells are not marked, an aqueduct is labelled on the channel north-west of Sunnyside. The aqueduct is not detailed on present day OS mapping of the area but the pond adjacent to Derncleugh is marked. There is no reservoir marked in the location of the present day covered reservoir next to Sunnyside Stables marked on present day OS mapping.

The Craigbank development and access road is marked on the 1st Edition and 2nd Edition 6 inch OS maps, as well as the present day mapping, though it should be noted that the present day Craigbank culverts are a new structure.

3.1.3 Other Sources of Information

Twenty-three cross-sections of the Cults Burn channel were recorded as part of a watercourse cross-section survey conducted by Fairhurst in two parts in February 2013. This survey included three sections at both the structure adjacent to the southern site boundary and the structure at the Craigbank access road, approximately 120m to the east. The cross-sections are shown on Drawing 92673/9001 & /9002 in Appendix A. Section locations are shown on Drawing 92673/9000.

3.1.4 Site Walkover

The site was visited by Fairhurst on the 28th February 2013. Significant areas of surface water and reeds were found on the north bank of the Cults Burn downstream of the site. At the site itself an area of higher land in the south-east corner had been subject to recent land-raising. The lower land within the site adjacent to the channel immediately upstream of this area was covered with surface water. A number of boreholes were scattered throughout the site, these are believed to have been installed as part of the site Ground Investigation.

Both structures included in the surveyed reach were measured with a tape measure and photographs were taken of these and other features within and around the site, the most pertinent of these are provided in Appendix D. It was noted that should either culvert surcharge then flood waters would overtop the associated roads and spill onto the Kirk Brae road, re-entering the channel downstream of the structures.

A local low point was noted on Craigton Road at the north-west corner of the site.

3.2 Proposed Development

The proposed development is residential. A proposed development layout at the time of writing has not been received, though indicative site layouts can be seen in the Friarsfield Development Framework prepared for Stewart Milne Homes in January 2012 by Ryder LLP and others. The residential proposals comprise residential development, with associated access roads, landscaped open areas and footpaths.

3.3 Sources of Flood Risk Information

Both SEPA and Aberdeen City Council were approached to establish if there are any records of flooding in the local area. At the time of writing no response has been received from SEPA. Aberdeen City Council's response noted that *"There are ongoing flooding problems with the Cults burn with a number of properties affected downstream of you site"* [sic]. No detailed information has been received about the area immediately surrounding or upstream of the site.

3.4 SEPA indicative Flood Map

SEPA's Indicative Flood Map (http://www.sepa.org.uk/flooding/mapping/) provides predictive guidance on the possible extent of functional floodplain (1 in 200 year flood extent) for catchments greater than 3km^2.

The site is not within any of the floodplains marked on the Indicative Flood Map. The closest 200yr flood plains marked on the map are fluvial floodplain on the Cults Burn approximately 120m to the east, roughly 2m below the lowest site level (cross-section survey), and fluvial flooding on the River Dee roughly 1km to the south of the site, over 10 m below site level (OS 1:25,000 map contours). Whilst the SEPA flood map can be a useful tool for initially establishing whether a site might be at risk of flooding, the following caveat is attached to its use:

> *"The Indicative River & Coastal Flood Map (Scotland) is designed to be used as a national strategic assessment of flood risk to support planning policy in Scotland. It has been developed to give an indication of whether a general area, not individual properties or specific location, may be affected by flooding".*

More detailed analysis is required to fully understand flood risk to the development site.

4 POTENTIAL SOURCES OF FLOOD RISK

At this location there are several potential sources of flooding that may require to be considered:

- **Fluvial flows:** Extreme fluvial flood events have the potential to cause rapid inundation of properties whilst posing a threat to the welfare of occupants and potentially preventing emergency access to properties and essential infrastructure. The closest 200 year functional flood plain shown on the SEPA flood map is on the Cults Burn downstream of the site, within model extents. The Cults Burn flows along the southern site boundary and potentially represents a risk of flooding to the site.

- **Infrastructure failure:** The failure of conveyance infrastructure such as culverts or bridges could increase the risk of flooding at the site. The capacity of the Sunnyside culvert represents a potential source of flood risk to the site and to one of the site access points, and blockage scenarios need to be considered.

- **Overland flow:** Overland flow occurs when the infiltration capacity of the ground is exceeded in a storm event. This could result in water travelling as sheet flow overland or excess water being conveyed from one location to another via local road networks. Overland flow from the higher land to the north of the site is a potential source of flood risk to the site.

- **Sewer flooding:** If the capacity of sewers is exceeded in an extreme event, or a blockage occurs, surcharging of the network can result in surface flooding. The local drainage network should be considered with a view to flood risk to the site.

- **Groundwater:** Groundwater flooding could occur at low points on any given site, particularly if that site is relatively low-lying or next to a water feature.

The following potential source of flood risk has been discounted:

- **Coastal flooding:** The elevation of the site means it is not at risk from tidal inundation or coastal waves.

5 HYDRAULIC ANALYSIS

5.1 Objectives

The Cults Burn has been identified as a potential source of flooding. An estimate of the 200 year design flow has been made using industry standard methods. This flow was used in a 1D hydraulic model constructed using ISIS (industry standard mathematical modelling software), incorporating the channel cross-sections surveyed for this purpose, to estimate the corresponding 200 year flood levels in the channel at locations within the development site. The hydraulic model includes representations of the structures in this reach to enable the assessment of their effect on flood levels.

5.2 Hydrology

A hydrological assessment was undertaken to estimate the peak flows at the site for the 1 in 200 year event. A design event of this return period represents the standard against which new development should be assessed with respect to SPP and local planning policy.

Peak flow estimation was carried out based on the Flood Estimation Handbook (FEH) Rainfall-Runoff method. The FEH was published in January 2000 by the Centre for Ecology and Hydrology (CEH), Wallingford (formerly the Institute of Hydrology), a component body of the Natural Environment Research Council.

The rainfall-runoff approach is based on FEH catchment descriptors and often found to over-predict peak flows in smaller catchments in the north-east of Scotland. The catchment area and FEH catchment descriptors have been taken from the FEH CD-ROM v.3. The area of the Cults Burn catchment at the downstream boundary of the site is given as 2.83km^2. Catchment descriptors are tabulated in Appendix B.

As the FEH CD-ROM has a 0.1km^2 resolution and does not account for structures or other non-hydraulic barriers to flow it can provide erroneous area estimates for smaller catchments. There are several field drains and other minor channels marked on the OS mapping within the catchment upstream. The area of the catchment was manually checked using OS 1:25,000 scale map contour lines alongside observations made during the site walkover survey, taking into account the possible effect any manmade watercourses may have, and found to be suitable. For the purpose of this assessment the FEH area of 2.83km^2 has been adopted.

The FEH CD-ROM presents urban extent information for the years 1990 and 2000. The URBEXT2000 is marginally higher than the URBEXT1990 value (0.0078 and 0.0067 respectively). This indicates that some development took place in the catchment during the '90s. A review of urban development within the catchment was carried out. The FEH catchment includes a developed area south of the site, at the edge of Cults. This area is saturated with housing that is not thought to have been built more recently than 2000. Aerial photography and OS mapping was examined and there is not considered to be any significant modern development in the upstream catchment. The URBEXT2000 figure 0.0078 was therefore considered to appropriately reflect this minimal urban extent.

The FEH notes that "*estimation of percentage runoff is probably the most important part of flood estimation using the FSR rainfall-runoff method*". Estimating standard percentage runoff (SPR) from FEH alone is not considered as reliable as using observed data, and various methods are available to improve the estimate of percentage runoff. In the absence of site-specific or donor catchment values, SPR can be derived from the baseflow index (BFI).

In Scotland, published values of BFI for main watercourses are available on the Institute of Hydrology BFI Scotland map. Though the Cults Burn is not shown on this map, the nearest watercourse represented on the map (the River Dee) has a BFI in the range of 0.65-0.69. This range of values is the lowest in the local area, and is likely to result in a conservative estimate of flow. Using the relationship:

SPR = 72.0 – 66.5 BFI

with a mid-range BFI (0.67), the SPR for the burn is estimated at **27.4%**.

The SPRHOST figure for the stream catchment is **28.4%**. As SPR has a direct scaling influence on the magnitude of the flood peak, a reliance on the catchment descriptor estimate alone could possibly lead to an under-prediction of flood flows; however, in this case the SPR figure derived from the BFI map is slightly smaller. The SPRHOST has therefore been adopted in the analysis of the Cults Burn.

The predicted 200 year flow using the FEH Rainfall-Runoff method is therefore **3.3m^3/s**.

The Institute of Hydrology Small Catchment Method (IH124) was also used to give an alternative peak flow estimate for comparison. The IH124 methodology was developed for small catchment applications (<25km^2). Using this method a 200 year design flow of **1.5m^3/s** is estimated for the Cults Burn at the downstream site boundary. Adding an urban adjustment to this method gives a design flow of **1.6m^3/s**.

5.2.1 Flow estimate

The FEH Rainfall-Runoff 200 year peak flow of **3.3m^3/s** has been adopted for the analysis as a precautionary approach. Catchment descriptors and output from the FEH rainfall-runoff analysis are provided in Appendix B.

5.3 Climate Change

The UK Climate Impacts Programme (UKCIP) is funded by the Department of the Environment to investigate the potential impacts of climate change in the United Kingdom. The UKCIP has produced assessments of the potential impacts based on rates of increase of greenhouse gas emissions consistent with the projections of the Intergovernmental Panel on Climate Change (IPCC).

In 1998 the IPCC published their technical report No. 1 entitled “Climate Change Scenarios for the United Kingdom”. Revised scenarios were published in April 2002 (UKCIP02), before both reports were superseded by the UK Climate Projections 2009 (UKCP09) in June 2009.

UKCP09 provides relative changes in precipitation at an improved 25km grid resolution. These show a range of relative increases in annual precipitation scenarios that could be expected for the grid box covering Cults for different future emission scenarios. For the period covering the 2080s, under the ‘high’ emission scenario, an increase in annual average precipitation of **2.8**% has been estimated (50th percentile).

The potential impact of future climate change is assessed as part of the model sensitivity analysis in Section 5.6.

5.4 Hydraulic Analysis Methodology

5.4.1 Model Extent

There are two key features along the course of the Cults Burn that could have an impact on flood water levels at the site:

- The Sunnyside culvert;
- The dual Craigbank culverts.

The upstream boundary of the model is set approximately 80m upstream of the site. The downstream boundary is set 136m downstream of the Craigbank culverts, approximately 280m downstream of the site.

5.4.2 Data Collection

The February 2013 survey gives channel levels for twenty-three sections of the Cults Burn, together with dimensions for the structures adjacent to the site and downstream, within this surveyed reach. Figures showing all the model cross-sections are provided in Appendix C. The locations of the cross-sections are shown in Drawing 92673/9000 in Appendix A.

The cross section survey was used alongside observations made during the site walkover survey to inform the choice of model parameters.

5.4.3 Model Construction

A flow hydrograph generated from the FEH catchment descriptors has been used as the upstream boundary, with a minimum model flow (0.5m^3/s) set to reduce model instability.

Various sources of information have been used to inform the parameters of the watercourse and floodplain represented in the model. Manning's n roughness has been allocated to cross-sections based on values advised by Chow (1959). A value of 0.04 is the most conservative value for a natural stream channel described by Chow as a "minor stream... on a plain [with a] clean, straight, full stage [with] more stones and weeds", whilst a value of 0.035 is the most conservative value for flood plains with "pasture…no brush…short grass".

