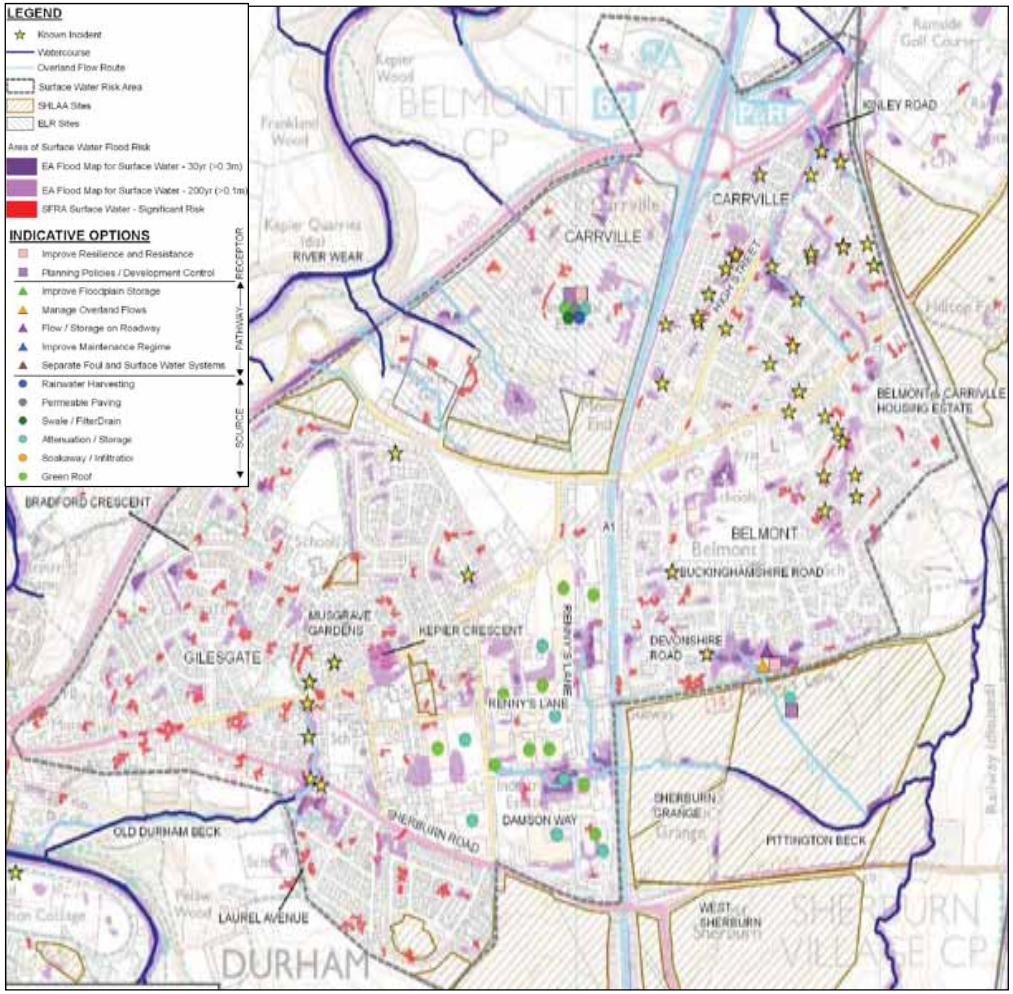
Appendix D – SWRA Action Plans

Capabilities on project:
Water

Appendix D – SWRA Action Plans

Action Plan: DC8 – Durham City



Brief

DC8 occupies high ground therefore the source of the surface water risk is rain falling across the SWRA rather than flowing into the area from elsewhere. The transport corridors (A1, A690 and railway) prevent overland flow leaving the area. This has resulted in an extensive sewer network which outfalls to the River Wear to the west and Pittington Beck to the east.

57 known flood incidents are known within the SWRA. The majority of known flood incidents at Gilesgate appear to be associated with an inadequate surface water sewer network and highways drainage. Blockages seem to be the main cause for the surface water issues. Northumbrian Water is in the process of completing a flood alleviation scheme involving oversized pipes to provide additional storage in the Belmont and Gilesgate systems. Durham County Council has undertaken works to improve highways drainage. This has included the provision of additional gullies and de-silting blocked highways drains.

585 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £610,000. Key surface water risk areas are near Devonshire Road and Damson Way.

Options

The SHLAA site to the south of Renny's Lane on Sherburn Grange presents significant opportunities for surface water management for both Devonshire Road and the industrial estate off Damson Way. The SFRA modelling has identified topographic lows that form overland flow paths which could be formalised to channel flood water out of these areas and into the SHLAA site which could provide storage in the form of ponds and wetlands.

