Newton Stewart
FLOOD PROTECTION SCHEME

118908

VM2 MEETING: STAKEHOLDER INFORMATION

FINAL

118908/JK/SI

02 NOVEMBER 2017

SWECO UK LIMITED

Change list

VER.	DATE	CHANGE CONCERNS	REVIEWED	APPROVED
1	02/11/17	ISSUE TO STAKEHOLDERS	JPF	JB

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1 Introduction

The Newton Stewart Flood Protection Scheme seeks to produce a design solution to the persistent flooding issues within the town. The project itself comprises the following key phases:

- **Feasibility** – identify the potential options available, and to reach conclusions on a preferred option;
- **Outline Design** – design of the preferred option and discussion of design choices with stakeholders through a further stakeholder (VM3) meeting and public exhibition;
- **Publication** – presentation of the final scheme design and application to Scottish Government for funding;
- **Detailed Design** – full engineering design of the preferred option; and
- **Construction** – the option will be built in this phase.

The purpose of the VM2 meeting will be to decide upon the preferred option for the scheme to take forward to outline & detailed design.

A VM1 meeting was held on the 1st August 2017 with stakeholders, a short-list of options was agreed from a long-list of all possible options. Following from the VM1 meeting a number of activities were carried out to provide the additional information necessary to facilitate the decision on a preferred option. These activities included: a detailed topographic survey within Newton Stewart, additional hydraulic modelling, cost-benefit analysis and geo-environmental studies.

Cost-benefit analysis has taken into account the economic impacts of each relevant option, considering the impact on residential and non-residential receptors; long-term health benefits of a flood protection scheme; road closures during flooding; damage to vehicles caused by water and the cost of evacuation during flooding. The study was compliant with the methodology outlined in the Flood Hazard Research Centre - *Multi-Coloured Manual for Economic Appraisal* and HM Treasury - *The Green Book: Appraisal and Evaluation in Central Government*. Estimates for construction costs were made using Spon's Civil Engineering & Highway works Price Book (at 2017 prices, for comparability with damage outputs from the multi-coloured manual tables). Note that at this stage, an optimism bias of 60% was used to account for uncertainties – in particular, the present lack of GI information. A benefit-cost ratio (BCR) was obtained for options where modelling predicted a potential impact in the town. BCR values less than 1.00 suggest that the costs of construction would be greater than the predicted benefits obtained from a reduction in flood damages. BCR values greater than 1.00 indicate where the potential reduction in flood damages would be greater than the capital cost of constructing a scheme (i.e. a positive case for government funding).

2 Short-List Options

This section outlines the short-listed options and analysis outcomes reached by Sweco and Kaya Consulting. These options comprise the following which are located in the catchment above Newton Stewart, and are shown in Figure 2-1:

- Option 2: Upstream storage at Linloskin Bridge;
- Option 4: Installation of obstructions on the River Cree;
- Option 20: Reinstate flood storage area at the Water of Minnoch;
- Option 21: Upstream storage at The Ghyll; and
- Option 22: Upstream storage in River Cree tributaries.

The short-list options also comprise a number of options which are located in Newton Stewart town itself, which are shown in Figure 2-2:

- Option 6: Construction of direct defences;
- Option 7: Increase flow area beneath A75 bridge;
- Option 9: Increase number and size of flood relief culverts beneath A75;
- Option 19: Reprofile land at Broomisle; and
- Option 24: Reprofile land around pumping station.