The culvert adjacent to the site is represented as a rectangular box culvert with the same Manning's roughness as the channel (0.04) on the invert and walls a roughness coefficient of 0.022 on the soffit. Appropriate values for the inlet were chosen from CIRIA C689. The spillway levels were taken from survey section XS6 and a weir coefficient of 1.6 chosen to represent the smooth nature of the structure and adjacent road.

The structure downstream of the site was represented by a concrete pipe and plastic pipe. The Manning's roughness coefficients for the top half and bottom half of the concrete culvert are chosen as 0.012 and 0.011 respectively. Manning's roughness for the plastic pipe is 0.011. Appropriate parameters for the inlets were chosen from CIRIA C689. Spillway levels for the access road and adjacent Kirk Brae road were taken from survey section XS12, whilst levels for the headwall were approximated from the site walkover notes. A weir coefficient of 1.0 was chosen as a potentially conservative estimate of the hydraulics at the overtopping points.

A number of sections were interpolated within the modelled reach to reduce instability introduced by the distance between sections.

Following preliminary model runs the downstream boundary was set at cross-section XS16. The downstream boundary was represented as a normal boundary with a 1:40 slope dictated by surveyed levels roughly 50m upstream and downstream of XS16.

The model was run under an unsteady flow regime over 9.5 model hours, with a fixed time step of 1 second. For each model set-up the initial conditions are first taken from the preliminary steady model run, before a 'snap shot' is taken of the model at a stable point for use as initial conditions in the final model run. This increases the stability of the model, lessening the possibility of rogue model results, and in more complex scenarios is an essential step in preventing terminal model instability.

5.5 Hydraulic Analysis Outcomes

Peak water levels predicted by the model for the 200 year design event are provided in Table 1. The corresponding flood extent is indicated on Drawing 92673/2001 in Appendix A.

A long-section of the modelled reach is shown in Figure 4.

Table 1: 200 year flood levels at model cross-sections (m AOD)

Cross-section reference	Flood Level (mAOD)
XS1	87.20
XS2	84.35
XS3	82.80
XS4	80.97
XS5	79.76
XS7	79.60
XS8	78.23
XS9	77.10
XS10	75.79
XS11	74.67
XS12	74.21
XS14	73.67
XS15	72.28
XS16	71.51

* Cross-sections at site highlighted in grey

Figure 4: ISIS model long-section, 200 year base case model run

The model indicates that flows will spill from the channel into the proposed development site at XS2 and XS7 to XS9. The model also predicts that neither structure along the modelled reach will have sufficient capacity to convey the 200 year flow without overtopping. The local ground levels around the culvert inlets suggest that flood waters exceeding culvert capacity at these locations will spill onto Kirk Brae road, but not into the proposed development site.

5.6 Sensitivity Analysis

In the absence of reliable gauged flow records to calibrate the model, proving techniques have been adopted to assess the influence that key model parameters have on the model. Understanding the model sensitivity is an essential step in the interpretation of the model results. Model sensitivity to channel roughness (Manning's n value), peak flow and downstream boundary slope is analysed. The 200 year event is chosen as a 'base case' model run. The results of this sensitivity analysis are provided in Table 2 below.

Table 2 - Hydraulic Modelling, Sensitivity Analysis Results (Peak water levels, m AOD)

Cross-section reference	200 year base case	+20% n	+20% Q	1:100 DS slope
XS1	87.20	87.26	87.26	87.20
XS2	84.35	84.39	84.39	84.35
XS3	82.80	82.86	82.86	82.80
XS4	80.97	81.02	81.03	80.97
XS5	79.76	79.77	79.81	79.76
XS7	79.60	79.64	79.65	79.60
XS8	78.23	78.26	78.26	78.23
XS9	77.10	77.12	77.12	77.10
XS10	75.79	75.88	75.88	75.79
XS11	74.67	74.73	74.76	74.67
XS12	74.21	74.23	74.28	74.21
XS14	73.67	73.74	73.74	73.67
XS15	72.28	72.35	72.34	72.29
XS16	71.51	71.55	71.55	71.63

* Cross-sections at the site highlighted in grey

Whilst the sensitivity results show the model to be responding to changes to roughness parameter and flow, the model is generally not overly sensitive to these changes and behaves as expected (a peak water level rise throughout the modelled reach). The exceptions to this are XS5 and XS12, where the increase in peak water levels are significantly lower for the roughness run than those indicated by the flow run. This is because much of the flood flow passes over the spillways at these two sections – as the weir coefficient is not lowered as part of the roughness increase the spillways affect the flow in the same way as the base case, thus the Manning's roughness coefficient has less of an the influence on 200 year flood level at these sections.

The downstream boundary slope run indicates that flood water levels are 0.13m higher with a 1:100 channel bed slope as the downstream boundary; however, flood levels are not affected at the site.

The results of the sensitivity analysis indicate that the model is not adversely sensitive to the three parameters tested.

5.7 Blockage Scenario

The agricultural activity and forested area in the upstream catchment along with the steep nature of the watercourse means there is the potential for large debris in the channel during a flood. Two blockage scenarios were investigated in order to assess the impact of blockages to both structures in the model reach: a 50% blockage and a 90% blockage. Both blockage scenarios are analysed for each structure separately using the 200 year flow event. The results from the blockage scenario runs are shown in Table 3 below.

Table 3 - Hydraulic Modelling, Blockage Analysis Results (m AOD)

Cross-section reference	200 year base case	50% block adjacent culvert	90% block adjacent culvert	50% block Craigbank culverts	90% Craigbank culverts
XS1	87.20	87.20	87.20	87.20	87.20
XS2	84.35	84.35	84.35	84.35	84.35
XS3	82.80	82.80	82.80	82.80	82.80
XS4	80.97	80.97	80.97	80.97	80.97
XS5	79.76	79.79	79.81	79.76	79.76
XS7	79.60	79.60	79.60	79.60	79.60
XS8	78.23	78.23	78.23	78.23	78.23
XS9	77.10	77.10	77.10	77.10	77.10
XS10	75.79	75.79	75.79	75.79	75.79
XS11	74.67	74.67	74.67	74.67	74.67
XS12	74.21	74.21	74.21	74.30	74.37
XS14	73.67	73.67	73.67	73.67	73.67
XS15	72.28	72.28	72.28	72.28	72.28
XS16	71.51	71.51	71.51	71.51	71.51

* Cross-sections at the site highlighted in grey

The blockage scenarios indicate that blockages raise flood levels at the upstream sections of the structures. A 90% blockage of the culvert adjacent to the site results in a 0.05m rise in flood level at XS5. Similarly a 90% blockage of the culverts downstream of the site result in a rise in peak water level of 0.15m at XS12. The larger rise predicted at XS12 is because not only does a larger proportion of the flood flow travel through the culverts at the downstream structure than at the structure adjacent to the site, but the wet spillway at XS5 is much wider than that at XS12.

Neither blockage scenario for the downstream structure (the culverts at the Craigbank access road) results in a higher water level in the channel adjacent to the site.

6 FLOOD RISK ANALYSIS

The potential sources of flooding identified in Section 4 are discussed below.

6.1 Fluvial Flood Risk

The hydraulic model of the Cults Burn predicts that adjacent to the site the burn channel has insufficient capacity to carry the 1 in 200 year event without flood water overtopping its banks. Flood waters are predicted to overtop the banks of the burn onto the floodplain on the left bank at certain locations within the site. The 200 year flood plain extends on the left bank of the Cults Burn within the site boundary downstream of the Sunnyside culvert. An indicative 200 year flood envelope is shown on Drawing 92673/2001 in Appendix A.

Sensitivity tests show the model is not overly sensitive to changes in model parameters. Furthermore, they show the model to be predicting the dynamics of the watercourse in a sensible manner that increases confidence in model predictions and show that possible changes in Manning's roughness coefficient, flow and the downstream boundary do not alter the base case predictions of the watercourse behaviour or adversely alter predicted flood levels.

A blockage of the Sunnyside culvert would increase flood levels at the culvert inlet by 0.03m, but otherwise predictions would stay the same as those for the 200 year event without blockage – flood waters spilling onto the Kirk Brae road and Sunnyside access road.

Proposed development layouts shown on the Friarsfield Development Framework show possible road layouts associated with the residential development. To comply with SPP, buildings and SUDS embankments should not be constructed within the 200 year flood envelope. Land raising in the 200 year floodplain should also be avoided. On several layouts in the Development Framework an ecological buffer zone with no development is identified along the banks of the Cults Burn. The 200 year flood envelope predicted by this report is entirely contained within the 'Structural Landscaping' area marked on the 'Indicative Design Concept', Figure 20 of the Friarsfield Development Framework.

A freeboard above predicted peak flood levels is required to account for uncertainties inherent in flood prediction. It is good practise to provide a minimum freeboard of 600mm above peak 200 year water levels predicted adjacent to sites; however, the channel level falls significantly within the site, from around 84mAOD at the west corner of the site to around 75mAOD in the south-east corner. It is therefore recommended that minimum finished floor levels should be set a minimum of **600mm above the 200 year flood water level predicted at each survey cross-section**, with the highest level chosen where points are straddled by two cross-sections.

6.2 Infrastructure Failure

Blockage of the Sunnyside culvert accentuates flood risk as noted in Section 6.1 above. If it were to block then flood water would overtop the channel banks onto the Kirk Brae road and the Sunnyside access.

The other structure on the adjacent reach of the Cults Burn is at the Craigbank access, approximately 120m downstream of the site. If the Craigbank culverts were to surcharge or block, flood water would overtop the channel banks, spilling onto the Kirk Brae and the Craigbank access. The topography suggests it would follow the Cults Burn east, away from the site. The risk of water backing up the channel to affect water levels at the site is assessed as part of the 'fluvial flood risk' section, above.

There is a service reservoir located midway up the site amongst the Sunnyside buildings. Existing ground levels indicate that any flooding associated with this covered reservoir would spill onto the site, either directly or after being diverted to the Sunnyside access by the building to the south of the reservoir, to flow down the site following the slope south to the Cults Burn. The risk of flooding from this source is considered to be very low.

6.3 Overland Flow

Higher land lies to the north of the site. Local topography suggests much of the runoff from this land will flow away from the site; however, OS 1:25,000 scale map contours suggest an area of potentially 4ha drains from a local high point at the corner of Den Wood towards the site. Some of the runoff from this area may be intercepted by Countesswells Road. In the event that excess flood water reaches Craigton Road at the north of the site the site walkover survey noted a possible flow pathway from the local low point on the road into the site's north-west corner. In addition to this a gated entrance was noted mid-way along the wall on the northern site boundary with Craigton Road; thus there is a minor risk of flood water entering the northern boundary of the site. The development layout should be designed to route any overland flow around and away from buildings.

Any planned site access to Craigton Road presents a potential flow route to possible excess flood water on the road. This should be taken into account in the detailing of any such access roads to maintain existing flow routes past the site where possible

6.4 Sewer Flooding

The entire site slopes down to the south/south-south-east. The land immediately uphill (north) of the site has only small developments along Craigton Road. In the event of a nearby sewer in this area reaching capacity and overflowing, flood water is expected to flow away from the site or along local roadways in preference to the site. The risk of overland flow on Craigton Road is discussed in section 6.3.

There may be informal land drainage associated with the existing fields within the boundaries of the proposed development site. Where these are affected by the development, they should be intercepted and diverted as required to maintain continuous, effective flow paths.

Flood flows from sewer flooding would be limited and, as with overland flow, can be mitigated by profiling development ground levels to route water around and away from proposed properties.

6.5 Groundwater

Though the site is located on a hill, with land to the north lying above site level and land to the south lying at a lower level than most of the site, there are distinct flat, low-lying areas on site next to the Cults Burn channel where surface water was encountered during the site walkover survey. It is unclear whether these areas of surface water were simply excess surface water (due to rainfall infiltrating slowly into the soil) or a result of a high water table.