If it is not possible to cross the A1 or Renny's Lane with formal overland flow paths it would be necessary to manage the surface water in situ. Within the Devonshire Road area are a number of small park areas that could be utilised for storage and the industrial estate off Damson Way has large car parking areas that could also provide storage. Alternatively the flat roofs at the industrial estate may present opportunities to retro-fit green roofs.

MCA Preferred Option (Score of +8)

- Planning Policies / Development Control

Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
DC8 - 1	Devonshire Road and Damson Way	Assess the viability of creating formalised flow paths to channel flood water into the SHLAA site to provide storage.	**Durham County Council** Northumbrian Water Environment Agency Developer	1-2 years Pre-development
DC8 - 2		Assess whether the local parks around Devonshire Way can be used for flood storage.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
DC8 - 3		Assess whether the industrial estate off Damson Way can be used for flood storage.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
DC8 - 4		Investigate the possibility of retro-fitting green roofs in the industrial estate.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years

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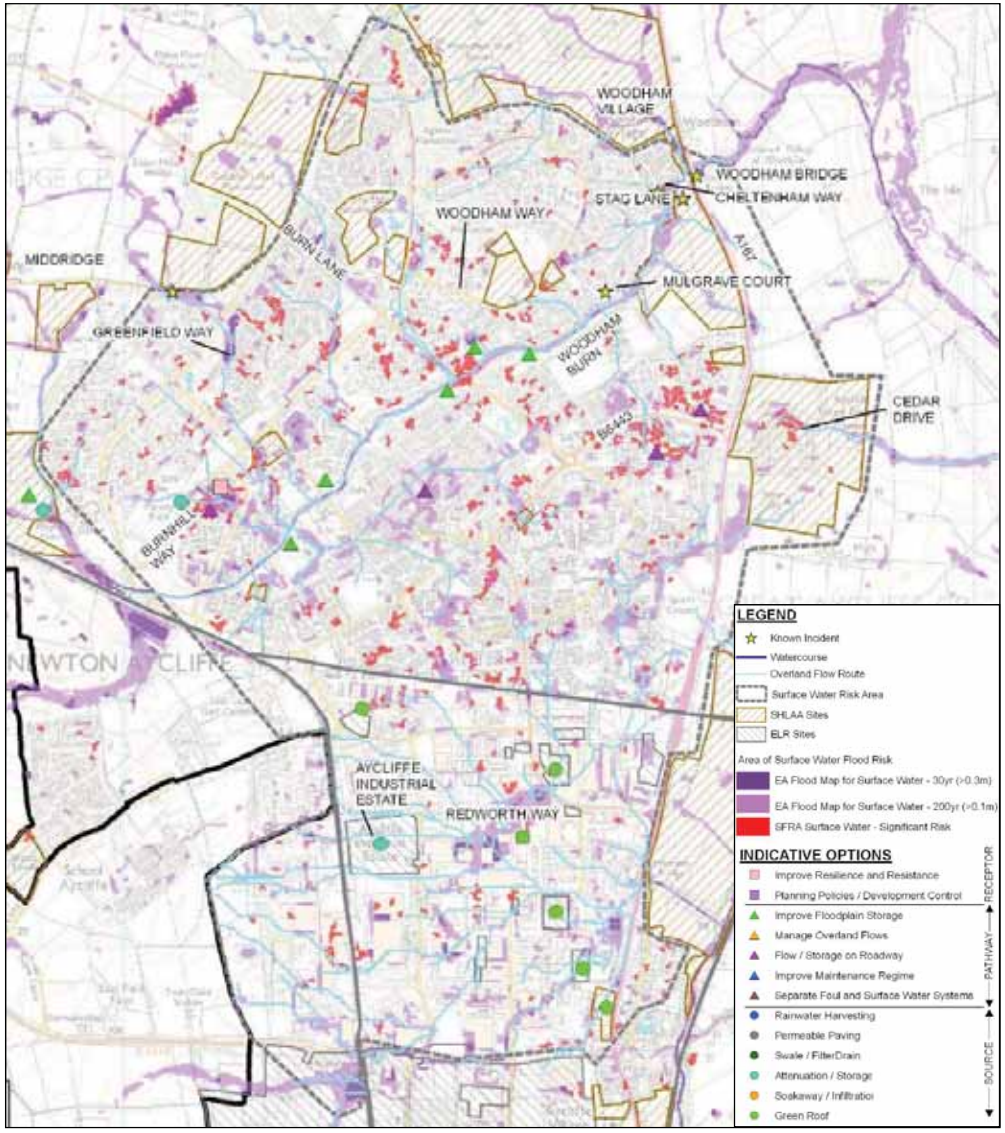
Action Plan: NEW1 – Newton Aycliffe