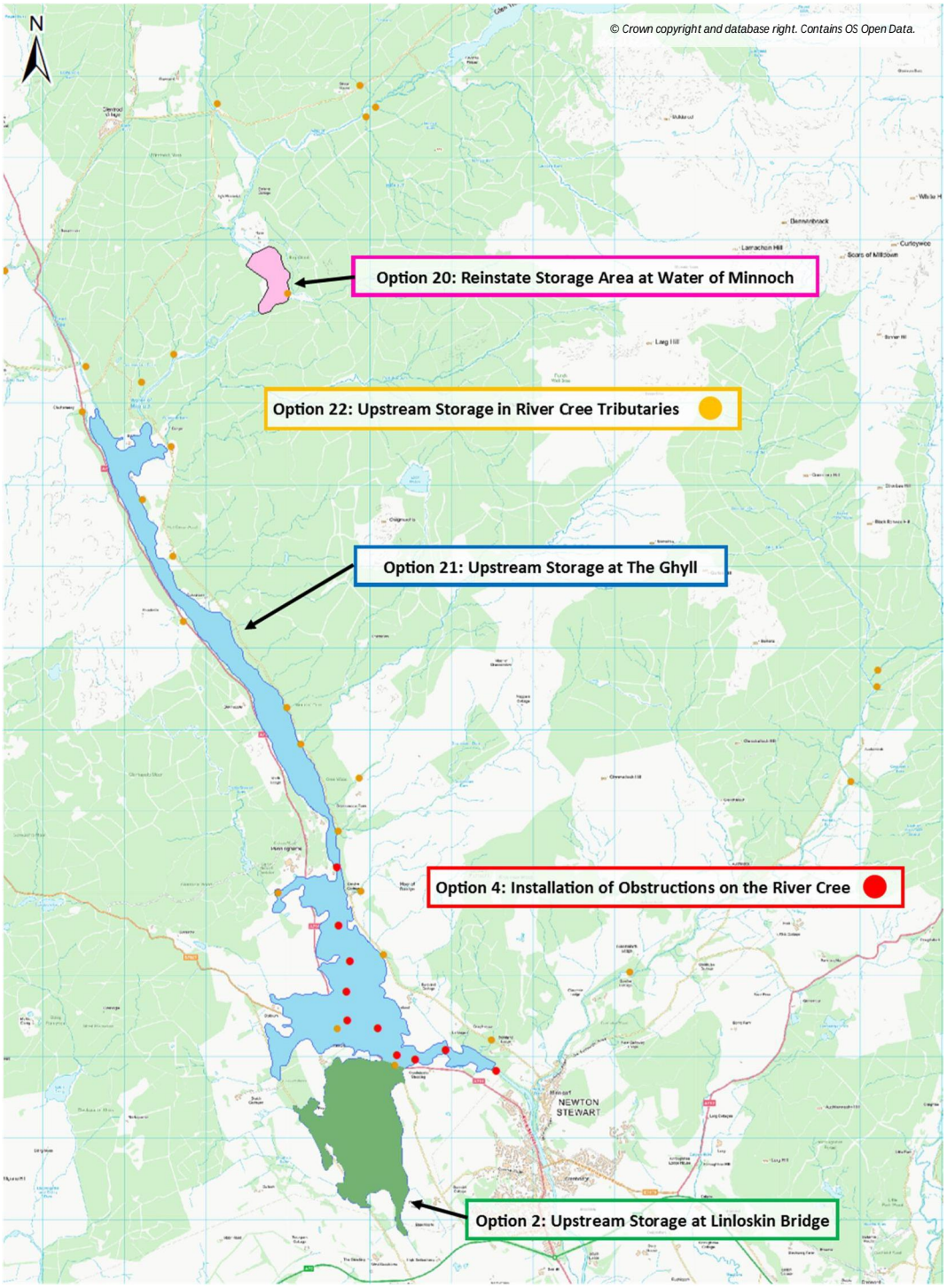

Figure 2-1 - Location of Upper Catchment Options

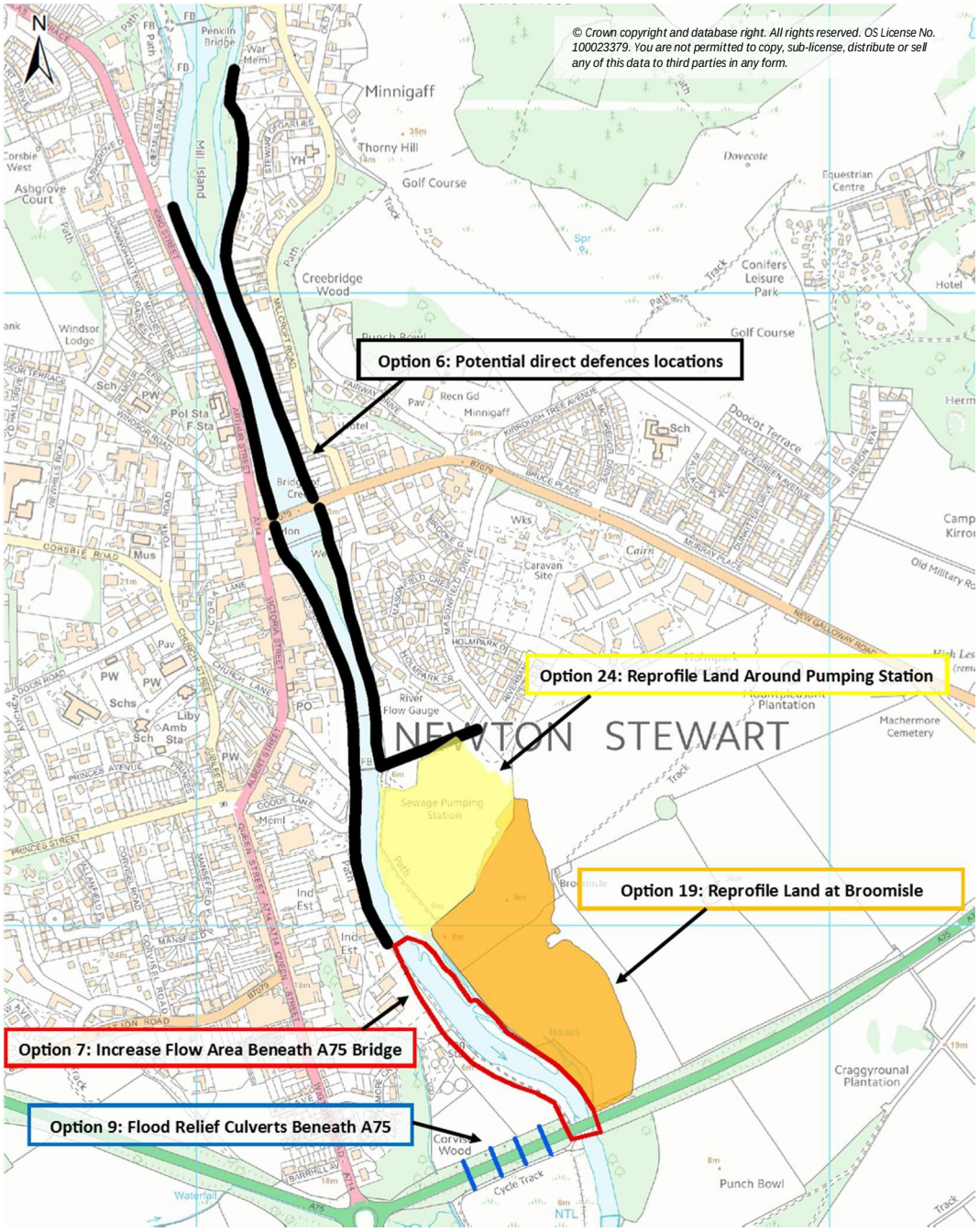

Figure 2-2 - Location of Town options

2.1 Option 2: Upstream Storage at Linloskin Bridge

It was agreed at the VM1 meeting that this option would be considered at a high-level to ascertain whether it would likely have any impact on flood levels within the town. Hydrological modelling predicts a negligible reduction in peak flows, the impact on the hydrograph can be seen in Figure 2-3. Note that the change in peak flow at Linloskin Bridge was found to be at or less than 0.15 m^3/s for the range of return periods tested.

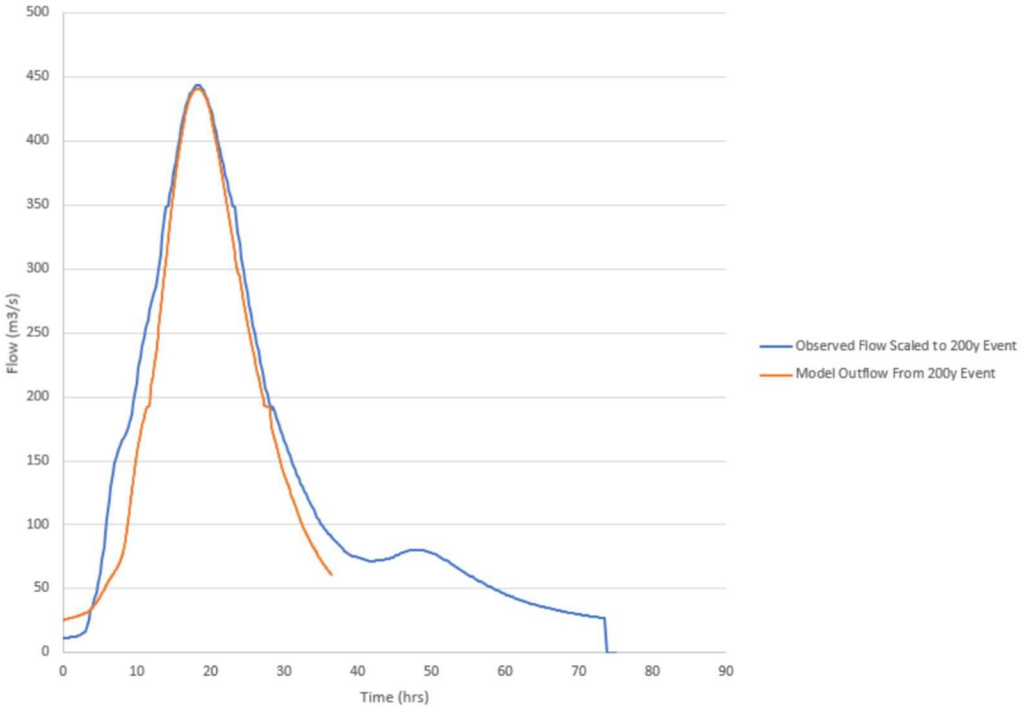

Figure 2-3 - Hydrograph Routing Model Changes on Upstream Storage - Impact on flow Hydrograph

2.2 Option 4: Installation of Obstructions on the River Cree

This option was considered at the VM1 meeting, hydraulic modelling predicts that the intervention has no positive impact on flood levels at high (1:200 year) return periods. Subsequently, additional modelling was carried out to look at the impacts on lower return period events. This yielded minimal impact, and geo-environmental considerations highlighted a number of undesirable impacts on protected species of fish in the Cree from the proposed impoundments. Figure 2-4 shows the 1:200 year flood outline for this option.