A number of boreholes were present on site at the time of the site walkover, it is not known if these form part of a site Ground Investigation. It is recommended that groundwater levels be monitored and the potential for variation in groundwater levels is taken into account in the design of the development.

7 CONCLUSION

Fairhurst was appointed by Stewart Milne Homes to produce a Flood Risk Assessment for a potential residential development site at Friarsfield on the outskirts of Cults, Aberdeen. Ground levels fall towards the Cults Burn that flows west to east alongside the southern site boundary. The burn channel is relatively steep and flows are culverted under the access to Sunnyside.

A hydraulic model of the Cults Burn has been constructed using cross-sections of the watercourse surveyed for this purpose. A flow estimate has been obtained from standard methods and input to the model to estimate peak 200 year water levels along the modelled reach, accounting for the capacity of the Sunnyside culvert at the site, the Craigbank culverts downstream of the site and the height of any flow route once the culvert has reached capacity. An indicative 200 year flood envelope has been mapped using these water levels, site levels from surveyed cross sections and observations made during the site walkover.

The 200 year flood is predicted to exceed capacity of the Cults Burn channel and in places overtop the burn's left bank onto the site. The land within the site slopes down to the Cults Burn from the north. This higher land is not predicted to be at risk of flooding. The capacity of both structures in the modelled reach is expected to be exceeded in such a flow event. Flood waters at these points are predicted to spill onto their associated access roads and Kirk Brae road. This would be accentuated by any blockage of the culverts. Flood water backing up from the Craigbank culverts does not reach the site. To comply with SPP, buildings and SUDS embankments should not be constructed within the 200 year flood envelope. Land raising in the 200 year floodplain should also be avoided.

A freeboard above predicted flood levels is required to account for uncertainties inherent in flood prediction. It is recommended that minimum finished floor levels should be set a minimum of **600mm above the 200 year flood water level predicted at each survey cross-section**, with the highest level chosen where points are straddled by two cross-sections. This gives an adequate freeboard of more than 600mm above the 200 year peak water level. Several indicative layouts in the Friarsfield Development Framework show an ecological buffer zone along the Cults Burn corridor. The 200 year flood envelope predicted by this report is entirely contained within the 'Structural Landscaping' area marked on the 'Indicative Design Concept', Figure 20 of the Friarsfield Development Framework.

There is not considered to be any appreciable risk to the site from local sewers or overland flow - any residual risk can be mitigated by profiling development ground levels to route water around and away from buildings. Any access from Craigton Road bounding the site to the north should discourage excess flood water on the road from entering the site. It is good practice to set finished ground levels so that they slope away from buildings on site, preventing any ponding of excess water and safely routing it to land drainage systems.

The design of a site drainage network and associated SUDS system is not part of the scope of this assessment. Any site drainage system should be designed to collect excess water on site and safely attenuate it to local greenfield runoff rates. SUDS principles should be adopted to mitigate the effect of the development in terms of flood risk both within and beyond the limits of the site.

REFERENCES

1. Aberdeen City Council, *Aberdeen Local Development Plan, Proposed Plan*, Sept. 2010. http://www.aberdeencity.gov.uk/planning_environment/planning/local_development_plan/pla_aldp_document_map.asp - Accessed 4th Mar 2013

2. Balkham, M, Fosbeary, C, Kitchen, A, Rickard, C. *Culvert design and operation guide, CIRIA report no. C689*, 2010

3. D C W Marshall & A C Bayliss. *Flood Estimation for Small Catchments, Institute of Hydrology report no. 124*, June 1994

4. Institute of Hydrology, *FEH CD-ROM v.3*, 2009.

5. Ryden LLP, *Friarsfield Development Framework,* Jan. 2012.

6. Scottish Government, *Scottish Planning Policy*, February 2010. http://www.scotland.gov.uk/Publications/2010/02/03132605/0 Accessed 18th Feb. 2013

7. Ven Te Chow, *Open Channel Hydraulics,* 1959.

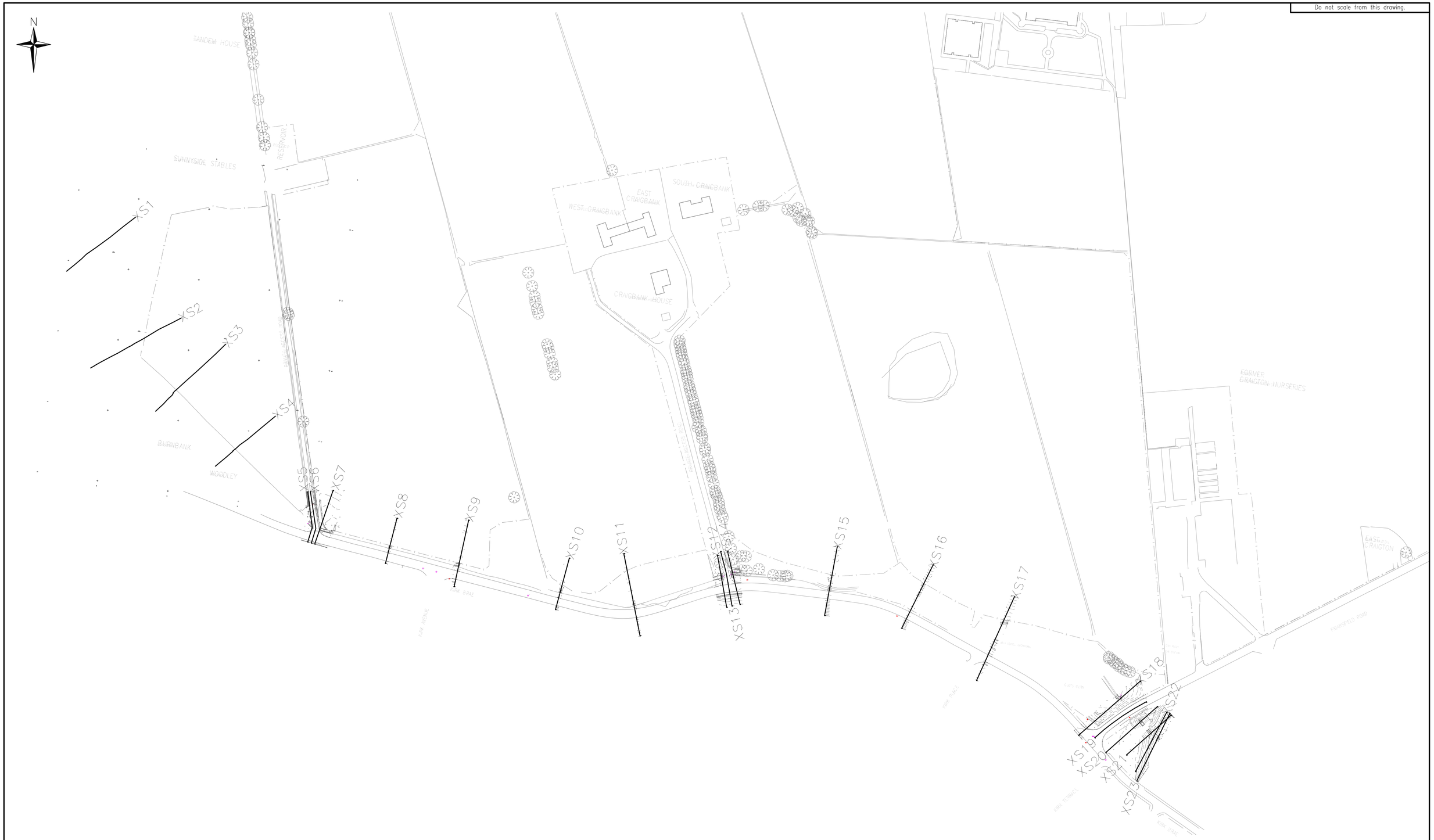
APPENDIX A – DRAWINGS

92673/9000: Hydrological Section Layout.

92673/9001 & /9002: Hydrological Sections.

92673/2001: 200 Year Flood Extent.

Do not scale from this drawing.



Rev.	Date	Description	Drawn	Checked	Approved

Notes:

Client:

STEWART Milne HOMES

Project Title:

FRIARSIELD, CULTS

Drawing Title:

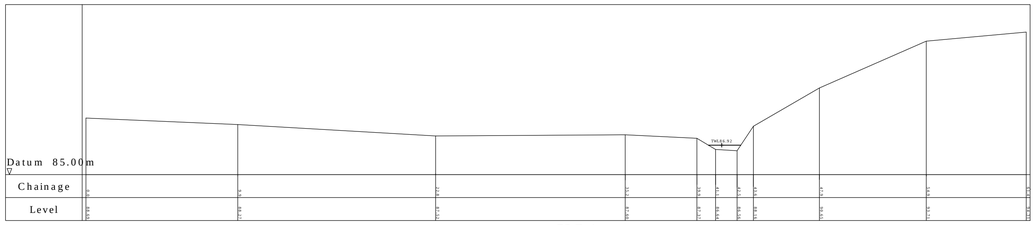
SECTION LOCATION PLAN

FAIRHURST

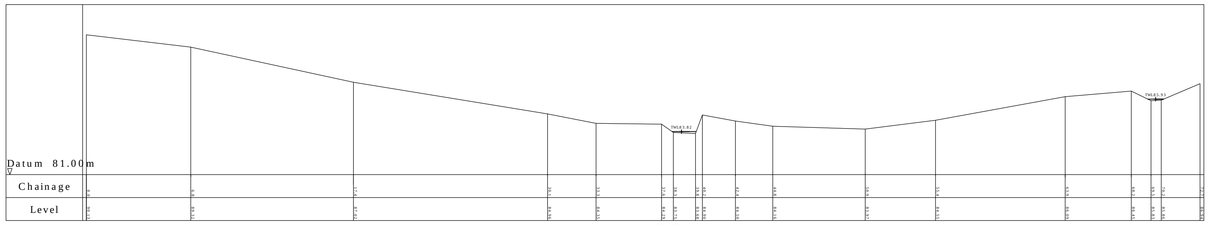
225 Bath Street,
GLASGOW, G2 4GZ
Tel: 0141 204 8800 Fax: 0141 204 8801

Scale at A1:	Status:		
1:1250	For Information		
Drawn:	Checked:	Approved:	
KAB			
Date:	Date:	Date:	
11/03/13			
Drawing No.:			Revision:
92673/9300			–

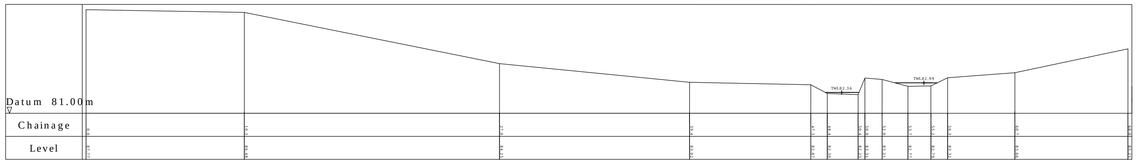
Do not scale from this drawing.



