Kilcreggan Surface Water Management Plan -Options Appraisal

Final Report

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Revision history

Revision Ref / Date	Amendments	Issued to
P01 01/07/19	-	Grant Whyte
P02 31/10/19	ABC Comments	Grant Whyte
P03 27/11/19	ABC Comments	Grant Whyte

Contract

This report describes work commissioned by Grant Whyte on behalf of Argyll & Bute Council by Purchase Order number AB315359. Argyll & Bute Council's representative for the contract was Grant Whyte. Steven Thomson of JBA Consulting carried out this work.

Prepared by .... Steven Thomson BSc (Hons) MSc GMICE

Senior Engineer

Reviewed by .... Rene Dobson BEng CEng MICE

Associate Director

Purpose

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Contents

1 Introduction

1.1 Site location

Tigh Dearg Road in Kilcreggan has a long history of surface water flooding due to overland flow from the steep hillside which the village is situated on. Overland flow overwhelms existing drainage and flows to the natural low point at the top of Tigh Dearg Road. In doing so it can often flood the neighbouring properties on Argyll Road causing substantial interior and exterior damage. The findings of the walkover generally corroborate well with the drainage survey undertaken in 2010 as part of the Grontmij flood study (Flood Management Programme – Phase 1, Argyll Road/Tigh Dearg Road, Kilcreggan – Grontmij, September 2010) .

The previous study proposed a drainage scheme which included upgrading the combined sewer beneath Tigh Dearg Road, creating new drainage on Barbour Road and new manholes and pipe work linking Barbour Road to Tigh Dearg Road. The study was never taken forward due to an unfavourable cost benefit ratio. This study aims to build on the knowledge gained from the 2010 study and propose alternative flood mitigation methods which provide a better cost benefit scheme.

1.2 Objectives of the study

The objective of this options appraisal study is to:

- Understand the condition and capacity of the existing drainage network
- Undertake a hydrological assessment of the contributing catchments
- Develop options that can mitigate flood risk in the Tigh Dearg Road area
- Undertake a cost benefit analysis of the proposed options
- Present a preferred option and next steps

2 Existing conditions

2.1 Site visit

On Tuesday 30th January 2018 Steven Thomson and Rene Dobson of JBA Consulting undertook site walkover surveys of 3 surface water flooding hotspots in the Dunoon area and 1 in Kilcreggan. The sites that were visited are those that had been highlighted in the Dunoon and Kilcreggan 2019 SWMPs as high priority (Kilcreggan SWMP 2019, JBA Consulting).

2.2 Existing Drainage Infrastructure

The major catchments which contribute is the field between Argyll Road and Barbour Road (Field D) as well as 3 fields above Barbour Road (A, B, C). All of the fields are used for grazing and anecdotal evidence suggests they are all almost permanently saturated which will only exacerbate overland flow. Drainage ditches are present along the northern edge of Barbour Road to intercept Runoff into stone cundies (culverts). The ditches are frequently over-topped sending flows over Barbour Road and into field D. The capacity and structural integrity of the existing cundies are unknown and not surveyed as superfluous to this study. A large catchment plan can be found in appendix C.

Figure 2-1: Catchments areas (Grontmij, 2010)

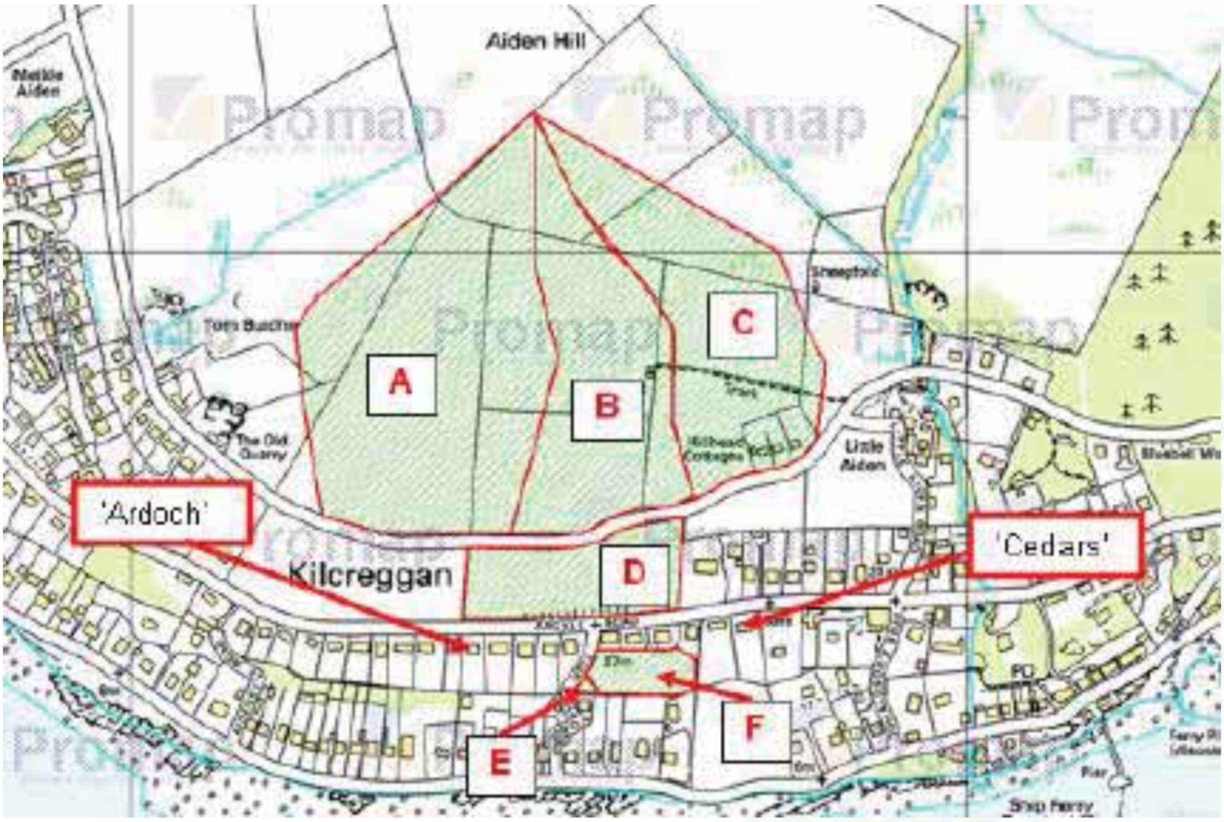
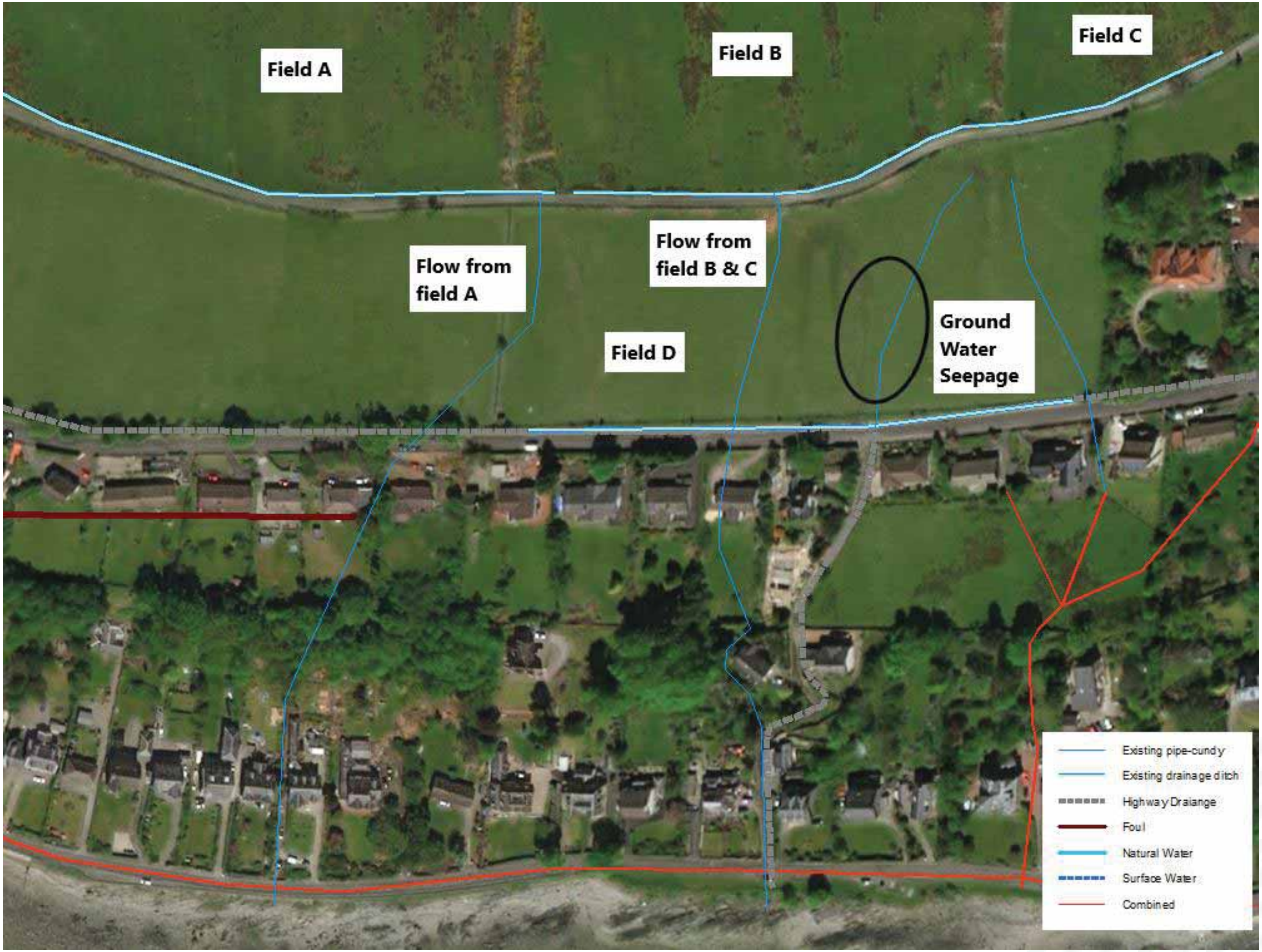


Figure 2-2: Existing drainage layout



2.3 Runoff from catchment A

Runoff from the western most field above Barbour Road discharges into a drainage ditch which then flows east before being culverted under Barbour Road in a 300mm ø culvert then dropping into a 300mm (W) x 200mm (H) stone cundy. The stone cundy is understood to take flows to the west passing below Argyll Road and the Inshalla property to an outfall on Shore Road away from the study area. The landowner of the fields suggested that this cundy is at least partially blocked. However, there was no evidence of this on the day of the site visit. The culvert under Barbour Road is likely to be overtopped during intense rainfall due to capacity issues and likelihood of blockages. This would result in substantial overland flow flowing through field D toward Argyll Road.

Figure 2-3: Existing drainage layout intercepting flows from field A highlighted yellow

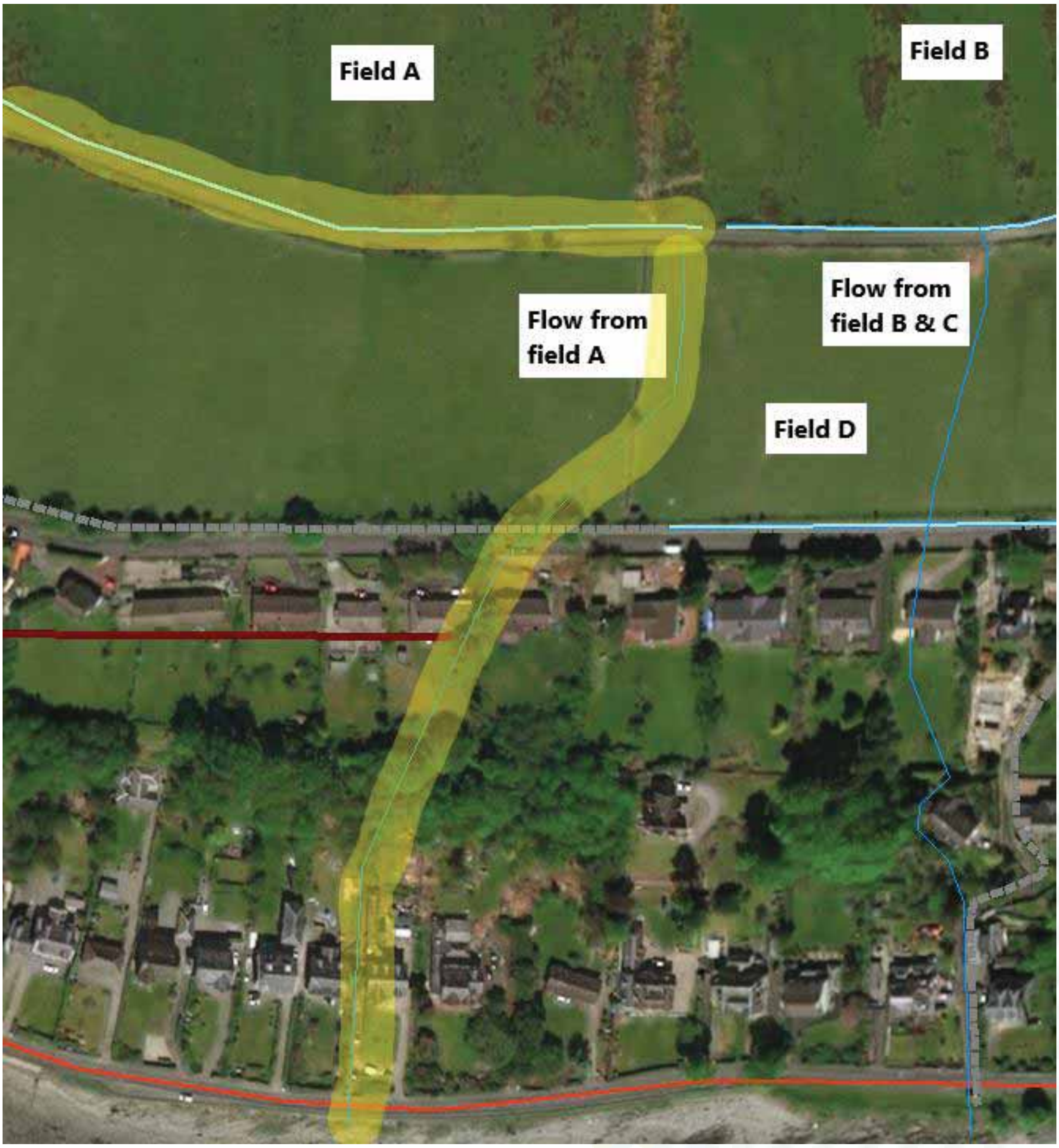
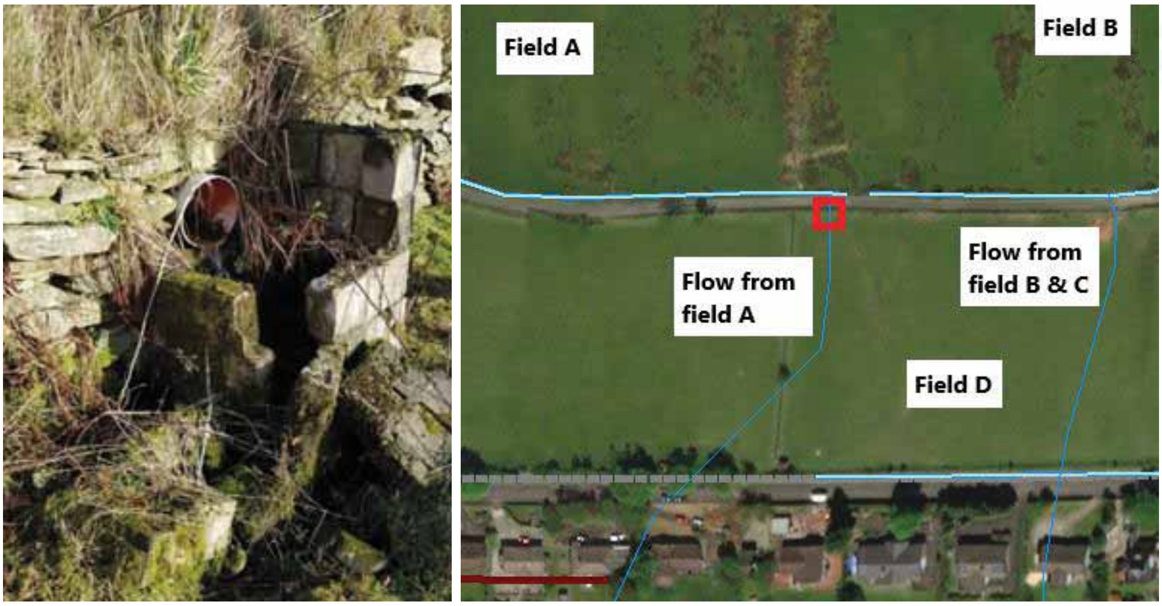


Figure 2-4: Culvert under Barbour Road discharging into stone cundy with flows from field A.



