Northumbria Integrated Drainage Partnership

NIDP Chirton Stage 2 SN017/0185

Stage 2 Diagnostic Study Report
February 2021

Client: NIDP

Project: Chirton Stage 2 Diagnostic Study

Document Title: Stage 2 Diagnostic Study Report

Stantec Project Code: 41523655497			Document Ref: RT-NN-2796-01		
Version	**Date**	**Description/Amendment**	**Prepared by (Author)**	**Checked by**	**Reviewed by**
01	January 2021	1st Issue	M Pyle	M Foster	G Rhodes
02	February 2021	Updated with combined figures for linked areas (Langley + Balkwell and Redesdale + Mindrum)	M Pyle	M Foster	G Rhodes

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Chirton NIDP Stage 2 Diagnostic Study and Identification of Opportunities

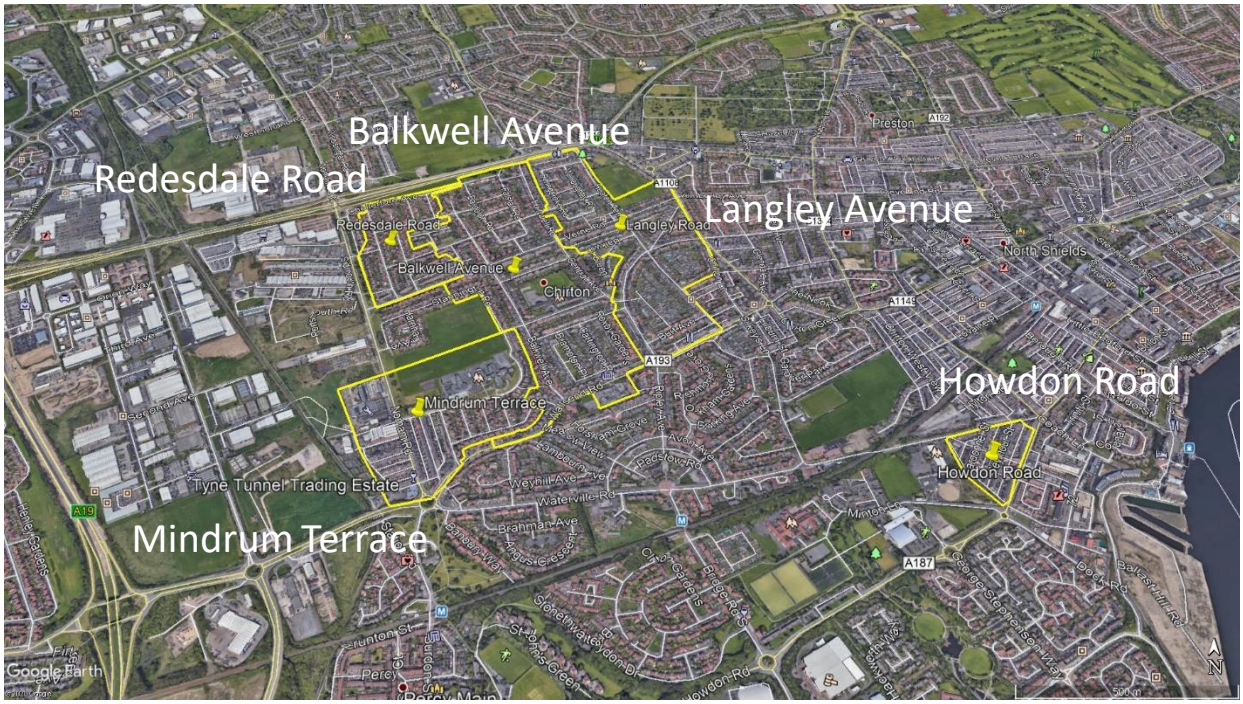
Project Overview: The Chirton NIDP Project aims to reduce flooding risk from surface water and combined drainage systems as well as provide wider benefits to the area including improved strategic drainage, investment in the local area, alignment with redevelopment, and enhancement to the local biodiversity, habitats, and green infrastructure.

The project included data collection, model updates to include surface overland flow routes, validation of existing issues, confirmation of flood risk, identification and optimisation of solutions, risk characterisation and an economic assessment of costs and benefits.

Partnership Project between:

North Tyneside Council

Opportunities in the area have led to a range of solutions including separation of highway drainage and connection to surface water systems, swales, rain gardens, bunds, attenuation of surface water, attenuation on the combined drainage network, and improvements to the existing drainage network.



Costs – Combined Areas

Opportunity Area	Cost Estimate	Potential Funding via FCERM GiA	Additional Funding Required
Langley Road + Balkwell Avenue	£2.8M	£4.6M	-
Redesdale Road + Mindrum Tce	£2.5M	£2.8M	-
Howdon Road	£968k	£870k	£98k

Benefits

	1198	Properties with reduced flood risk
	485	Properties moved EA Flood Risk Category
	22	Properties that have reported flooding with reduced flood risk
	0.67 ha	New habitat and improved biodiversity
	9 ha	Runoff area reduction, that no longer drains to treatment
	16	Dual manholes separated to reduce surface water to treatment and flooding from the foul network
	13 No.	Reduced CSO spills per year
	13,600 m^3	Reduced CSO spill volume per year
	£41M	Property Flood Damages Avoided
	£7M	Additional Benefits Identified
	5 schemes	Included in the EA's Medium Term Plan
	4:1	Benefit Cost Ratio
	Regeneration	Investment in an area with planned redevelopment and potential to align works
	Green Infrastructure	New assets that support flood risk reduction while offering opportunities for education, health, and well being
	Partnership Project	Funding Potential from EA's FCERM GiA, EA's Local Levy, Council Investment, NWG Investment

Flood Risk Reduction by Area – Combined Areas

Opportunity Area	Properties with reduced flood risk	Properties moved EA Flood Risk Category	Properties that have reported flooding with reduced flood risk
Langley Road + Balkwell Avenue	694	292	14
Redesdale Road + Mindrum Tce	412	122	6
Howdon Road	92	71	2
Total	**1198**	**485**	**22**

Flood Risk Reduction by Area

Opportunity Area	Properties with reduced flood risk	Properties moved EA Flood Risk Category	Properties that have reported flooding with reduced flood risk
Balkwell Avenue	334	113	5
Langley Road	360	179	9
Redesdale Road	122	81	1
Mindrum Terrace	290	41	5
Howdon Road	92	71	2
Total	**1198**	**485**	**22**

Costs

Opportunity Area	Cost Estimate	Potential Funding via FCERM GiA	Additional Funding Required
Balkwell Avenue	£1.5M	£1.8M	-
Langley Road	£1.3M	£2.8M	-
Redesdale Road	£1.6M	£1.8M	-
Mindrum Terrace	£882k	£970k	-
Howdon Road	£968k	£870k	£98k

2. STUDY OVERVIEW

As part of the Northumbria Integrated Drainage Partnership, the Chirton Stage 2 Diagnostic Study is a joint partnership study between North Tyneside Council (NTC), the Environment Agency (EA), and Northumbrian Water (NWG) to manage surface water and reduce flood risk from a number of sources. The study also aims to understand current and future drainage issues in the area, share data, promote integrated sustainable drainage solutions, promote 'best possible' service to the public while balancing environmental needs and costs, and provide risk based evidence for future business planning.

Participants in this study include;

- Northumbrian Water Group (NWG) – Sewerage Service Provider
- North Tyneside Council (NTC)– Lead Local Flood Authority and Highway Authority
- Environment Agency (EA)
- Esh Stantec – Lead Consultant

NWG are responsible for the foul, combined and surface water sewer networks in the area. NTC are responsible for overland surface water runoff, culverted watercourses, ordinary watercourses, and highway drainage. The EA is responsible for main rivers.

Key individuals within the project are identified in Table 1.1.

Table 1.1 – Chirton NIDP Project Team

Name	Organisation	Role
Elaine Smith	Northumbrian Water Group	Investment Delivery Project Manager
Loren Jennings	Northumbrian Water Group	Investment Delivery Project Manager
Andrew Burnett	North Tyneside Council	Flood Risk Manager
Nicola Hyslop	Environment Agency	Lead Partnerships and Strategic Overview
Joe McCarty	Environment Agency	Strategic Studies Liaison
Craig Stephenson	Esh Stantec	Consultant Project Manager
Gwen Rhodes	Esh Stantec	Consultant Technical Lead
Matthew Foster	Esh Stantec	Senior Modeller/Engineer
Mitchell Pyle	Esh Stantec	Project Modeller / Engineer

The project will be delivered in discrete stages:

- Stage 1 – Desktop study of existing data and prioritisation of opportunities
- Stage 2 – Diagnostic study and identification of future opportunities
- Stage 3 – Outline Business Case / Preliminary Design
- Stage 4 – Detailed Design
- Stage 5 – Construction

This report documents Stage 2, the diagnostic study and identification of future opportunities. Stage 2 includes data collection, model updates, review of the baseline flood risk, agreement of opportunity areas, opportunity identification, long list of options, solution testing, preferred solution identification, flood risk assessments, benefit assessments, cost estimates, and future programme development.

3. STAGE 1 RECOMMENDATIONS

An extensive data collection and review exercise was completed as part of Stage 1 of the Chirton Strategic Study (SN017/0185) and was completed in 2018. Following the data review exercise, a total of six opportunity areas were identified by the project team, which are:

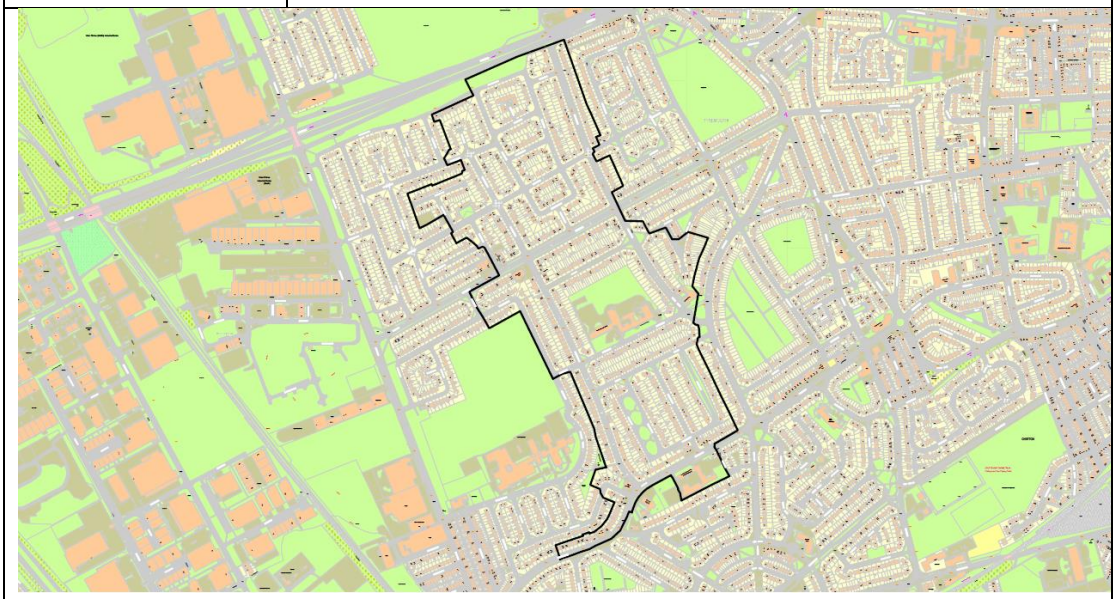
- Balkwell Avenue (Issue Refs 1, 8, 17, 18, 19)
- Langley Road (Issue Refs 2, 3, 10, 13, 25, 29)
- Redesdale Road (Issue Refs 7, 12, 39)
- Mindrum Terrace (Issue Refs 16, 21B)
- Howdon Road (Issue Ref 6)
- Angus Crescent (Issue Ref 21A)