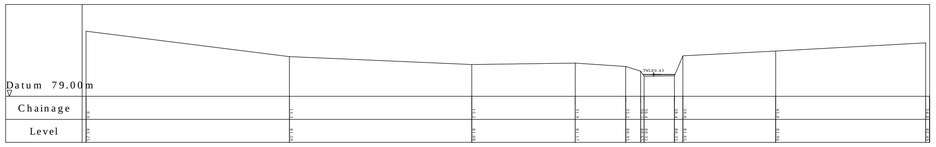
XS1



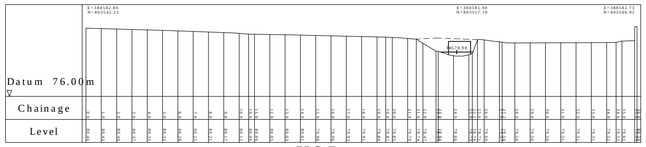
XS2



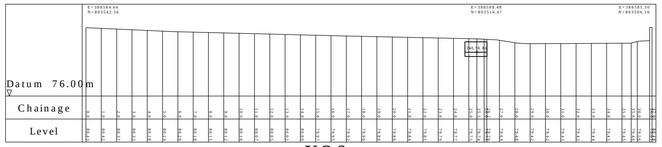
XS3



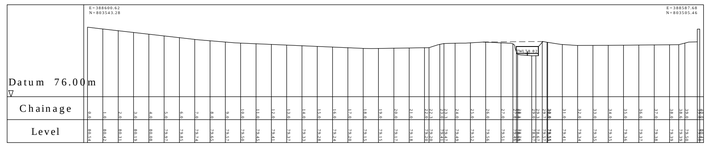
XS4



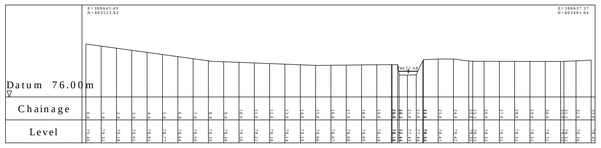
XS5



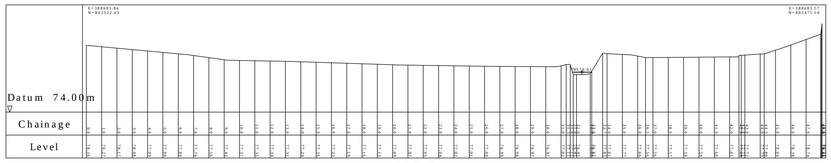
XS6



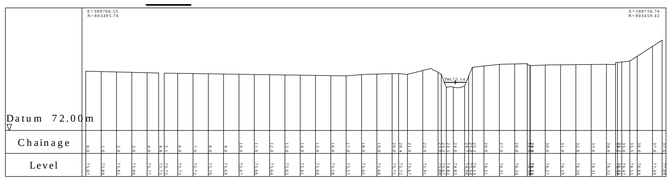
XS7



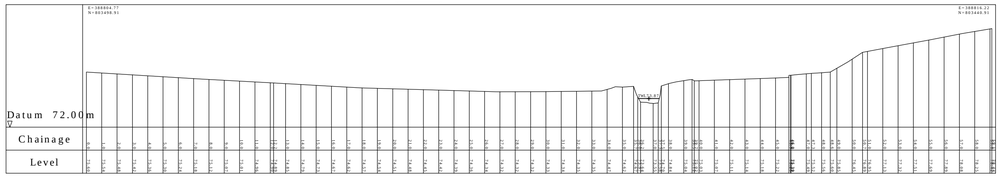
XS8



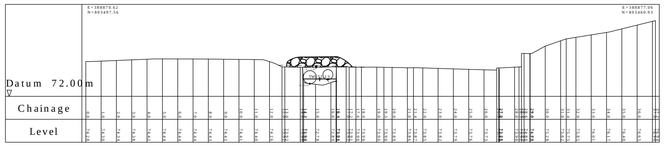
XS9



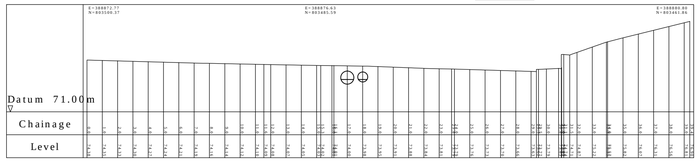
XS10



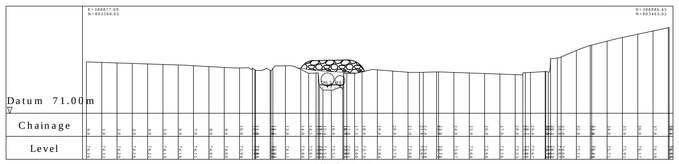
XS11



XS12



XS13



XS14

Rev.	Date	Description	Drawn	Checked	Approved

Notes:

Client: STEWART Milne HOMES

Project Title: FRIARSIELD, CULTS

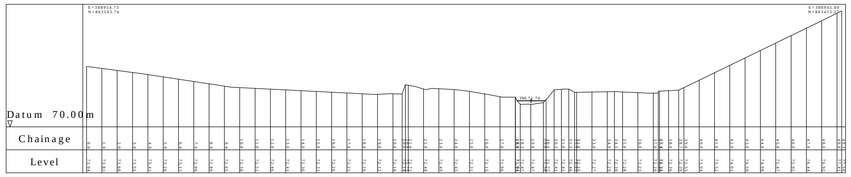
Drawing Title: FLOOD MODELLING SECTIONS SHEET 1 OF 2

FAIRHURST
225 Bath Street,
GLASGOW, G2 4GZ
Tel: 0141 204 8800 Fax: 0141 204 8801

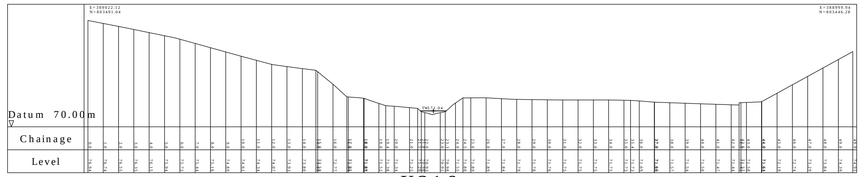
Scale at A1:	Status:		
1:200	For Information		
Drawn:	Checked:	Approved:	
KAB			
Date:	Date:	Date:	
11/03/13			

Drawing No.: 92673/9301 Revision: –

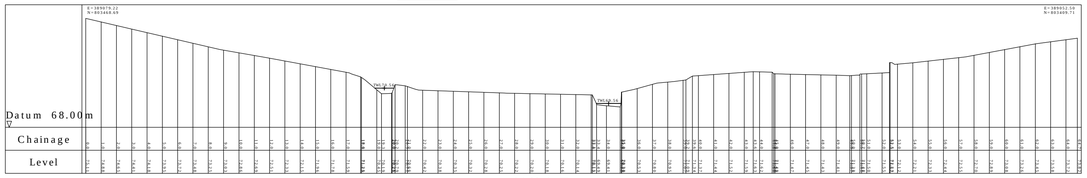
Do not scale from this drawing.



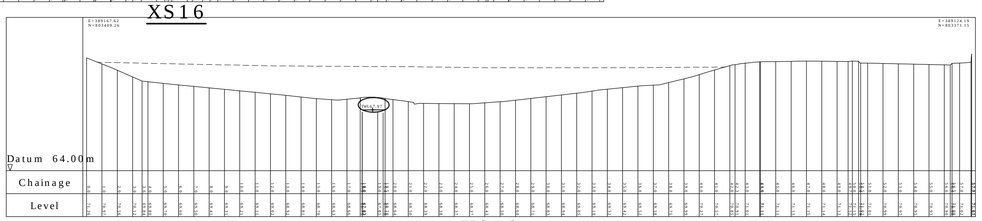
XS15



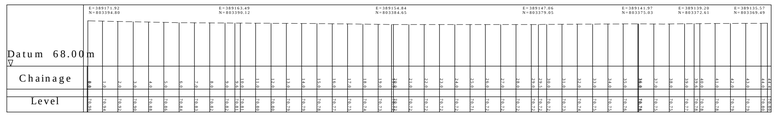
XS16



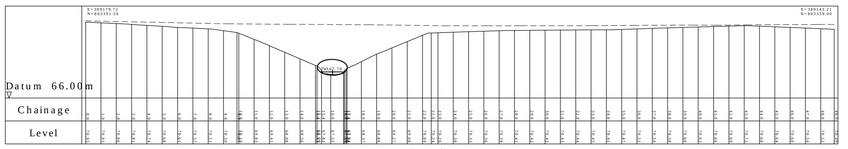
XS17



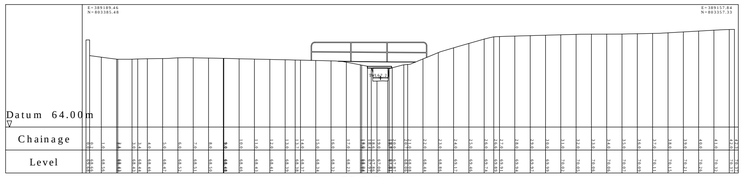
XS18



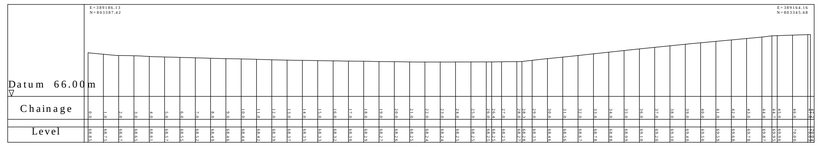
XS19



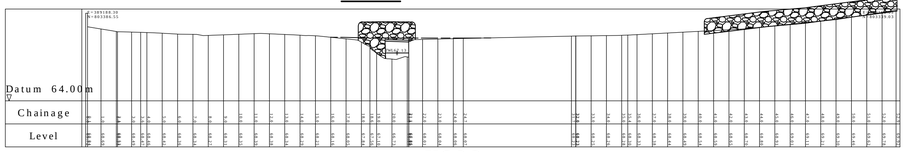
XS20



XS21



XS22



XS23

Rev.	Date	Description	Drawn	Checked	Approved

Notes:

Client: STEWART Milne HOMES

Project Title: FRIARSIELD, CULTS

Drawing Title: FLOOD MODELLING SECTIONS SHEET 2 OF 2

FAIRHURST
225 Bath Street,
GLASGOW, G2 4GZ
Tel: 0141 204 8800 Fax: 0141 204 8801

Scale at A1:	Status:		
1:200	For Information		
Drawn:	Checked:	Approved:	
KAB			
Date:	Date:	Date:	
11/03/13			
Drawing No.:			Revision:
92673/9302			–

Do not scale from this drawing.