2.4 Runoff from catchment B & C

Runoff from fields B & C are intercepted by a drainage ditch which drains into a filter trench before being culverted beneath Barbour Road in a 225mm diameter plastic pipe. This culvert is often surcharged which results in overland flow spilling over the road and into the gated vehicular access to field D below. This has resulted in substantial erosion of the road edge and field access. Continued overtopping will require remedial works to the carriageway and field access.

There is a break in the pipe approximately halfway between Argyll Road and Barbour Road where the pipe is open and the construction changes from plastic pipe to vitrified clay. It has been assumed this was due to a blockage in the pipe. This pipe then continues to flow under Argyll Road, below the 'Lettermay' property and onto lower Tigh Dearg Road before discharging at an outfall under Shore Road. The outfall consists of a 225mm ∅ pipe which was flowing adjacent to a 300mm ∅ pipe which was dry during the site visit. It is not known if the 2 pipes are linked. Based on the flow observed at Barbour Road, the opening in the pipe and outfall at Shore Road, the pipe/cundy is believed to be intact but with a very limited capacity relative to the catchment.

Figure 2-5: Existing drainage layout intercepting flows from fields B & C highlighted yellow

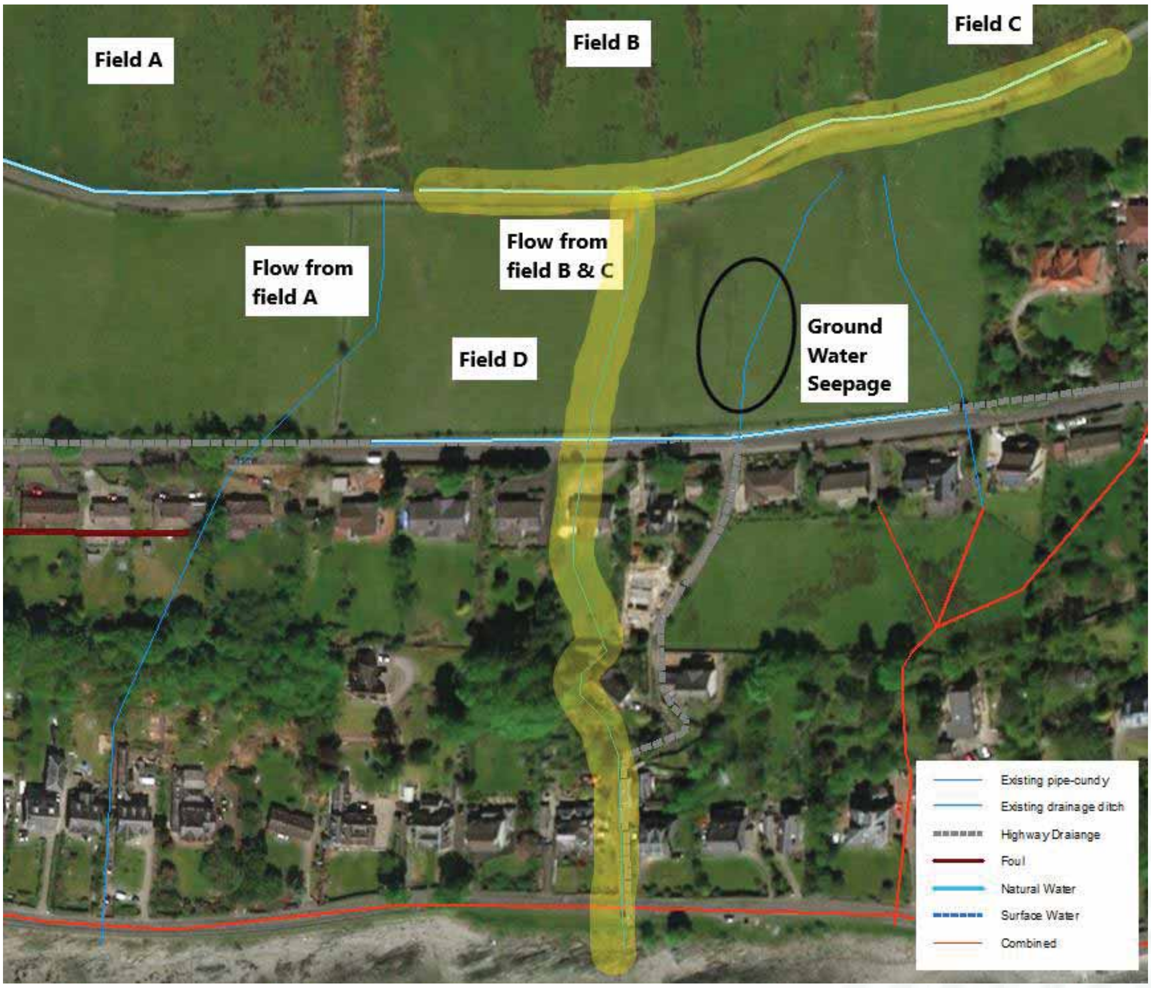


Figure 2-6: Damage to road and field access exacerbated by overtopping culvert carrying flows from fields B & C.

Figure 2-7: Manhole downstream of Barbour Road culvert discharging flows from fields B & C into a stone cundy which changes to a 300mm ø PPE pipe at an unknown distance downstream.

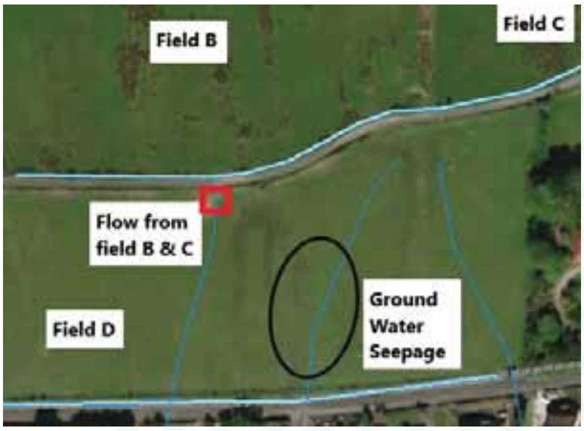
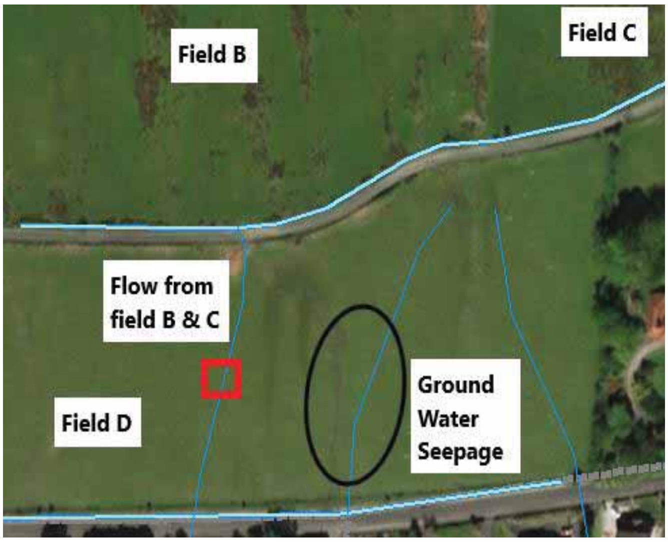


Figure 2-8: Open pit showing change in construction from 300mm ø twinwall PPE to 225mm ø VC pipe - possible previous blockage location



2.5 Runoff from field D

Further land drainage is visible toward the east of the field D. However, they are suspected to be blocked or broken (by water damage) as there is significant seepage from the hillside which has resulted in terracing and ponding of surface water on the slope.

Figure 2-9: Land drainage manhole

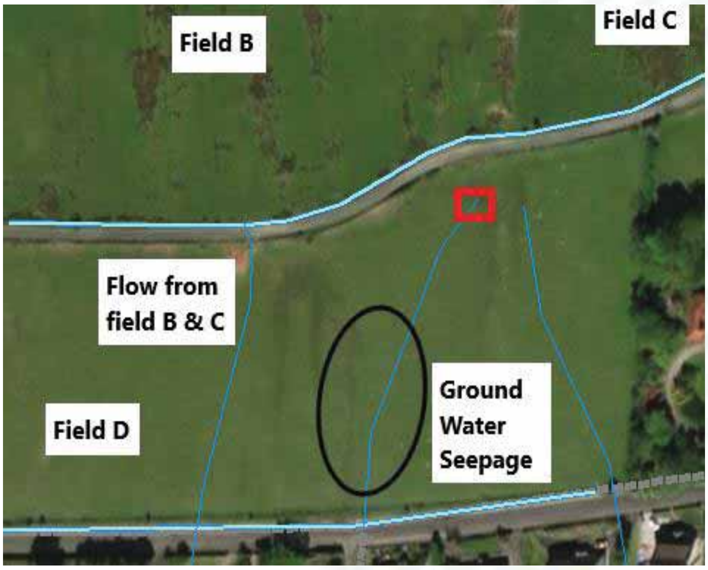
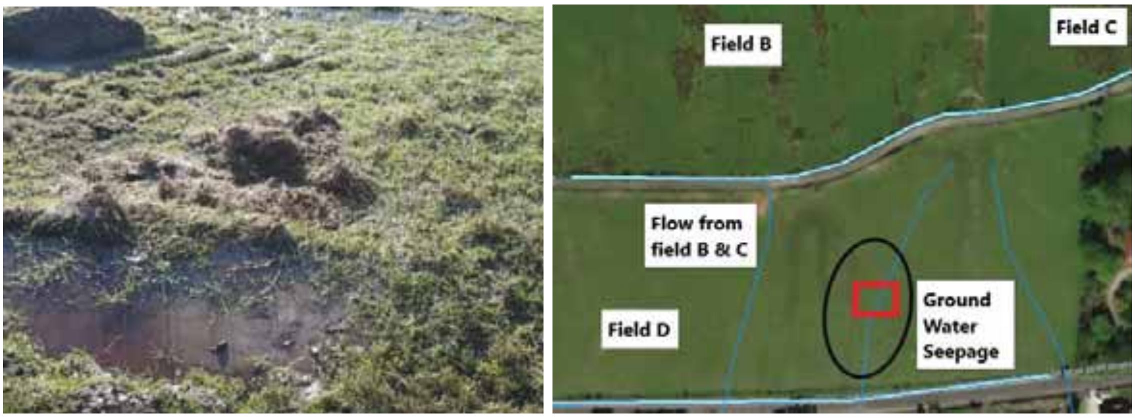


Figure 2-10: Typical ponding of ground water seepage possibly due to damaged pipe



2.6 Argyll Road Drainage

The drainage channel on Argyll Road was installed by Argyll and Bute Council (ABC) in 2011 and consists of high capacity kerbing on the roadside with square concrete paving slabs lining the channel. The channel has an average cross-sectional area of 0.22m^2. The channel is known to intercept a significant majority of the runoff which emanates from the field above. However, the channel is constrained by its outfall, a 225mm diameter combined sewer which conveys flows down Tigh Dearg Road and into a large pumped main under Shore Road. A steel grill covers the catch pit which connects the surface water channels to the combined sewer. The grill has very little available screen area and will be easily blocked by debris. According to residents this has blocked in the past exacerbating flooding. A 225mm diameter sewer below Argyll Road carries foul flow from properties as well as surface water from road gullies. This flows to the combined sewer below Tigh Dearg Road.

Figure 2-11: ABC installed drainage channel looking west from catch pit (left picture) and east from catch pit (right picture)

Figure 2-12: ABC installed catch pit with incoming flow from the hillside to the north discharging into the 225mm ø combined sewer

2.7 Tigh Dearg Road

Where flows overwhelm the drainage installed on Argyll Road they then continue down Tigh Dearg Road itself. Due to the gradient of the road the velocity of the flows flowing down Tigh Dearg are significant causing damage to the road surface. Residents have installed diversion channels and informal high kerbing in an effort to protect their properties.

There are only 3 road gullies present on Tigh Dearg Road one of which was completely blocked by road chippings/gravel during the site inspection, likely a result of erosion by flood waters. Surface water flooding continues down Tigh Dearg Road and over Shore Road before discharging onto the beach below.

Figure 2-13: Existing outfall consists of a stone cundy below Shore Road followed by a section of plastic pipe which discharges flows onto a disused CSO below. The combined sewer which flows down Tigh Dearg Road is intercepted under Shore Road and does not outfall onto the beach but into the rising sewer main.

Figure 2-14: Bottom of Tigh Dearg Road and Shore Road

Figure 2-15: Roof drainage discharging to road surface also kerb height increased by timber sleepers to deflect water away from the property

Figure 2-16: Lower bend on Tigh Dearg Road looking south

Figure 2-17: Upper bend on Tigh Dearg Road looking north

Figure 2-18: Upper bend on Tigh Dearg Road looking south

Figure 2-19: Road gully connecting directly to the combined sewer with inlet from the adjacent field

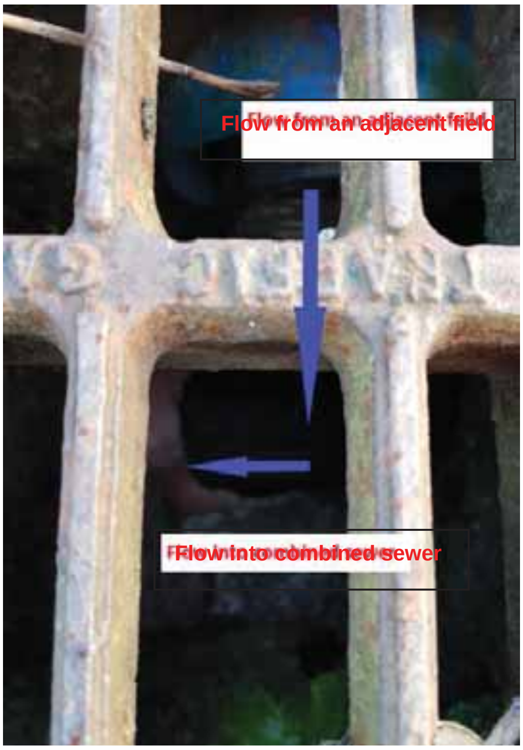


Figure 2-20: Tigh Dearg Road upper with recently installed telecoms cabinet in verge

Figure 2-21: Drainage channel within property boundary to intercept flows and discharge back onto Tigh Dearg Road

2.8 Site surveys (Topo, drainage etc)

A topographical survey undertaken in the 2010 Grontmij study was made available for this study. This covered the majority of the catchments Argyll Road and Shore Road however there was no survey of Tigh Dearg Road itself.

As part of the Grontmij study a comprehensive drainage survey was undertaken which was analysed as part of the walk over survey and appeared to correlate well to site observations 9 years later.

3 Hydrology

A hydrological assessment of the catchments that effect the Argyll Road and Tigh Dearg Road are presented within Appendix A. This report forms an update to the Hydrological assessment undertaken by Grontmij in 2010. The peak flows per catchment have been included below for convenience. In the context of this review climate change uplifts have been applied at 20% in accordance with SEPA's Technical Flood Risk Guidance for Stakeholders, Version 12, 2019.

Figure 3-1: Catchment extents and naming convention.