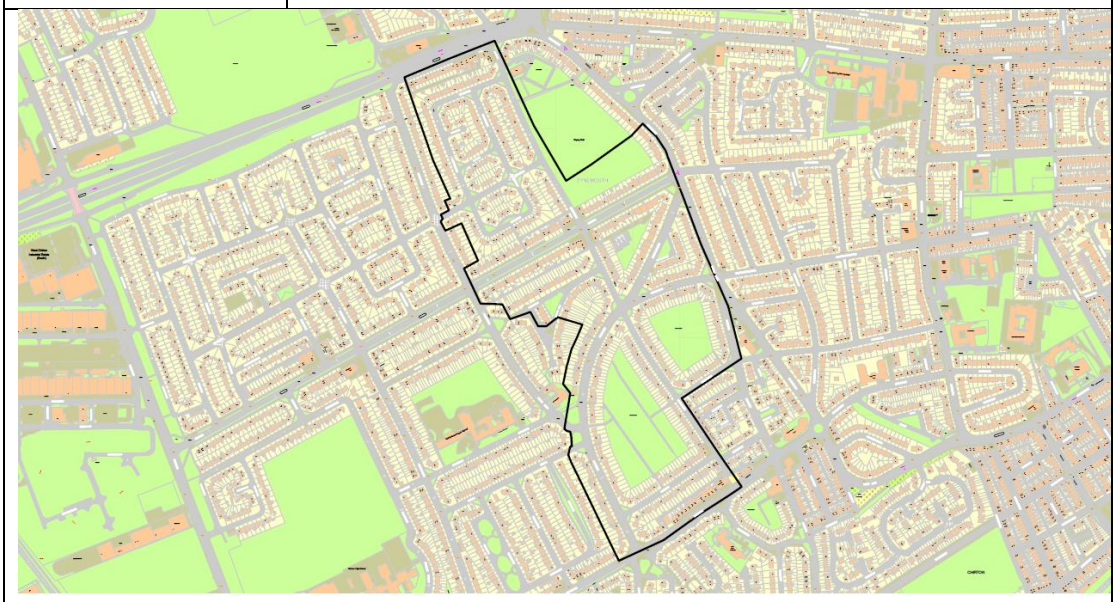
The Stage 1 deliverables and study plan are located on Sharepoint here: https://nwgcloud.sharepoint.com/sites/SN017-0185/default.aspx

The Stage 1 Study recommended further data collection including:

- CCTV / connectivity surveys and desktop investigations of existing assets;
- Manhole survey data to locally enhance the NWG DAS sewer model;
- Consideration of topographic surveys to aid in design of above ground surface water features.
- Obtain information from NTC and EA about schemes carried out in the area and any information they might have.
- Obtain information on planned developments in the area;
- Integrated hydraulic assessment of sewers, overland flow from greenfield runoff and 2D modelling of overland flow paths;
- Produce outline solutions to reduce flood risk to all parties;
- Define the benefits to each stakeholder; and
- Produce outline cost estimates of the preferred options.

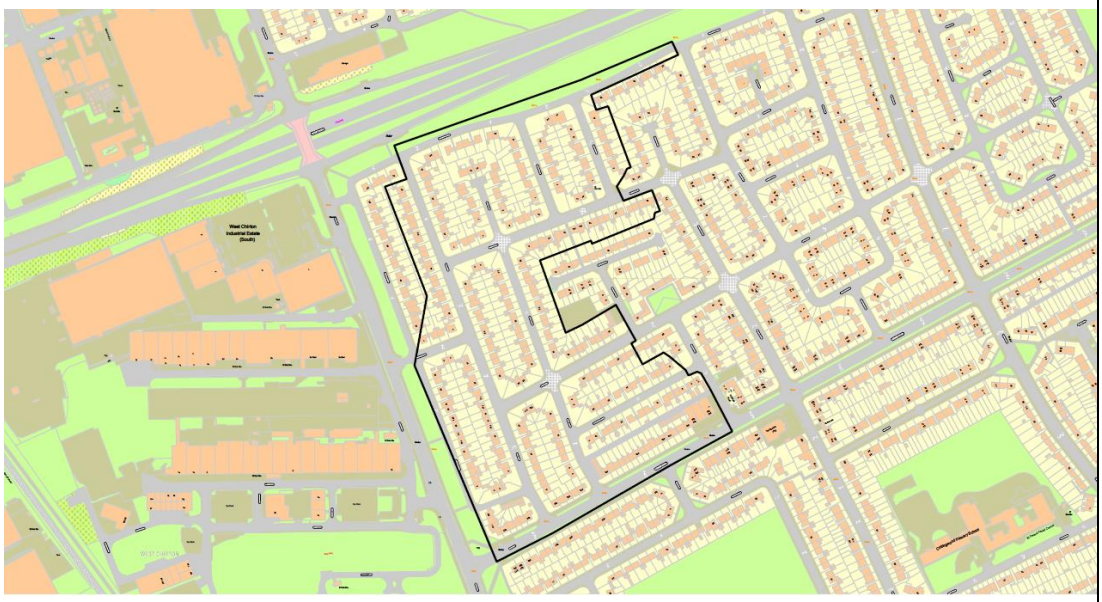
4. OPPORTUNITY AREAS

Opportunity Area	Balkwell Avenue
	
Description of area	This opportunity area is located within the central part of the Chirton Drainage Area (05-D38) and spans approximately 36 ha with a population of around 3674. The urban area is of medium density residential areas with a small amount of commercial buildings along the A193. Within the study areas also sits Collingwood Primary School and St Joseph's RC Primary School. To the north, the area is bounded by the A1058 Coast Road.
Existing drainage	The area is predominately combined with small areas of separate sewer systems eventually draining to the combined system. The combined sewer flows south to Wallsend Road and then south west towards Station Road Hunters Close CSO (Chirton CSO 1). Flows then enter the interceptor sewer, carrying flows south and then west along Howdon Road to Howdon STW. The overflows at the CSO discharge to a surface water sewer which flows south-east toward an outfall where it discharges into Albert Edward Dock, on the River Tyne.
Reported Issues	• Internal property flooding predicted in CAP model due to surcharge and overland flow. NWG reported flooding data shows mixture of blockages and hydraulic causes on Verne Road and Balkwell, Stannington Road, Brampton Place, and Redesdale Grove. • NTC reports flooding in Brampton Place, Verne Road, Craster Road, and Central Avenue in 2007. Issues can also be located on the plan, 41526497-01-GIS0002 (Appendix A)
Previous Studies	Chirton CAP Study 2017 Rainwise - SuDS for Schools – Collingwood Primary School

Opportunity Area	Langley Road
	
Description of area	This opportunity area is located towards the central and eastern part of Chirton Drainage Area (05-D38) and spans approximately 27 ha with a population of around 2215. The urban area is of medium density residential areas with the south side of the area consisting of allotments and residential areas. To the north side of the area, most of the land is residential streets with some commercial areas along Verne Road. The northern outline of the area is bounded by the A1058 Coast Road.
Existing drainage	The drainage in this area is predominately combined with small areas of partially separate properties with dedicated surface water drainage, eventually connecting into the combined system. The sewer network serving the area flows south along Silkey's Lane and Minton Lane towards NTY040 Howdon Road/Dock Road CSO which spills into an overflow pipe flowing south-east of the CSO until discharging into the River Tyne at the outfall NZ35674104. The continuation pipe flows west from the CSO along Howdon Road to Howdon STW.

Opportunity Area	Langley Road
Reported Issues	• Internal property flooding predicted in CAP model due to surcharge and overland flow. NWG reported flooding data shows a mixture of blockages and hydraulic causes on Verne Road, Heaton Terrace, and Balkwell Green. • NTC reported water coming out of road surface near a takeaway restaurant. A surface water culvert is believed to have been capped off, resulting in flooding in heavy rainfall. • NTC reported flooding in Balkwell Green in 2005. • NWG record repeated blockages and debris accumulation along Heaton Terrace. CCTV identified a severe dip 3-8m upstream of MH NZ3468170. These issues may have caused internal flooding. • NWG reported sewer flooding at Heaton Terrace / Balkwell Green. This was linked with a soft blockage, however CCTV identified up to 40% root mass near NZ34681607. Issues can also be located on the plan, 41526497-01-GIS0001 (Appendix A)
Previous Studies	Chirton CAP Study 2017

Opportunity Area	Redesdale Road



Description of area	This opportunity area is located at the centre of Chirton Drainage Area (05-D38) and spans approximately 10 ha with a population of around 1793. The urban area is of medium density residential areas with green spaces around the area. The area is adjacent to the A1058 Coast Road to the north and Norham Road to the west.
Existing drainage	The drainage in this area is a separate system serving the housing estate running parallel to Norham Road. The flow from the north of the study area flows south then west out from Nunwick Gardens into the separate sewers along Norham Road flowing to the south. The southern part of the area drains south into the separate system along Verne Road, flowing west then south to then converge with the flow from the northern part of study area at the north side of Bugatti Industrial Park. The foul flow enters Mindrum Terrace NTY053 (Chirton CSO 4) with the continuation flow entering the combined system and the spill pipe discharging to the surface water pipe containing flow from Redesdale Road. The combined flow meets Station Road Hunters Close CSO (Chirton CSO 1) which continuation flow travels south east until it meets the interceptor along Howdon Road which flows west to Howdon STW. The two spill pipes overflow into two separate sewers which flow south-east before converging at Redburn Dene and spilling into the River Tyne at Albert Edward Dock. The area has dual manholes that link the foul and surface water networks.

Opportunity Area	Redesdale Road
Reported Issues	• Internal property flooding predicted in CAP model due to surcharge and overland flow. NWG reported flooding data shows a mixture of blockages and hydraulic causes on Redesdale Road and Walwick Avenue. • NTC reports flooding along Coast Road in 2005. • NTC reports flooding along Verne Road / Craster Road in 2007. • A potential pollution issue has been identified based on existing dual manholes, which link the foul and surface water networks. Issues can also be located on the plan, 41526497-01-GIS0005.
Previous Studies	Chirton CAP Study 2017 NWG Dual Manhole Project

Opportunity Area	Mindrum Terrace
	
Description of area	This opportunity area is located to the south-western part of Chirton Drainage Area (05-D38) which spans approximately 8 ha with a population of around 1411. This area consists of residential, community and industrial properties with pockets of green space. The residential properties are situated in the south-eastern and south-western corners of the area, whilst the industrial properties are found in the north-western corner, and Norham High School is situated in the north and north-eastern parts of the study area. To the south, the area is bounded by the A193.
Existing drainage	The drainage in this area is mainly combined with some separate drainage in the industrial areas which connects into the combined system. Other separate flows are along Wooler Avenue, Beadnell Avenue and Mindrum Terrace which flow into the main surface water sewer heading south collecting spills from Mindrum Terrace NTY053 (Chirton CSO 4) and Station Road Hunters Close CSO (Chirton CSO 1), heading south east to discharge into the River Tyne at Albert Edward Dock. Mindrum Terrace NTY053 (Chirton CSO 4) is in the south-west corner of the study area, the continuation flow passes to Station Road Hunters Close CSO (Chirton CSO 1) which continues south east until meeting the interceptor on Howdon Road, flowing west to Howdon STW.