THIS REGISTER IS A NON-EXHAUSTIVE LIST OF RESIDUAL HAZARDS RELATING TO THE WORKS SHOWN ON THIS DRAWING THAT HAVE BEEN IDENTIFIED DURING THE DESIGN STAGE

SIGNIFICANT RESIDUAL HAZARDS	DETAILS

Rev.	Date	Description	Drawn	Checked	Approved

NOTES:

1. FLOOD INUNDATION EXTENT BASED ON SITE SURVEY DRAWING 92673/9010 RECEIVED 26/02/13.

LEGEND:

- 1 in 200yr FLOOD ENVELOPE SHOWN RELATIVE TO DEVELOPMENT EXTENTS ONLY
- INDICATIVE DEVELOPMENT BOUNDARY
- WATERCOURSE

Client: STEWART Milne HOMES

Project Title: FRIARSIELD, CULTS

Drawing Title: 200 YEAR FLOOD EXTENTS

FAIRHURST
225 Bath Street,
GLASGOW, G2 4GZ
Tel: 0141 204 8800 Fax: 0141 204 8801

Scale at A1:	Status:	
1:1000	For Information	
Drawn: KAB	Checked: EJC	Approved: KMHB
Date: 07/03/13	Date: 08/03/13	Date: 08/03/13
Drawing No.: 92673/2001		Revision: –

APPENDIX B – HYDROLOGY

FEH Catchment Descriptors

Table 4: FEH Catchment Descriptors (FEH CD-ROM v3)

Descriptor	Value
Easting	388700
Northing	803500
AREA	2.83
ALTBAR	136
ASPVAR	0.61
BFIHOST	0.571
DPLBAR	0.88
DPSBAR	44.1
FARL	1
LDP	4.04
PROPWET	0.42
SAAR	837
SPRHOST	28.4
URBEXT1990	0.0067
URBEXT2000	0.0078

FAIRHURST

Rainfall-Runoff Analysis Output

****
HYDROLOGICAL DATA

Catchment: XS1
****
Catchment Characteristics
****
Easting : 388700 Northing : 803500
Area : 2.830 km2
DPLBAR : 1.880 km
DPSBAR : 44.100 m/km
PROPWET : 0.420
SAAR : 837.000 mm
Urban Extent : 0.008
c : -0.010
d1 : 0.470
d2 : 0.423
d3 : 0.258
e : 0.228
f : 2.231
SPR : 28.400 %
****
Summary of estimate using Flood Estimation Handbook rainfall-runoff method
****
Estimation of T-year flood
==========
Unit hydrograph time to peak : 3.100 hours
Instantaneous UH time to peak : 3.050 hours
Data interval : 0.100 hours
Design storm duration : 5.700 hours
Critical storm duration : 5.695 hours
Return period for design flood : 200.000 years
requires rain return period : 246.667 years
ARF : 0.970
Design storm depth : 65.220 mm
CWI : 119.700
Standard Percentage Runoff : 28.400 %
Percentage runoff : 31.575 %
Snowmelt rate : 0.000 mm/day
Unit hydrograph peak : 0.201 (m3/s/mm)
Quick response hydrograph peak : 3.224 m3/s
Baseflow : 0.066 m3/s
Baseflow adjustment : 0.500 m3/s
Hydrograph peak : 3.290 m3/s
Hydrograph adjustment factor : 1.000

Flags
=====
Unit hydrograph flag : FSRUH
Tp flag : FEHTP
Event rainfall flag : FEHER
Rainfall profile flag : WINRP
Percentage Runoff flag : FEHPR
Baseflow flag : F16BF
CWI flag : FSRCW