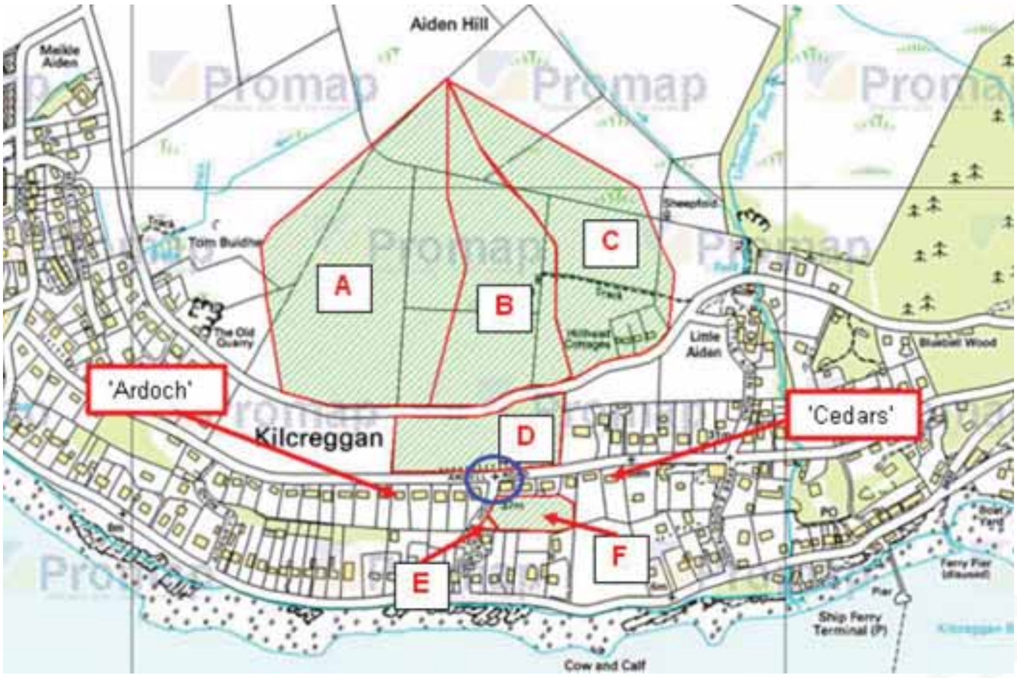


Table 3-1: Updated Peak Flows

Site	Return period (years)								
	2	5	10	30	50	75	100	200	200 CC
	Flow (m³/s)								
A	0.13	0.18	0.22	0.29	0.32	0.35	0.37	0.43	0.51
B	0.07	0.10	0.12	0.15	0.17	0.19	0.20	0.23	0.27
C	0.08	0.11	0.13	0.17	0.19	0.21	0.22	0.26	0.31
D	0.03	0.04	0.05	0.07	0.07	0.08	0.09	0.10	0.12
E	0.0012	0.0018	0.0021	0.0028	0.0031	0.0034	0.0036	0.0041	0.0049
F	0.012	0.018	0.021	0.028	0.031	0.034	0.036	0.041	0.049

Further information on the hydrological assessment approach and parameters used can be found in Appendix A.

4 Existing Infrastructure Capacity

Using the updated hydrology it is possible to estimate the current level of protection offered by the existing drainage network.

These estimates have been based on measurements of the visible infrastructure taken during the site walkover (JBA 2019), the tender drawing package (Grontmij 2010), CCTV survey and various other sources of information provided by ABC.

4.1 Surface water channel Argyll Road

The surface water channel constructed by ABC in 2011, consists of a channel formed of concrete paving slabs and high containment kerbs. The channel drains field D with flows directed toward a catch pit at the north side of the carriageway at the junction with Tigh Dearg Road.

The channel has been divided into east and west runs for the purpose of the calculation which was undertaken using the Mannings equation. The cross-sectional area and gradient are likely to vary along the drainage channel. As the calculations are based on limited data gleaned from the site walkover the estimated capacity and subsequent level of protection are approximate. Topographical survey to be undertaken during detailed design will accurately confirm the capacity.

Figure 4-1:Argyll Road approximate catchment drainage divide

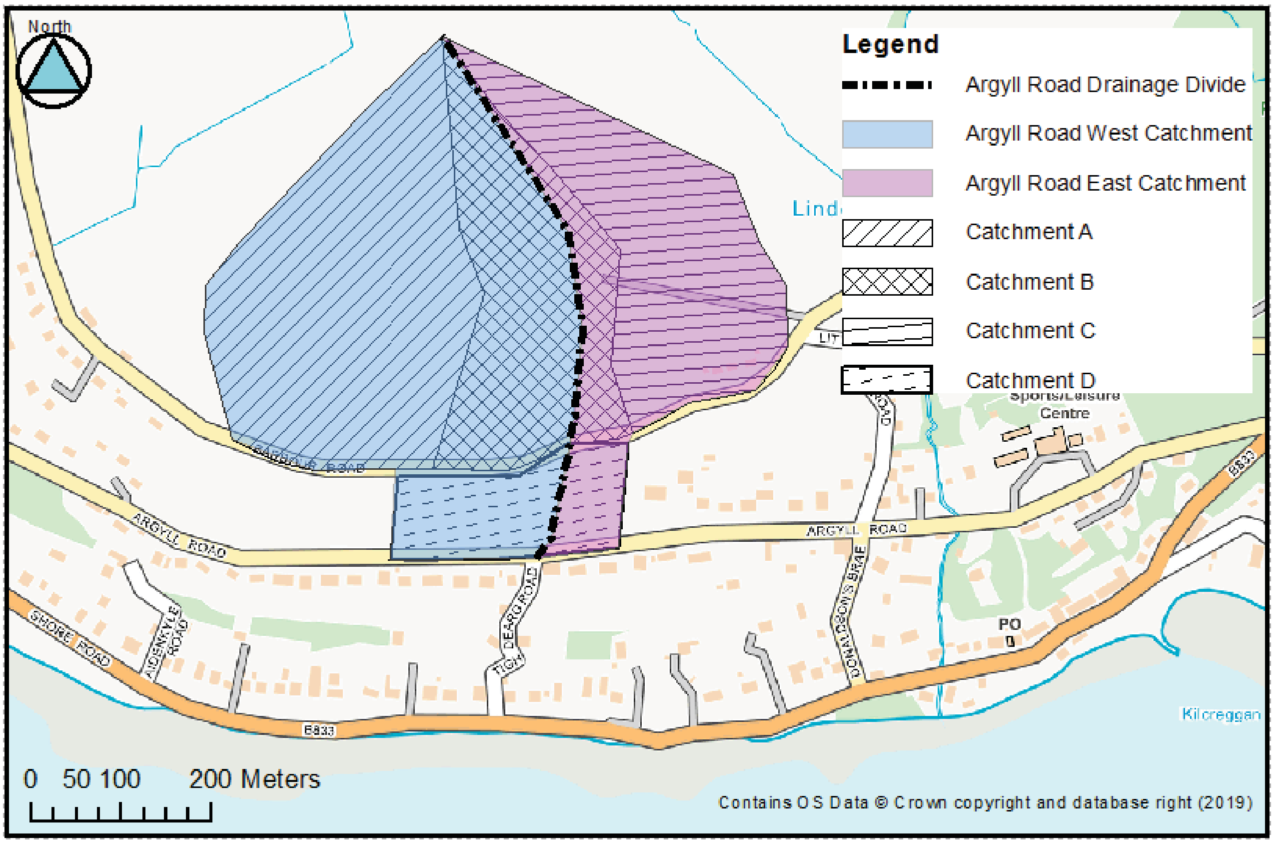


Table 4-1: Estimated standard of protection offered by existing drainage channel (assuming no flow restriction at the outfall)

Channel	Estimated catchments drained	Slope	Channel length	Area	Q	V	Approximate standard of protection without CC uplift
East of Tigh Dearg Road	B (25%) C (100%) D (25%)	1 in 400	95m	$0.22m^2$	0.207 m^3/s	0.941m/s	1:20yr
West of Tigh Dearg Road	A (100%) B (75%) D (75%)	1 in 50	145m	$0.22m^2$	0.586 m^3/s	2.663m/s	1:50yr

4.2 Combined sewer

The flows from two surface water channels enter a collection chamber which drains into a 225mm diameter combined sewer which flows under Argyll Road before flowing down Tigh Dearg Road. The gradient of the existing sewer cannot be confirmed using the existing information. A gradient of 1:30 has been assumed in the calculation, which is based on Grontmij's proposed scheme, it should be noted that this is likely to be the maximum possible gradient. Hence, it is likely that flows are lower than the estimate, particularly as it was found to be partially obstructed during the CCTV survey.

Using Colebrook-White flow charts, the sewer has a maximum flow of 0.085m3/s (85l/s). The flows for a 1 in 2-year event are $0.31m^3/s$ (310l/s), the existing pipe has the capacity to convey approximately 30% of the 2-year flow.

As discussed, this is the flow of the pipe running at capacity at a likely optimistic gradient hence, actual capacity of the combined sewer is likely to be closer to 50 l/s which explains why the residents experience flooding on such a frequent basis. Once on Tigh Dearg Road itself the gradient increase substantially to 1:8 enabling the pipe to convey upto $0.180m^3/s$ (180l/s).

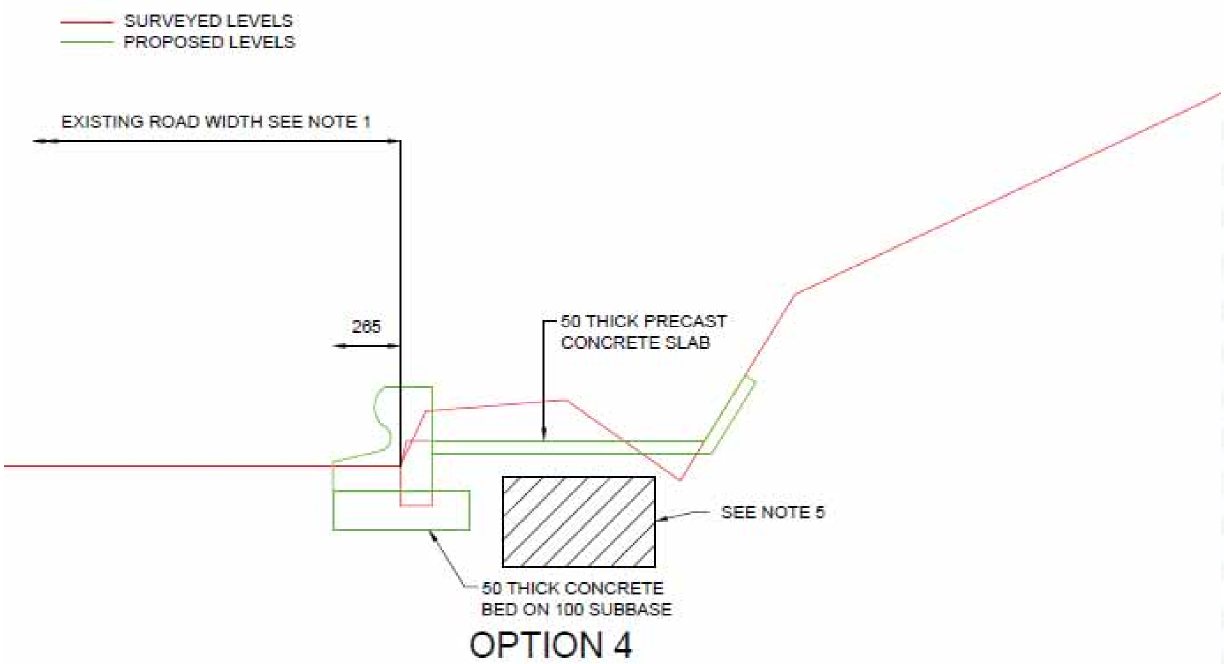
4.3 Existing network flood scenario

The limited capacity of the combined sewer causes the surface water channels on Argyll Road to overtop and spill onto the road itself. The overflow quickly overwhelms the few road gullies in the area as they are also connected to the combined sewer. This results in flows entering properties on Argyll Road or flowing down Tigh Dearg Road.

4.4 Existing network physical limitations

During the design of the existing surface water channels multiple designs for the channel were considered. The option selected had a minimal decrease in available road space and avoided services which are located in the vicinity of the surface water channels as shown below in the hatched box.

Figure 4-2: Existing channel with regard to services (Grontmij, 2010)



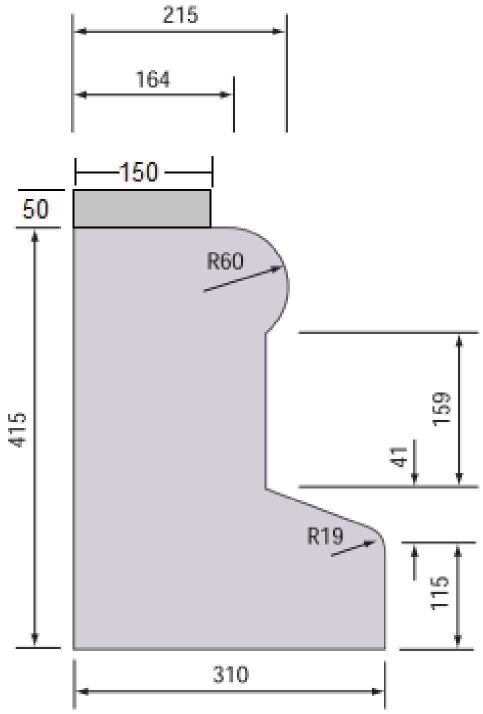
5 Options appraisal

5.1 Option 1: Improve existing surface water channel on Argyll Road and construct a new surface water pipe down Tigh Dearg Road

5.1.1 This option will consist of the following actions:

- Refurbish existing surface water channels on Argyll Road. There are areas of mortar loss and broken paving slabs which has resulted in widespread seepage out of the channel. The affected areas should be repointed with any broken slabs replaced. By increasing the height of the east channel by approximately 50mm both channels will have the capacity to drain the 1:50yr event. This could be achieved by adding a single course of concrete kerb edging (50mm x 150mm) secured on top of the high containment kerb using a mortar bed. Alternatively, the invert of the channel could be lowered depending on the construction beneath the existing paving slabs.

Figure 5-1: Existing high capacity kerb with additional 50mm x 150mm kerb top



- Creating a new collection chamber and disconnecting from the combined sewer. The new chamber inlet will extend to the west of the current location to allow the outgoing pipe to miss the combined sewer manhole as it crosses Argyll Road, but still intercept the flow from the cundy from the north. The surface water channel invert will be lowered locally around the chamber (upto 0.5m). This will allow for a substantially a larger screen area. This could be further increased by adding an additional section of north facing screen which would require some regrading of the adjacent slope. The larger screen will reduce the risk of blockage substantially. Screen blockage or partial blockage by debris (leaves/ small vegetation/silt) may result in the drainage channel being over-topped before its maximum capacity is exceeded.
- Install 20m of new 525mm diameter precast concrete surface water pipe which will connect to a new manhole in the carriageway of Tigh Dearg Road. The pipe will be laid at a gradient of approximately 1:30 and will pass below the other services in Argyll Road. This will likely require a 2m deep excavation and will convey flows up to the 1:75year event.
- Install 180m of new 450mm diameter precast concrete surface water pipe below Tigh Dearg Road to the west of the combined sewer running approximately in parallel. This

run has an average gradient of 1:8 and will require at least 8 bend units and 4 manholes to navigate the tight corners present on Tigh Dearg Road. This will convey flows up to 1:200year event. In the lower section this will also intercept a stone cundy which flows under Shore Road. The pipe will follow its current alignment where possible. This activity will require the excavation of a trench up to 2m deep for the full length of Tigh Dearg Road.

- Finally, a 15m section of 450mm diameter precast concrete pipe laid at a gradient of 1:29 will convey flows below Shore Road. There are multiple services in Shore Road however, the new pipe will follow the alignment of the existing surface water pipe which successfully navigates the utilities. A new outfall will be constructed.

5.1.2 Benefits of proposed scheme

- This will offer a level of protection of up to 1:50 year event for all properties known to be affected by flooding in the Argyll Road and Tigh Dearg Road area.
- Surface water is removed from the sewer network.
- This will utilise the existing surface water channel.
- Conventional construction methods.
- Low maintenance particularly downstream of the collection chamber.
- Option to increase initial pipe diameter under Argyll Road to 750mm to convey flows up to the 200-year +CC event. This could future proof the scheme to an extent as additional drainage could be connected to capture any over spill from the drainage channels. Equally the drainage channel's capacity itself could be increased at a future stage.