Opportunity Area	Mindrum Terrace
Reported Issues	• NTC reported surface water flooding along Fallodon Road and Biddleston Crescent in 2007. • NTC reported flooding at Mindrum Terrace in 2007. • There are areas with potential for surface water separation including Norham High School, along Norham Road and at Norham Business Centre. Issues can also be located on the plan, 41526497-01-GIS0003.
Previous Studies	Chirton CAP Study 2017

Opportunity Area	Howdon Road

Description of area	This opportunity area is located to the south-eastern part of Chirton Drainage Area (05-D38) and spans approximately 4 ha with a population around 470. This area consists of residential properties and is bounded by the A187 Howdon Road along its eastern border and Waterville Primary School to the north-western outline.
Existing drainage	The drainage in this area is combined. Flows converge in the south west corner of the study area and travel to NTY0404 Howdon Road / Dock Road CSO. The continuation pipe from this CSO connects into the interceptor sewer along Howdon Road, travelling west to Howdon STW. The spill pipe flows south east along Dock Road and Ballast Hill Road before discharging into the River Tyne.
Reported Issues	• Internal property flooding predicted in CAP model due to surcharge and overland flow. NWG reported flooding data shows this area has a cluster of flooding properties caused by blockages and hydraulic causes. Issues can also be located on the plan, '41526497-01-GIS-0006' (Appendix A).
Previous Studies	Chirton CAP Study 2017

Opportunity Area	Angus Crescent
	
Description of area	This opportunity area is located to the south-western part of Chirton Drainage Area (05-D38) adjacent to the Metro line and spans approximately 8 ha with a population around 509. This area consists of residential properties with pockets of green space to the south-west.
Existing drainage	The drainage in this area is separate with storm and foul flows. The north west corner of the area has combined flows which flow into the foul. The separate surface water sewer flows out to the south west corner of the area and travels south east from here to eventually discharge into Albert Edward Dock. The foul sewer flows out of the area at the south-east corner and travels south east connecting into the combined sewer near the roundabout where Bridge Road South meets Howdon Road. From here, the combined flow heads east along Howdon Road to Smiths Park Bridge A9-101 (Royal Quays CSO 1). The continuation pipe from this CSO travels west along Howdon Road to Howdon STW. The spill pipe flows south east to discharge near North Shields SPS Royal Quays (Royal Quays SPS 1) into the River Tyne at Albert Edward Dock.
Reported Issues	• Reports of surface water flooding in the area of Angus Crescent • Reports of flooding also behind railway embankment. Issues can also be located on the plan, '41526497-01-GIS-0004' (Appendix A).
Previous Studies	Chirton CAP Study 2017

5. UNDERSTANDING THE ISSUES

Following on from the desktop data collection at Stage 1, Stage 2 includes targeted data collection and model updates to better represent the existing drainage systems and reported flooding. These updates improve the understanding existing flood risk and will allow for successful solution development.

The following tasks were completed and are described in the sections below:

- Data collection to understand connectivity, capacity, and drainage assets;
- Hydraulic model updates to utilise additional data, add detail in the opportunity areas, and improve model confidence;
- Baseline model assessment to replicate current issues and understand a range of flooding mechanisms;
- Present day and 2040 scenarios were created and models run for a set of rainfall events;
- Flood risk assessment to compile model results, identify worst cases, and analyse locations of flood risk; and
- Review and agreement of areas to progress.

A site visit was planned for Spring 2020, but did not occur due to restrictions related to the COVID-19 pandemic. A site visit to identify flow routes, key features to include in the model, and potential options in each area was not completed. The area is known to the project team due to other historic work in the area and living within close proximity. Mapping tools, aerial photos, and knowledge from the NTC team members were utilised. A site visit will be planned for the next phase of works.

5.1 Data Collection

In Stage 2, various survey works were undertaken to increase confidence in the hydraulic model in the study areas. A total of 62 manhole surveys and seven CSO surveys were completed by 360 Mapping and connectivity and gulley tracing by Kilbrides in December 2019.

5.1.1 *Balkwell Avenue Data Collection*

The following data collection was completed in the Balkwell Avenue opportunity area:

- 7 manhole surveys were completed for Balkwell Avenue The manholes identified for survey were those that held potential separation opportunities and where confirmation of levels and pipe sizes were needed.
- Gully tracing was carried out in sections of highway to confirm if there is highway drainage and where it connects into the sewer network along Brampton Place and Cartington Road.

5.1.2 *Langley Road Data Collection*

The following data collection was completed in the Langley Road opportunity area:

- A total of 8 manhole surveys were requested. These manholes were deemed key manholes or to have potential to be utilised for surface water separation opportunities.

- A CCTV survey was requested and carried out along Verne Road.

5.1.3 *Redesdale Road Crescent Data Collection*

The following data collection was completed in the Redesdale Road opportunity area:

- A total of 2 manhole surveys were requested. These manholes were deemed key manholes or to have potential to be utilised for surface water separation opportunities.

- Surveys from the Dual Manhole Study were utilised.

5.1.4 *Mindrum Terrace*

The following data collection was completed in the Mindrum Terrace opportunity area:

- A total of 5 manhole and 2 CSO surveys were requested. These surveys were to obtain definite levels of key manholes and potential opportunities for surface water separation.

- Gully tracing was completed on Norham Road to confirm whether there is highway drainage and where it connects into the sewer network.

- A CCTV survey was requested along Elsdon Terrace.

5.1.5 *Howdon Road*

The following data collection was completed in the Howdon Road opportunity area:

- A total of 8 manhole and 2 CSO surveys were requested. These surveys were to obtain definite levels of key manholes and potential opportunities for surface water separation.

- Gully tracing was completed on Howdon Road, Seymour Street and Cardonnel Street to confirm whether the highway drainage exists and where it connects into the sewer network.

5.1.6 *Angus Crescent*

The following data collection was completed in the Angus Crescent opportunity area:

- A total of 8 manhole surveys were requested. These surveys were to obtain definite levels of key manholes and potential opportunities for surface water separation.

5.2 Hydraulic Model Updates

An existing Infoworks ICM hydraulic model for the Chirton drainage area (05-D38), which was updated as part of NWG's DWMP programme, was provided by NWG for

use in this study. The following updates were made to the hydraulic model as part of this Stage 2 study;

- Manhole survey data collected as part of this study was added to the hydraulic model.
- Drainage information from a recent development near Mindrum Terrace was utilised. This showed there was no changes required to the existing drainage network as part of the development drainage plan.
- CSO Surveys: Four full CSO surveys were carried out for this study area. NZ34677413, NZ35671631, NZ33676501 & NZ33675615. All CSO survey cards were returned completed and updated in the model.
- Subcatchment detail improved in the study areas.

A 2D model of the NIDP Study Area was created in InfoWorks ICM to allow an assessment of overland flow paths. The following improvements to the 2D model were completed:

- Ground model created from available 1 m, 2 m and 5 m resolution DTM data
- Assessment of ground model using Arc Hydro to determine contributing areas (runoff from green spaces) and overland flow paths. This was used to size the 2D zone defined in the hydraulic model.
- To generate runoff in open green space, a method was developed to apply rainfall directly and utilise the NewUK runoff to slow flow and allow some losses that can vary with initial conditions and with time.
- Buildings have been included in the 2D model as porous polygons, to force flow to route around the properties. Building polygons were extracted from MasterMap data.
- All properties were assumed to have a 150 mm threshold.

5.3 Performance Assessment

Stage 2 model simulations were completed for the design storm events agreed by the project team. These events were 5, 10, 15, 20, 30, 40, 50, 75, 100, 200 year return periods for summer and winter events for 3 durations (short, medium, long). As the design is progressed at a later stage, additional durations will need to be completed. In addition, revised FEH13 rainfall should be utilised at the next phase. The following models were created.

Table 5.4.1 – Chirton Strategic Study Models

Scenario Reference	Model Reference	Description	Comment
Base	MB01	Existing model. Assumes clean system. Recent developments are included.	Baseline

Scenario Reference	Model Reference	Description	Comment
Base	N02_Chirton_2040	Creep and new developments modelled for 2040 design horizon and rainfall applied with a 20% uplift for climate change	2040 Design Horizon Baseline

***Note a Do Nothing (No Maintenance) scenario has not been modelled.

5.4 Baseline Assessment

Following data collection, model updates, and review of initial outputs with NTC, the baseline model was run. The results were analysed to understand the flood risk from the different mechanisms and to identify where this is caused by a network incapacity within the drainage systems and / or overland flow issues.

5.4.1 *Balkwell Avenue*

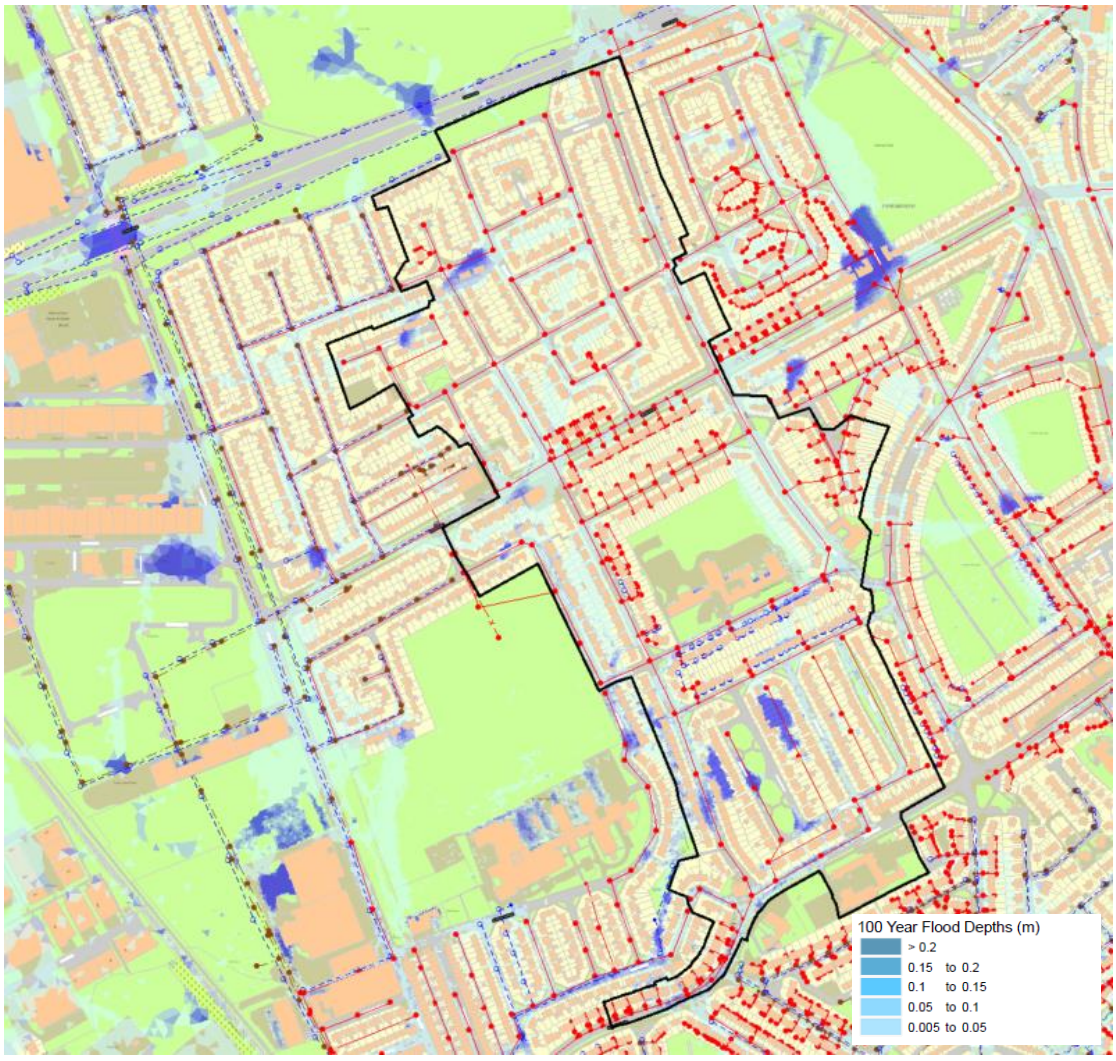


Figure 5.4.1 – Baseline Model Results at Balkwell Avenue (1 in 100 year)