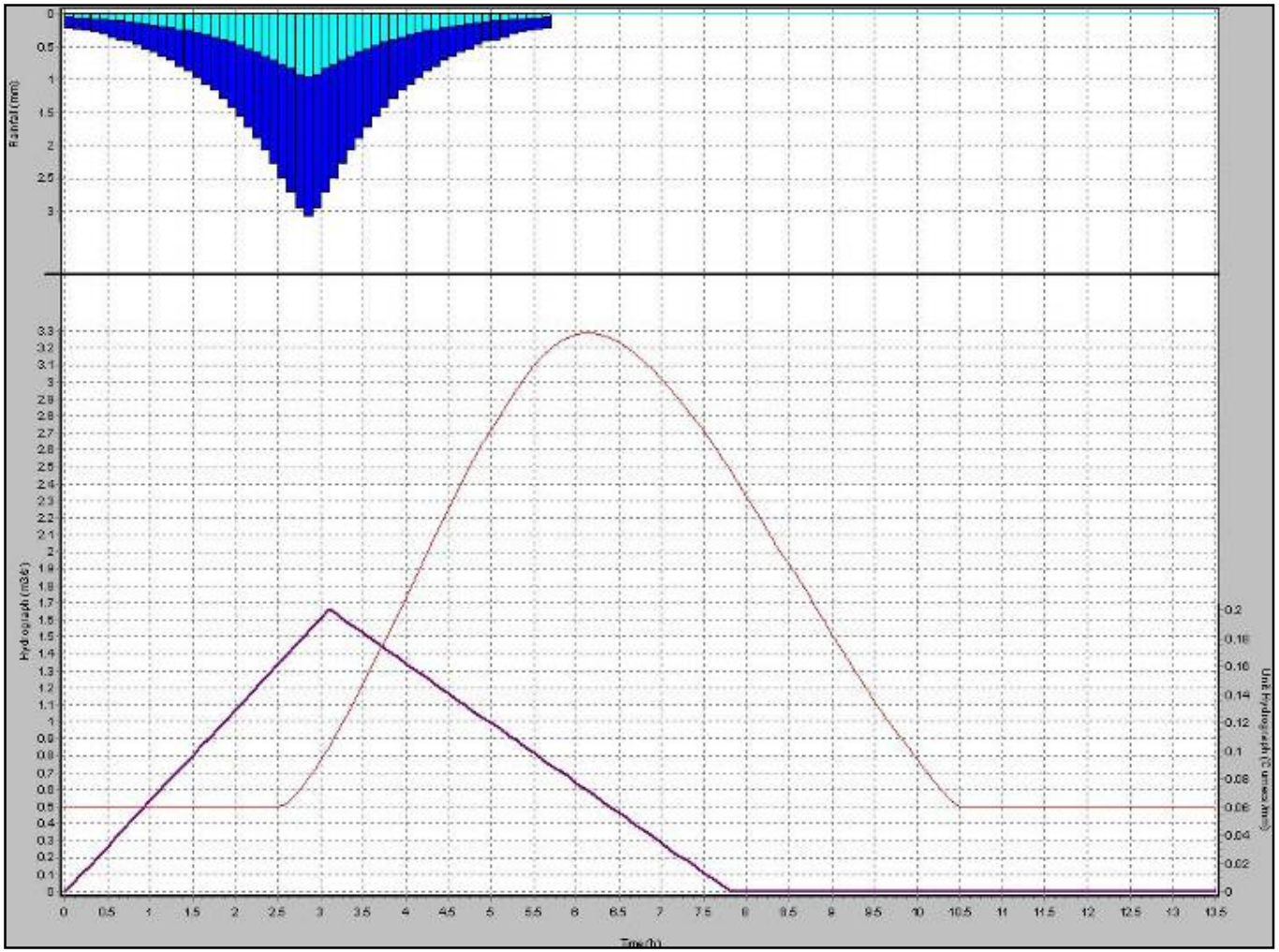


Figure 5: ISIS calculated hydrograph data

APPENDIX C – HYDRAULIC MODELLING

Model Cross-sections

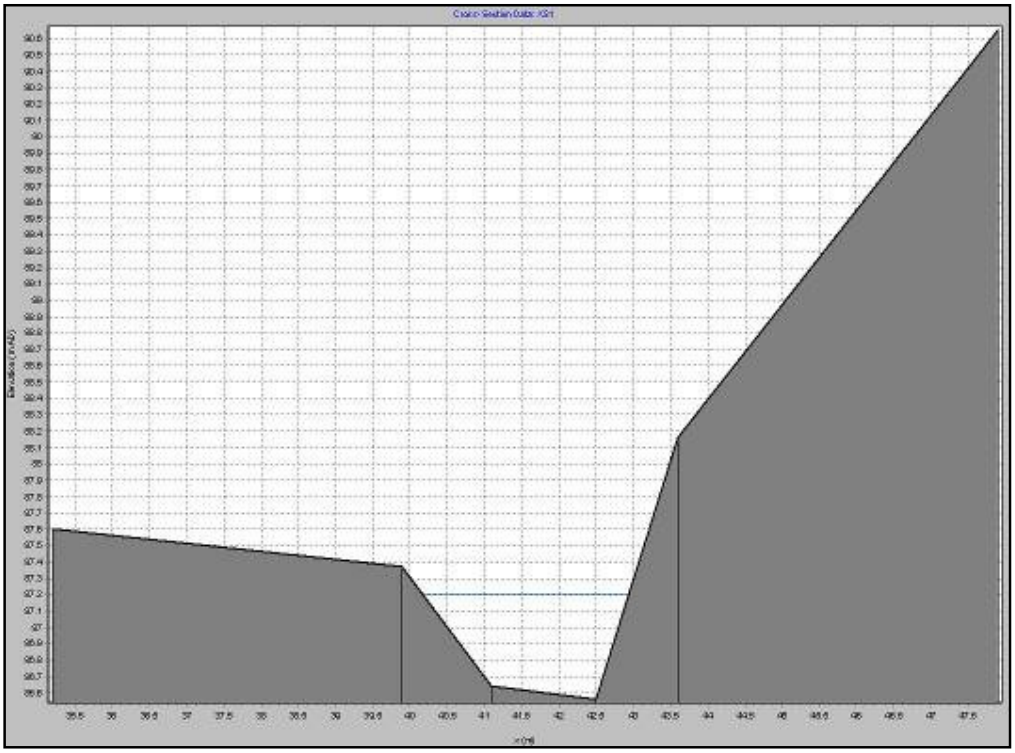


Figure 6: Cross-section of XS1, 200 year base case run

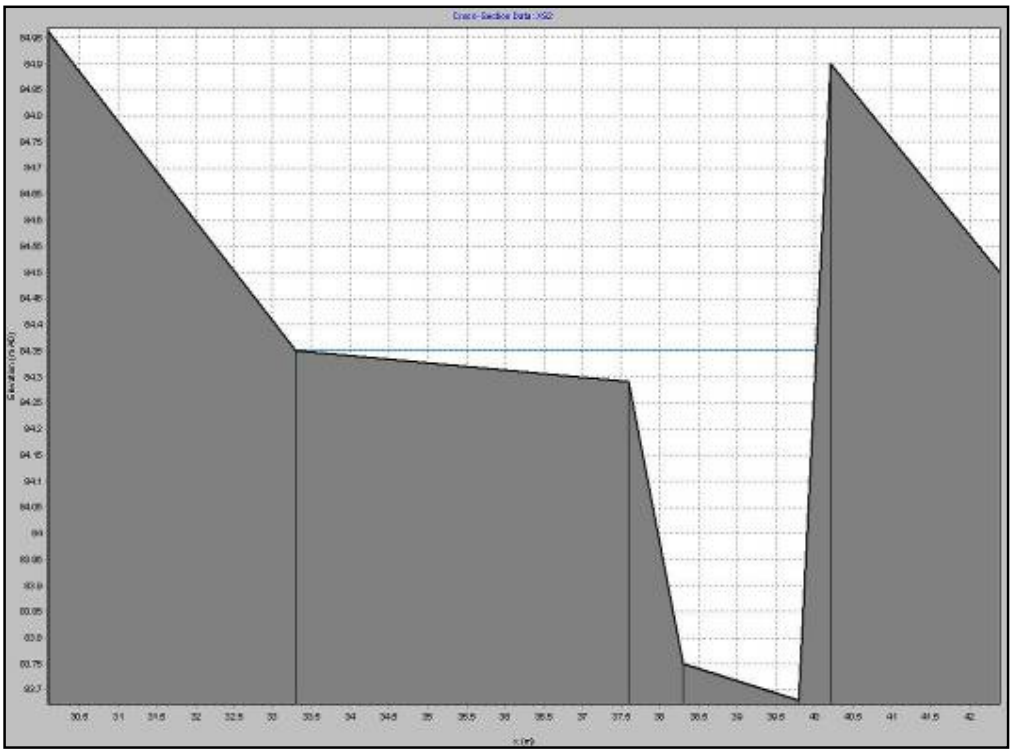


Figure 7: Cross-section of XS2, 200 year base case run

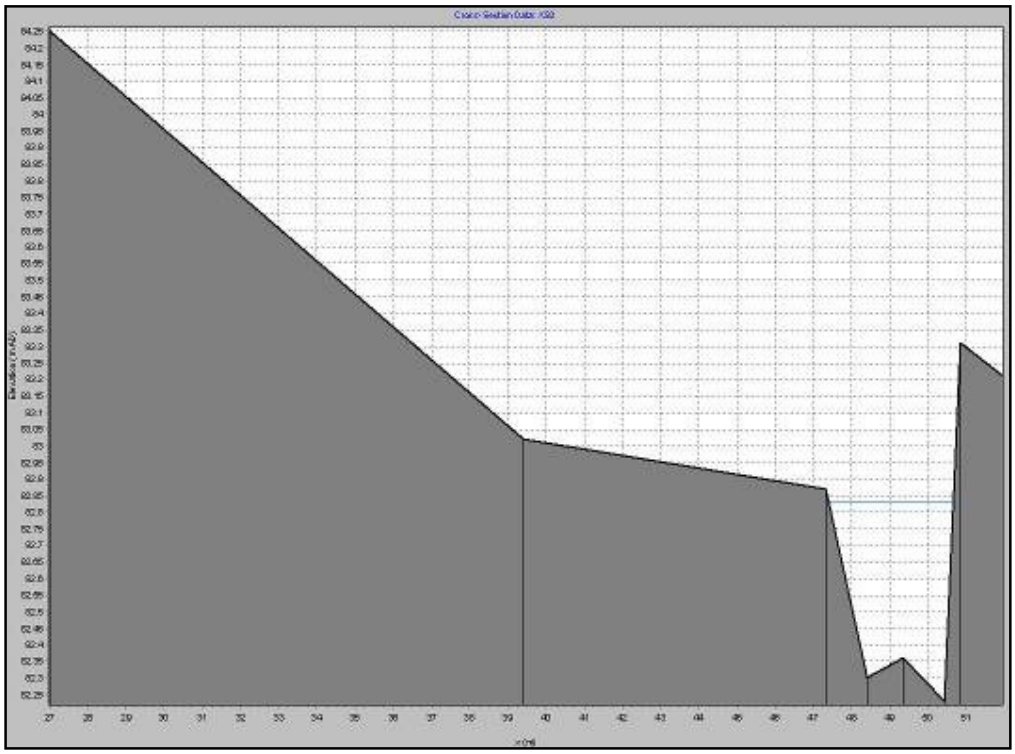


Figure 8: Cross-section of XS3, 200 year base case run

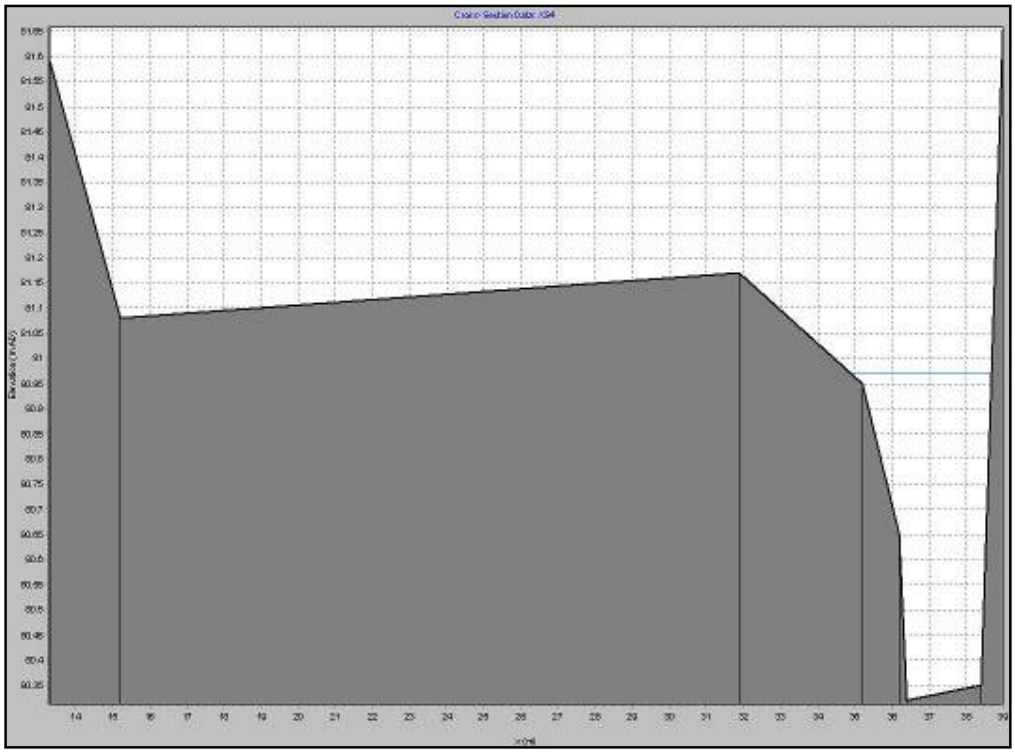


Figure 9: Cross-section of XS4, 200 year base case run

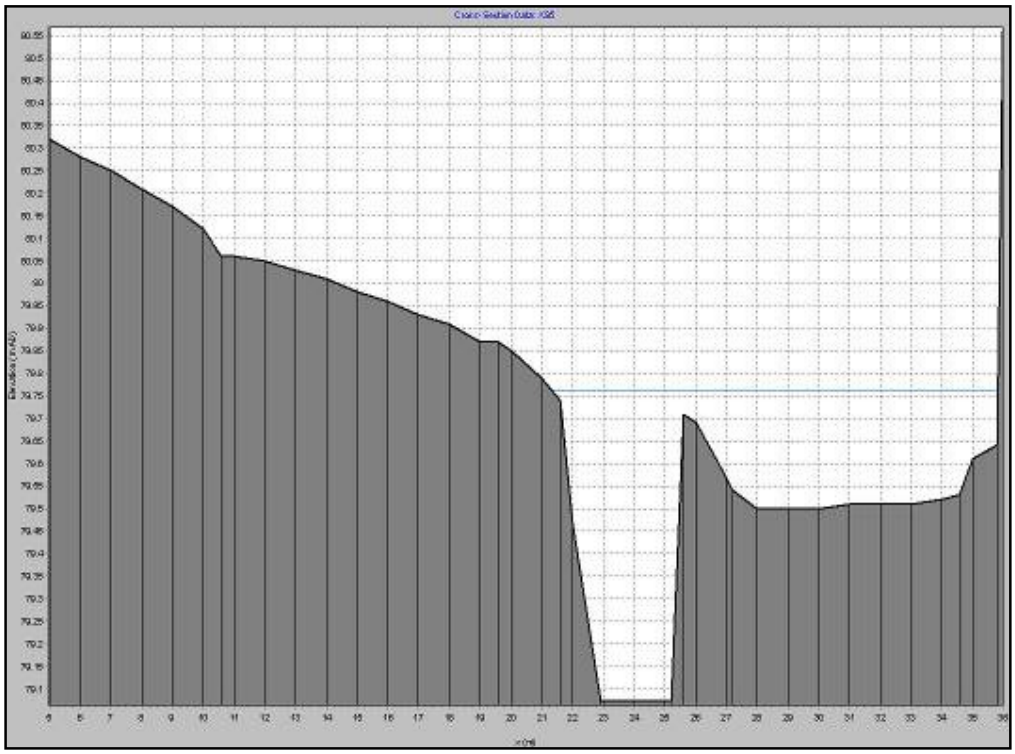


Figure 10: Cross-section of XS5, 200 year base case run

Figure 11: Cross-section of XS7, 200 year base case run

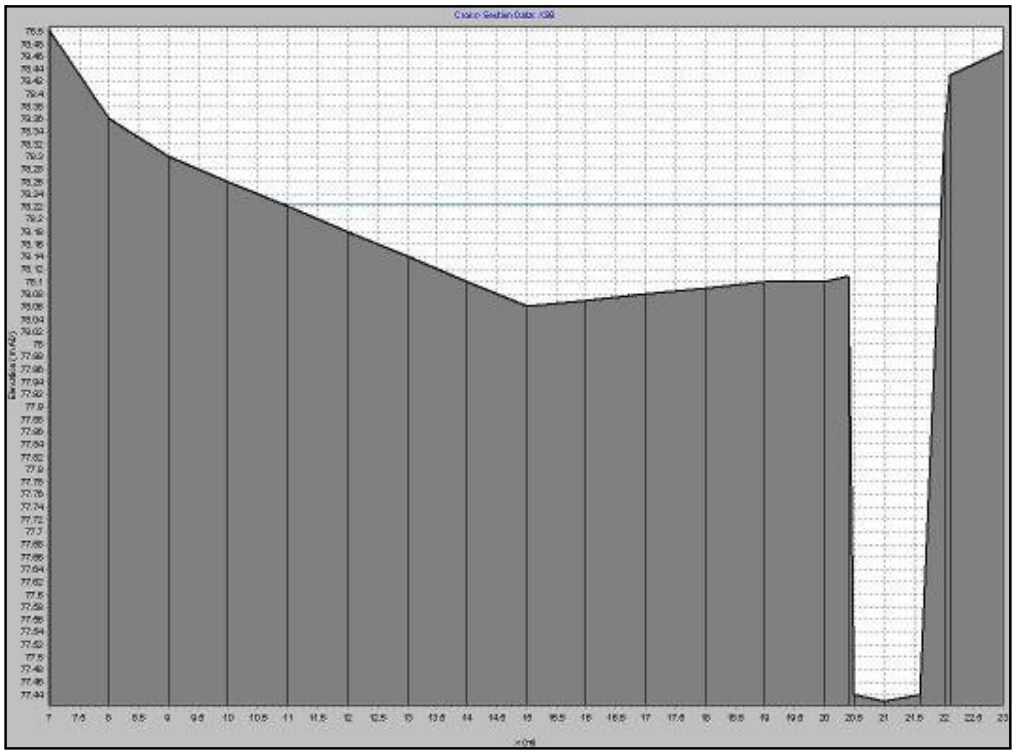


Figure 12: Cross-section of XS8, 200 year base case run