Brief

NEW1 contains 13 SHLAA sites, 15 ELR sites, and five known flood incidents. The site is predominantly flat and heavily developed with a high percentage of impermeable areas. The known incidents are clustered together and the Environment Agency agreed that the known flood incidents along Woodham Village are a result of fluvial flooding from Woodham Burn. It is likely that when river levels are high, the surface water sewers from the low lying Stag Lane and Cheltenham Way are unable to discharge. The Environment Agency has undertaken works and hydraulic modelling of Woodham Burn.

Durham County Council engineers advised that the surface water flood problem at Middridge is a result of surface water running off the field to the north. The field is designated as a SHLAA site therefore if it comes forward for development planning control ought to recommend that source control measures area implemented to manage the downstream risk to Middridge.

707 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £793,000. Key areas across Newton Aycliffe affected by surface water in exceedance events include; Burnhill Way, the area to the south of Woodham Burn and parts of the Industrial Estate.

Options

The residential area between Burnhill Way and Woodham Burn is a hotspot for surface water. The source of this water may be the playing fields immediately to the north of Burnhill Way, which if used for storage would provide benefits. Alternatively storage could be provided along the road to prevent surface water flooding to properties. Kerbing could be used to contain and attenuate surface waters until the sewer system has capacity.

The area immediately to the south of Woodham Burn faces similar problems, lots of localised areas of flood risk hence storage in the road is again likely to be the best option given the highly urbanised nature of the area. However there is open floodplain alongside Woodham Burn which can be used to provide storage, if the water can be transferred from the urban setting to the river setting. This would require the formal overland flow paths to be instated.

The industrial estate in the south of Newton Aycliffe contains lots of flat roofs, therefore retro-fitting of green roofs is an option, however this is unlikely to be cost effective measure. The potential ELR sites should implement source control measures where possible. One option would be to set one aside and create a storage area to hold excess runoff or a wetland to provide the additional benefits of green infrastructure.

MCA Preferred Options (Joint Score of +5)

- Flow/Storage on Roadway
- Improve Floodplain Storage
- Planning Policies / Development Control
- Improve Resilience and Resistance

Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
NEW1 - 1	Burnhill Way	Assess the viability between of using the playing fields to the north for flood storage and storing water in roadways.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
NEW1 – 2		Assess potential ELR sites to find a suitable site to store water to hold excess runoff, or a wetland to provide additional benefits of green infrastructure.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
NEW1 – 3	Industrial Estate	Determine whether green roofs are viable.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
NEW1 - 4	Middridge	If the SHLAA site comes forward for development planning, assess the requirement for source control measures to manage the downstream risk.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development

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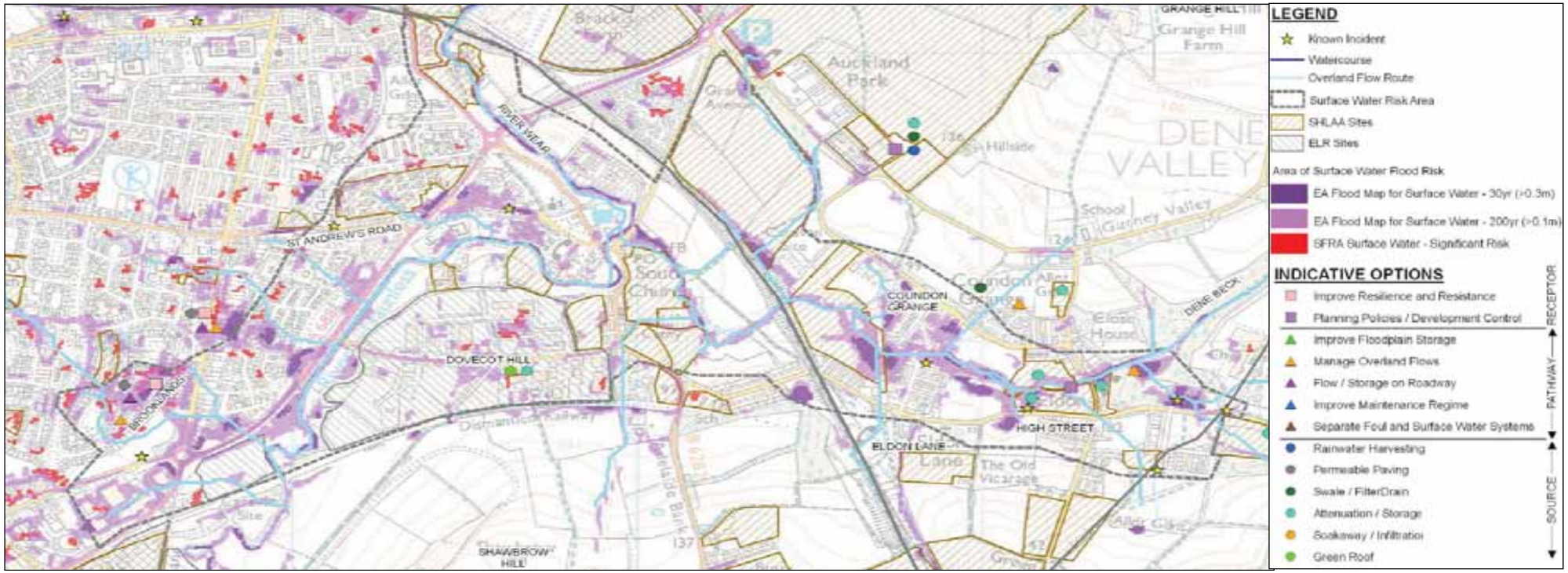
Action Plan: BIS3 – Bishop Auckland