Figure 5.4.1 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Balkwell Avenue. The 2D model predicts flooding from the combined drainage network as well as overland flow that cannot enter the surcharged system. Overland flows move north to south along the highways in this area. Flooding is predicted along Central Avenue, Verne Road, Craster Avenue, and Brampton Place, where it has been reported. As shown on the problem definition plan (41526497-01-0002, Appendix A), the predicted flooding aligns with reported flooding in the area.

5.4.2 *Langley Road*

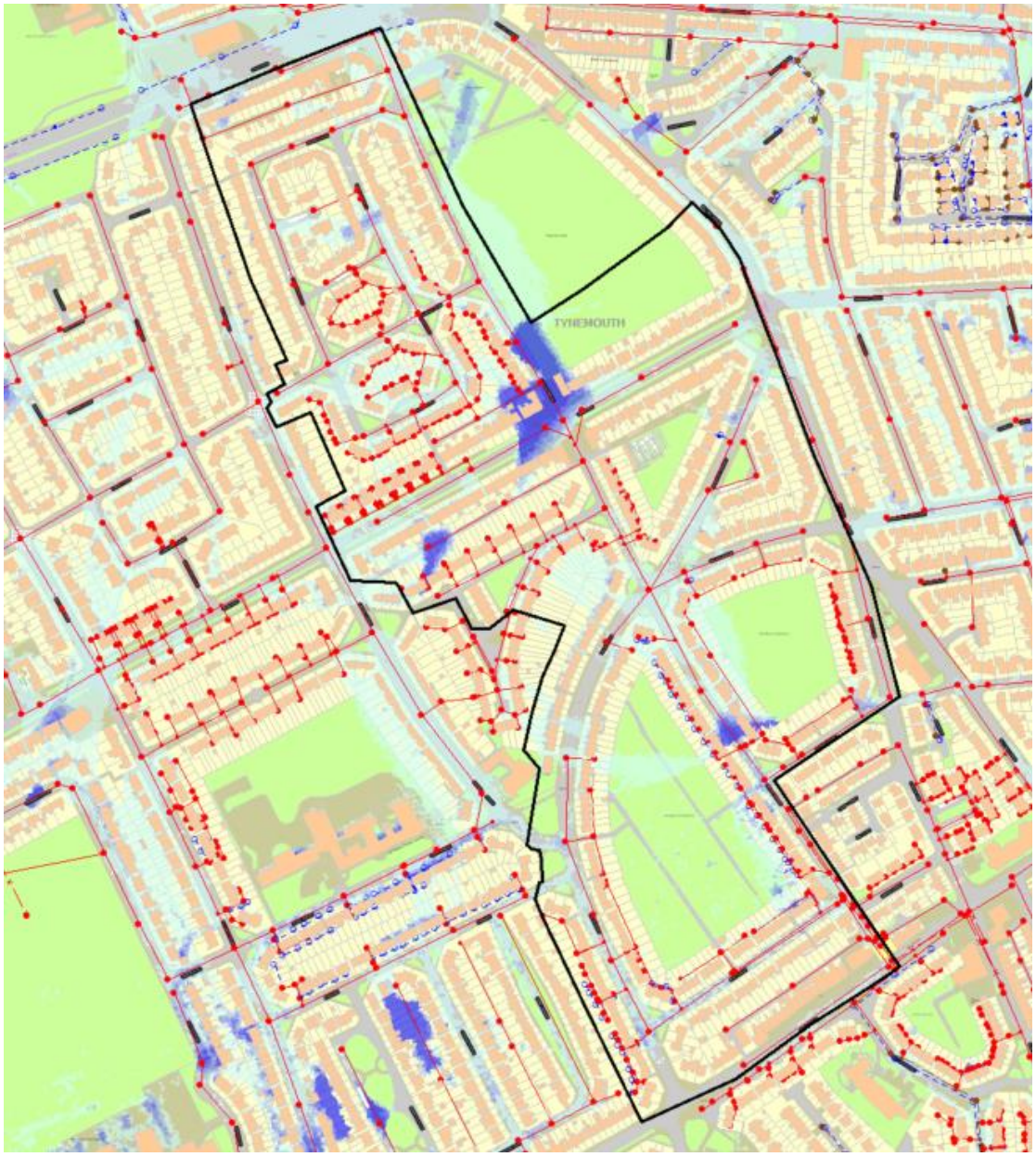


Figure 5.4.2 – Baseline Model Results at Langley Road (1 in 100 year)

Figure 5.4.2 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Langley Road. The 2D model predicts flooding from the combined drainage network as well as overland flow that cannot enter the surcharged system. Overland flows move north to south along the highways in this

area. There is a low spot at the junction of Verne Road and Heaton Terrace where overland flow accumulates. There is flooding predicted from the combined system to the rear (south) of Verne Road. As shown on the problem definition plan (41526497-01-0001, Appendix A), the predicted flooding aligns with reported flooding in the area.

5.4.3 *Redesdale Road*

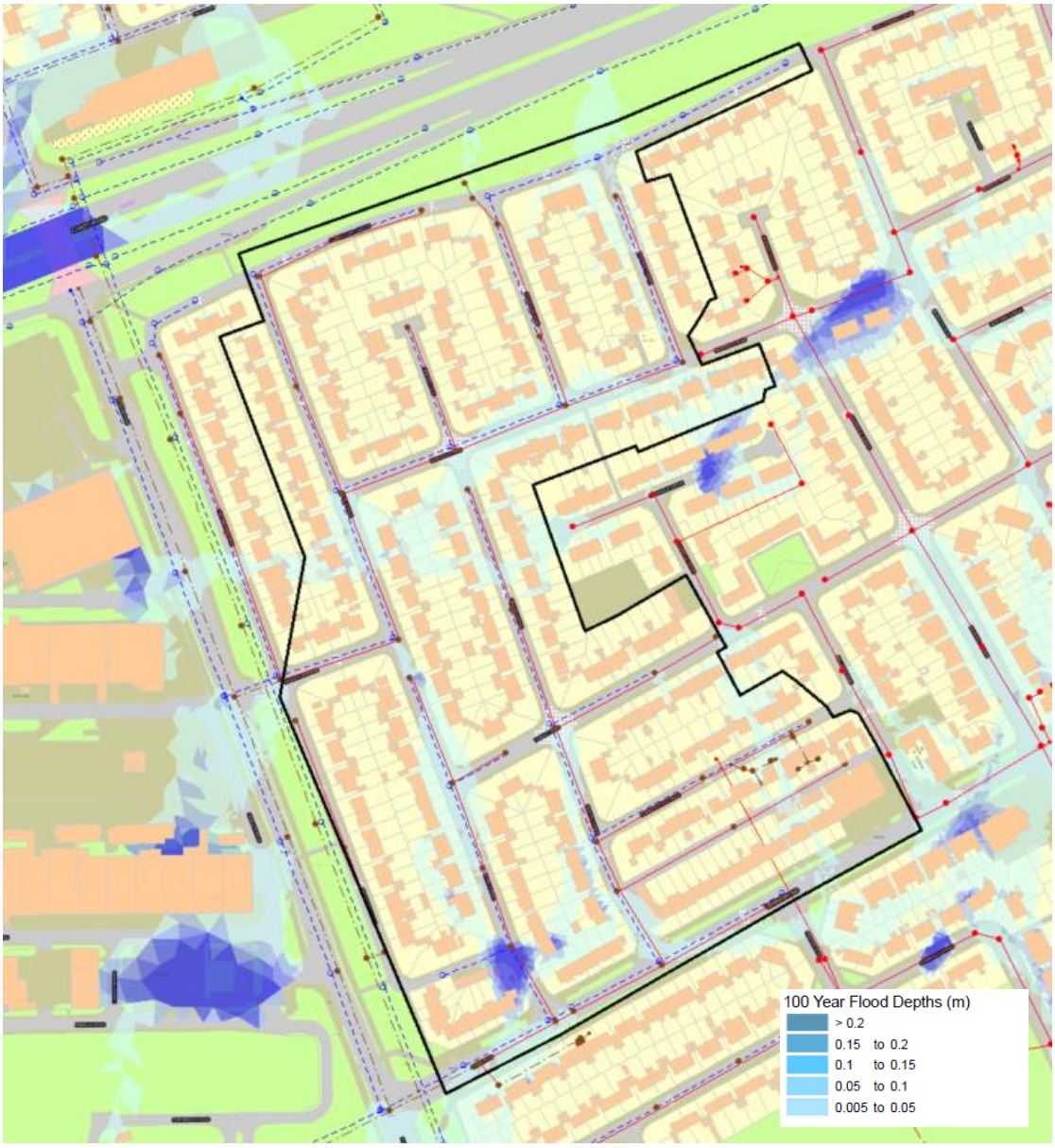


Figure 5.4.3 – Baseline Model Results at Redesdale Road (1 in 100 year)

Figure 5.4.3 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Redesdale Road. The 2D model predicts flooding from the drainage networks as well as overland flow that cannot enter the surcharged system. Surcharging in the surface water system causes the dual manholes to operate, and the surface water system surcharges into the foul network. This results initially in additional flow to treatment and in larger events to flooding from the foul system. Overland flows move north to south along the highways in this area. Flooding is predicted along Verne Road, which aligns with reports in this area. As

shown on the problem definition plan (41526497-01-0005, Appendix A), the predicted flooding appears to be more wide spread than known reports of flooding in the area.

5.4.4 *Mindrum Terrace*

Figure 5.4.4 – Baseline Model Results at Mindrum Terrace (1 in 100 year)

Figure 5.4.4 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Mindrum Terrace. The 2D model predicts surface water flooding from the north along Norham Road towards the industrial area and towards Norham High School. Overland flow travels along Wooler Avenue aligning with the route of the surface water drainage. There is also overland flow and flooding along Wallsend Road. Flooding predicted along Stannington Road aligns with reports of flooding in the area. Flooding along Mindrum Terrace also aligns with flooding reported in this area. As shown on the problem definition plan (41526497-01-0003, Appendix A), the predicted flooding appears to be more wide spread than known reports of flooding in the area.