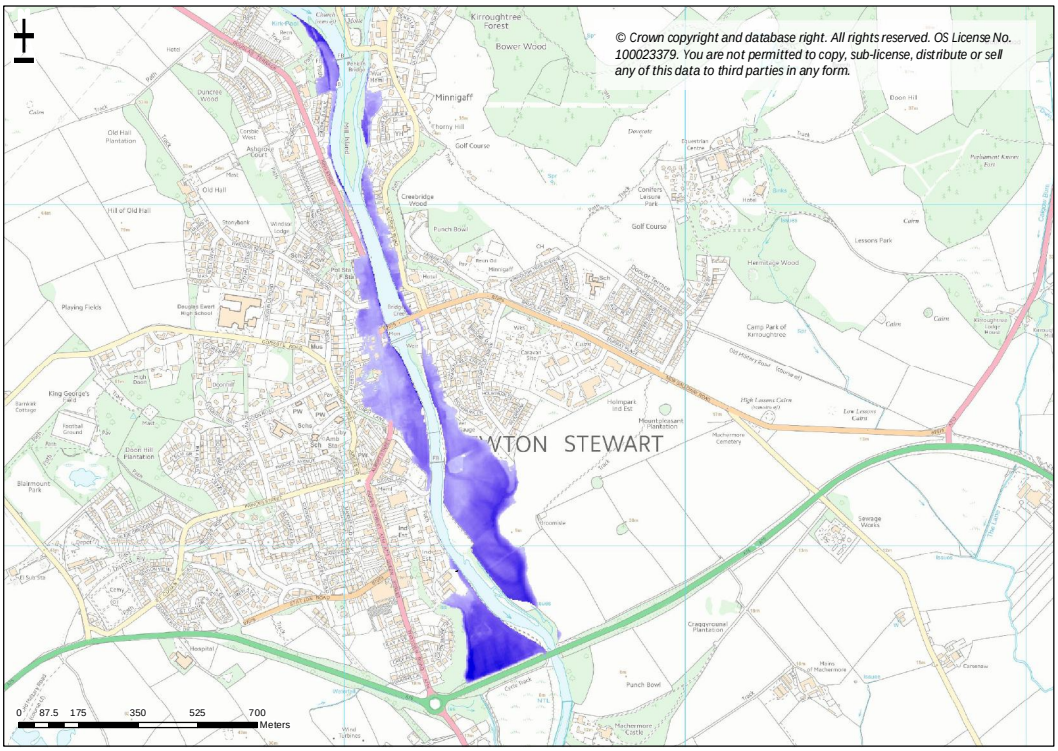

Figure 2-4 - Installation of Obstructions on the River Cree – 1:200 Year Flood Outline

2.3 Option 6: Construction of Direct Defences

The construction of direct defences was considered at all locations currently at risk of flooding during the 1:200 year event. The analysis was sub-divided into separate areas, the results of which have been reported in turn below. The direct defences would likely be in form of traditional walls; they could be designed and constructed as mass concrete retaining walls, reinforced concrete retaining walls or masonry walls. The health, safety and environmental issues, method of construction and construction materials would impact on the cost of the project. The height of the wall defences will be determined from the hydraulic modelling output and analysis. The aesthetics of the direct defences would be considered in the design phases of the project.

2.3.1. Option 6a: Direct Defences South-West

Modelling of this option has indicated that direct defences of the south-western part of the town would not provide adequate protection. The hydraulic model predicts that water will reach the defended area through overland flow paths, bypassing the wall. Due to the change in flow dynamics across the floodplain, construction of defences in this area alone would, in fact, increase the number of flooded receptors from 133 (at present) to 144 at the 1:200 year event. Benefits are seen up to the 1:100 year event, however, and thus a benefit cost ratio (BCR) of 0.62 was obtained. The predicted flood outline for the option, along with indicative siting location of direct defences, can be seen in Figure 2-5.

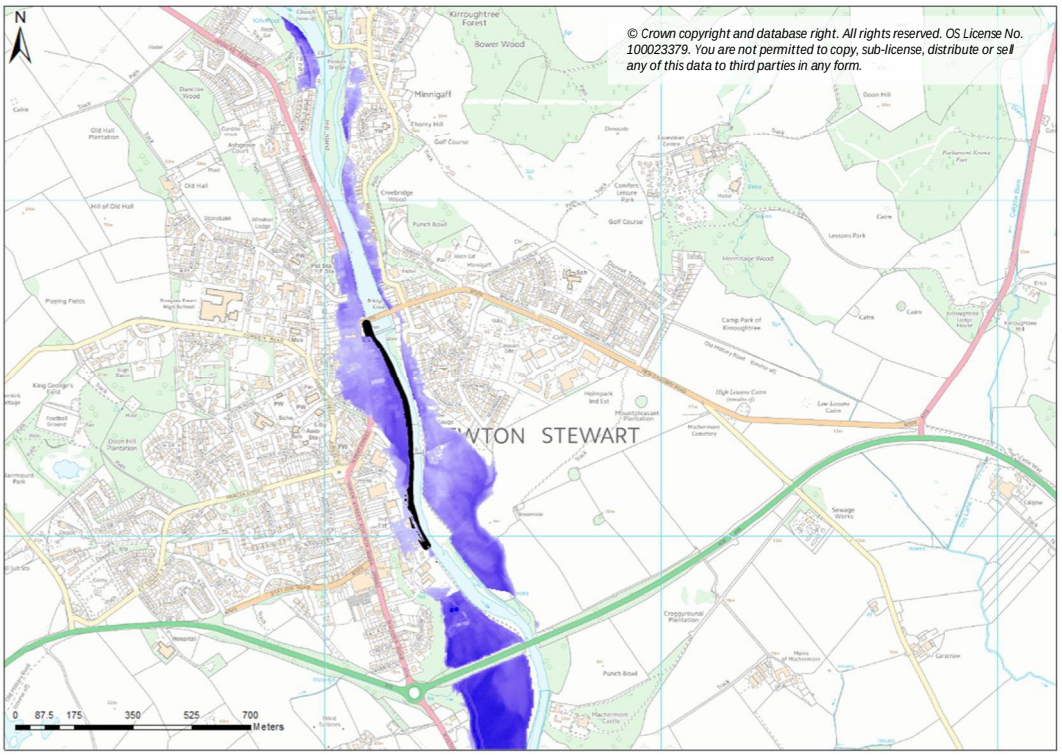

Figure 2-5 - Direct Defences South-West - 1:200 Year Flood Outline

2.3.2. Option 6b: Direct Defences North-West

The predicted flood outline for this option, along with indicative siting location of direct defences, can be seen in Figure 2-6. This figure shows that defences in the north-western area do protect the land behind them; with a reduction in the number of flooded receptors found from 133 (at present) to 99 at the 1:200 year event. A BCR of 0.84 was obtained for this option.

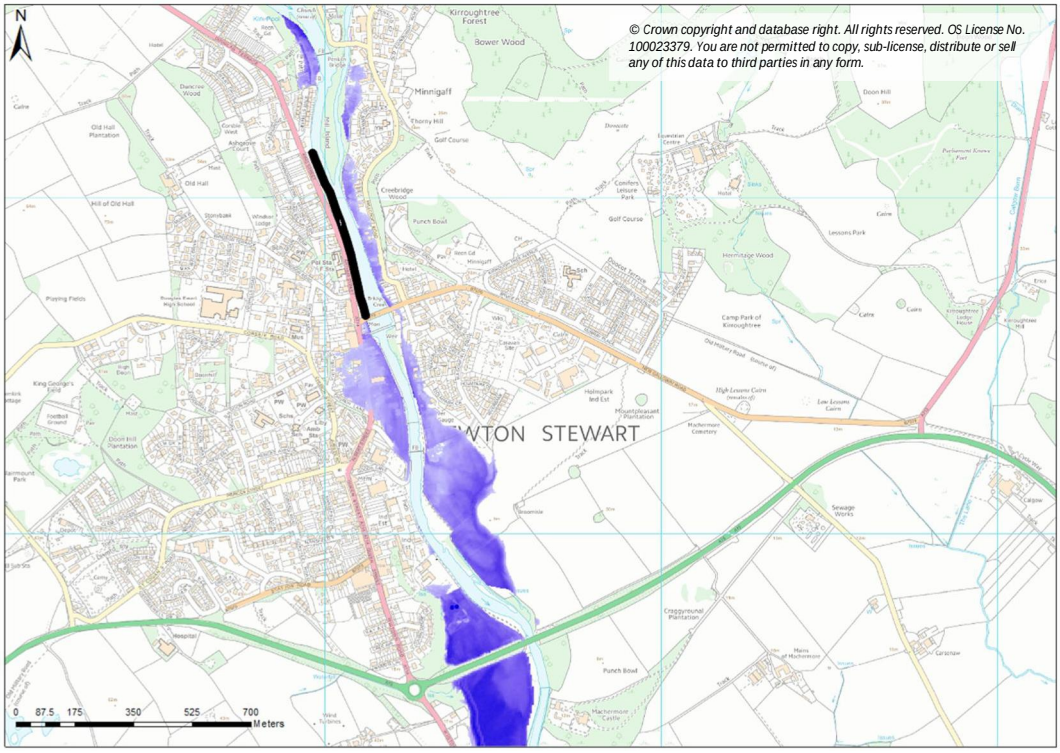

Figure 2-6 - Direct Defences North-West - 1:200 Year Flood Outline

2.3.3. Option 6c: Direct Defences West

Hydraulic modelling predicts that walls sited on the western bank of the River Cree could reduce the number of flooded receptors from 133 (at present) to 27. The option was shown to have a BCR of 1.24, demonstrating a positive case for funding. The 1:200 year flood outline for this option is shown in Figure 2-7. Cognisance of a number of listed structures throughout the town would be required during construction to ensure there is no impact on their operation and accessibility. Increases in flood levels (at the 1:200 year return period event) of up to 100mm at existing receptors were predicted on the east side, with no new receptors brought into risk. Implementation of this option would be conditional on mitigation works being carried out to ensure no increase in water level on the eastern riverside.