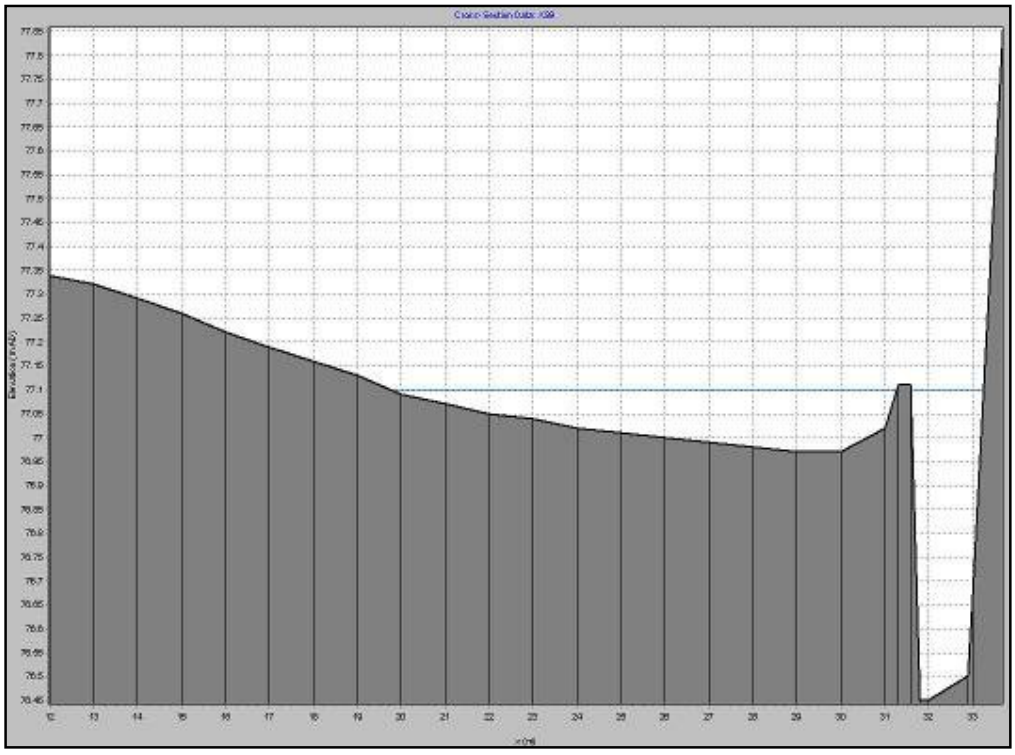


Figure 13: Cross-section of XS9, 200 year base case run

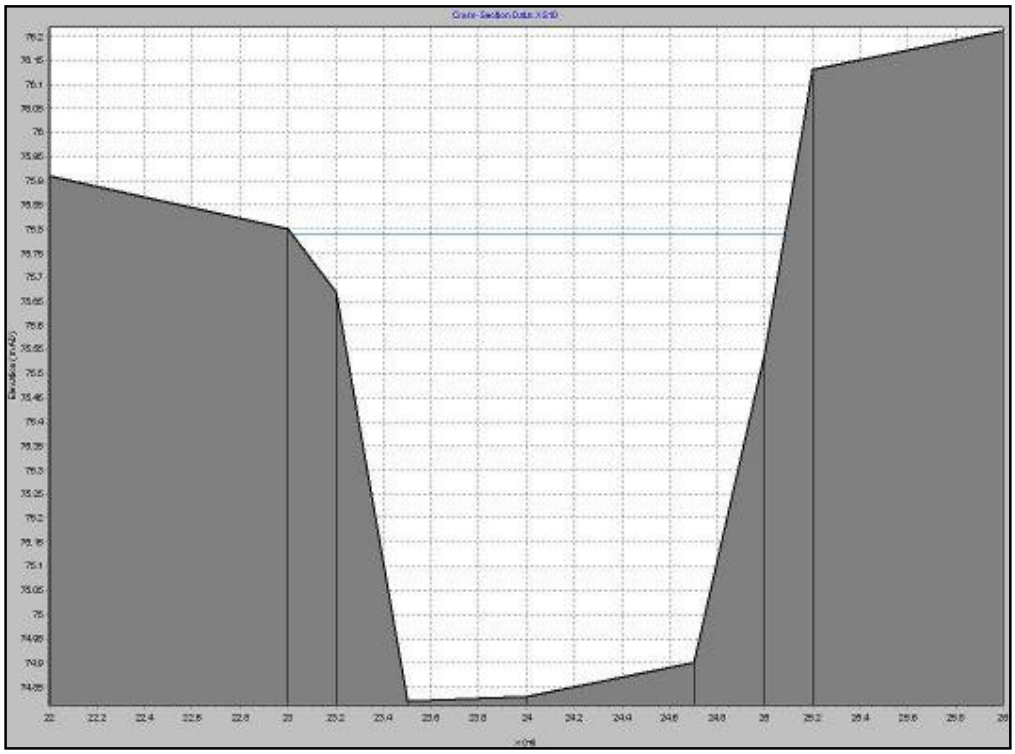


Figure 14: Cross-section of XS10, 200 year base case run

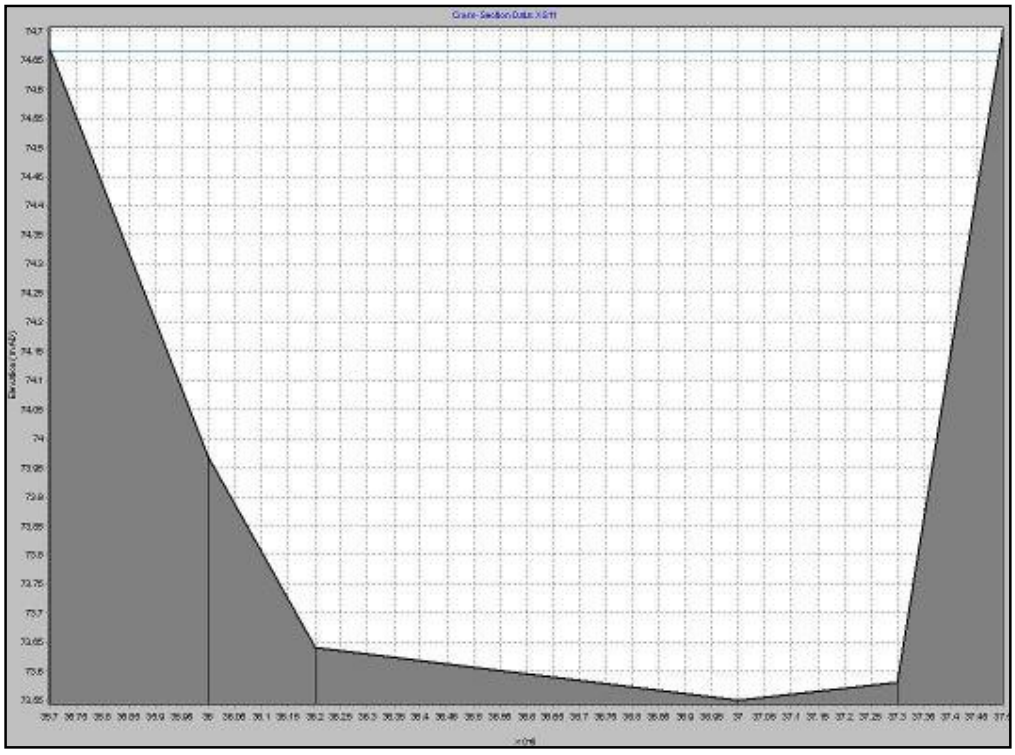


Figure 15: Cross-section of XS11, 200 year base case run

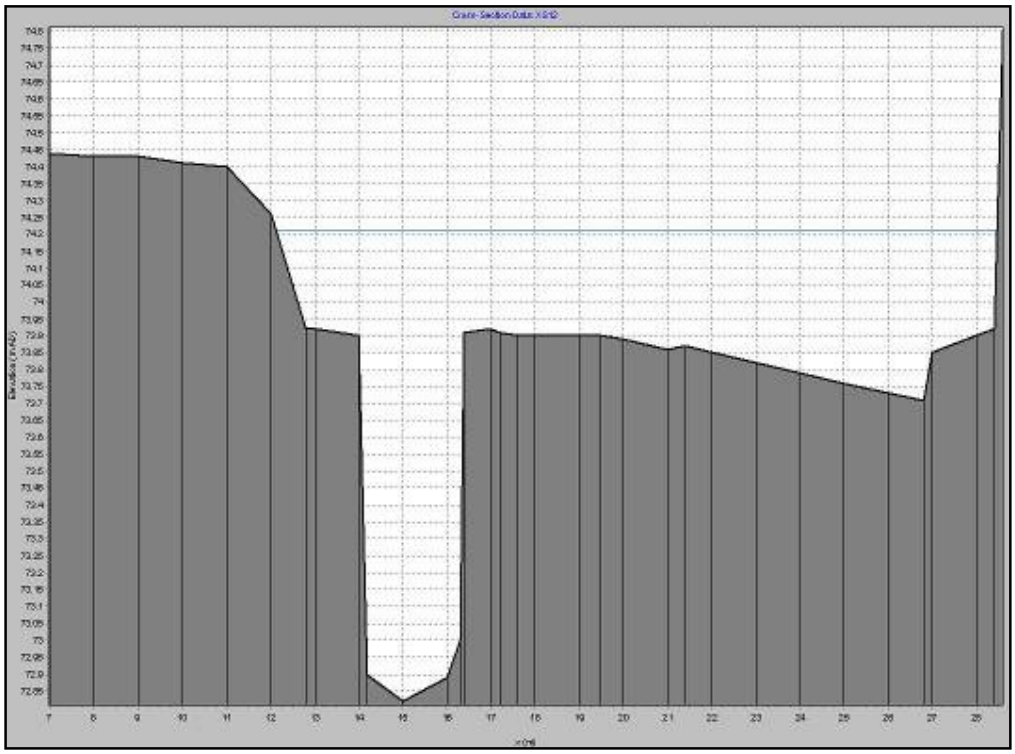


Figure 16: Cross-section of XS12, 200 year base case run

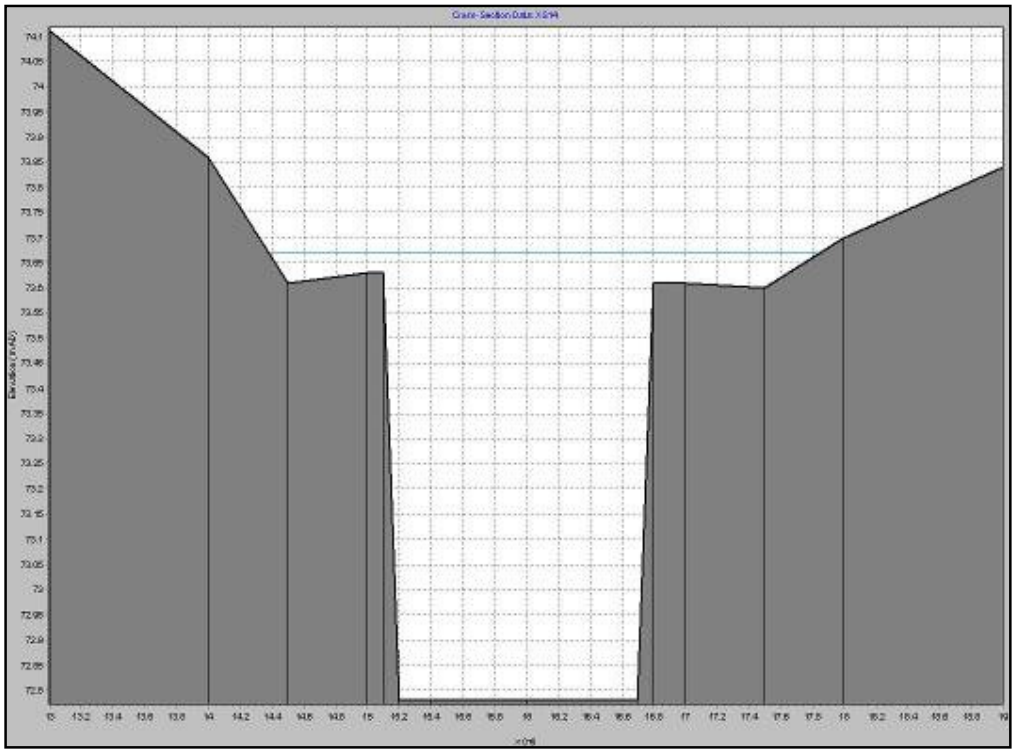


Figure 17: Cross-section of XS14, 200 year base case run

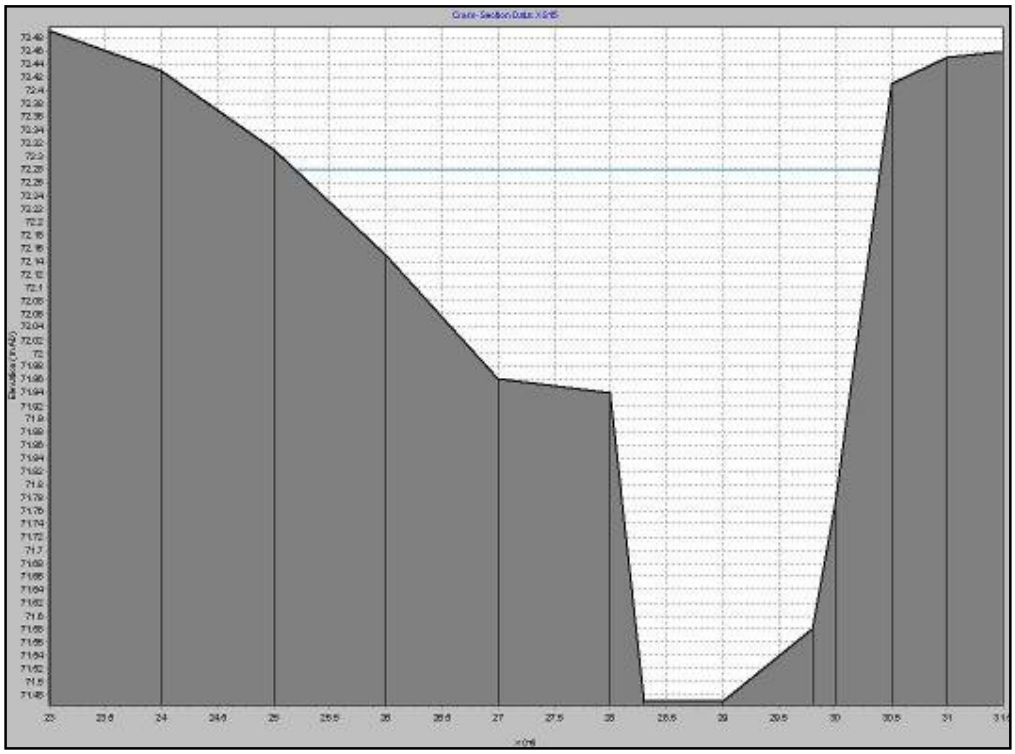


Figure 18: Cross-section of XS15, 200 year base case run

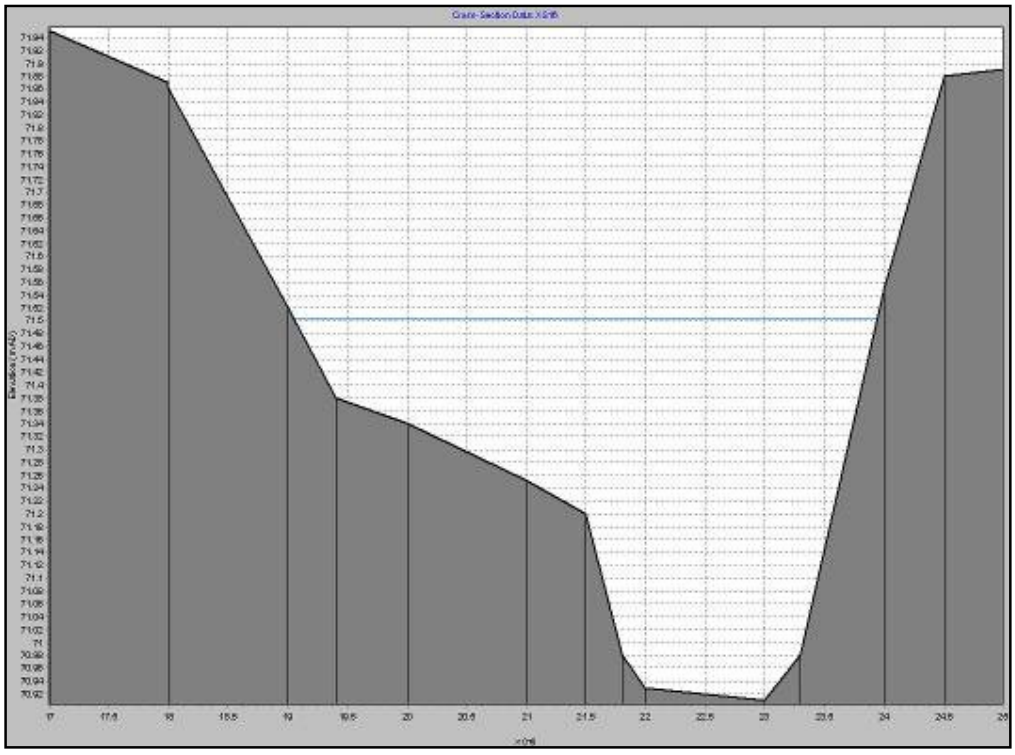


Figure 19: Cross-section of XS16, 200 year base case run

Cross-sections of Model Structures

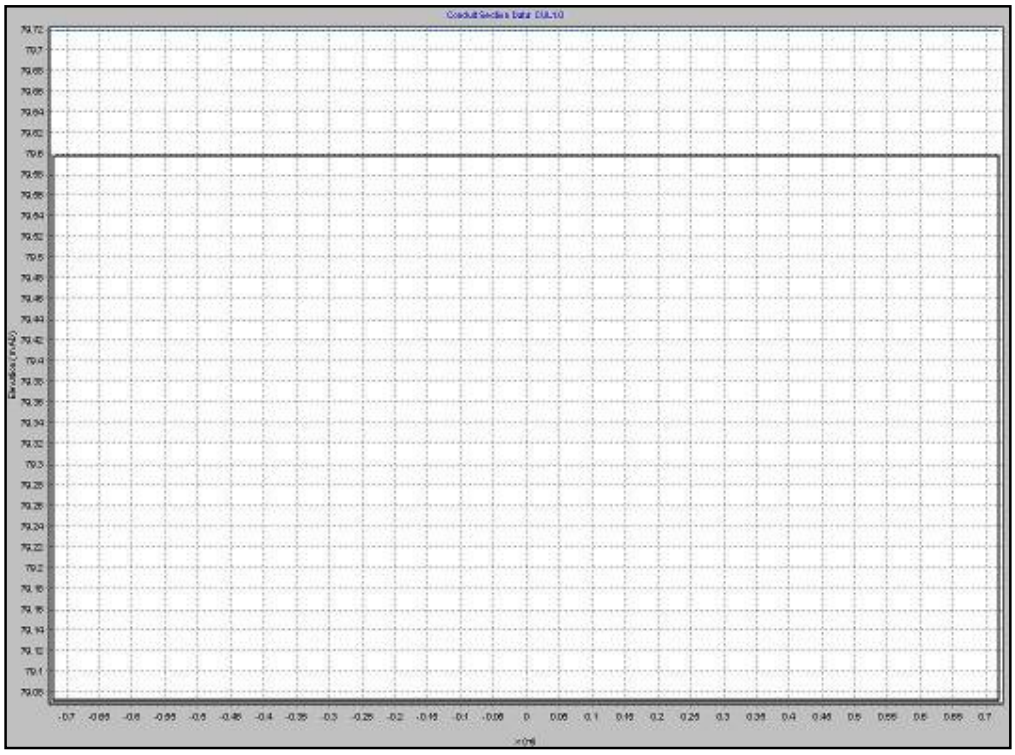