5.4.5 *Howdon Road*

Figure 5.4.5 – Baseline Model Results at Howdon Road (1 in 100 year)

Figure 5.4.5 shows the maximum depth of flooding on the surface for a 1 in 100 year critical duration event for the baseline model at Howdon Road. The 2D model predicts surface water flooding along Upper Elsdon Street and Howdon Road. The model also predicts surcharge and flooding from the combined system to the rear (east) of Seymour Street and the rear (west) of Howdon Road. As shown on the problem definition plan (41526497-01-0006, Appendix A), the predicted flooding aligns with reported flooding in the area.

5.5 Flood Risk Assessment

Updates to the existing model and replicating reported issues in the area were a milestone within the project. These model outputs were used to complete a flood risk assessment across the range of events. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant,

intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods. In addition, 50yr RP was run to input into the damages assessment.

5.6 Stage 2 Interim Memo

The baseline flood risk and residential properties that potentially would benefit from a solution were reviewed. Esh Stantec provided a Stage 2 Interim Memo (Appendix B) summarising this information for each opportunity area.

For Stage 2 the areas agreed to be progressed and discussed in this report are:

- Balkwell Avenue
- Langley Road
- Redesdale Road
- Mindrum Terrace
- Howdon Road

The Angus Crescent Opportunity Area was agreed not to be progressed due to the low number of properties with predicted flood risk.

6. OPPORTUNITIES

For each opportunity area, a long list of options was considered that include a range of solutions such as catchment wide strategic solutions, localised flooding solutions, sustainable urban drainage opportunities, above ground attenuation, below ground storage solutions and upsizing of drainage networks. All of the options considered for an area have been compiled into a 'Long List of Options'.

From this long list, many factors were considered to determine the best options to take forward in a short list and as a preferred solution; model results, flood risk reduction, land use, disruption, cost were considered. This information is summarised in Section 6.2 – 6.6. The options agreed to be most viable are discussed in more detail. Discussions of option development from meetings were recorded in the Collaboration Tool, which is included in Appendix C.

An economic assessment was then completed for the preferred solutions. This assessment analysed the cost of the project (or the investment to the area), the damages avoided due to flood risk reduction, and the wider benefits such as biodiversity, amenity, or recreation.

The sections below provide detail of the five areas separately. However, Langley Road Opportunity Area and Balkwell Avenue Opportunity Area are adjacent to each other and solutions from Langley Road Opportunity Area drain into proposed solutions for Balkwell Avenue Opportunity Area. Similarly, Redesdale Road Opportunity Area is adjacent to Mindrum Terrace Opportunity Area and the proposed solutions for Redesdale Road Opportunity Area drain into proposed solutions for Mindrum Terrace Avenue Opportunity Area. Alterations could be made if the downstream areas were not progressed or were progressed at a later time. Combined total costs are included in the Executive Summary, combined FCERM calculators are included in Appendix E and a combined NWG Asset Planning table is included in Appendix F.

6.1 Assessment Methodology

6.1.1 *Long List of Options*

A long list of options was compiled and is included in Sections 6.2 – 6.6. This list includes a comprehensive list of options that considers ways to change the source, modify the pathway, manage, or modify receptors with the aim of reducing flood risk, improving drainage, and making use of available space for surface water attenuation. Every combination of options was not modelled. The minimum number of options were progressed to achieve widespread flood risk reduction. The effectiveness of options was tested, and options were altered or eliminated if flood risk reduction was not achieved. Options were considered to allow for adaptation to future changes in risk. Strategic and catchment changing options were identified where appropriate to consider long term betterment and incorporation of future development. Preferred options and ideas were discussed with the project partners and variations were tested within the hydraulic model to maximise benefits.

6.1.2 *Preferred Options*

From the long list of options, ideas were discussed with the project partners and variations were tested within the hydraulic model to maximise benefits. Options with greater environmental and social benefits were prioritised where possible. All options will require further development and stakeholder engagement.

6.1.3 *Geological Data*

A geotechnical desk study report was not carried out as part of the Stage 2 Study due to the extent of the size of the Opportunity Areas and the resulting large cost associated. Historical maps of the area were reviewed to understand previous land use.

To support the project, NTC consulted with their internal contaminated land team. Location plans for the Opportunity Areas were shared. The NTC contaminated land team shared information on historical land use such as approximate mine shaft locations and locations of former landfill areas.

A geotechnical desk study for the solution locations should be completed once there is more certainty that the study will progress to the next phase. There may be information available from recent development near Mindrum Terrace that can be utilised.

In addition, it will be prudent to undertake targeted intrusive ground investigation to provide detailed geotechnical and geo-environmental characterisation of materials in situ at each site, including soil sampling to enable laboratory testing during the design phase.

6.1.4 *Ecological Information*

An environmental screening was carried out by NWG. This identified:

- Street trees may be subject to tree protection orders (TPOs) and be of amenity value;
- Trees / shrubs have nesting bird potential Feb-Aug;
- Invasive non-native plant species;
- Open excavations pose hazard to hedgehogs.

A site specific ecological study should be carried out during Stage 3 to identify the risks and opportunities to ecology with regards to the proposed works.

6.1.5 *Utility Services*

Utility services information was requested for all the Opportunity Areas. This information was utilised in the option development process.

Further review of the utility crossings, potential diversion requirements, GPR surveys, and trial holes should be carried out during Stage 3 to identify risks and improve cost estimates.

6.1.6 *Flooding Damages*

Flood damage cost values were based on the Flood and Coastal Erosion Risk Management Handbook for Economic Appraisal (or “Multi-Coloured Handbook”) (2020), noting that the National Receptor Database assigns a compatible “MCM code” defining the category of each receptor in the database. The difference between the baseline flood risk and the solution flood risk is the avoided damages, or the benefit of the scheme.

In addition to residential and non-residential property damages, the economic appraisal considers the following forms of damage or benefit based on the MCM method:

- Emergency services response costs; as per MCM (2020) guidance, this is assumed to equal 5.6% of total (capped) property damage costs.

Damages related to residential evacuation and emergency accommodation costs, privately-owned vehicle damage, and intangible health benefits to the economy associated with a reduction in flood risk to residential properties could be further assessed.

Sensitivity testing was completed to check the impact of a few locations with high surcharge predictions. There was minimal impact to the damages or damages avoided due to the small number of properties affected.

6.1.7 *Additional Benefits*

Wider benefits were also reviewed for inclusion in the economic appraisal, where appropriate, using the methodology set out in the CIRIA Research Project RP993, Demonstrating the Multiple Benefits of SuDS (2015) and the B£ST Evaluation Tool (Release 5; July 9). Benefits that were assessed include:

- Air quality related to the addition of new trees;
- Amenity related to street improvements through greening and improvements to local park or green space;
- Biodiversity and ecology related to changes to land use by providing semi-wet areas, pockets of greenspace / habitat, and diversifying planting;
- Education by providing areas for use and discussion;
- Enabling development by providing new surface water drainage and reducing demand on the existing combined sewer network;
- Health related to encouraging physical activity or visits to green spaces for emotional well-being,
- Water quality related to the reduction in CSO spill frequency and volume; and
- Reduced area contributing runoff to the combined sewer.

A summary of the benefit assessment is included in Appendix H.

6.1.8 *EA Partnership Funding Calculator*

The EA's Partnership funding calculator for FCERM Grant-in-Aid spreadsheet (dated 2020) was completed in conjunction through discussions with the project partners. A version was provided in July 2020 for submission for the EA's 10 Year Medium Term Plan update. Following updates to solution modelling, 2040 design horizon modelling, and a review of cost estimates, an update of the FCERM GiA Calculators is included in Appendix E.

6.2 Options – Balkwell Avenue

6.2.1 *Long list of options*

Solutions for this opportunity area will reduce flood risk from incapacity in the combined sewer system by removing or attenuating surface water and improving capacity.

Table 6.2.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
B1	Do Nothing	No cost;	No	Does not resolve flooding issues, unacceptable option
B2	Do minimum	Low cost; provides basic maintenance of systems	No	Would not resolve incapacity issues
B3	Basin within the green verge north of Bellister Road. Divert highway drainage and connect into basin to attenuate SW flows.	Provides attenuation of fast response runoff in existing combined system and reduces flood risk	Yes	N/A
B4	Highway separation on Verne Road to intercept and attenuate highway runoff into B5. Surface water from Langley Road A5 would connect in as well.	Provides attenuation of fast response runoff in existing combined system and reduces flood risk	Yes	N/A
B5	New surface drainage in Balkwell Avenue; Approx. 660m of new 300mm SW pipe; Gulley reconnections to new SW pipe from Bellister	Reduces incapacity on combined network. Expensive, but significantly reduces surcharge in the system	Yes	N/A
B6	Attenuation of SW within open public green space at junction of The Quadrant and Central Avenue.	Attenuates highway drainage, reduces peak flows in combined system	Yes	N/A

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
B7	Attenuation of SW within open public green space at Brampton Place with highway disconnection.	Attenuates highway drainage, reduces peak flows in combined system	Yes	N/A
B8	Connect SW attenuation to existing surface water network NZ33688001 between Biddlestone Crescent and Balkwell Avenue.	Large amount of surface water removal from combined system	Yes	N/A
B9	Connect SW attenuation to existing surface water network NZ33679804 at junction of Wallsend Road and Meadow View. With attenuation.	Large amount of surface water removal from combined system	No	Diversion route limited by urban area. Highly disruptive and expensive.
B10	Connect SW attenuation to existing surface water network NZ34682002 at junction of Wallsend Road and Ripley Avenue. With attenuation.	Large amount of surface water removal from combined system	No	Diversion route limited by urban area. Highly disruptive and expensive.
B11	Separation of SW drainage of partially separate properties along Oswin Terrace, Sunniside and Balkwell Ave. Connect into B5.	Attenuates property drainage, reduces peak flows in combined system	Yes	N/A

6.2.2 *Preferred Options*

Option B3 involves surface water separation of highway drainage from the combined sewer along Redesdale Grove. This would require approximately 1700 m² of gully diversions along Redesdale Grove to then connect into the new surface water basin in green space opposite the junction of Langley Road and Bellister Road. Attenuated flow is then controlled back into the combined system.

Option B4 involves surface water separation of highway drainage from the combined sewer along Verne Road. This requires approximately 2000 m² of gully diversions

along Verne Road to then connect into the new surface water drainage in Balkwell Avenue (B5).

Option B5 involves new surface drainage in Balkwell Avenue. Approx. 660 m of new 300 mm surface water pipe with gulley reconnections to the new surface water pipe. Options B3 and B4 require this option to be implemented.

Option B6 involves attenuation of surface water flows within open public green space at junction of The Quadrant and Central Avenue. This requires approximately 2000 m² of gully diversions along Central Avenue to connect into the new attenuation basin. The discharge from the basin connects into option B11.

Option B7 involves attenuation of surface water in the open public green space at Brampton Place with approximately 1600 m² of highway drainage disconnection. This will be attenuated and discharged back into the new surface water drainage in Sunniside (option B11).

Option B8 involves connecting the new surface water drainage sewer (Option B5) into the existing surface water system at manhole NZ33688001.