5.1.3 Assumptions and risk

- That the minimum gradient (1:30) is achievable from the new collection chamber to the manhole at the top of Tigh Dearg Road whilst passing below the services within the road. These include telecoms, combined sewer and electricity. These could be confirmed on site or with utilities survey (GPR) in advance of works. The invert of the watermain is known to be 0.8m below road level. The inverts and gradients have been assumed to follow information shown on Grontmij's drawing 102740-005-DRG-9604 attached in appendix C.
- That there is sufficient space in Tigh Dearg Road to construct the new pipe.
- That the increase in cross sectional area required to achieve the capacity in the east Argyll Road drainage channel can be achieved by a small increase in height. The total additional height required will be informed by a topographical survey during the detailed design.
- That by following the line of the existing surface water outfall the pipe services will be avoided in Shore Road.
- That local connection to services on Tigh Dearg Road will pass over the pipe.
- No improvements are needed to the ditches on Barbour Road or to the existing cundies hence flooding will continue to occur on Barbour Road and field D.
- That the existing cundies and culverts will be maintained as well as possible.
- That the existing road gullies on Argyll Road and will remain insitu connected to the combined sewer.
- That the new screen and collection chamber will be added to the priority inspection regime.
- That the existing surface of Tigh Dearg Road will not be replaced with the exception of the excavated trench.
- That there is no replacement or realignment of the sewer pipe in Tigh Dearg Road.

5.1.4 Costs

Item	Quantity	Units	Unit cost	Cost (£)	Source
General					
Site welfare & store establishment	1	sum	3414.45	3414.45	CESMM3 Unit Costs
Site welfare & store maintenance	8	weeks	105.06	840.48	CESMM3 Unit Costs
Site supervision	8	weeks	1422	11376	CESMM3 Unit Costs
Traffic Management	8	weeks	1500	12000	Estimate
Repair and upgrade existing channel					
Concrete kerb edging 50mm x 150mm	94	m	6.35	596.9	CESMM3 Unit Costs
Paving slabs (replace broken)	10	m3	17.79	177.9	CESMM3 Unit Costs
New collection chamber cover/screen	1	No.	2500	2500	Estimate
1350x700 brick chamber upto 2.5m deep (no cover)	1	No.	2846.26	2846.26	CESMM3 Unit Costs
Tigh Dearg Road					
Supply 525mm diameter concrete pipe	20	m	£47	940.00	Marshalls CPM Buyers Guide 2019
Supply 450mm diameter concrete pipe	180	m	£38	6908.40	Marshalls CPM Buyers Guide 2019
Install 525mm θ concrete Pipe upto 2m deep	20	m	61.8	1236	CESMM3 Unit Costs
Install 450mm θ concrete Pipe upto 2m deep	180	m	51.76	9316.8	CESMM3 Unit Costs
bend units (450mm diameter)	8	No.	380	3040	Marshalls CPM Buyers Guide 2019
Disposal of excavated material	100	m3	50	5000	CESMM3/estimate
Precast concrete manhole 1200mm upto 2m deep	4	No.	1532.1	6128.4	CESMM3 Unit Costs
Shore Road to Outfall					
Supply 450mm diameter concrete pipe	20	m	38	767.60	Marshalls CPM Buyers Guide 2019
Install 450mm θ concrete Pipe upto 2m deep	20	m	1.76	1035.2	CESMM3 Unit Costs
Precast concrete outfall	1	No.	500	3500	Estimate
Road Resurfacing					
200mm sub base (Type 1)	4	3	8.14	1678.16	CESMM3 Unit Costs
HRA Binder Course 80mm	30	m2	8.23	6015.9	CESMM3 Unit Costs
HRA Surface Course 60mm	30	m2	6.27	5369.1	CESMM3 Unit Costs
Subtotal				**84687.55**	
Construction inflation index adjustment (2016 to 2019)	10.1	%	-	92478.80	
Optimism Bias	60	%	-	147966.09	OFNS
Detailed design costs	19	%	-	28113.56	
Total				**£176,080**	

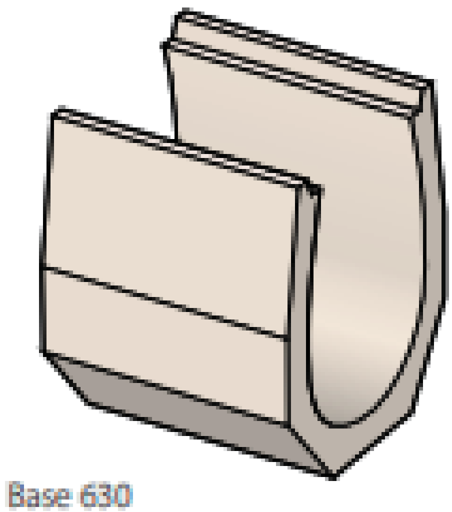
5.2 Option 2: Improve existing surface water channel on Argyll Road and new Max-E 630 shallow concrete channel down Tigh Dearg Road

5.2.1 This option will consist of the following actions:

- Refurbish existing surface water channels on Argyll Road as per option 1.
- Create a new collection chamber and disconnect from the combined sewer as per option 1.
- Install 20m of new 525mm diameter precast concrete surface water pipe which will connect to a new manhole in the carriageway of Tigh Dearg Road as per option 1.
- Install 180m of new Max-E channel 630 (or similar). This is a precast concrete channel which sits at the surface. The excavation for this would consist of a 1m x 1m trench on the eastern side of the road for the full length of Tigh Dearg Road. This will convey flows up to the 1:200 year event. The lower section will also intercept a stone cundy which flows under Shore Road. The channel sections are encased in concrete with either a concrete lid with slots or a cover plate to allow for road surfacing.
- Finally, a new manhole at the base of Tigh Dearg will convert the Max-E channel back to a pipe in order to navigate the services on Shore Road as per option 1.

Figure 5-2: Max-E channel with adjacent kerb and black top

Figure 5-3: Max-E channel 630 base unit



5.2.2 Benefits of proposed scheme

- This will offer a level of protection of up to the 1:50 year event for all properties known to be affected by flooding along Argyll Road.
- Surface water is removed from the combined sewer network.
- This will utilise the existing surface water channel.
- Shallow excavation will reduce volume of material leaving site and allow for a quicker construction.
- Option to increase initial pipe diameter under Argyll Road to 750mm to convey flows up to the 200-year event. This could future proof the scheme to an extent as additional drainage could be connected to capture any over spill from the drainage channels. Equally the drainage channel's capacity itself could be increased at a future stage.

5.2.3 Assumptions and risk

- As per option 1 with the exception that any local services will need to pass under the structure.
- That the slits on top of the concrete Max E channel will be cleaned periodically to prevent blinding.
- That local connection to services on Tigh Dearg Road will pass under the channel although in general utilities are typically located between 0.6-1.2mbgl which may clash with the channel invert (1mbgl). This may require additional work on site and extra work with utility providers.
- That the proposed channel will run down the eastern edge of Tigh Dearg Road. This may clash with the combined sewer particularly at bend locations which may result in local diversions of the combined sewer. This should be achievable due to the gradient of Tigh Dearg Road but would carry additional cost.

5.2.4 Costs

Item	Quantity	Units	Unit cost	Cost (£)	Source
General					
Site welfare & store establishment	1	sum	3414.45	3414.45	CESMM3 Unit Costs
Site welfare & store maintenance	8	weeks	105.06	840.48	CESMM3 Unit Costs
Site supervision	8	weeks	1422	11376	CESMM3 Unit Costs
Traffic Management	8	weeks	1500	12000	Estimate
Repair and upgrade existing channel					
Concrete kerb edging 50mm x 150mm	94	m	6.35	596.9	CESMM3 Unit Costs
Paving slabs (replace broken)	10	m3	17.79	177.9	CESMM3 Unit Costs
New collection chamber cover/screen	1	No.	2500	2500	Estimate
1350x700 brick chamber upto 2.5m deep (no cover)	1	No.	2846.26	2846.26	CESMM3 Unit Costs
Tigh Dearg Road					
Supply 525mm diameter concrete pipe	20	m	£47	940.00	Marshalls CPM Buyers Guide 2019
Install 525mm θ concrete Pipe upto 2m deep	20	m	61.8	1236	CESMM3 Unit Costs
Excavate 1m x 1m trench down Tigh Dearg Road	180	m3	3.41	613.8	CESMM3 Unit Costs
Place 100-150mm thick concrete surround	35	m3	18.1	633.5	Marshalls
Max E 630 base unit	360	No.	79.85	28746	Marshalls
Max E 365 cover unit	720	No.	30.16	21715.2	Marshalls
Max E cover access covers	4	No.	311.76	1247.04	Marshalls
Max E ancillary products	1	No.	520	520	Marshalls
Installation Labour costs (drainage gang)	80	hr	60.27	4821.6	CESMM3 Unit Costs
Precast concrete manhole 1200mm upto 2m deep	2	No.	1532.1	3064.2	CESMM3 Unit Costs
Shore Road to Outfall					
Supply 450mm diameter concrete pipe	20	m	38	767.60	Marshalls CPM Buyers Guide 2019
Install 450mm θ concrete Pipe upto 2m deep	20	m	1.76	1035.2	CESMM3 Unit Costs
Precast concrete outfall	1	No.	500	3500	Estimate
Road Resurfacing					
200mm sub base (Type 1)	4	3	8.14	1678.16	CESMM3 Unit Costs
HRA Binder Course 80mm	30	m2	8.23	6015.9	CESMM3 Unit Costs
HRA Surface Course 60mm	30	m2	6.27	5369.1	CESMM3 Unit Costs
Subtotal				**115655.29**	
Construction inflation index adjustment (2016 to 2019)	9.2	%	-	126295.58	
Optimism Bias	60	%	-	202072.92	OFNS

Detailed design costs	19	%	-	38393.86	
Total				**£240,467**	

5.3 Option 3: Utilise existing channel with new Max-E 365 shallow concrete channel down Tigh Dearg Road

5.3.1 This option will consist of the following actions:

- Refurbish existing surface water channels on Argyll Road as per option 1.
- Create a new collection chamber and disconnect from the combined sewer as per option 1.
- Install 20m of new 525mm diameter precast concrete surface water pipe which will connect to a new manhole in the carriageway of Tigh Dearg Road as per option 1.
- Install 180m of new Max-E 365 channel (or similar). This is a precast concrete channel which sits at the surface. The excavation for this would consist of a 0.6m x 0.6m trench for the full length of Tigh Dearg Road. The channel would align with the left hand side of the road. This will convey flows up to 1:10 year event. The channel sections are encased in concrete with either a concrete lid with slots or a cover plate to allow for road surfacing.
- The Max-E channel will cross directly over Shore Road at surface level using F900 rated cover.
- 3 access covers will be incorporated into the design.
- Bend units will be used to navigate the tight bends in the road.

Figure 5-4: Max-E channel 365 base unit and cover units

Figure 5-5: Max-E channel installation method with 365 unit

5.3.2 Benefits of proposed scheme

- This will offer a level of protection of up to 1:10 year event for all properties known to be affected by flooding in the Argyll Road and Tigh Dearg Road area.
- Surface water is removed from the sewer network.
- This will utilise the existing surface water channel.
- Shallow excavation will reduce costs and construction time.
- The very shallow nature of this channel means that it should cross over all services hence it is a particularly low risk option.

5.3.3 Assumptions and risk

- As per option 1 with the exception that any local services will need to pass under the structure. In general, services are typically buried between 0.6m - 1.2m hence the risk of a clash is lower due to the shallow excavation.
- That the slits on top of the concrete Max E channel will be cleaned periodically to prevent blinding.

5.3.4 Costs

Item	Quantity	Units	Unit cost	Cost	Source
General					
Site welfare & store establishment	1	sum	3414.45	3414.45	CESMM3 Unit Costs
Site welfare & store maintenance	8	weeks	105.06	840.48	CESMM3 Unit Costs
Site supervision	8	weeks	1422	11376	CESMM3 Unit Costs
Traffic Management	8	weeks	1500	12000	Estimate
Repair and upgrade existing channel					
Concrete kerb edging 50mm x 150mm	94	m	6.35	596.9	CESMM3 Unit Costs
Paving slabs (replace broken)	10	m3	17.79	177.9	CESMM3 Unit Costs
New collection chamber cover/screen	1	No.	2500	2500	Estimate
1350x700 brick chamber upto 2.5m deep (no cover)	1	No.	2846.26	2846.26	CESMM3 Unit Costs

Tigh Dearg Road					
Supply 525mm diameter concrete pipe	20	m	£47	940.00	Marshalls CPM Buyers Guide 2019
Install 525mm θ concrete Pipe upto 2m deep	20	m	61.8	1236	CESMM3 Unit Costs
Excavate 0.730m x 0.610m trench down Tigh Dearg Road	80	m3	3.41	272.8	CESMM3 Unit Costs
Disposal of excavated material	80	m3	50	4000	CESMM3/estimate
Place 100-150mm thick concrete surround	27	m3	18.1	488.7	Marshalls
Max E 365 base unit	360	No.	30.6	11016	Marshalls
Max E 365 cover unit	720	No.	30.16	21715.2	Marshalls
Max E cover access covers	4	No.	11.76	1247.04	Marshalls
Max E ancillary products	1	No.	20	520	Marshalls
Installation Labour costs (drainage gang)	80	hr	0.27	4821.6	CESMM3 Unit Costs
Precast concrete manhole 1200mm upto 2m deep	2	No.	532.1	3064.2	CESMM3 Unit Costs
Supply 525mm diameter concrete pipe	20	m	47	940.00	Marshalls CPM Buyers Guide 2019
Install 525mm θ cocnrete Pipe upto 2m deep	20	m	1.8	1236	CESMM3 Unit Costs
Excavate 0.730m x 0.610m trench down Tigh Dearg Road	80	m3	.41	272.8	CESMM3 Unit Costs
Disposal of excavated material	80	m3	0	4000	CESMM3/estimate
Shore Road to Outfall					
Supply 450mm diameter concrete pipe	20	m	38	767.60	Marshalls CPM Buyers Guide 2019
Install 450mm θ concrete Pipe upto 2m deep	20	m	1.76	1035.2	CESMM3 Unit Costs
Precast concrete outfall	1	No.	500	2500	Estimate
Road Resurfacing					
200mm sub base (Type 1)	4	m3	8.14	152.56	CESMM3 Unit Costs
HRA Binder Course 80mm	30	m2	8.23	546.9	CESMM3 Unit Costs
HRA Surface Course 60mm	330	m2	16.27	5369.1	CESMM3 Unit Costs
Subtotal				**93444.89**	
Construction inflation index adjustment (2016 to 2019)	10.1	%	-	102882.82	OFNS
Optimism Bias	60	%	-	164612.52	
Detailed design costs	19	%	-	31276.38	
Total				**£195,889**	

5.4 Option 4: Option 3 (Max-E channel) with kerbing and depression in carriage way

5.4.1 This option will consist of the following actions:

- Refurbish existing surface water channels on Argyll Road as per option 1.
- Create a new collection chamber and disconnect from the combined sewer as per option 1.
- Install 20m of new 525m diameter concrete surface water pipe which will connect to a new manhole in the carriageway of Tigh Dearg Road as per option 1.
- Install 180m of new Max-E 365 channel (or similar) as per option 3.
- Drop the invert of the Max-E channel by 0.1m and install new kerbing against the left-hand side of the road. Resurface the left hand side of the road providing a cross fall toward the kerb from the road centreline. This will create an overflow channel on the surface. This combined approach will convey flows up to the 1:50year event. The channel sections are encased in concrete with either a concrete lid with slots or a cover plate to allow for road surfacing.
- An extra-large gully connected to a new manhole will allow surface flows to enter a chamber before passing under Shore Road in a pipe to a new outfall.
- Bend units will be used to navigate the tight bends in the road.

5.4.2 Benefits of proposed scheme

- This will offer a level of protection of up to 1:50 year event for all properties known to be affected by flooding in the Argyll Road and Tigh Dearg Road area.
- Surface water is removed from the sewer network.
- This will utilise the existing surface water channel.
- Shallow excavation will reduce costs.

5.4.3 Assumptions and risk

- As per option 3 with the exception that any local services will need to pass under the structure. In general, services are typically buried between 0.6m - 1.2m hence the risk of a clash is lower due to the shallow excavation.
- Surface water at road level will flow at 3.85m/s within a channel of approximate width of 1.2m (maximum depth 0.1m). This mirrors the existing conditions found during flood scenarios but in a more controlled manner with return periods below 1:10 year kept below the surface.
- That the slits on top of the concrete Max E channel will be cleaned periodically to prevent blinding.
- That local land raising is possible on Tigh Dearg Road to place new kerbing particularly at property boundaries.