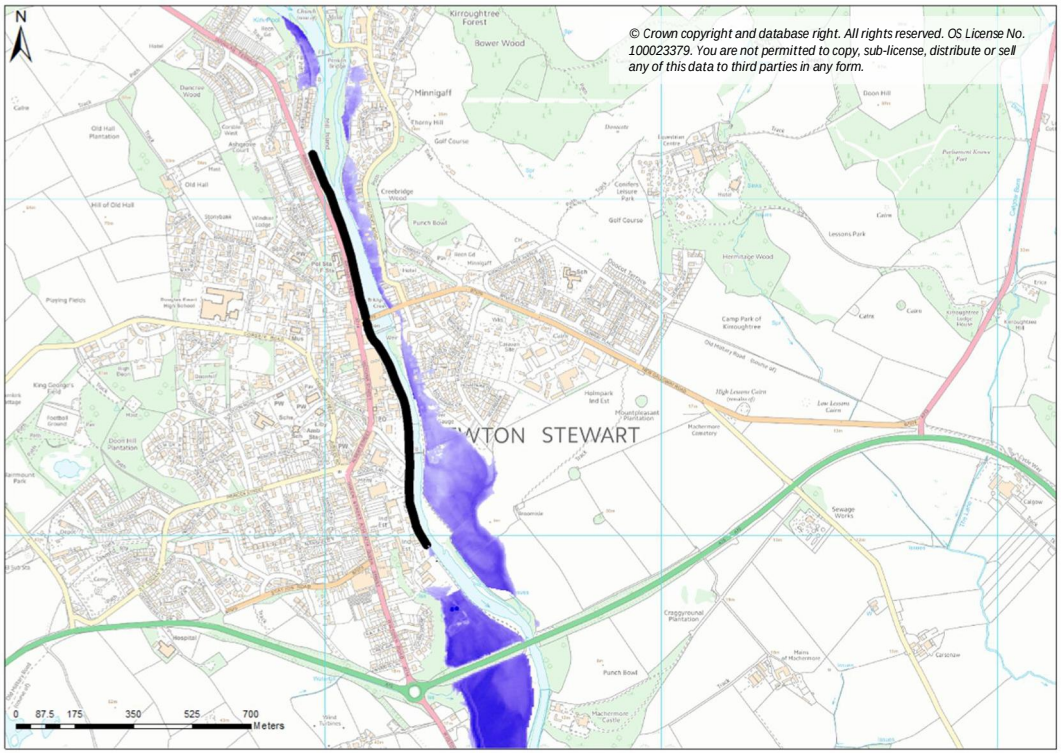

Figure 2-7 - Direct Defences West - 1:200 Year Flood Outline

2.3.4. Option 6d: Direct Defences West & South-East

Direct defences in the areas indicated in Figure 2-8, are predicted to further reduce flood risk within the town. Implementation of defences in these areas is predicted to reduce the number of flooded receptors from 133 (at present) to 20 at the 1:200 year return period event. The option was shown to have a cost-benefit ratio of 0.86. Cognisance of a number of listed structures throughout the town would be required during construction to ensure there is no impact on their operation and accessibility. Increases in flood levels (at the 1:200 year return period event) of up to 100mm at existing receptors were predicted in the north-east of the town, with no new receptors brought into risk. Implementation of this option would be conditional on mitigation works being carried out to ensure no increase in water level on the north-eastern riverside.

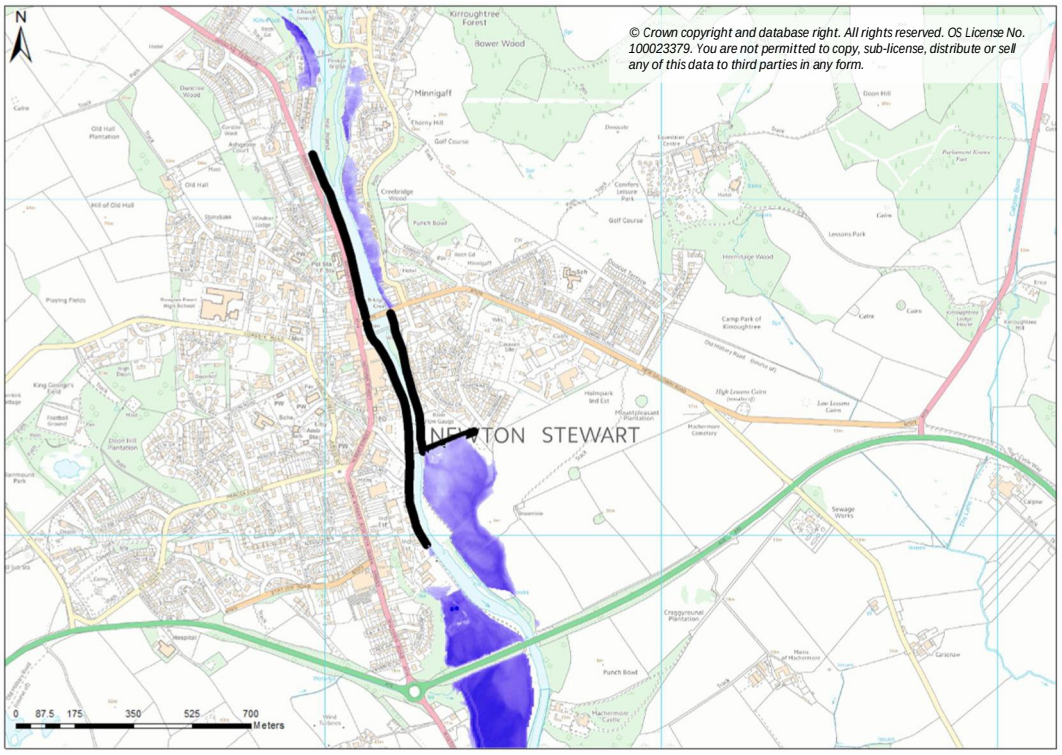

Figure 2-8 - Direct Defences West & South-East - 1:200 Year Flood Outline

2.3.5. Option 6e: Direct Defences All Areas

Direct defences in all areas is predicted to reduce the number of flooded receptors from 133 (at present) to 2, at the 1:200 year return period event. The indicative locations of defences and predicted flood outline can be seen in Figure 2-9. This option yielded a BCR of 0.68. Cognisance of a number of listed structures throughout the town would be required during construction to ensure there is no impact on their operation and accessibility. Advanced construction techniques to install defences in areas of restricted access may be also required.