Option B11 involves separation of surface water drainage of the partially separate system properties along Oswin Terrace, Sunniside and Balkwell Avenue. This will be carried out by diverting the private surface water connections of the properties into the new surface water drainage sewer, which is then connected into new surface water sewer option B5.

The proposed options are shown on '41526497-01-4001 Options Plan Balkwell Avenue'. See Appendix D.

6.2.3 *Options Summary*

Option	Option Ref.	Summary
Balkwell Avenue	B3	120 m^3 attenuation basin 1700 m^2 of area with new surface water drainage and gulley connections Basin inlet and outlet structures
Balkwell Avenue	B4	2000 m^2 of area with new surface water drainage and gulley connections
Balkwell Avenue	B5	500 m of 300 mm diameter new surface water pipework 1600 m^2 of area with new road drainage for gully reconnections into the above pipework
Balkwell Avenue	B6	350 m^3 attenuation basin 2000 m^2 of area with new surface water drainage and gulley connections Basin inlet and outlet structures 10 m SW outlet sewer
Balkwell Avenue	B7	300 m^3 attenuation basin 1600 m^2 of area with new surface water drainage and gulley connections Basin inlet and outlet structures

		50 m SW outlet sewer
Balkwell Avenue	B8	50 m of 300 mm diameter surface water pipework
Balkwell Avenue	B11	470 m of 225 mm diameter surface water pipework disconnection Intercept surface water at 10 locations

6.2.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, NTC highways department, NTC planning department, developers, landowners, council ecologist, and utility service providers if any diversions are required.

6.2.5 *Site Constraints*

Site constraints that will need to be considered include:

- Liaison with NTC highways department
- Overhead cables
- Services

6.2.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, confirm connectivity queries, and confirm levels for crossing of existing assets or other services.

6.2.7 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix E FCERM GiA Calculator and Appendix F NWG Asset Planning Table and shown on the Solution Plans in Appendix D.

Table 6.2.8.1 – NWG Flood Risk Net Properties at Risk - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	184	64	0	37	15	16
Solution	146	34	16	18	22	17
Difference	-38	-30	16	-19	7	1

Table 6.2.8.2 – NWG Flood Risk Net Properties at Risk - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	233	77	0	52	35	22	440
Solution	159	64	20	31	27	21	600
Difference	-74	-13	20	-21	-8	-1	160

In total, 334 properties would benefit from flood risk reduction when looking at this range of return periods. The full table is included in Appendix F and will be used by NWG Asset Planning.

Table 6.2.8.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	294	18	36	23	20
Solution	217	25	59	11	79
Difference	-77	7	23	-12	59

In total, 113 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.2.8 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh Stantec cost estimators for additional items. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix G.

Table 6.2.9.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	2,040,000
Project Overheads Cost (£)	490,000
Risk (10%) (£)	204,000
Total Cost + Risk (£)	2,734,000
OPEX Cost (£)	30,000
Total Cost + Risk + OPEX (£)	**2,764,000**

6.2.9 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.2.10.1 – List of Benefits

Types of Benefit	
Flood Risk – Residential Property Damages Avoided (£ NPV)	£5,218,000
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£-
Other Flooding Damages Avoided	£287,000
Wider Benefits (£ NPV)	£2,100,000
Water Quality (CSO Reductions – volume, frequency)	N/A
Habitat Creation and Biodiversity Enhancement (m2, type)	770 m^2, Attenuation basins
Reduced Contribution Area to Public Sewer (ha)	1.7
Benefit : Cost Ratio	4.8 : 1

6.2.10 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency. The FCERM GiA Calculator is included in Appendix E.

Funding Sources	
Potential funding available via FCERM	£1,800,000
Additional funding required from other sources	-

While additional funding may not be required from other sources, all project partners would benefit from the scheme and may be willing and able to contribute to the project. In addition to the project partners, there may be other stakeholders that will be considered and may be able to contribute to the project.

6.3 Options - Langley Road

6.3.1 *Long list of options*

Solutions for this opportunity area will reduce flood risk from incapacity in the combined sewer system by removing or attenuating surface water and improving capacity.

Table 6.3.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
A1	Do Nothing	No cost;	No	Does not resolve flooding issues, unacceptable option
A2	Do minimum	Low cost; provides basic maintenance of systems	No	Would not resolve incapacity issues
A3	Surface water attenuation as a swale in green space adjacent to Langley Road to collect highway runoff from Heaton Terrace and surrounding highways.	Reduces incapacity in existing combined system and attenuates surface water flows to be controlled back into the system.	Yes	N/A
A4	Raingardens within the green verges around Langley Road/Orlando Road and surrounding area. Disconnect highway drainage and connect into rain gardens to attenuate SW flows.	Reduces incapacity in existing combined system and attenuates surface water flows to be controlled back into the system.	Yes	N/A
A5	Disconnect highway drainage on Verne Road to intercept and attenuate highway runoff. Connects to new drainage from Balkwell Avenue (B4) to a surface water outfall.	Reduces incapacity in existing combined system and attenuates surface water flows to be controlled back into the system.	Yes	N/A

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
A6	New surface drainage in Heaton Terrace; Approx 835 m of new 300 mm dia SW pipe; Gulley reconnections to new SW pipe; Connect SW attenuation from other upstream SW separation	Removes flows from full combined system but be very disruptive due to works required in new development	No	New sewer route limited by urban area. Highly disruptive and expensive.
A7	Rain gardens and planters to replace neutral green space around adjacent to drainage network serving the combined sewer that under capacity.	Attenuation of surface runoff into the combined system	No	Spares areas of green space, disruptive to connect back into suitable SW locations.
A8	Attenuation of SW with open public green space at junction of The Quadrant and Central Avenue.	Attenuates highway drainage, reduces peak flows in combined system	No	Mutual catchment benefit with Balkwell Avenue option B6
A9	Localised attenuation on SW drainage of partially separate properties along Heaton Terrace, south of Langley Road using rain barrel / water butt.	Attenuates property drainage, reduces peak flows in combined system	Yes	N/A
A10	Connect SW attenuation to existing combined network.	Minimal flood risk reduction and environmental benefits. Expensive and disruptive	No	Does not provide flood risk benefit
A11	Connect SW attenuation to existing surface water network at manhole NZ34684201. With attenuation.	Removes SW flows from the combined system	No	Expensive and highly disruptive to transfer flow to this location
A12	Online combined upsizing along Heaton Terrace between manhole NZ34681601 and NZ34683307.	Addresses combined system incapacity and reduced surcharge levels	Yes	N/A

6.3.2 *Preferred options*

Option A3 involves surface water attenuation as a swale in green space adjacent to Langley Road to collect highway runoff from Heaton Terrace and surrounding highways. This flow will then be attenuated before being released back into the existing systems further downstream at the junction of Verne Road and Langley Road. Attenuated flows are controlled and connected to option A5 to be separated from the combined system. Mature trees in this area are to be avoided and retained. Landownership of this area needs to be confirmed.

Option A4 involves rain gardens within the green verges around Langley Road/Orlando Road and surrounding area to attenuate surface runoff. Highway drainage separation is connected into option A3.

Option A5 involves disconnecting of the highway drainage on Verne Road to intercept and attenuate highway runoff and then redirect flows back into the existing system downstream. Separated drainage is then connected though to Balkwell Avenue option B4 to be separated from the combined system.

Option A9 involves localised attenuation on surface water drainage of partially separate properties along Heaton Terrace, south of Langley Road using rain barrel / water butt. This option will attenuate the private connections and utilise the storage volume before releasing it back into the combined system. There are approximately 41 properties identified that are suitable for this measure. This assumes that residents agree and accept these proposals. The solution also assumes that residents will empty the rain barrel / water butt in advance of a large rainfall events, refer to section 6.3.4.

Option A12 involves online combined upsizing along Heaton Terrace between manhole NZ34681601 and NZ34683307. This will include approximately 124 m of 450 mm diameter and 248 m of 525 mm diameter sewer.

The proposed options are shown on '41526497-01-4002 Options Plan Langley Rd'. See Appendix D.

6.3.3 *Options Summary*

Option	Option Ref.	Summary
Langley Road	A3	1400 m^2 of area with new surface water drainage and gulley connections 100 m Swale Inlet and outlet structures for swale 10 m of 225 mm diameter outlet sewer Trees near swale
Langley Road	A4	5150 m^2 of area with new surface water drainage and gulley connections 1850 m^2 rain gardens around Langley Road and Orlando Road

Option	Option Ref.	Summary
Langley Road	A5	3550 m^2 of area with new surface water drainage and gulley connections
Langley Road	A9	41 No. rain barrel / water butt and connections
Langley Road	A12	124 m of 450 mm diameter surface water pipework 248 m of 525 mm diameter surface water pipework

6.3.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, NTC highways department, landowners, council ecologist, and utility service providers if any diversions are required. The solution includes providing rain barrels / water butts at some properties, which will require community outreach and education on the purpose and maintenance of these assets. Liaison would be required with NTC on proposed attenuation areas and liaison with the highways department and local residents on placement of rain gardens.

6.3.5 *Site Constraints*

Site constraints that will need to be considered include:

- Liaison with NTC highways department,
- Liaison with local resident on placement of rain gardens,
- Liaison with ecologist on mature trees within close proximity of works,
- Overhead cables,
- Services.

6.3.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, confirm connectivity queries, and confirm levels for crossing of existing assets or other services.

6.3.7 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix E FCERM GiA Calculator and Appendix F NWG Asset Planning Table and shown on the Solution Plans in Appendix D.

Table 6.3.8.1 – NWG Flood Risk Net Properties at Risk - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	173	28	0	25	16	11
Solution	32	8	15	18	37	24
Difference	-141	-20	15	-7	21	13

Table 6.3.8.2 – NWG Flood Risk Net Properties at Risk - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	119	49	0	45	7	4	329
Solution	85	30	12	22	28	14	481
Difference	-34	-19	12	-23	21	10	152

In total 360 properties would benefit from flood risk reduction when looking at this range of return periods. The full table is included in Appendix F and will be used by NWG Asset Planning.

Table 6.3.8.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	214	16	15	16	7
Solution	75	31	46	5	111
Difference	-139	15	31	-11	104

In total, 179 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.3.8 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh cost estimators for additional items such as bunds and inlets. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix G.

Table 6.3.9.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	1,150,000
Project Overheads Cost (£)	310,000
Risk (10%) (£)	115,000
Total Cost + Risk (£)	1,575,000
OPEX Cost (£)	30,000
Total Cost (£)	**1,605,000**

6.3.9 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.3.10.1 – List of Benefits

Types of Benefit	Quantity
Flood Risk – Residential Property Damages Avoided (£ NPV)	£17,905,000
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£338,000
Other Flooding Damages Avoided	£1,022,000
Wider Benefits	£2,300,000
Habitat Creation and Biodiversity Enhancement (m^2, type)	2980 m^2, swale; rain gardens
Reduced Contribution Area to Public Sewer (ha)	1.4
Benefit : Cost Ratio	16 : 1

6.3.10 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency. The FCERM GiA Calculator is included in Appendix E.

Funding Sources	
Potential funding available via FCERM	£2,800,000
Additional funding required from other sources	-

While additional funding may not be required from other sources, all project partners would benefit from the scheme and may be willing and able to contribute to the project. In addition to the project partners, there may be other stakeholders that will be considered and may be able to contribute to the project.