5.4.4 Costs

Item	Quantity	Units	Unit cost	Cost	Source
General					
Site welfare & store establishment	1	sum	3414.45	3414.45	CESMM3 Unit Costs
Site welfare & store maintenance	8	weeks	105.06	840.48	CESMM3 Unit Costs
Site supervision	8	weeks	1422	11376	CESMM3 Unit Costs
Traffic Management	8	weeks	1500	12000	Estimate
Repair and upgrade existing channel					
Concrete kerb edging 50mm x 150mm	94	m	6.35	596.9	CESMM3 Unit Costs
Paving slabs (replace broken)	10	m3	17.79	177.9	CESMM3 Unit Costs
New collection chamber cover/screen	1	No.	2500	2500	Estimate
1350x700 brick chamber upto 2.5m deep (no cover)	1	No.	2846.26	2846.26	CESMM3 Unit Costs
Tigh Dearg Road					
Supply 525mm diameter concrete pipe	20	m	£47	940.00	Marshalls CPM Buyers Guide 2019
Install 525mm θ cocnrete Pipe upto 2m deep	20	m	61.8	1236	CESMM3 Unit Costs
Excavate 0.730m x 0.610m trench down Tigh Dearg Road	80	m3	3.41	272.8	CESMM3 Unit Costs
Disposal of excavated material	80	m3	50	4000	CESMM3/estimate
Place 100-150mm thick concrete surround	27	m3	18.1	488.7	Marshalls
Max E 365 base unit	360	No.	30.6	11016	Marshalls
Max E 365 cover unit	720	No.	30.16	21715.2	Marshalls
Max E cover access covers	4	No.	11.76	1247.04	Marshalls
Max E ancillary products	1	No.	20	520	Marshalls
Installation Labour costs (drainage gang)	80	hr	0.27	4821.6	CESMM3 Unit Costs
Precast concrete manhole 1200mm upto 2m deep	2	No.	532.1	3064.2	CESMM3 Unit Costs
Shore Road to Outfall					
Supply 450mm diameter concrete pipe	20	m	38	767.60	Marshalls CPM Buyers Guide 2019
Install 450mm θ concrete Pipe upto 2m deep	20	m	51.76	1035.2	CESMM3 Unit Costs
Precast concrete outfall	1	No.	3500	3500	Estimate
Road Resurfacing					
200mm sub base (Type 1)	4	m3	8.14	152.56	CESMM3 Unit Costs

HRA Binder Course 80mm	50	m2	8.23	2734.5	CESMM3 Unit Costs
HRA Surface Course 60mm	150	m2	16.27	2440.5	CESMM3 Unit Costs
Subtotal				**93703.89**	
Construction inflation index adjustment (2016 to 2019)	10.1	%	-	103167.98	OFNS
Optimism Bias	60	%	-	165068.773	
Detailed design costs	19	%	-	31363.07	
Total				**196,432**	

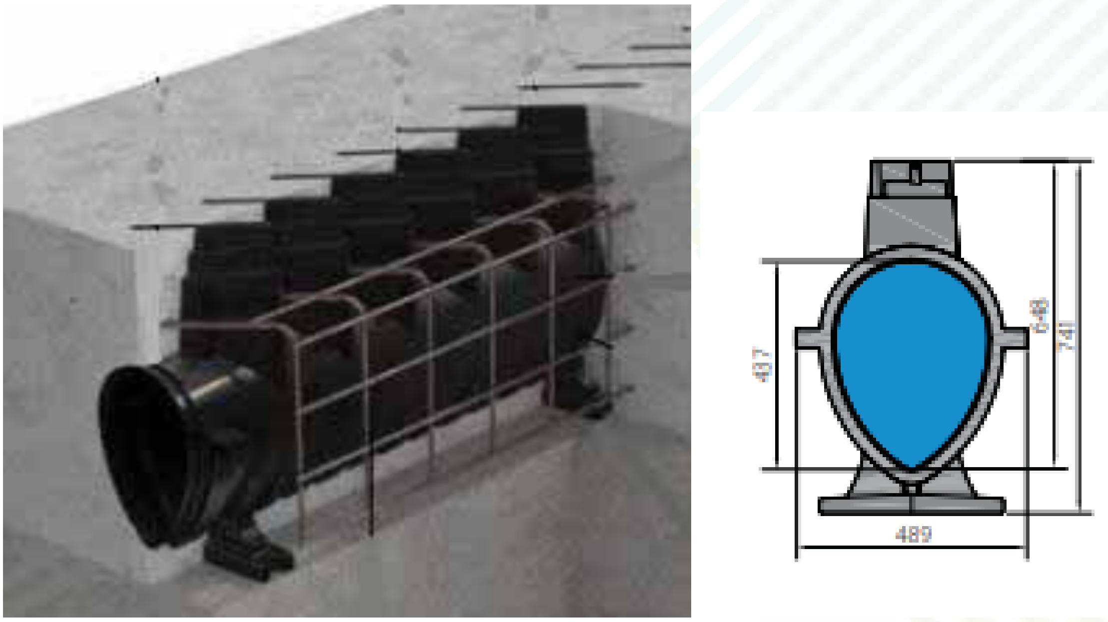
6 Increasing the Standard of Protection to 1:200year Event

Options 1, 2 and 4 offer the possible option of increasing the standard of protection up to the 1:200 year event (excluding Climate Change) if additional drainage was provided on Argyll Road to catch any overspill from the surface water channel. The total flow generated under the 1:200 year event from the catchments above Argyll Road is 1.05m3/s. Given that the proposed schemes utilising the existing channel will account for the 1:50 year event, 0.75m3/s, this leaves approximately 0.27m3/s to be conveyed by other means.

6.1.1 This option will consist of the following actions:

- Undertake the works associated with options 1, 2 or 4.
- Excavate a 0.8m wide, 1m deep trench against the toe of the existing high capacity kerbing of the surface water channel. The trench will run from the new collection pit created in the proposed options for 50m to the east and 70m to the west. This has been taken as approximately half of the total distance of the east and west run respectively.
- Install 130m of Drexus XL 425 linear drainage complete with lightly reinforced concrete surround.

Figure 6-1: Drexus XL 425 installation and cross section



- Connect the linear drainage to the new collection chamber.

- Increase the pipe size under Argyll Road to 750mm diameter precast concrete.

6.1.2 Benefits of proposed scheme

- This will offer a level of protection of up to 1:200 year event for all properties known to be affected by flooding in the Argyll Road and Tigh Dearg Road area.

6.1.3 Assumptions and risk

- The interception rate of the chosen high capacity linear drain will affect the standard of protection that can be offered. At this stage a conservative distance of half the total run length has been assumed.
- The trench required to construct the linear drainage may clash with services. The linear drainage run could be moved to the southern side of the road against the kerb if required.

6.1.4 Costs

Item	Quantity	Units	Unit cost	Cost	Source
High Capacity Linear Drainage Argyll Road					
Additional site time required	1	week	2950.02	2950.02	CESMM3 Unit Costs
Increase pipe under Argyll Road 525mm to 750mm diameter	20	m	62.09	1241.8	CESMM3 Unit Costs
Excavate 0.8m x 1m x 70m trench down along Argyll Road	56	m3	3.41	190.96	CESMM3 Unit Costs
Disposal of excavated material	56	m3	50	2800	CESMM3/estimate
Place 100-150mm thick concrete surround (assumed C30)	34	m3	97.80	3325.2	Marshalls
Install Drexus XL 425 units (2m lengths)	35	No.	197.67	6918.45	Marshalls
Cast concrete cover to road level (assumed C30)	12	m3	97.80	1173.6	CESMM3 Unit Costs
Subtotal				**18600.03**	
Construction inflation index adjustment (2016 to 2019)	10.1	%	-	20478.63	OFNS
Optimism Bias	60	%	-	32765.81	
Detailed design costs	19	%	-	6225.50	
Total				**£38991**	**cost in addition to other options

7 Damages and benefits assessment

7.1 Guidance

In accordance with the Scottish Government's Appraisal Guidance, benefits are taken as Annual Average Damages (AAD) avoided by scheme options expressed as their Present Value (PV) using Treasury discount rates.

7.2 Damage methodology

Flood losses for this site can be broken down into two key aspects: direct flood damage to the 5 properties at risk; and indirect road damage repairs and clean up costs. Wider health and wellbeing aspects may also be applicable, along with road disruption and delay, but these are not considered to be significant at this stage.

Flood damages to properties are usually assessed for individual events and properties, or using higher level 'weighted annual average damage' datasets. SEPA's SPAADE dataset is recommended for SWMP studies and has been used here. The standard value of £1,100 (2010 values) has been updated to 2019 values using the Government GDP deflator series (2019 estimate of £1,284). It should be noted that the previous Grontmij study used a slightly higher value of £1,791 per property.

In order to determine the benefits of the scheme for a range of different standards of protection, the SPAADE value has been scaled using a weighting derived from FHRC's Weighed Annual Average Damage (WAAD) dataset.

The SPAADE values have been applied to each property and total present values over the appraisal period have been estimated by discounting future flood losses over a 100 year period.

7.3 Business case

In order to assess the economical viability of each option an analysis of the estimated construction costs versus the present value damages has been undertaken. The benefit-cost ratio is the total present value benefits divided by the total present value costs. A value above unity suggests that the scheme is economically viable. Further details on the cost analysis undertaken can be found in appendix B.

Table 7-1: Benefit-cost analysis of options

	Do Nothing	Option 1	Option 2	Option 3	Option 4
Level of protection offered	0	1:50yr	1:50yr	1:10yr	1:50yr
Estimated construction cost	0	£176,080	£240,467	£197,985	£196,432
Annual average damages	£6,422	£410	£410	£2,008	£410
Present Value damages	£191,454	£12,218	£12,218	£59,864	£12,218
Annual average road clean-up	£4,000	£0	£0	£0	£0
Present Value road clean-up	£119,252	£0	£0	£0	£0
Total PV damage	£310,706	£12,218	£12,218	£59,864	£12,218
Total PV benefits	-	£298,488	£298,488	£250,842	£298,488
Cost benefit ratio	-	1.7	1.2	1.3	1.5

All options have a benefit cost ratio greater than 1, thus all are considered to be cost effective. Option 1 has the highest benefit-cost ratio and would be considered to be the preferred option economically.

As previously discussed, it is possible to lift the standard of protection offered by the options above by adding additional high capacity linear drainage along Argyll Road and increasing the pipe diameter under Argyll Road. The business case of the options can be explored below.

Table 7-2: Benefit-cost analysis of options

	Do Nothing	Option 1a	Option 2a	Option 4a
Level of protection offered	0	1:200yr	1:200yr	1:200yr
Estimated construction cost	0	£215,071	£279,458	£235,423
Annual average property damage	£6,422	£52	£52	£52
Present Value property damages	£191,454	£1,542	£1,542	£1,542
Annual average road clean-up	£4,000			
Present Value road clean-up	£119,252	0	0	0
Total PV damage	£310,706	£1,542	£1,542	£1,542
Total PV benefits	-	£309,164	£309,164	£309,164
Cost benefit ratio	-	1.4	1.1	1.3

All options have a benefit cost ratio greater than 1, thus all are considered to be cost effective. Option 1a has the highest benefit-cost ratio and would be considered to be preferred option economically.

8 Choosing the Preferred Option

8.1 Method of assessing and prioritising options

The assessment process aims to scope measures that will achieve multiple objectives in the context of site constraints and future development. A Multi-Criteria Assessment (MCA) screening exercise has been completed to consider the relative merits of each measure. It is recognised that it is important to ensure options are compared thoroughly, consistently and carefully reviewing options against the following criteria:

- Technical Feasibility – is it easily implemented?
- Relative Cost – how expensive is it in comparison to other measures?
- Economic Viability – is it expensive to implement?
- Social Impact and Acceptability – how will it impact on residents?
- Environmental – how will it impact the environment?
- Sustainability – is it a sustainable approach?

Detailed cost estimates have not been prepared as the funding and delivery mechanisms are not yet known. Each management option will be scored against each of the criteria set out above using relative indicator, in line with UK guidance:

- **U** - not applicable or unacceptable outcome
- **-2** - severely negative outcome
- **-1** - moderately negative outcome
- **0** - neutral outcome
- **+1** - moderately positive outcome, or
- **+2** - strongly positive outcome

The measures with the lowest overall combined scores from the MCA will be screened out to produce a short list of preferred options. The short-listed mitigation measures provide the starting point for a more detailed economic assessment should stakeholders such as Argyll and Bute Council and/or Scottish Water wish to take any of the sites further and implement surface water management measures.

Mitigation Measures	Technical	Relative Cost	Economic	Social Impact	Environment	Sustainability	Overall	Shortlist?
Option 1 Concrete culvert	+2	+1	+1	+2	+2	+1	7	Yes
Option 2 – Max E 630	-1	-1	-2	+2	+2	+1	1	No
Option 3 – Max E 325	+1	0	-1	+1	+2	+1	4	maybe
Option 4 – Max E 325 + Road depression	+1	0	-1	+2	+2	+1	5	maybe

8.2 Determining the preferred option

The results of the MCA analysis above shows Options 1 is most favourable however, options 3 and 4 should be considered further.

Options 3 and 4 are essentially the same with Option 4 allowing overland flow down Tigh Dearg Road which can convey flows up to the 1:50 year event. The overland flows at the 1:50 year event is fast (3.85m/s) but very shallow (0.1m). There is, however, no way to limit the flows for events beyond the 1:50 year return period in which the overland flow will be slightly deeper and faster hence more hazardous. The velocities and depths could be determined by 2D hydraulic modelling which would help identify the risk and hazards associated with the overland flow.

The component part of both options is the Max E 325 channel. The main benefit of the Max- E 325 channel is that it's very shallow construction (up to 0.6mbgl) which will likely be above the various utilities present on Tigh Dearg Road and be relatively straight forward to construct. However, the limited depth results in limited capacity only accommodating flows up to 1:10 year event before surcharging occurs. This is substantially lower than the potential capacity of Option 1 which is also significantly cheaper. The only scenario in which Options 3 and 4 can be considered is if the utilities in Tigh Dearg Road are too complex to allow for Option 1 to be constructed.

9 Further studies

In order to progress to the preferred options, it would be prudent to undertake additional investigations to ensure the feasibility of the proposed options before the detailed design stage.

- Topographic survey of Argyll Road, Tigh Dearg Road, Shore Road and waterfront.
- Confirm service location and depths in Argyll Road, Tigh Dearg Road and Shore Road using a ground penetrating radar (GPR) survey and/or inspection pits.
- 2D hydraulic model to asses overland flow paths pre/post construction (requires topographical survey).

The design could progress to construction without undertaking such surveys however, this would increase project risk substantially and possibly lead to complication and ultimately increase expense during construction.

10 Conclusion

The analysis undertaken in this options appraisal study on flood risk mitigation measures at Tigh Dearg Road has provided a preferred option based on the information available. The preferred option is Option 1/1a which involves:

- Refurbishing the existing surface water channel on Argyll Road to increase the overall capacity to 1:50 year event.
- Construct a new wider collection chamber/screen and disconnect from the combined sewer.
- Install a 525mm diameter concrete pipe under Argyll Road to a new manhole near the top of Tigh Dearg Road.
- Install a 450mm diameter concrete pipe under Tigh Dearg Road incorporating multiple manholes and bend units to navigate the tight geometry.
- Continue the 450mm diameter concrete pipe under Shore Road and construct a new outfall.
- Option to increase the pipe size under Argyll Road and incorporate high capacity linear drainage in Argyll Road to raise the standard of protection to the 1:200 year event.

This option has an estimated construction cost of approximately £108,351 (£134,443 for 1:200yr) which includes an optimism bias of 60% which is standard at this level of design. The option explained above and indeed all of the options require further information and design in order to analyse detailed costs and risks.

Appendices

A Hydrological Assessment

NOTE TO FILE

JBA Project Code: 2018s0549
Contract: Kilcreggan – Tigh Dearg Road
Client:
Day, Date and Time: 26/02/2019
Author: Sam Cogan
Subject: Hydrology/Peak flow re-assessment NTF

1 Background and Scope

In 2010, Grontmij were appointed by Argyll & Bute Council to investigate flooding problems at Tigh Dearg Road, Kilcreggan. Kilcreggan is a small village at the foot of Aiden Hill on the southern tip of Rosneath Peninsula in Argyll. Tigh Dearg Road is situated to the east of the village and is a steep, narrow access road which connects Argyll Road and Shore Road.

The objective of the 2010 study was to alleviate flooding of properties in Argyll Road (between "Ardoch" and "Cedars"), Tigh Dearg Road and "Auchendarroch" on Shore Road. The flooding is caused by overland flow from Barbour Road, which overtops the drainage systems in Argyll Road, and overland flow from properties at the rear of "Auchendarroch". Tigh Dearg Road in Kilcreggan has a long history of surface water flooding due to overland flow from the steep hillside which the town is situated on. Overland flow overwhelms existing drainage and flows to the natural low point at the top of Tigh Dearg Road. In doing so it can often flood the neighbouring properties on Argyll Road causing substantial interior and exterior damage.