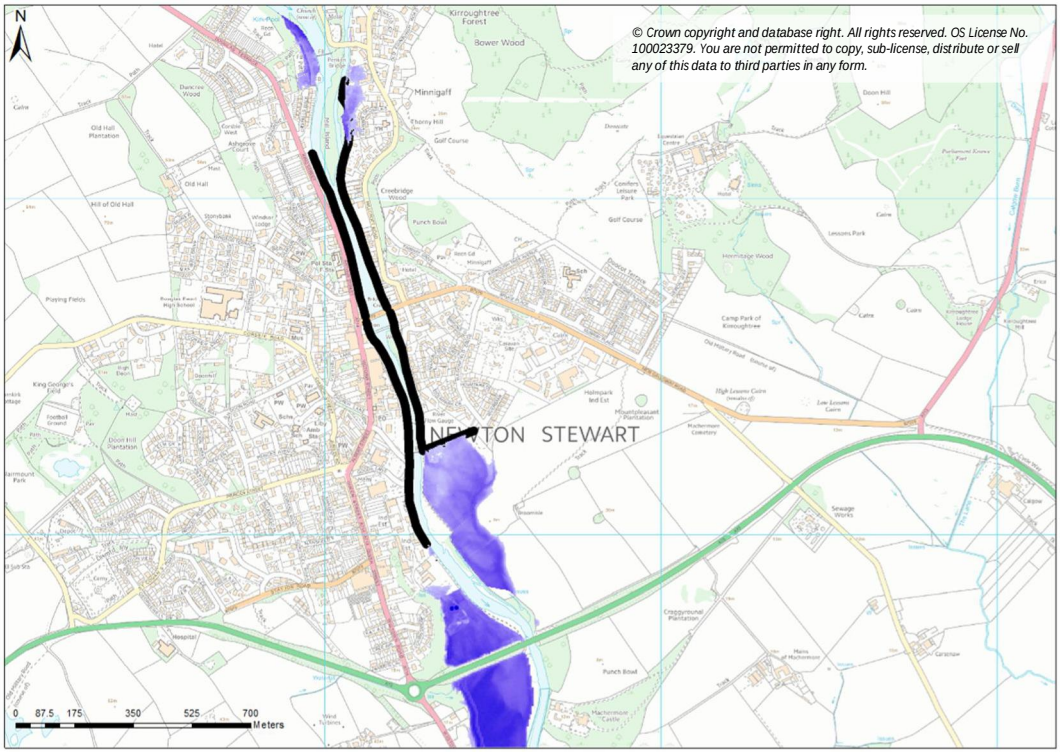

Figure 2-9 - Direct Defences All Areas - 1:200 Year Flood Outline

2.3.6. Summary of Direct Defence Options' Findings

Direct defences have been shown to have the greatest impact of all options on the reduction of the number of receptors at risk of flooding throughout the town. Furthermore, certain combinations have been shown to have a BCR of greater than 1.00, indicating that a positive case for funding would be possible. Option 6 may benefit from being considered in conjunction with other options, with the aim of reducing design defence heights and increasing the BCR. Further modelling can be carried out at outline design stage to optimise defences in this manner. The following summarises the findings:

- **6a: South-West:** Option at this location alone indicates additional receptors would be brought into risk of flooding;
- **6b: North-West:** Provides protection to a small number of receptors in the north-west of the town, with no impact elsewhere and a BCR less than 1.00;
- **6c: West:** Provides protection to a high number of receptors in the west of the town; with a BCR greater than 1.00 showing positive case for funding. Increases in water levels to existing receptors in the east by up to 100mm at the 1:200 year event would be mitigated at the outline design stage;
- **6d: West & South-East:** Provides protection to a high number of receptors, but with a BCR less than 1.00. Increases in water levels to existing receptors in the east by up to 100mm at the 1:200 year event would be mitigated at the outline design stage;
- **6e: All Areas:** Provides protection to a high number of receptors throughout the town, but with a BCR less than 1.00 and potential construction complexities identified.

Thus, the concept of utilising direct defences has been shown to significantly reduce the number of receptors impacted by flood risk within the town and also has (or may be designed such that it will have) a positive business case.

2.4 Option 7: Increase Flow Area beneath A75 Bridge

The flow area beneath the A75 bridge can be increased by reducing the level of land on which footpaths and scrubland is currently situated. To facilitate increased flows, a two-stage channel would be constructed upstream of the bridge. Modelling has shown a predicted flow capacity increase of 35m^3/s through the A75 bridge (at hydrograph peak) as a result of this intervention.

This option did not reduce the number of receptors within the town at the 1:200 year event. The option reduced overall damage for most return periods and a BCR of 9.84 was obtained. This figure is high in comparison to those reported for other options due to the low expected cost of implementing the option. This option can be combined with the preferred option to optimise its impact. The 1:200 year flood outline for this option is shown in Figure 2-10. Design and construction of this intervention would need to account for the protected species of fish present at this location.

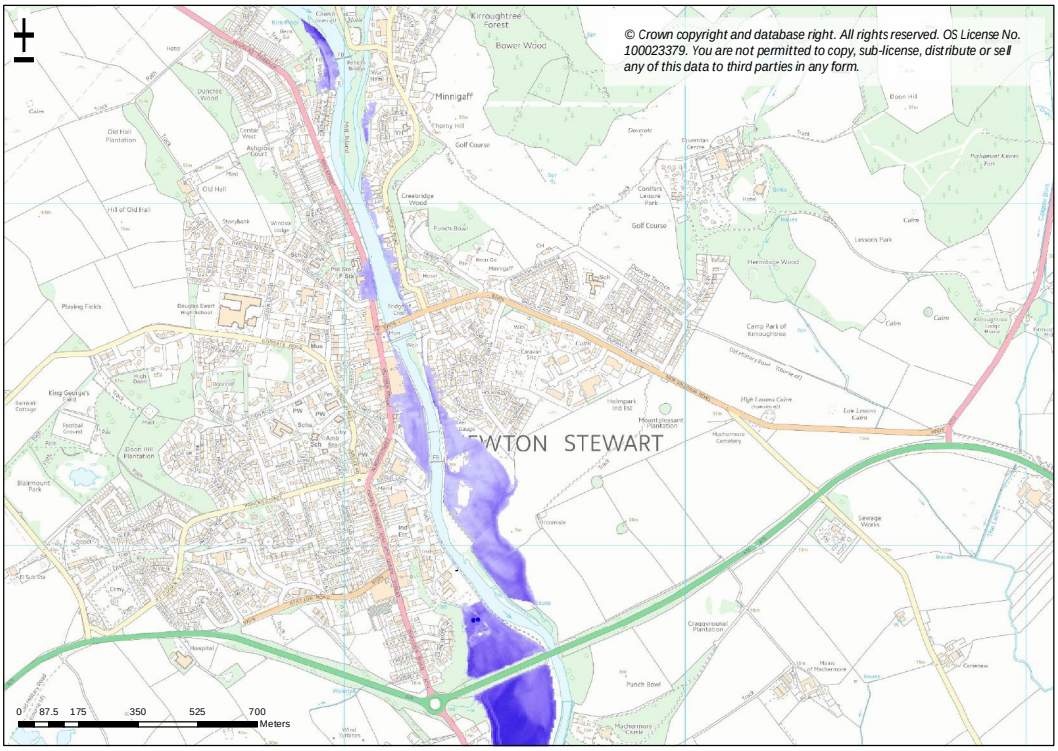

Figure 2-10 - Increase Flow Area beneath A75 Bridge - 1:200 Year Flood Outline

2.5 Option 9: Increase the Number and Size of A75 Flood Relief Culverts

This option considered upsizing, and providing additional, flood relief culverts through the A75 embankment on the western floodplain of the Cree. Three scenarios were tested, none of which reduced the number of receptors at the 1:200 year event:

- **Option 9a:** 1x additional flood relief culvert beneath A75 embankment – BCR of 0.31;
- **Option 9b:** 2x additional flood relief culverts beneath A75 embankment – BCR of 0.24; and
- **Option 9c:** 2x additional flood relief culverts beneath A75 embankment *and* upsizing of all culverts – BCR of 0.14.

This option would require complex geotechnical work within the embankment itself; which comes with risks to i) the construction programme; and ii) operation of the active A75 road. The 1:200 year flood outline for this option (same result for all sub-scenarios tested) is shown in Figure 2-11.