6.4 Options – Redesdale Road

6.4.1 *Long list of options*

Solutions for this opportunity area will reduce flood risk from surface water and foul system by providing storage on the surface water system and addressing the dual manholes in the catchment.

Table 6.4.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
D1	Do Nothing	No cost;	No	Does not resolve flooding issues, unacceptable option
D2	Do minimum	Low cost; provides basic maintenance of systems	No	Would not resolve incapacity issues
D3	Disconnect all dual manholes within Redesdale Road area (16 in total).	Removes the SW connection from the foul system, removes risk from foul surcharge	Yes	N/A
D4	Diversion of West Chirton (South) Industrial Estate surface water drainage.	Removes the surface water from the network and reduces risk of surcharge further downstream	Yes	N/A
D5	Below ground storage within open space within West Chirton (South) Industrial Estate.	Attenuates the surface water flows in the system to relief the system	No	Expensive and unnecessary due to viable SUDS option
D6	SW relief bifurcation with additional upsizing. This links to C4 (Mindrum Terrace)	Relieve the system of surface water surcharge flood risk	Yes	N/A
D7	SW relief bifurcation on Simonburn Ave	Relieve the system of surface water surcharge flood risk	Yes	N/A
D8	Pond / Wetland storage within open space within West Chirton (South) Industrial Estate off Barmouth Road.	Attenuates the diverted surface water flows in the network. Removes surface water flow from surcharged system.	Yes	N/A

6.4.2 *Preferred options*

Option D3 involves disconnecting all dual manholes within Redesdale Road area (16 in total). This will ultimately remove the surface water connection from the network and therefore reduced the risk of foul surcharge and reduce volume of treated flow.

Option D4 involves diversion of West Chirton (South) Industrial Estate surface water drainage. This will require disconnecting all the surface water connections around the industrial estate and then directing flows in a new surface water sewer to attenuation basin, Option D8.

Option D6 involves bifurcating from the surface water system at manhole NZ33684319 with additional upsizing of the system from Denton Avenue to the junction of Harnham Avenue. Surface water flows are attenuated in a swale in the verge of Norham Road as part of Mindrum Terrace Option C4.

Option D7 involves surface water bifurcation on Simonburn Avenue to relieve surcharge.

Option D8 involves a pond / wetland storage within the open space in West Chirton Industrial Estate, off Barmouth Road. This option will include 850 m^3 of storage in the open space to attenuate flows that have been disconnected and redirected in option D4 from the industrial estate. This will then be controlled back into the system just downstream of the pond/wetland storage location. Flow is discharged at a controlled rate back into the surface water system upstream of manhole NZ33681201. Land ownership for this area has not been confirmed.

The proposed options are shown on '41526497-01-4003 Options Plan Redesdale Road'. See Appendix D.

6.4.3 *Options Summary*

Option	Option Ref.	Summary
Redesdale Road	D3	Modifications to 16 dual manholes
Redesdale Road	D4	13,890 m^2 of area with new surface water drainage and gulley connections 710 m of 225 mm diameter surface water pipework
Redesdale Road	D6	242 m of 450 mm diameter surface water pipework 165 m of 375 mm diameter surface water pipework
Redesdale Road	D7	33 m of 300 mm surface water pipework
Redesdale Road	D8	850 m^3 storage pond. D4 connections into D8.

6.4.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, NTC planning department, NTC highways department, landowners, council ecologist, and utility service providers if any diversions are required.

6.4.5 *Site Constraints*

Site constraints that will need to be considered include:

- Liaison with NTC highways department,
- Liaison with ecologist on mature trees within close proximity of works,
- Overhead cables,
- Services.

6.4.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, confirm connectivity queries, and confirm levels for crossing of existing assets or other services.

6.4.7 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix E FCERM GiA Calculator and Appendix F NWG Asset Planning Table and shown on the Solution Plans in Appendix D.

Table 6.4.8.1 – NWG Flood Risk Net Properties at Risk - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	72	8	0	5	6	4
Solution	24	0	0	0	0	0
Difference	-48	-8	0	-5	-6	-4

Table 6.4.8.2 – NWG Flood Risk Net Properties at Risk - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	39	27	0	11	3	0	90
Solution	59	15	7	8	5	9	138
Difference	20	-12	7	-3	2	9	48

In total, 122 properties would benefit from flood risk reduction when looking at this range of return periods. The full table is included in Appendix F and will be used by NWG Asset Planning.

Table 6.4.8.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	85	6	8	6	11
Solution	24	0	2	0	90
Difference	-61	-6	-6	-6	79

In total, 81 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.4.8 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh cost estimators for additional items such as bunds and inlets. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix G.

Table 6.4.9.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	1,010,000
Project Overheads Cost (£)	300,000
Risk (10%) (£)	111,000
Total Cost + Risk (£)	1,521,000
OPEX Cost (£)	30,000
Total Cost (£)	**1,551,000**

6.4.9 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.4.10.1 – List of Benefits

Types of Benefit	
Flood Risk – Residential Property Damages Avoided (£ NPV)	£11,123,000

Types of Benefit	
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£-
Other Flooding Damages Avoided	£623,000
Wider Benefits	£790,000
Water Quality (CSO Reductions – volume, frequency)	N/A
Habitat Creation and Biodiversity Enhancement (m^2, type)	Approx. 850 m^2 basin
Dual manholes separated to reduce surface water to treatment and flooding from the foul network	16
Benefit : Cost Ratio	7 : 1

6.4.10 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency.

The FCERM GiA Calculator is included in Appendix E.

Funding Sources	
Potential funding available via FCERM	£1,900,000
Additional funding required from other sources	-

While additional funding may not be required from other sources, all project partners would benefit from the scheme and may be willing and able to contribute to the project. In addition to the project partners, there may be other stakeholders that will be considered and may be able to contribute to the project.

6.5 Options – Mindrum Terrace

6.5.1 *Long list of options*

Solutions for this opportunity area will reduce flood risk from surface water, reduce flood risk from the combined sewer system by providing storage on the combined system and providing some localised upsizing, provide localised surface water attenuation, and separate surface water flows from the combined system.

Table 6.5.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
C1	Do Nothing	No cost;	No	Does not resolve flooding issues, unacceptable option
C2	Do minimum	Low cost; provides basic maintenance of systems	No	Would not resolve incapacity issues
C3	Attenuation in green space in eastern verge of Norham Road (south of junction with Verne Road)	Attenuates highway drainage, reduces peak flows in combined system	No	Other attenuation had more benefits to the wider study area
C4	Attenuation swale (550 m³) within green corridor parallel to Norham Road (between Stannington Road and Alnwick Avenue). This attenuates flow from the north from Redesdale Road Option D6.	Attenuates highway drainage, reduces peak flows in combined system	Yes	N/A
C5	Attenuation of highway drainage rain gardens in green space at the top and bottom of Beadnell, Etal, Ford and Alnmouth Avenues.	Attenuates highway drainage, reduces peak flows in combined system	Yes	N/A

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
C6	Attenuation swale in green space verge on Biddlestone Cresent, along east boundary of Norham High School.	Attenuates highway drainage, reduces peak flows in combined system	Yes	N/A
C7	Separation of SW sewer from combined system in Rothbury Terrace (opposite Go North East Percy Main Depot)	Reduces surface water flows in the system and reduces peak flows in the combined.	Yes	N/A
C8	Geocellular storage within Norham High School car park		No	Expensive and no biodiversity benefits
C9	SUDS controls at Norham High School. Disconnect car park surface water (into C6)	Attenuates private connections in the car park	Yes	N/A
C10	Divert surface water drainage into basin (500 m³) in green space between school and day nursery.	Attenuates the diverted flows and relief the system of the highway drainage	Yes	N/A
C11	Bund behind Norham High School and Day Nursery to divert overland flow into swale (option C4)	Protects school and nursery from overland flow.	Yes	N/A

6.5.2 *Preferred options*

Option C4 involves a 210 m attenuation swale (550 m³) within green corridor parallel to Norham Road (between Stannington Road and Alnwick Avenue). This will include disconnecting highway flows and relieving the system of the surface water flows. Flows will be attenuated and controlled back into the system downstream. The option will include approximately 125 m of 225 mm diameter of new pipework to connect to and from the existing system.

Option C6 involves an attenuation swale in green space verge on Biddlestone Cresent, along east boundary of Norham High School. This will consist of diverting highway

flows towards a 70 m swale in the green space to be able to attenuate flows in this area and will be controlled back into the system.

Option C7 involves separation of a surface water sewer from the combined system in Rothbury Terrace (opposite Go North East Percy Main Depot). This will include separating the surface water out of the combined system at Rothbury Terrace and include around 20 m of 600 mm diameter pipe to divert flow into the existing surface water system.

Option C9 involves SUDS controls at Norham High School and disconnecting the car park surface water drainage into option C6 attenuation basin.

Option C10 involves diverting surface water drainage into basin (500 m^3) in green space between school and day nursery. This will be used to attenuate the flows from options C6 and C9 before controlling flows back into the system.

Option C11 – Bund used to direct overland flow around the west side of Norham High School and Day Nursery and divert flows into the swale option C4.

The proposed options are shown on '41526497-01-4004 Options Plan Mindrum Terrace'. See Appendix D.

6.5.3 *Options Summary*

Option	Option Ref.	Summary
Mindrum Terrace	C4	210 m attenuation swale 125 m of 225 mm dia. surface water pipework Swale inlet and outlet
Mindrum Terrace	C6	1370 m^2 of area with new surface water drainage and gulley connections 70 m attenuation swale Swale inlet and outlet
Mindrum Terrace	C7	20 m of 600 mm dia. surface water pipework
Mindrum Terrace	C9	2000 m^2 of area with new surface water drainage and gulley connections Inlet to swale at C6
Mindrum Terrace	C10	500 m^3 attenuation basin 30 m of 225 mm dia. surface water drainage to connect into basin Basin inlet and outlet
Mindrum Terrace	C11	195 m x 1 m x 0.5 m bund

6.5.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, NTC planning department, NTC highways department, landowners, council ecologist, and utility service providers if any diversions are required.

6.5.5 *Site Constraints*

Site constraints that will need to be considered include:

- Liaison with NTC highways department,
- Liaison with ecologist on mature trees within close proximity of works,
- Overhead cables,
- Services.

6.5.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, confirm connectivity queries, and confirm levels for crossing of existing assets or other services.

6.5.7 *CSO Impact*

A typical year storm (2015) was extracted from the local 10-year time series rainfall to assess the impact of the solution on CSOs.

Table 6.5.7.1 – CSO Changes to Spill Frequency and Volume

	Baseline		Solution	
	Spill Frequency	Spill Volume (m^3)	Spill Frequency	Spill Volume (m^3)
CHIRTON CSO 1	5	4000	2	1200

The model results indicate the proposed solution does not cause detriment to CHIRTON CSO 1.

6.5.8 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix E FCERM GiA Calculator and Appendix F NWG Asset Planning Table and shown on the Solution Plans in Appendix D.

Table 6.5.8.1 – NWG Flood Risk Net Properties at Risk - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	17	9	0	30	8	4
Solution	5	12	4	4	2	3
Difference	-12	3	4	-26	-6	-1

Table 6.5.8.2 – NWG Flood Risk Net Properties at Risk - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	184	27	0	18	36	11	155
Solution	28	19	11	4	21	31	355
Difference	-156	-8	11	-14	-15	20	200

In total, 290 properties would benefit from flood risk reduction when looking at this range of return periods. The full table is included in Appendix F and will be used by NWG Asset Planning.