The 2010 study proposed a drainage scheme which included upgrading the combined sewer beneath Tigh Dearg Road, creating new drainage on Barbour Road & Argyll Road and new manholes and pipe work linking Barbour Road to Tigh Dearg Road. The study was never taken forward due to an unfavourable cost benefit ratio.

On the whole, JBA aims to build on the knowledge gained from the 2010 study and proposed alternative flood mitigation methods which have a smaller financial impact but still provide residents with a suitable level of protection (which is variable at this stage, currently floods at less than the 1:2yr event). However, as the previous study was undertaken in 2010, the peak flow levels derived by Grontmij are unlikely to be suitable for this assessment. Therefore, an update to peak flows is required.

The primary purpose of the hydrological study is to re-assess the flows that reach the top of Tigh Dearg Road that were derived during the initial 2010 study by Grontmij.

The return periods required for this study are:

- 2
- 5
- 10
- 30
- 50
- 100
- 200
- 200 with an allowance for climate change

2 Catchment Delineation and Peak Flow Estimation Methodology

Details of how the areas draining to Tigh Dearg Road have been determined and the approach for estimating peak flows generated from each of the drainage areas are provided in the subsequent sections.

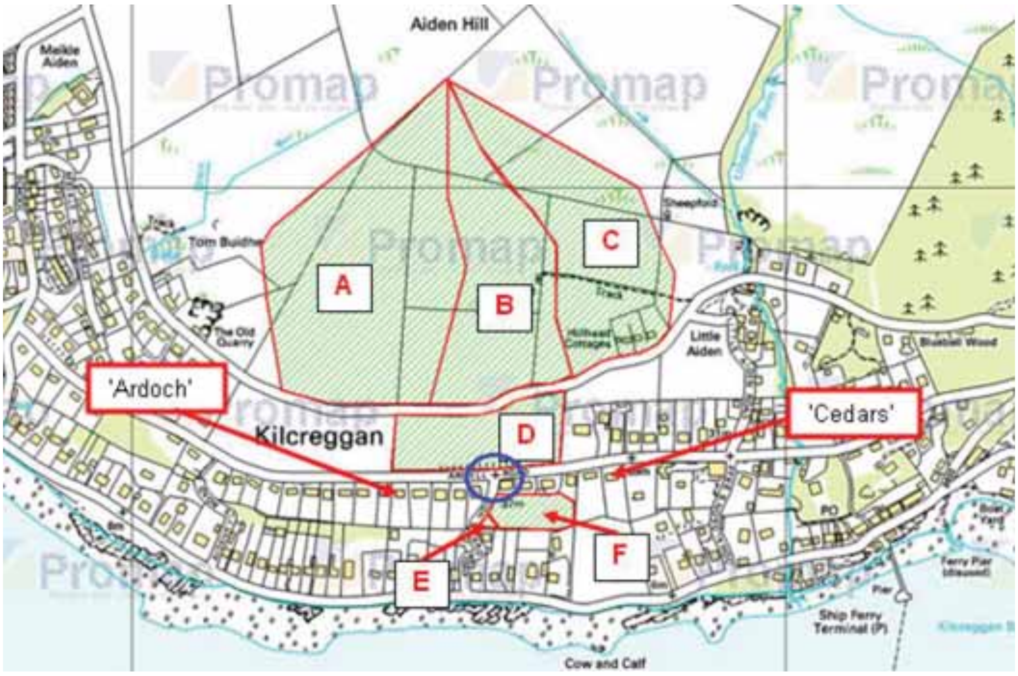
2.1 Catchment Delineation

Drainage areas which route to a topographical low point at the top of Tigh Dearg Road are based on those derived within the Grontmij 2010 study (See Table 2-1 and Figure 2-1, below). The catchment boundaries were checked against Ordnance Survey mapping and found reasonable for re-use in this current study without any further modifications.

Table 2-1 Respective catchment areas

Site	Area (km^2)
A	0.104
B	0.055
C	0.062
D	0.024
E	0.001
F	0.010

Figure 2-1: Grontmij 2010 defined catchment extents and naming convention.



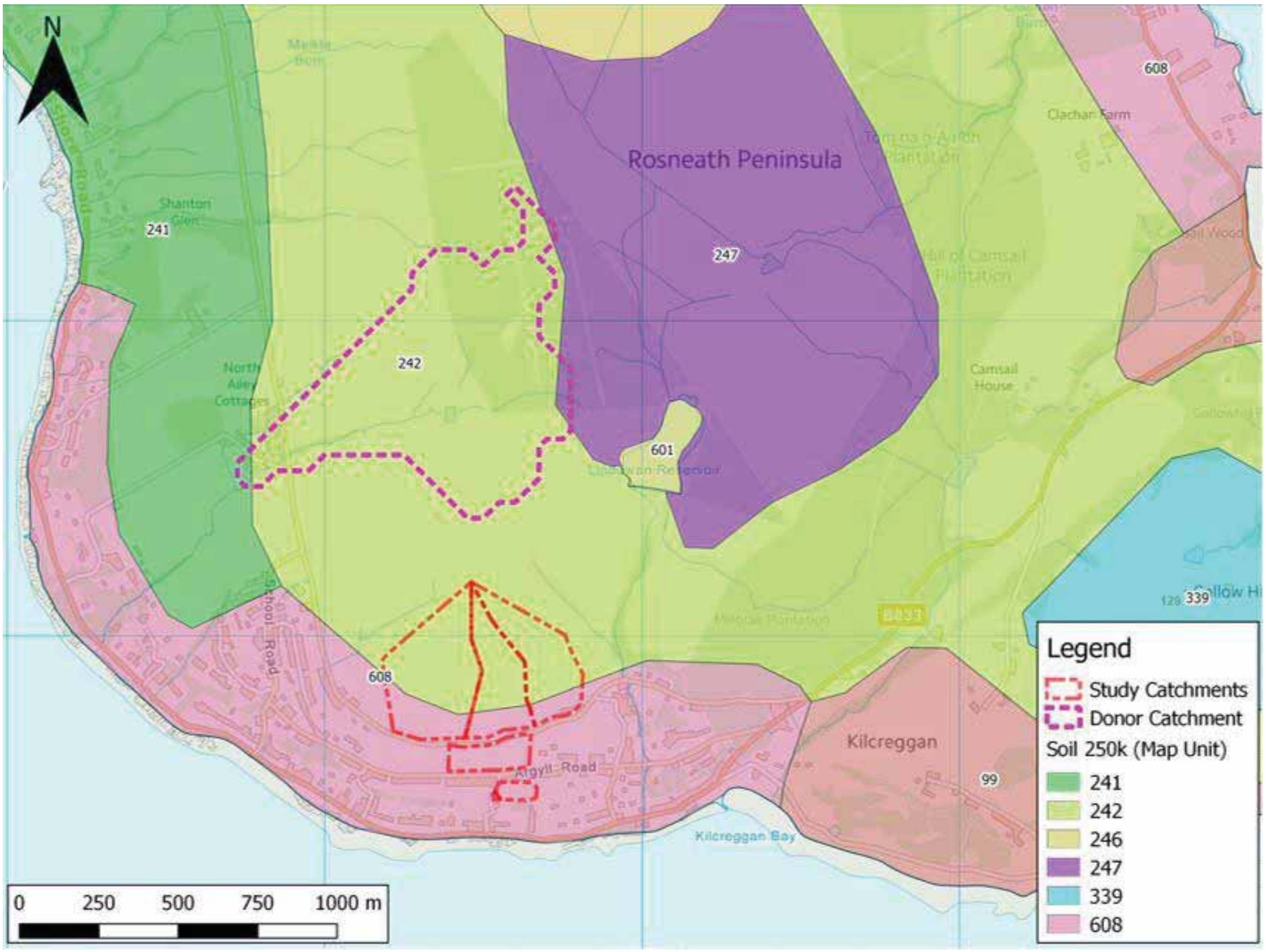
2.2 Catchment Descriptors

The Grontmij 2010 study states the catchment areas and shows catchment extent only. In order to derive estimates of peak flood flows, FEH catchment descriptors are required. The FEH web service defines the catchment area, and catchment descriptors for catchments >0.5km²; as the drainage areas are all <0.5km², catchment descriptors are not directly available. The preferred method for estimating flow in catchments smaller than 0.5km² is to use a suitably sized donor catchment with similar catchment descriptors and to scale the donor flow estimates by the ratio of catchment areas[1].

2.2.1 Donor catchment

Catchment descriptors were extracted for a nearby rural catchment shown to have a broadly similar distribution of soil type and assumed to be similar in other respects such as annual rainfall, catchment wetness (PROPWET) etc. Key FEH catchment descriptors are presented in Table 2-2.

Figure 2-2: Donor catchment location overlain on 1:250,000 scale National Soil Map.



[1] SEPA (2018) Technical Flood Risk Guidance for Stakeholders - SEPA requirements for undertaking a Flood Risk Assessment - Version 10, July 2018

Table 2-2 Key catchment descriptors extracted for donor catchment

Desciptor	Value
AREA	0.51
ALTBAR	131
BFIHOST	0.373
DPLBAR	0.80
DPSBAR	76.4
FARL	1.00
FPEXT	0.015
LDP	1.51
PROPWET	0.74
SAAR	1649
SPRHOST	29.4
URBEXT1990	0.00
URBEXT2000	0.00

2.3 Peak Flow Estimation

This study will derive updated flows using the Revitalised Flood Hydrograph method (ReFH2) and compare them to the flows stated within the Grontmij 2010 study.

As stated, the preferred approach for estimating flow in catchments smaller than 0.5km² is to derive peak flow estimates for a suitable donor catchment and to scale the estimates by the ratio of catchment areas.

2.3.1 Donor Peak Flow Estimates

Estimates of peak flood flows were derived for the donor catchment shown in Figure 2-2 using the recommended storm duration given by the ReFH2 software, i.e. 02:42 (2.7hr).

The critical storm duration - i.e. that which produces the greatest flow (or water level) at the study site - was assessed through an iterative approach whereby storm duration was incrementally increased until peak flow was no longer observed to increase, but rather decrease.

For the donor catchment the critical storm duration for the 200-year return period was found to be 02:30 (2.5hr); for the 100-year, 75-year and 50-year the critical storm duration was found to be the recommended duration i.e. 02:42 (2.7hr) and for the 30-year, 10-year, 5-year and 2-year return periods critical storm duration was found to be slightly greater i.e. 03:06 (3.1hr). Estimated peak flows for the donor catchment are shown in Table 2-3. those values highlighted in yellow, are the final adopted donor catchment peak flow estimates.

Table 2-3 Estimated donor peak flows for varying storm duration.

Storm Duration (Hours: Minutes)	02:30	02:42	02:54	03:06	03:18
Time Step (Hours: Minutes)	00:06	00:06	00:06	00:06	00:06
Return period (years)	Flow (m³/s)				
2	0.610	0.619	0.628	0.635	0.640
5	0.884	0.892	0.899	0.904	0.908
10	1.083	1.090	1.095	1.098	1.101
30	1.417	1.421	1.423	1.423	1.422
50	1.585	1.587	1.587	1.586	1.583
75	1.725	1.726	1.725	1.723	1.719
100	1.829	1.830	1.828	1.825	1.820
200	2.104	2.103	2.099	2.094	2.086

2.3.2 Subject Catchment Peak Flow Estimates

Estimates of peak flood flows were derived for the subject catchments by scaling the estimates of peak flow from Table 2-3 by the ratio of catchment areas. Resulting flows are presented in Table 2-4. It should be noted that the flows presented in Table 2-4 represent rural peak flow estimates, i.e. as the donor catchment adopted has an URBEXT value of zero, no consideration to any urban influence is included in the flow estimates presented in Table 2-4.

Table 1-4 Estimated subject site peak flows (rural).

	Return period (years)							
	2	5	10	30	50	75	100	200
Site	Flow (m³/s)							
A	0.13	0.18	0.22	0.29	0.32	0.35	0.37	0.43
B	0.07	0.10	0.12	0.15	0.17	0.19	0.20	0.23
C	0.08	0.11	0.13	0.17	0.19	0.21	0.22	0.25
D	0.03	0.04	0.05	0.07	0.07	0.08	0.09	0.10
E	0.0012	0.0018	0.0021	0.0028	0.0031	0.0034	0.0036	0.0041
F	0.012	0.018	0.021	0.028	0.031	0.034	0.036	0.041

Of the six subject catchments considered, only catchments C and E are shown by 1:50,000 scale Ordnance Survey mapping as containing areas of urban/built development, all others are completely rural and hence no adjustment to the peak flow estimate in Table 2-4 required.

Table 2-5 presents URBAN50k values, a measure of catchment urban extent, for catchments C and E. Resulting Urban Adjustment Factors (UAF) are calculated using the method incorporated in WINFAP v4. Final flows for catchments C and E are derived by multiplying the peak flow estimates presented in Table 2-4 by the calculated UAFs presented in Table 2-5.

Table 2-5 Calculated Urban Adjustment Factors

Site/Catchment	URBAN50k	UAF (WINFAP-FEH V4)
C	0.004	1.002
E	0.002	1.001

2.3.3 Climate change allowance

The scope calls for an allowance for climate change to be applied to the 200-year peak flow estimate. SEPA's recommendation is a minimum allowance of +20%[2], however some local authorities may request a higher standard. An uplift of 20% is applied to the 200-year peak flow estimate.

2.3.4 Final Peak Flows

Table 2-6 Final Peak Flows

Site	Return period (years)								
	2	5	10	30	50	75	100	200	200 CC
	Flow (m^3/s)								
A	0.13	0.18	0.22	0.29	0.32	0.35	0.37	0.43	0.51
B	0.07	0.10	0.12	0.15	0.17	0.19	0.20	0.23	0.27
C	0.08	0.11	0.13	0.17	0.19	0.21	0.22	0.26	0.31
D	0.03	0.04	0.05	0.07	0.07	0.08	0.09	0.10	0.12
E	0.0012	0.0018	0.0021	0.0028	0.0031	0.0034	0.0036	0.0041	0.0049
F	0.012	0.018	0.021	0.028	0.031	0.034	0.036	0.041	0.049

[2] SEPA (2018) Technical Flood Risk Guidance for Stakeholders - SEPA requirements for undertaking a Flood Risk Assessment - Version 10, July 2018

2.3.5 Comparison to 2010 study

Table 2-7 Comparison of peak flow estimates for the 30-year and 200-year CC design events

Study	Return Period	A	B	C	D	E	F
		Peak Flow (m^3/s)					
2010	30-year	0.23	0.13	0.14	0.03	0.004	0.04
2019	30-year	0.29	0.15	0.17	0.07	0.003	0.03
2010	200-year CC	0.43	0.24	0.27	0.12	0.007	0.07
2019	200-year CC	0.51	0.27	0.31	0.12	0.005	0.05

Peak flows derived under this current study are broadly consistent with those derived in the earlier 2010 study. Flows for catchments A-D are shown to have increased from relative to those derived within 2010. Whilst peak flows for catchments E and F have decreased slightly.

The Grontmij study adopted the Institute of Hydrology 124 method for deriving flows whereas the current study has adopted the ReFH2 method utilising the latest FEH-2013 DDF model. The general agreement between the final estimates and those previously derived gives some degree of confidence in the current estimates.