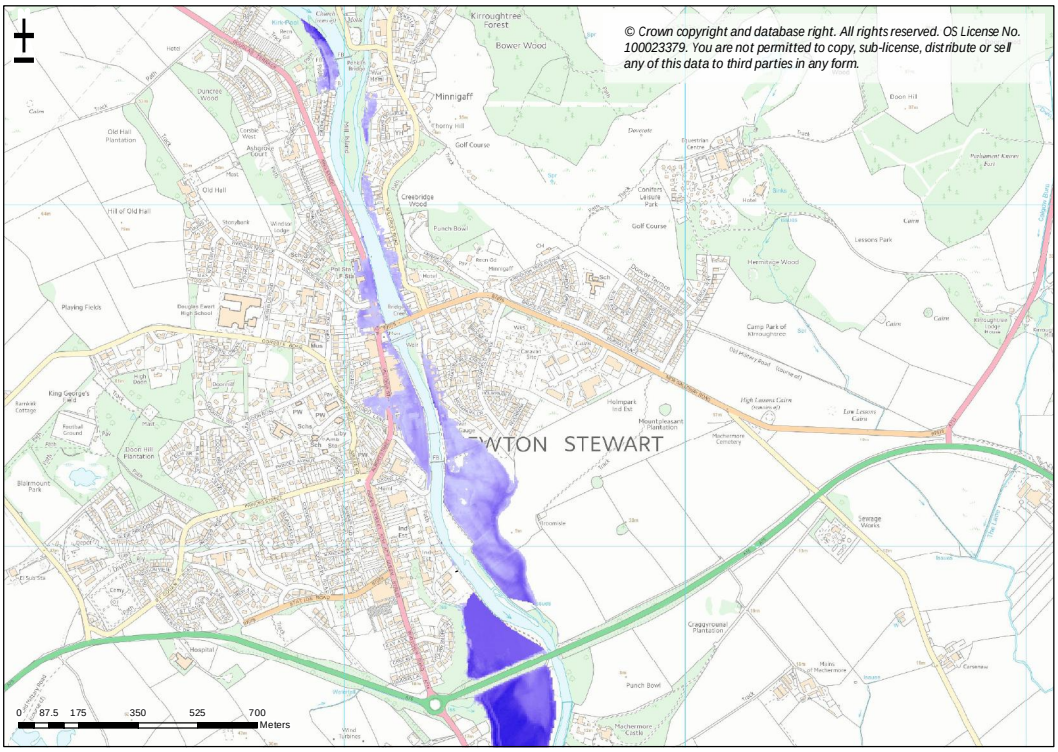

Figure 2-11 - Increase the Number and Size of A75 Flood Relief Culverts - 1:200 Year Flood outline

2.6 Option 19: Reprofile Land at Broomisle

This option considered re-profiling of land in the Broomisle area to reduce levels and provide an additional area for flood storage just upstream of the A75. This option did not reduce the number of impacted receptors during a flood event and yielded a BCR of 0.09. A construction risk of potentially infilled quarries and gravel pits has been identified, suggesting potential issues with contaminated land. The 1:200 year flood outline for this option is shown in Figure 2-12.

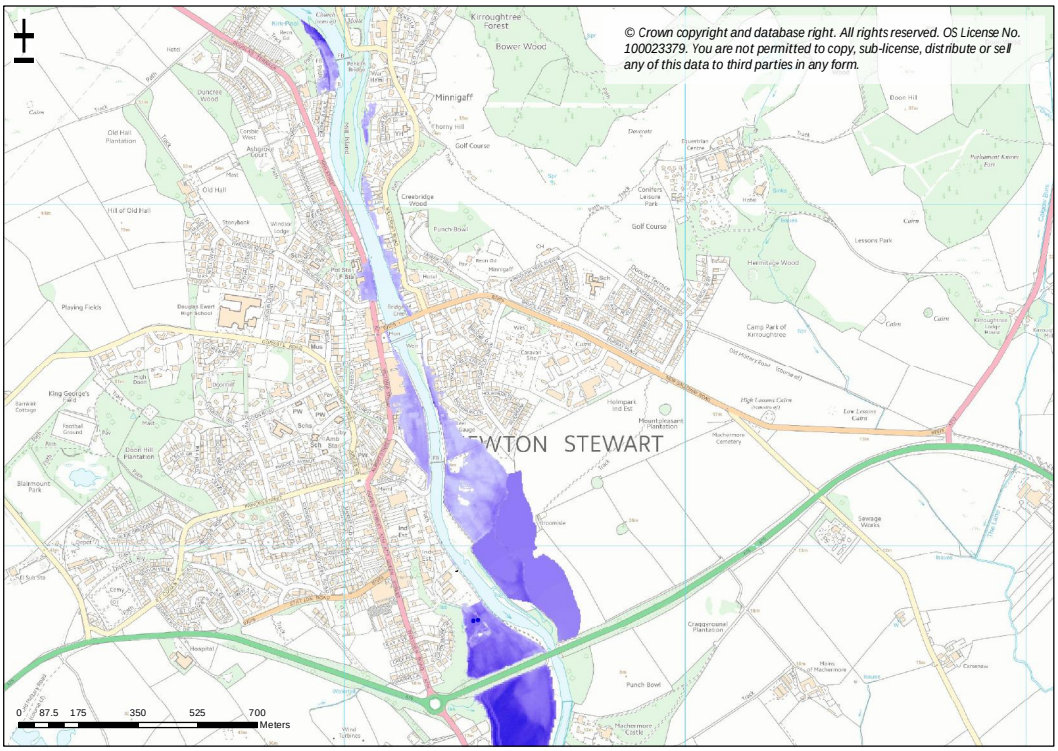

Figure 2-12 - Reprofile Land at Broomisle - 1:200 Year Flood Outline

2.7 Option 20: Reinstate Flood Storage Area at Water of Minnoch

A former flood storage area on the Water of Minnoch in the upper catchment was identified. High-level modelling has shown that no benefit to the scheme is found if brought back into use. Modelling has also shown there to be no impact on flows within the town from this option, and the 1:200 year flood outline is shown on Figure 2-13.

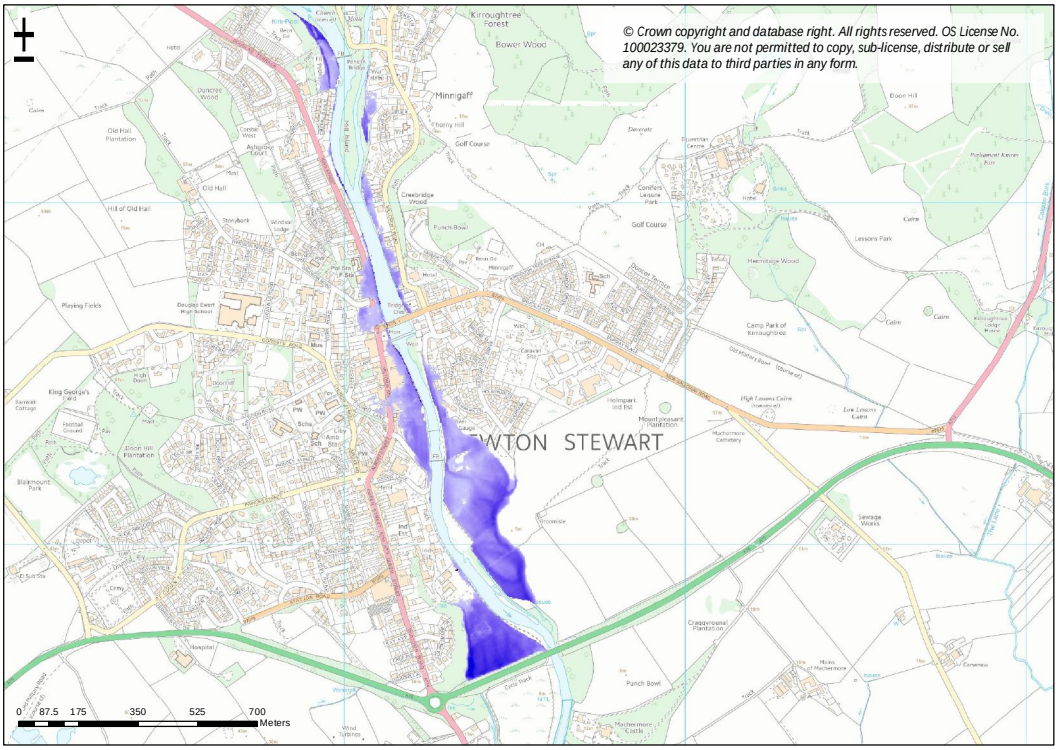

Figure 2-13 - Reinstate Flood Storage Area at Water of Minnoch - 1:200 Year Flood Outline

2.8 Option 21: Upstream Storage at The Ghyll

A potential upstream storage area in The Ghyll area was identified, and has been modelled in detail. Modelling predicts a positive impact on flood receptors within the town, the flood outline for this option is shown on Figure 2-14. Geo-environmental investigation has highlighted the presence of former lead mines within the area, which would be flooded by this option. This could pose a health risk and would require significant and lengthy additional investigative works to make safe during any construction phase.