Table 6.5.8.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	52	6	8	7	1
Solution	23	2	11	1	37
Difference	-29	-4	3	-6	36

In total, 41 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.5.9 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh cost estimators for additional items such as bunds and inlets. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix G.

Table 6.5.9.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	620,000
Project Overheads Cost (£)	170,000
Risk (10%) (£)	62,000
Total Cost + Risk (£)	852,000
OPEX Cost (£)	30,000
Total Cost (£)	**882,000**

6.5.10 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.5.10.1 – List of Benefits

Types of Benefit	
Flood Risk – Residential Property Damages Avoided (£ NPV)	£810,000
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£650,000
Other Flooding Damages Avoided	£82,000
Wider Benefits	£1,800,000
Water Quality (CSO Reductions – volume, frequency)	2800 m^3, 3 No.
Habitat Creation and Biodiversity Enhancement (m2, type)	1500 m^2, swales; rain gardens
Reduced Contribution Area to Public Sewer (ha)	4.4
Benefit : Cost Ratio	4 : 1

6.5.11 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency.

The FCERM GiA Calculator is included in Appendix E.

Funding Sources	
Potential funding available via FCERM	£980,000
Additional funding required from other sources	-

While additional funding may not be required from other sources, all project partners would benefit from the scheme and may be willing and able to contribute to the project. In addition to the project partners, there may be other stakeholders that will be considered and may be able to contribute to the project.

6.6 Options – Howdon Road

6.6.1 *Long list of options*

Solutions for this opportunity area will address flood risk from surcharge in the combined system by reducing surface water contribution. These solutions aim to remove surface water from the combined system by separation.

Table 6.6.1 – List of Options Considered

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
E1	Do Nothing	No cost;	No	Does not resolve flooding issues, unacceptable option
E2	Do minimum	Low cost; provides basic maintenance of systems	No	Would not resolve incapacity issues
E3	Highway separation on Upper Eldson Street, Cardonall Street and Seymour Street	Separates highway drainage and relieves the combined system reducing surcharge	Yes	N/A
E4	New SW drainage at Cardonall Street and Seymour Street	Separates flows from the combined system	Yes	N/A
E5	New SW drainage along boundary of disused gas distribution site towards Howdon Road	Separates flows from the combined system	Yes	N/A
E6	Rain gardens on Upper Elsdon Street	Attenuation of surface runoff	No	Not enough benefit to study area

Option	Option & Description	Benefits	Taken Forward	Reason Not Taken Forward
E7	Divert new separated surface water through Burdon Main Road into CSO overflow sewer	Separates flows from the combined system	Yes	N/A
E8	Convert car parking space into permeable pavement	Reduce peak runoff response	No	Ownership and ongoing maintenance requirements.
E9	New SW separation and diversion through Penman Street and Howdon Road	Separates flows from the combined system	No	Requires significant work in Howdon Rd and greater disruption. Does not achieve as much SW removal as option E5
E10	Connect SW separation pipework into a swale along boundary of disused gas distribution site towards Howdon Road	Attenuates SW flows and provides biodiversity benefit	No	Issues relating to unknown land ownership and potential land contamination

6.6.2 *Preferred options*

Option E3 involves highway separation on Upper Eldson Street, Cardonall Street & Seymour Street. This will be achieved by disconnecting the highway drainage and gullies from surrounding streets and redirected into the new surface water drainage system that is part of Option E4/5 & 7.

Option E4 involves a new surface water drainage system around the Howdon Road study area running through Cardonall Street & Seymour Street

Option E5 involves a new surface water drainage system from Penman Street along the boundary of the disused gas distribution site towards Howdon Road. This option also requires breaking through or tunnelling under a wall at two locations.

Option E7 involves the connection pipework from options E4 and E5 across Howdon Road and through Burdon Main Row into the overflow sewer of NTY040 HOWDON ROAD/DOCK ROAD CSO.

6.6.3 *Options Summary*

Option	Option Ref.	Summary
Howdon Road	E3	7000 m^2 of area with new surface water drainage and gulley connections
Howdon Road	E4	390 m of 225 mm dia. surface water pipework
Howdon Road	E5	65 m of 300 mm dia. surface water pipework 2 Wall crossings (tunnel beneath or break through and repair)
Howdon Road	E7	90 m of 300 mm surface water pipework to connect into outlet of CSO

6.6.4 *Stakeholders*

Stakeholders that should be consulted would include local residents, local businesses, NTC planning department, NTC highways department, landowners, council ecologist, and utility service providers if any diversions are required.

6.6.5 *Site Constraints*

Site constraints that will need to be considered include:

- Liaison with NTC highways department,
- Liaison with landowner for Option E5,
- Possibly contaminated ground on former gas works site (Option E5),
- Brick wall to cross under,
- Liaison with local resident on placement of new trees,
- Overhead cables,
- Services.

6.6.6 *Additional Data Requirements*

Additional survey data at drainage connection locations, confirm connectivity queries, and confirm levels for crossing of existing assets or other services.

6.6.7 *CSO Impact*

A typical year storm (2015) was extracted from the local 10-year time series rainfall to assess the impact of the solution on CSOs.

Table 6.6.7.1 – CSO Changes to Spill Frequency and Volume

	Needs		Solution	
	Spill Frequency	Spill Volume (m^3)	Spill Frequency	Spill Volume (m^3)
HOWDON ROAD/DOCK ROAD CSO	60	44,000	50	33,200

The model results indicate the proposed solution does not cause detriment to HOWDON ROAD/DOCK ROAD CSO.

6.6.8 *Flood Risk*

A flood risk assessment was completed for the solution. The change of flood risk was compared to the baseline to determine the number of properties with reduced flood risk. Flood risk is assessed by the EA for 20, 30, 75, 100, and 200 year return periods to correspond with the very significant, significant, intermediate, moderate, and low risk bands respectively. Flood risk is assessed by NWG for 5, 10, 15, 20, 30, and 40 year return periods for internal and external (curtilage). The changes in flood risk are shown in Appendix E FCERM GiA Calculator and Appendix F NWG Asset Planning Table and shown on the Solution Plans in Appendix D.

Table 6.6.8.1 – NWG Flood Risk Net Properties at Risk - Internal

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr
Baseline	18	0	0	5	40	21
Solution	0	11	7	0	0	0
Difference	-18	11	7	-5	-40	-21

Table 6.6.8.2 – NWG Flood Risk Net Properties at Risk - External

	1 in 5 yr	1 in 10 yr	1 in 15 yr	1 in 20 yr	1 in 30 yr	1 in 40 yr	> 1 in 40 yr
Baseline	0	0	0	0	3	5	0
Solution	0	0	0	0	1	7	66
Difference	0	0	0	0	-2	+2	+66

In total, 92 properties would benefit from flood risk reduction when looking at this range of return periods. The full table is included in Appendix F and will be used by NWG Asset Planning.

Table 6.6.8.3 – EA Flood Risk Improvements

	20 yr Very Significant	30 yr Significant	75 yr Intermediate	100 yr Moderate	200 yr Low
Baseline	36	37	22	7	15
Solution	31	0	5	24	57
Difference	-5	-37	-17	17	42

In total, 71 properties have moved flood risk category. There are some additional neighbouring properties that may also be able to be improved with some optimisation of the solution at a later phase.

6.6.9 *Costs*

To estimate costs of the solution, NWG's DWMP Cost Estimate tool was utilised which provides unit rates for a range of sustainable and traditional solutions. These costs were supplemented with high level costs from Esh cost estimators for additional items such as bunds and inlets. Design costs were estimated to be 10% of the construction cost. The detailed cost estimate is provided in Appendix G.

Table 6.6.9.1 – Summary of Costs

Cost Element	Cost Estimate (£)
Design and Construction Cost (£)	680,000
Project Overheads Cost (£)	190,000
Risk (10%) (£)	68,000
Total Cost + Risk (£)	938,000
OPEX Cost (£)	30,0000
Total Cost (£)	**968,000**

6.6.10 *Benefits*

Benefits were assessed as described in Section 6.1 and are summarised below.

Table 6.6.10.1 – List of Benefits

Types of Benefit	
Flood Risk – Residential Property Damages Avoided (£ NPV)	£3,400,000

Types of Benefit	
Flood Risk – Non-Residential Property Damages Avoided (£ NPV)	£65,000
Wider Benefits	£596,000
Other Flooding Damages Avoided	£195,000
Water Quality (CSO Reductions – volume, frequency)	33,200 m^3, 10 No.
Habitat Creation and Biodiversity Enhancement (m2, type)	New trees
Reduced SW Contribution Area to Public Sewer (ha)	0.7
Benefit : Cost Ratio	4 : 1

6.6.11 *FCERM GiA Calculator*

The costs and benefits were put into the EA's FCERM GiA Calculator to determine potential funding that may be available. This includes a 10% risk contingency.

The FCERM GiA Calculator is included in Appendix E.

Funding Sources	
Potential funding available via FCERM	£870,000
Additional funding required from other sources	£938,000

The additional funding would need to be considered by the project partners to determine if the project is viable to progress.

7. NEXT STAGE

7.1 Programme

A programme for the next stages of the project have been included in Appendix I. This is subject to prioritisation and funding decisions by each of the partner organisations: North Tyneside Council, Northumbrian Water, and the Environment Agency. In addition, land negotiations and liaison with other stakeholders may impact the programme.

If all areas progress, connections between Langley Road Opportunity Area. and Balkwell Avenue Opportunity Area should be planned and connections between Redesdale Road Opportunity Area and Mindrum Terrace Opportunity Area should be planned. Solutions could be modified if the downstream areas were not progressed or were progressed at a later time.

7.2 Recommendations

In the next design phase of the project, the following additional data collection is recommended.

- Topographic surveys of green areas where attenuation basins are proposed;
- Manhole surveys of low spots
- Surveys of crossings and connection locations;
- Flow survey to monitor flows in key location to increase model confidence;
- Threshold level surveys at properties with suspect connection levels;
- A check for 1st and 2nd floor flats should be completed. There may be some counted as residential properties with improvements in Mindrum Terrace Opportunity Area and possibly other areas.
- Site visit to further development options and identify any additional risks or data requirements;
- Geotechnical Desk Study;
- Ground Investigation;
- Ecological Walkover;
- Trial Pits and GPR surveys;
- Confirm land ownership;
- Community engagement to promote and recommend rain barrels / water butts and gain agreement for installation and maintenance;
- Confirm ownership and maintenance of new assets;
- Engage with stakeholders to maximise environmental and social benefits from proposals; and
- Update of FEH13 rainfall.

7.3 Risks

Some risks that should be noted and explored further at the next stage include:

- Land ownership
- Services
- Ground conditions
- Ecological constraints
- Unidentified surface water / land drainage connections
- Unidentified foul connections into drainage to be utilised as surface water
- Alignment of funding sources from project partners
- Agreement on operation and maintenance of assets

Appendix A - Problem Definition Plans

Appendix B - Stage 2 Interim Memo

Appendix C - Collaboration Tool

Appendix D - Solution Plans

Appendix E – FCERM GiA Calculator

Appendix F - NWG Asset Planning Table

Appendix G - Cost Estimates

Appendix H - Benefit Assessment

Appendix I - Programme