B Economic Analysis

Project Summary Sheet

Client/Authority	Prepared (date)	28/06/2019
Argyll and Bute Council	Printed	30/10/2019
Project name	Prepared by	AEP
Kilcreggan options appraisal	Checked by	RD
Project reference 2018s0549	Checked date	28/06/2019

Base date for estimates (year 0)	Jun-2019		
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)	
Year	0	30	75
Discount Rate	3.5%	3.00%	2.50%
Optimism bias adjustment factor	60%		

Costs and benefits of options

	Costs and benefits £				
Option name	Do-nothing	Option 1	Option 2	Option 3	Option 4
AEP or SoP (where relevant)	50%	2%	2%	10%	2%
COSTS:					
PV capital costs	0	110,050	150,292	123,741	122,770
PV operation and maintenance costs	0	0	0	0	0
PV other	0	0	0	0	0
Optimism bias adjustment	0	66,030	90,175	74,244	73,662
PV negative costs (e.g. sales)	0	0	0	0	0
PV contributions					
Total PV Costs £ excluding contributions	0	176,080	240,467	197,985	196,432
BENEFITS:					
PV monetised flood damages	191,454	12,218	12,218	59,864	12,218
PV monetised flood damages avoided		179,236	179,236	131,590	179,236
PV road drainage and clearing	119,252	0	0	0	0
PV road drainage and clearing avoided		119,252	119,252	119,252	119,252
Total monetised PV damages £	310,706	12,218	12,218	59,864	12,218
Total monetised PV benefits £		298,488	298,488	250,842	298,488
PV damages (from scoring and weighting)					
PV damages avoided/benefits (from scoring and weighting)					
PV benefits from ecosystem services					
Total PV damages £	310,706	12,218	12,218	59,864	12,218
Total PV benefits £		298,488	298,488	250,842	298,488
DECISION-MAKING CRITERIA:					
***Based on monetised PV benefits (** excludes benefits from scoring and weighting and ecosystem services)*					
Net Present Value **NPV**		122,408	58,021	52,857	102,056
Average benefit/cost ratio **BCR**		1.7	1.2	1.3	1.5
		Highest bcr			

Brief description of options:

Option 1	Do-nothing
Option 2	Option 1
Option 3	Option 2
Option 4	Option 3
Option 5	Option 4

Comments and assumptions:

CLIENT	**Argyll and Bute Council**		Mandatory input by user
PROJECT	**Kilcreggan options appraisal**		Optional input by user
SUMMARY			Calculated by spreadsheet

PART 1: PROJECT DESCRIPTION

Project name	Kilcreggan options appraisal
Project reference	2018s0549
Project location	**Kilcreggan options appraisal**

PART 2: GENERALITIES

Test discount rate	3.5%	3.0%	2.5%
Appraisal period (years)	100		
PV factor for appraisal period	29.813		

PART 3: CALCULATION OF BENEFITS

3.1 Define the benefit area

Residential properties at risk for 200 year event (nr)	5	
Average property value (£)	149,036	
Flood warning? (None/<8 hour/>8 hour)	None	0

3.2 Direct damage to residential properties

	Standard of protection (return period)	**Properties at risk**	**Properties protected (default)**	**Properties protected (default)**	**AAD per property**	**Total AAD**
		nr	**%**	**nr**	**£**	**£**
1	No protection	0	n/a	0	£ 1,284	£ -
0.5	50% (2-years)	5	n/a	0	£ 1,284	£ 6,422
0.2	20% (5-years)	0	5%	0.25	£ 780	£ -
0.1	10% (10-years)	0	10%	0.25	£ 402	£ -
0.04	4% (25-years)	0	25%	0.75	£ 192	£ -
0.02	2% (50-years)	0	80%	2.75	£ 82	£ -
0.01	1% (100-years)	0	93%	0.65	£ 20	£ -
0.005	0.5% (200-years)	0	100%	0.35	£ 10	£ -
	Total	**5**		**5**		**£ 6,422**
	PV damage (PVd)					**£ 191,454**
	Write-off value					£ 745,180
	PVd capped					**£ 191,454**

3.3 Direct damage to non-residential properties

Standard of protection (return period)	**Retail**	**Offices**	**Warehouses**	**Leisure**	**Playing Field**	**Sports Centre**	**Marina**	**Sports Stadium**	**Public Buildings**	**Industry**	**Car park**	**SubStation**	**NRP sector average**	**Total AAD**
Properties protected	**2**	**3**	**4**	**51**	**521**	**523**	**526**	**525**	**6**	**8**	**910**	**960**		
	nr	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**£**
No protection														£ -
20% (5-years)														£ -
10% (10-years)														£ -
4% (25-years)														£ -
2% (50-years)														£ -
1% (100-years)														£ -
0.5% (200-years)														£ -
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**£ -**
PVd non-residential														**£ -**

3.4 Other flood losses: road disruption and emergency costs

		Property Count	**Percentage Properties**	**Percentage Damage**	
Direct damage: residential		5	100.0%	100.0%	£ 191,454
Direct damage: non-residential		0	0.0%	0.0%	£ -
Sub-total: direct damage	**Total**	**5**	**100%**	**100%**	**£ 191,454**
TOTAL PVd					**£ 191,454**

CLIENT	Argyll and Bute Council		Mandatory input by user
PROJECT	Kilcreggan options appraisal		Optional input by user
SUMMARY			Calculated by spreadsheet

PART 1: PROJECT DESCRIPTION

Project name	Kilcreggan options appraisal
Project reference	2018s0549
Project location	**Kilcreggan options appraisal**

PART 2: GENERALITIES

Test discount rate	3.5%	3.0%	2.5%
Appraisal period (years)	100		
PV factor for appraisal period	29.813		

PART 3: CALCULATION OF BENEFITS

3.1 Define the benefit area

Residential properties at risk for 200 year event (nr)	5	
Average property value (£)	149,036	
Flood warning? (None/<8 hour/>8 hour)	None	0

3.2 Direct damage to residential properties

	Standard of protection (return period)	**Properties at risk**	**Properties protected (default)**	**Properties protected (default)**	**AAD per property**	**Total AAD**
		nr	**%**	**nr**	**£**	**£**
1	No protection	0	n/a	0	£ 1,284	£ -
0.5	50% (2-years)	0	n/a	0	£ 1,284	£ -
0.2	20% (5-years)	0	5%	0.25	£ 780	£ -
0.1	10% (10-years)	5	10%	0.25	£ 402	£ 2,008
0.04	4% (25-years)	0	25%	0.75	£ 192	£ -
0.02	2% (50-years)	0	80%	2.75	£ 82	£ -
0.01	1% (100-years)	0	93%	0.65	£ 20	£ -
0.005	0.5% (200-years)	0	100%	0.35	£ 10	£ -
	Total	**5**		**5**		**£ 2,008**
	PV damage (PVd)					**£ 59,864**
	Write-off value					£ 745,180
	PVd capped					**£ 59,864**

3.3 Direct damage to non-residential properties

Properties protected

Standard of protection (return period)	**Retail**	**Offices**	**Warehouses**	**Leisure**	**Playing Field**	**Sports Centre**	**Marina**	**Sports Stadium**	**Public Buildings**	**Industry**	**Car park**	**SubStation**	**NRP sector average**	**Total AAD**
	2	**3**	**4**	**51**	**521**	**523**	**526**	**525**	**6**	**8**	**910**	**960**		
	nr	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**£**
No protection														£ -
20% (5-years)														£ -
10% (10-years)														£ -
4% (25-years)														£ -
2% (50-years)														£ -
1% (100-years)														£ -
0.5% (200-years)														£ -
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**£ -**
PVd non-residential														**£ -**

3.4 Other flood losses: road disruption and emergency costs

		Property Count	**Percentage Properties**	**Percentage Damage**	
Direct damage: residential		5	100.0%	100.0%	£ 59,864
Direct damage: non-residential		0	0.0%	0.0%	£ -
Sub-total: direct damage	**Total**	**5**	**100%**	**100%**	**£ 59,864**
TOTAL PVd					**£ 59,864**

CLIENT	Argyll and Bute Council		Mandatory input by user
PROJECT	Kilcreggan options appraisal		Optional input by user
SUMMARY			Calculated by spreadsheet

PART 1: PROJECT DESCRIPTION

Project name	Kilcreggan options appraisal
Project reference	2018s0549
Project location	**Kilcreggan options appraisal**

PART 2: GENERALITIES

Test discount rate	3.5%	3.0%	2.5%
Appraisal period (years)	100		
PV factor for appraisal period	29.813		

PART 3: CALCULATION OF BENEFITS

3.1 Define the benefit area

Residential properties at risk for 200 year event (nr)	5	
Average property value (£)	149,036	
Flood warning? (None/<8 hour/>8 hour)	None	0

3.2 Direct damage to residential properties

	Standard of protection (return period)	Properties at risk	Properties protected (default)	Properties protected (default)	AAD per property	Total AAD
		nr	%	nr	£	£
1	No protection	0	n/a	0	£ 1,284	£ -
0.5	50% (2-years)	0	n/a	0	£ 1,284	£ -
0.2	20% (5-years)	0	5%	0.25	£ 780	£ -
0.1	10% (10-years)	0	10%	0.25	£ 402	£ -
0.04	4% (25-years)	0	25%	0.75	£ 192	£ -
0.02	2% (50-years)	5	80%	2.75	£ 82	£ 410
0.01	1% (100-years)	0	93%	0.65	£ 20	£ -
0.005	0.5% (200-years)	0	100%	0.35	£ 10	£ -
	Total	**5**		**5**		**£ 410**
	PV damage (PVd)					**£ 12,218**
	Write-off value					£ 745,180
	PVd capped					**£ 12,218**

3.3 Direct damage to non-residential properties

Properties protected

Standard of protection (return period)	Retail	Offices	Warehouses	Leisure	Playing Field	Sports Centre	Marina	Sports Stadium	Public Buildings	Industry	Car park	SubStation	NRP sector average	Total AAD
	2	3	4	51	521	523	526	525	6	8	910	960		
	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	£
No protection														£ -
20% (5-years)														£ -
10% (10-years)														£ -
4% (25-years)														£ -
2% (50-years)														£ -
1% (100-years)														£ -
0.5% (200-years)														£ -
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**£ -**
PVd non-residential														**£ -**

3.4 Other flood losses: road disruption and emergency costs

		Property Count	Percentage Properties	Percentage Damage	
Direct damage: residential		5	100.0%	100.0%	£ 12,218
Direct damage: non-residential		0	0.0%	0.0%	£ -
Sub-total: direct damage	**Total**	**5**	**100%**	**100%**	**£ 12,218**
TOTAL PVd					**£ 12,218**

Project Summary Sheet

Client/Authority				Prepared (date)	28/06/2019
Argyll and Bute Council				Printed	30/10/2019
Project name				Prepared by	AEP
Kilcreggan options appraisal				Checked by	RD
Project reference	2018s0549			Checked date	28/06/2019
Base date for estimates (year 0)	Jun-2019				
Scaling factor (e.g. £m, £k, £)	£	(used for all costs, losses and benefits)			
Year	0	30	75		
Discount Rate	3.5%	3.00%	2.50%		
Optimism bias adjustment factor	60%				

Costs and benefits of options

	Costs and benefits £				
Option name	Do-nothing	Option 1a	Option 2a	Option 4a	
AEP or SoP (where relevant)	50%	0.5%	0.5%	0.5%	
COSTS:					
PV capital costs	0	134,419	174,661	147,139	
PV operation and maintenance costs	0	0	0	0	
PV other	0	0	0	0	
Optimism bias adjustment	0	80,651	104,797	88,284	
PV negative costs (e.g. sales)	0	0	0	0	
PV contributions					
Total PV Costs £ excluding contributions	0	215,070	279,458	235,423	
BENEFITS:					
PV monetised flood damages	191,454	1,542	1,542	1,542	
PV monetised flood damages avoided		189,912	189,912	189,912	
PV road drainage and clearing	119,252	0	0	0	
PV road drainage and clearing avoided		119,252	119,252	119,252	
Total monetised PV damages £	310,706	1,542	1,542	1,542	
Total monetised PV benefits £		309,164	309,164	309,164	
PV damages (from scoring and weighting)					
PV damages avoided/benefits (from scoring and weighting)					
PV benefits from ecosystem services					
Total PV damages £	310,706	1,542	1,542	1,542	
Total PV benefits £		309,164	309,164	309,164	
DECISION-MAKING CRITERIA:					
Based on monetised PV benefits (*ex* ***cludes benefits from scoring and weighting and ecosystem services)***					
Net Present Value **NPV**		94,094	29,706	73,741	
Average benefit/cost ratio **BCR**		1.4	1.1	1.3	
		Highest bcr			

Brief description of options:

Option 1	Do-nothing
Option 2	Option 1a
Option 3	Option 2a
Option 4	Option 4a
Option 5	

Comments and assumptions:

CLIENT	Argyll and Bute Council		Mandatory input by user
PROJECT	Kilcreggan options appraisal		Optional input by user
SUMMARY			Calculated by spreadsheet

PART 1: PROJECT DESCRIPTION

Project name	Kilcreggan options appraisal
Project reference	2018s0549
Project location	**Kilcreggan options appraisal**

PART 2: GENERALITIES

Test discount rate	3.5%	3.0%	2.5%
Appraisal period (years)	100		
PV factor for appraisal period	29.813		

PART 3: CALCULATION OF BENEFITS

3.1 Define the benefit area

Residential properties at risk for 200 year event (nr)	5	
Average property value (£)	149,036	
Flood warning? (None/<8 hour/>8 hour)	None	0

3.2 Direct damage to residential properties

	Standard of protection (return period)	Properties at risk	Properties protected (default)	Properties protected (default)	AAD per property	Total AAD
		nr	%	nr	£	£
1	No protection	0	n/a	0	£ 1,284	£ -
0.5	50% (2-years)	5	n/a	0	£ 1,284	£ 6,422
0.2	20% (5-years)	0	5%	0.25	£ 780	£ -
0.1	10% (10-years)	0	10%	0.25	£ 402	£ -
0.04	4% (25-years)	0	25%	0.75	£ 192	£ -
0.02	2% (50-years)	0	80%	2.75	£ 82	£ -
0.01	1% (100-years)	0	93%	0.65	£ 20	£ -
0.005	0.5% (200-years)	0	100%	0.35	£ 10	£ -
	Total	**5**		**5**		**£ 6,422**
	PV damage (PVd)					**£ 191,454**
	Write-off value					£ 745,180
	PVd capped					**£ 191,454**

3.3 Direct damage to non-residential properties

Properties protected

Standard of protection (return period)	Retail	Offices	Warehouses	Leisure	Playing Field	Sports Centre	Marina	Sports Stadium	Public Buildings	Industry	Car park	SubStation	NRP sector average	Total AAD
	2	3	4	51	521	523	526	525	6	8	910	960		
	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	nr	£
No protection														£ -
20% (5-years)														£ -
10% (10-years)														£ -
4% (25-years)														£ -
2% (50-years)														£ -
1% (100-years)														£ -
0.5% (200-years)														£ -
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**£ -**
PVd non-residential														**£ -**

3.4 Other flood losses: road disruption and emergency costs

		Property Count	Percentage Properties	Percentage Damage	
Direct damage: residential		5	100.0%	100.0%	£ 191,454
Direct damage: non-residential		0	0.0%	0.0%	£ -
Sub-total: direct damage	**Total**	**5**	**100%**	**100%**	**£ 191,454**
TOTAL PVd					**£ 191,454**

CLIENT	**Argyll and Bute Council**		Mandatory input by user
PROJECT	**Kilcreggan options appraisal**		Optional input by user
SUMMARY			Calculated by spreadsheet

PART 1: PROJECT DESCRIPTION

Project name	Kilcreggan options appraisal
Project reference	2018s0549
Project location	**Kilcreggan options appraisal**

PART 2: GENERALITIES

Test discount rate	3.5%	3.0%	2.5%
Appraisal period (years)	100		
PV factor for appraisal period	29.813		

PART 3: CALCULATION OF BENEFITS

3.1 Define the benefit area

Residential properties at risk for 200 year event (nr)	5	
Average property value (£)	149,036	
Flood warning? (None/<8 hour/>8 hour)	None	0

3.2 Direct damage to residential properties

	Standard of protection (return period)	**Properties at risk**	**Properties protected (default)**	**Properties protected (default)**	**AAD per property**	**Total AAD**
		nr	**%**	**nr**	**£**	**£**
1	No protection	0	n/a	0	£ 1,284	£ -
0.5	50% (2-years)		n/a	0	£ 1,284	£ -
0.2	20% (5-years)	0	5%	0.25	£ 780	£ -
0.1	10% (10-years)	0	10%	0.25	£ 402	£ -
0.04	4% (25-years)	0	25%	0.75	£ 192	£ -
0.02	2% (50-years)	0	80%	2.75	£ 82	£ -
0.01	1% (100-years)	0	93%	0.65	£ 20	£ -
0.005	0.5% (200-years)	5	100%	0.35	£ 10	£ 52
	Total	**5**		**5**		**£ 52**
	PV damage (PVd)					**£ 1,542**
	Write-off value					£ 745,180
	PVd capped					**£ 1,542**