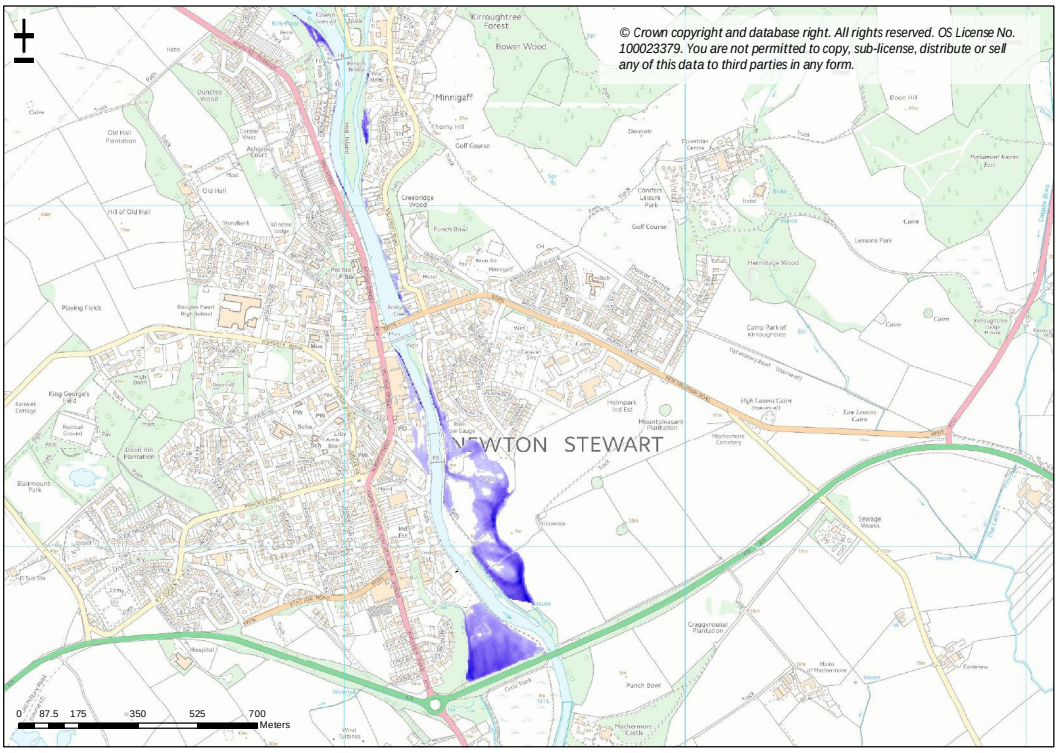

Figure 2-14 - Upstream Storage at The Ghyll - 1:200 Year Flood Outline

2.9 Option 22: Upstream Storage in River Cree Tributaries

This option was discussed at the VM1 meeting and shown not to be feasible in its full form. Hence, it was agreed that a small number of tributaries (7 tested, out of 44 identified as potentially useful) would be impounded to observe the impact on flood levels in the town. The findings showed no impact on peak hydrograph flows, with this output shown on Figure 2-15.

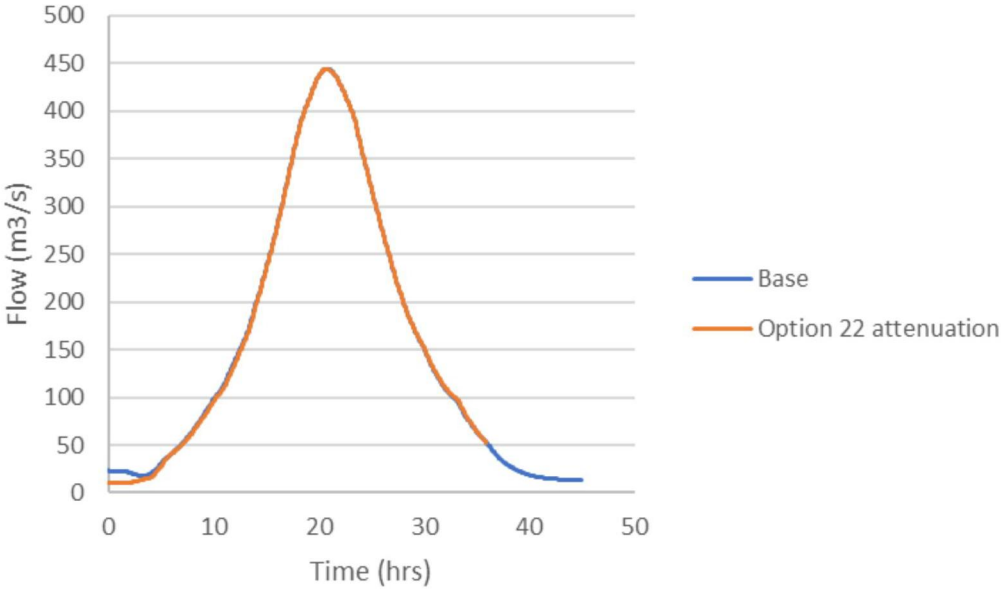

Figure 2-15 - Upstream Storage in River Cree Tributaries - Impact on Flow Hydrograph

2.10 Option 24: Re-profile Land around Pumping Station

Concerns were raised at the VM1 meeting that the construction of a pumping station within the floodplain has resulted in a recent increase in flood levels within Newton Stewart. Moving this key piece of infrastructure is not feasible, hence an option to re-profile land around the site was considered. It was found that reprofiling of land in this area could potentially reduce the number of flooded receptors from 133 (at present) to 131. Furthermore, the option was shown to have a cost-benefit ratio of 1.48 showing a positive case for funding. This option would need to be considered in conjunction with others to have any substantial impact on overall flood risk in the town. A number of construction issues have been identified at the site, including the presence of potentially infilled quarries and gravel pits; the possible cut-off of an active access road during construction and the risk of impacting the operation of the pumping station itself. This greatly reduces the viability of this option. Figure 2-16 shows the 1:200 year flood outline for this option.