Figure 20: Cross-section of CUL1.0 – culvert adjacent to the site, 200 year base case run

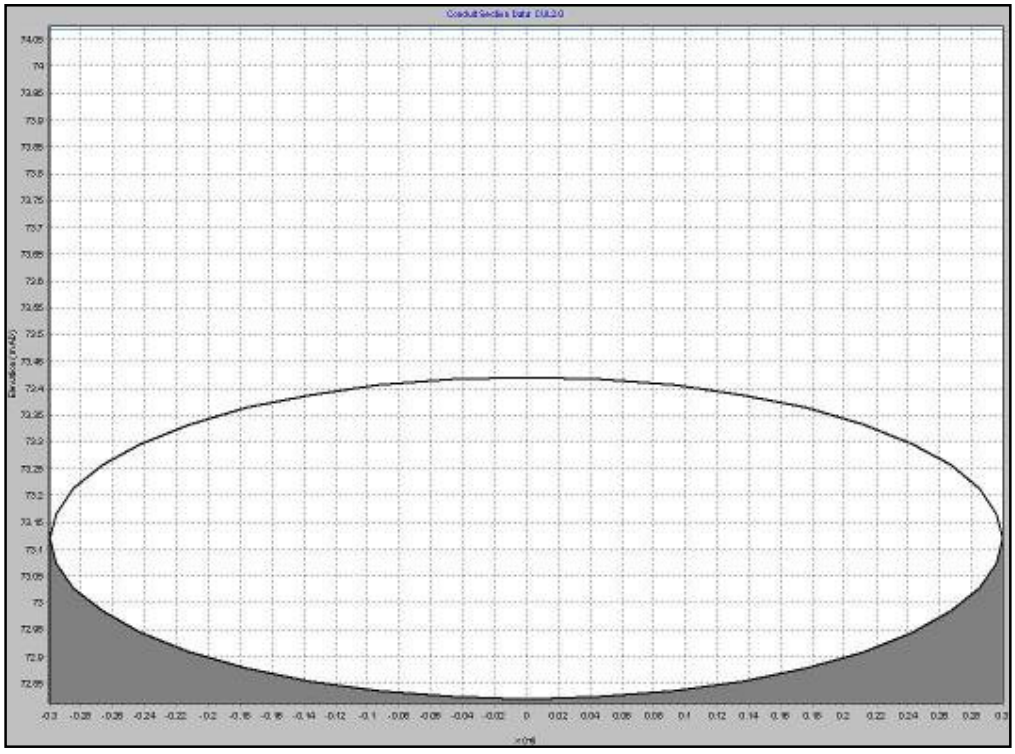


Figure 21: Cross-section of CUL2.0 – concrete culvert at Craigfield access road, 200 year base case run

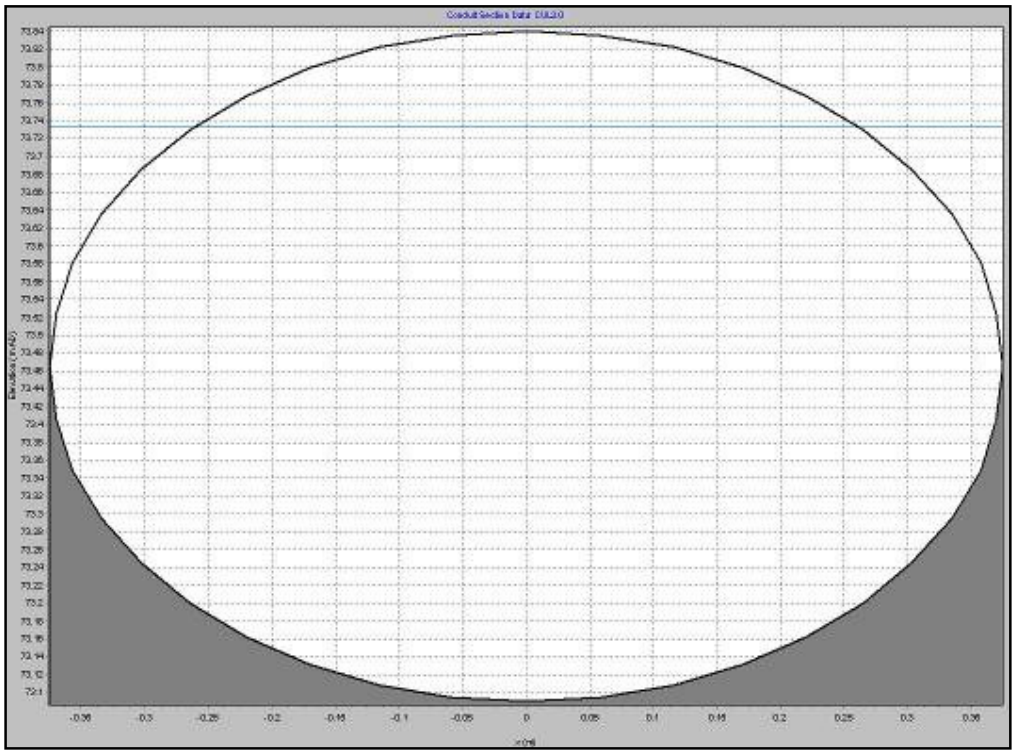


Figure 22: Cross-section of CUL3.0 – plastic culvert at Craigfield access road, 200 year base case run

APPENDIX D – PHOTOGRAPHS OF SITE LOCATION

Photo1: View of the Sunnyside culvert inlet from within the site

Photo 2: View of the upstream face of the Craigbank culverts

Photo 3: View looking west, upstream, along the southern site boundary from the Sunnyside culvert

Photo 4: View of the high land in the south-east corner of the site

Photo 5: View of the lower land within the site, looking west from the higher land in the SE site corner