3.3 Direct damage to non-residential properties

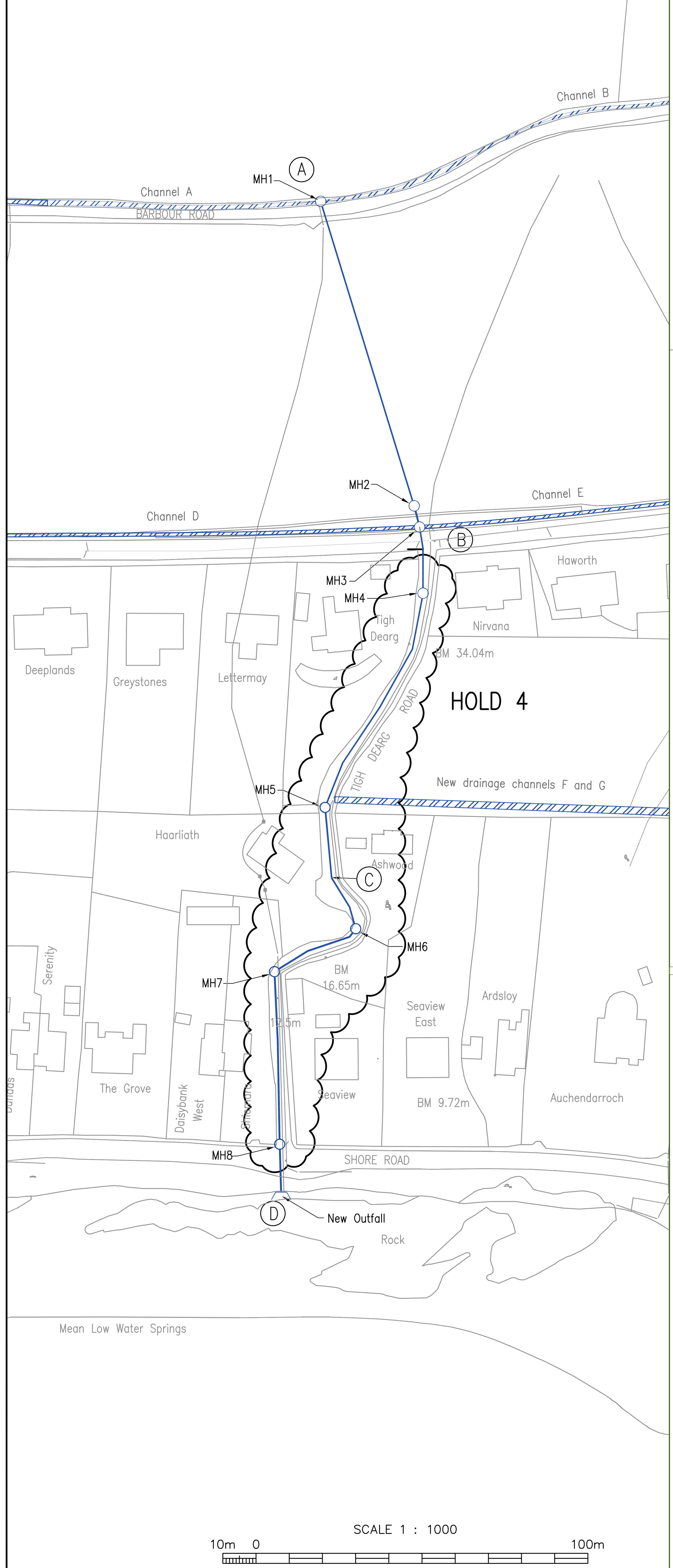
Standard of protection (return period)	**Properties protected**													
	Retail	**Offices**	**Warehouses**	**Leisure**	**Playing Field**	**Sports Centre**	**Marina**	**Sports Stadium**	**Public Buildings**	**Industry**	**Car park**	**SubStation**	**NRP sector average**	**Total AAD**
	2	**3**	**4**	**51**	**521**	**523**	**526**	**525**	**6**	**8**	**910**	**960**		
	nr	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**nr**	**£**
No protection														£ -
20% (5-years)														£ -
10% (10-years)														£ -
4% (25-years)														£ -
2% (50-years)														£ -
1% (100-years)														£ -
0.5% (200-years)														£ -
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**£ -**
PVd non-residential														**£ -**

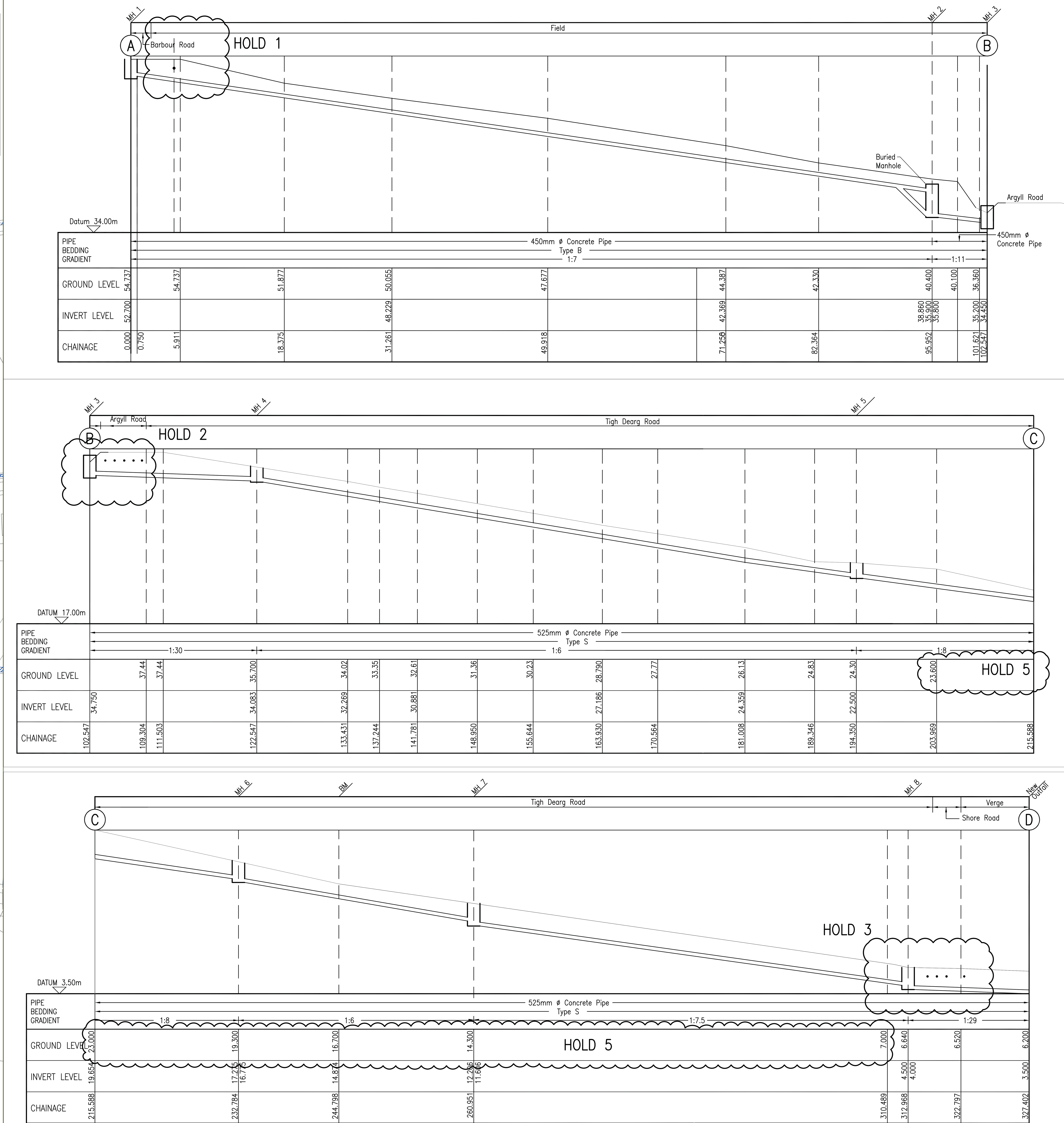
3.4 Other flood losses: road disruption and emergency costs

	Property Count	**Percentage Properties**	**Percentage Damage**	
Direct damage: residential	5	100.0%	100.0%	£ 1,542
Direct damage: non-residential	0	0.0%	0.0%	£ -
Sub-total: direct damage — **Total**	**5**	**100%**	**100%**	**£ 1,542**
TOTAL PVd				**£ 1,542**

C Drawing No. 102740-005-DRG-9604 (Kilcreggan Flood Study - Grontmij, 2010)

Hold	Date	Description
1	13.07.10	Invert levels of pipe subject to on site confirmation of water main
2	13.07.10	Invert levels of pipe subject to on site confirmation of telecom, combined sewer, water main, electricity.
3	13.07.10	Invert levels of pipe subject to on site confirmation of electricity and water mains.
4	13.07.10	Invert levels of pipe subject to on site confirmation of ground levels on Tigh Dearg Road, location and depths of combined sewer and telecom
5	06.08.10	Ground levels on Tigh Dearg Road to be confirmed (see Note 3).





LONGITUDINAL SECTION C-D

Scale 1:250

A1

Notes:

1. All dimensions in millimetres and all levels in metres AOD unless shown otherwise.
2. Surface Water on Argyll Road between "Cedars" and "Ardoch" drains into existing foul sewer.
3. Ground levels taken from DeneTech topograpgical survey information (April 2010), ground levels on Tigh Dearg Road to be confirmed by Contractor prior to pipework installation.
4. Refer to 102740-005-DRG-9601 for indicative utility locations, exact service locations and depths unknown. Contractor to confirm prior to pipework installation.
5. Invert levels on Tigh Dearg Road dependent on results of ground level survey and service depths confirmation.
6. Type B and S bedding to be in accordance with Manual of Contract Documents for Highway Works Volume 3 Highway Construction Details.

Reference Drawings:

102740-005-DRG-9601 - Existing Services Plan
102740-005-DRG-9602 - Proposed Drainage Layout
102740-005-DRG-9603 - Manhole & Channel Schedule
102740-005-DRG-9606 - Section Through MH2 and MH3

Legend:

Proposed surface water pipe

Proposed surface water channel

HEALTH AND SAFETY INFORMATION

IN ADDITION TO THE HAZARDS NORMALLY ASSOCIATED WITH THE TYPES OF WORK DETAILED ON THIS DRAWING, PLEASE NOTE THE FOLLOWING :
(SEE DRA REF. 102740-005-GEN-0001)

CONSTRUCTION PHASE	
Environmental issues – destruction of a possible conserved habitat/hedgerow.	Council/contractor will need to liaise with SEPA, SNH & other relevant statutory bodies prior to construction.
Tigh Dearg Road – Steep narrow road with several service crossings of unconfirmed depth and location. Pipe route/invert levels may have to be altered.	Ground levels and service depths/locations require confirmed prior to construction.
Significant overland flow through fields above Barbour Road and above Argyll Road during high rainfall events.	Contractor to be aware of weather forecasts and plan accordingly.
Ground conditions unknown (potentially large quantities of rock excavation required)	S.I. to confirm rockhead prior to commencing works.
SW OPs ACCESS – HORIZONTAL, VERTICAL, PEDESTRIAN, VEHICLE/PLANT	
Access required to manhole at Barbour Road & Argyll Road for maintenance of catchpit and removal of silt/debris.	Council to add removal of silt in these manholes to maintenance schedule and inspect manhole regularly to ensure no blockages.
SW OPs HANDLING / LIFTING STRATEGY	
N/A	N/A

IT IS ASSUMED THAT ALL WORKS WILL BE CARRIED OUT BY A COMPETENT PERSON WORKING, WHERE APPROPRIATE, TO AN APPROVED SAFE SYSTEM OF WORK

Current Issue Information:
0B Provided for Tender Issue

REV	DESCRIPTION	DRAWN	CHK'D	APP'D	DATE
0B	FOR TENDER	GW	SC	SC	15.09.10
0A	FOR INFORMATION	DJF	SC	CW	03.08.10

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CLIENT

Argyll & Bute COUNCIL

PROJECT

FLOOD MANAGEMENT PROGRAMME PHASE 1

TITLE

TIGH DEARG ROAD KILCREGGAN LONGITUDINAL SECTION

STATUS

FOR TENDER

ORIGINATED	DRAWN	CHECKED	APPROVED
SM	DJF	SC	CW
DATE 22.06.10	DATE 22.06.10	DATE 02.08.10	DATE 02.08.10

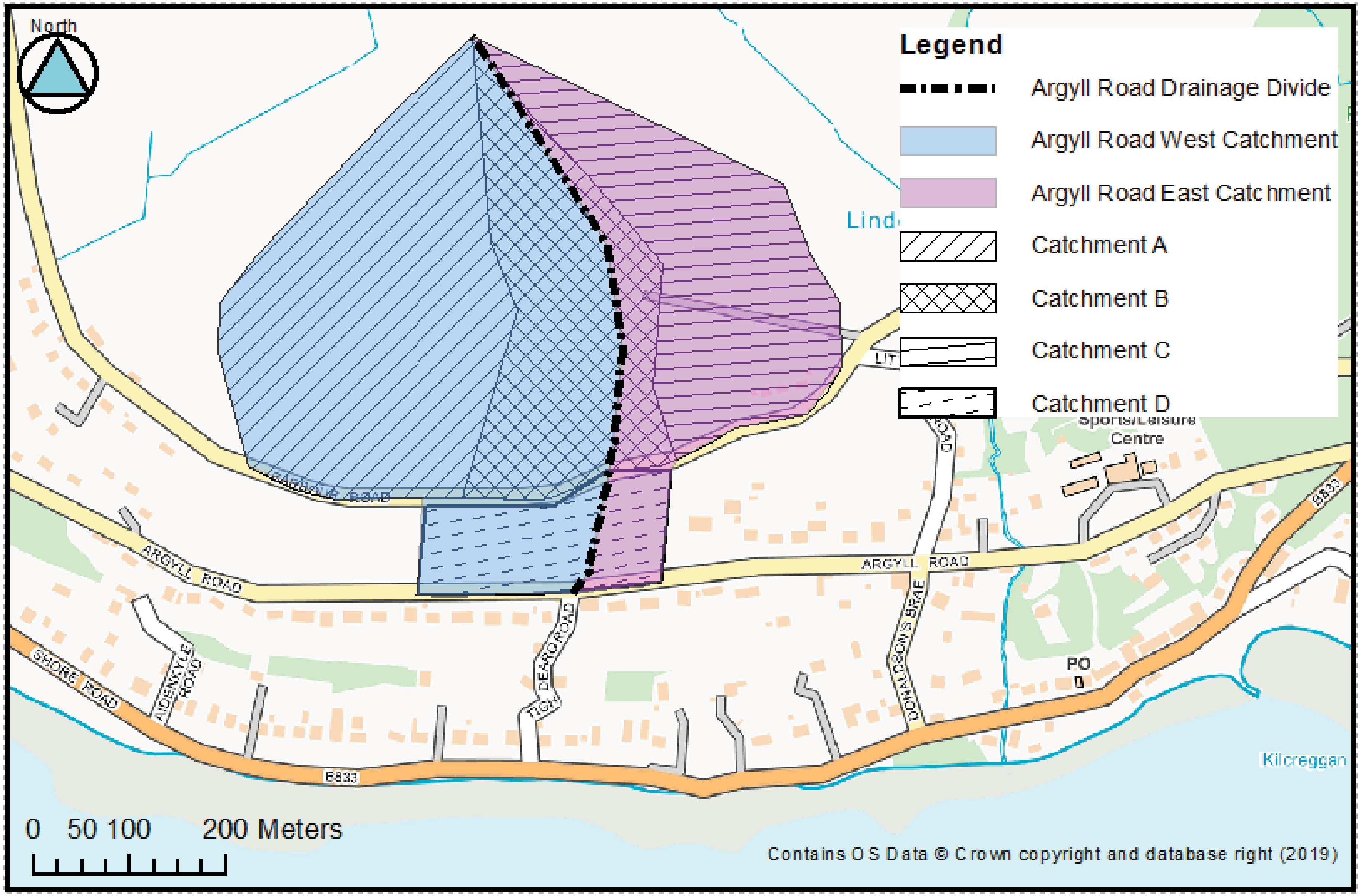
DRAWING SCALE	ORIGINAL DRAWING SIZE
1:1000	A1

DRAWING No.	REV.
102740-005-DRG-9604	0B

F:\U4060\proj\102740 Flood Management Pro\C Data\70 CAD Area\Tigh Dearg\ 102740-005-DRG-9604-0B.dwg

A3 - 420x297

D Hydrological Catchment Plan



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