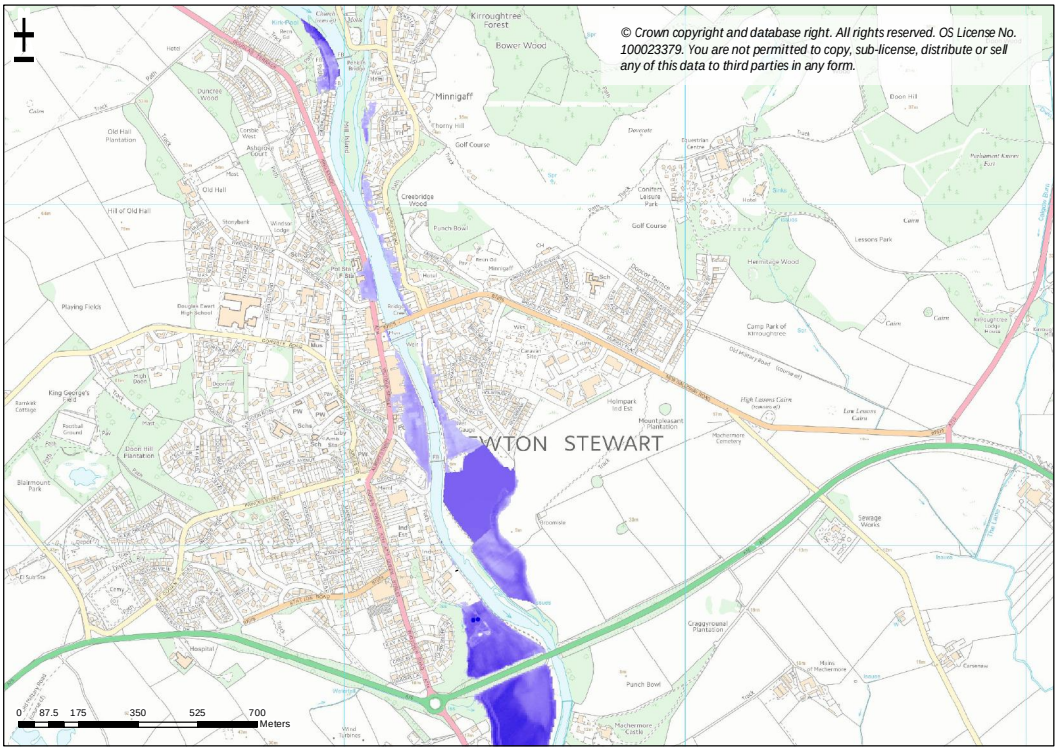

Figure 2-16 - Reprofile Land around Pumping Station - 1:200 Year Flood Outline

2.11 Option Combinations

A number of options were considered in combination with each other, and their modelling/BCR results were found to be:

- **Combination 1:** Options 7 & 9: No reduction in receptors at 1:200 year, BCR = 0.32;
- **Combination 2:** Options 7 & 19: No reduction in receptors at 1:200 year, BCR = 1.10;
- **Combination 3:** Options 7 & 24: Reduction in flooded receptors by 2, BCR = 1.26.
- **Combination 4:** Options 7, 9 & 19: No reduction in receptors at 1:200 year, BCR = 0.15;
- **Combination 5:** Options 9 & 19: Reduction in flooded receptors by 2, BCR = 0.26;
- **Combination 6:** Options 9 & 24: No reduction in receptors at 1:200 year, BCR = 0.50; and
- **Combination 7:** Options 19 & 24: Reduction in flooded receptors by 1, BCR = 0.42.

It should be noted that the option combinations are still subject to the same construction risks as identified for the individual options. These include the risk of disrupting the A75 road (option 9), the presence of potentially infilled quarries and gravel pits (options 19 & 24) and potential impacts the existing pumping station (option 24).

A further comment, relating to the combination of options 7 & 19 (combination 2), is that these, by their nature, are very similar and hence results indicate that an improved consideration of option 7 at outline design may yield similar benefits.

Further combinations may be modelled at the outline design stage, dependent on decisions reached at the VM2 meeting.

3 Summary

The short-list options have been subject to further assessment. The information provided in this report will be used at the VM2 meeting to assist stakeholders in their decision making regarding the preferred scheme option. A full summary of the analysis outcomes and comment from an engineering perspective have been provided in Table 3-1 and Table 3-2. A sensitivity analysis was carried out on the optimism bias for the BCR, ranging 40 – 80%. Due to a current lack of GI, the optimism bias in the results quoted remains at 60%, this may decrease as further information becomes available. Only option combination 2 was affected by the sensitivity analysis (combination of options 7 & 19), where an 80% optimism bias took the BCR to below 1.00.

Table 3-1- Summary of Findings (Short-List) - 1 of 2

Option	Description	Reduction in Receptors at 1:200 Year Event	Estimated Construction Cost	Estimated Option Benefits	BCR (Optimism Bias 60%)	Comment on Option Feasibility
2	Upstream Storage at Linloskin Bridge	0	N/A	N/A	N/A	Negligible impact on flow hydrograph found.
4	Installation of Obstructions on the	0	N/A	N/A	N/A	No reduction in receptors, undesirable environmental impacts identified.
6a	Direct Defences South-West	-11	£3,361,551.19	£3,322,124.80	0.62	Option 6 considered as one option, shown to have potential for significant reduction in receptors. Mitigation works required for wall sites in some locations, and consideration in conjunction with other options may increase BCR or reduce wall heights (or both).
6b	Direct Defences North-West	34	£2,353,281.61	£3,173,282.39	0.84	
6c	Direct Defences West	106	£5,714,832.80	£11,307,419.31	1.24	
6d	Direct Defences West & South-East	113	£8,373,531.99	£11,585,276.14	0.86	
6e	Direct Defences All Areas	131	£11,888,183.52	£12,861,955.69	0.68	
7	Increase Flow Area Beneath A75 Bridge	0	£51,018.23	£803,255.57	9.84	Negligible impact at low return periods, but improved design and combination with other options may yield improved results. Concept has been shown to have a positive case for funding.
9a	Additional Flood Relief Culvert Beneath A75	0	£635,698.00	£316,988.10	0.31	BCR shows no case for funding, with no reduction in number of receptors and high risks at construction stage.
9b	2x Additional Flood Relief Culverts	0	£836,698.60	£320,552.86	0.24	BCR shows no case for funding, with no reduction in number of receptors and high risks at construction stage.
9c	Upsizing Flood Relief Culverts Beneath A75	0	£1,470,075.39	£322,298.57	0.14	BCR shows no case for funding, with no reduction in number of receptors and high risks at construction stage.
19	Reprofile Land at Broomisle	0	£2,119,299.34	£317,697.92	0.09	BCR shows no case for funding, with no reduction in number of receptors.

Table 3-2 - Summary of Findings (Short-List) - 2 of 2

Option	Description	Reduction in Receptors at 1:200 Year Event	Estimated Construction Cost	Estimated Option Benefits	BCR (Optimism Bias 60%)	Comment on Option Feasibility
20	Reinstate Storage Area at Water of Minnoch	0	N/A	N/A	N/A	Modelling has shown there to be no impact at the town.
21	Upstream Storage at The Ghyll	N/A	N/A	N/A	N/A	Modelling has shown positive impact throughout the town. Significant environmental and safety concerns due to presence of former lead mining in potential storage area.
22	Upstream Storage in River Cree Tribuaties	0	N/A	N/A	N/A	Negligible impact on flow hydrograph found.
24	Reprofile Land Around Pumping Station	2	£1,227,049.40	£2,906,159.14	1.48	Reduction in flood risk for small number of receptors with BCR showing a case for funding. High construction risks at this location due to presence of critical infrastructure and need to close access roads.
C1	Options 7 & 9	0	£1,521,093.62	£770,446.93	0.32	BCR shows no case for funding, with no reduction in number of receptors.
C2	Options 7 & 19	1	£2,170,317.47	£3,811,089.04	1.10	Combination shows minimal reduction in receptors and positive business case. Combination similar to a refinement of option 7 on its own.
C3	Options 7 & 24	2	£1,278,067.63	£2,570,301.63	1.26	Combination shows minimal reduction in receptors and positive business case. Combination subject to the same high construction risks as the standalone Option 24.
C4	Options 7, 9 & 19	0	£3,640,392.96	£850,301.99	0.15	BCR shows no case for funding, with no reduction in number of receptors.
C5	Options 9 & 19	2	£3,589,374.73	£1,468,017.56	0.26	BCR shows no case for funding.
C6	Options 9 & 24	0	£2,697,124.79	£2,173,732.73	0.50	BCR shows no case for funding, with no reduction in number of receptors.
C7	Options 19 & 24	1	£3,346,348.74	£2,224,797.89	0.42	BCR shows no case for funding.