Brief

The River Gaunless flows in a northerly direction through the SWRA before discharging into the River Wear to the north. The eastern portion of the SWRA is drained by Dene Beck. The SWRA is located at the bottom of the steeply sloped Grange Hill and Shawbrow Hill with an urbanised area to the west. BIS3 has experienced eight known flood incidents.

Many of the historical flood incidents in Bishop Auckland are a result of fluvial flooding from the River Gaunless and therefore cannot be solved as part of a SWMP. The Environment Agency has implemented a flood alleviation scheme for Bishop Auckland providing flood storage that now provides a standard of protection of 1 in 200 years. Surface water incidents have occurred in the east of the SWRA near Eldon and have been related to maintenance and insufficient drainage capacity within the sewer system.

The Environment Agency's Flood Map for Surface Water identifies surface water risk areas near Counden Grange, Brooklands and Dovecot Hill. Several SHLAA and ELR sites are located near these areas and present opportunities to address the surface water issues. 296 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £365,000.

Capabilities on project:
Water

Options

Surface water in the Coundon Grange area will be a result of rainfall running off Grange Hill to the north. The SHLAA sites on Grange Hill present opportunities for strategic surface water management, reducing runoff from Grange Hill by holding and delaying runoff before it affects residential properties. Storage areas in the form of ponds, wetlands, swales and rainwater harvesting could all be encouraged through planning policies and development control. Whilst measures implemented on the SHLAA sites would have wider benefits, they would not directly solve the problems at Coundon Grange. It may be possible to put swales or filter drains above the residential area to intercept flows coming off the hill or channel overland flows into storage areas in the SHLAA sites.

In the Brooklands area there is little redevelopment in this already heavily urbanised setting. This limits the potential to provide storage ponds or implement mitigation measures through re-development rather they would have to be implemented through retro-fit schemes. In this area the most preferable measures are likely to be improving resilience and resistance or storage of water in the roads. Kerbing could be provided to contain and attenuate surface waters until the combined sewer system has capacity. Retro-fitting permeable pavements may provide some benefit and it may be possible to provide an overland flow route to the River Gaunless. Incorporated into future capital renewal surfacing works, this would involve roadway re-grading and profiling of the carriageway to provide an overland flow path out of the area to reach the river.

The ELR site at Dovecot Hill presents opportunities to implement source control measures such as green roofs and storage to manage the risks faced by the site.

MCA Preferred Options (Joint Score of +7)

- Attenuation Storage
- Swales/Filter Drain
- Planning Policies / Development Control

Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
BIS3 - 1	Coundon Grange	Assess the benefit of creating swales or filter drains above Coundon Grange to intercept flows coming off the hill, or channel overland flows into storage areas.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
BIS3 - 2		Encourage source control measures such as ponds, wetlands, swales and rainwater harvesting for any new developments, encouraged through planning policy and development control.	**Durham County Council** Northumbrian Water Environment Agency	Pre-development
BIS3 - 3	Brooklands and Wider Area	Improve resilience and resistance.	**Home Owners** Durham County Council	1-2 years
BIS3 - 4		Investigate potential to store water in the roads through kerbing and the possibility of retro-fitting permeable paving to provide an overland flow route to the River Gaunless.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
BIS3 - 5	Dovecot Hill	Encourage source control measures such as green roofs and storage. Enforced through planning policy and development control.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development

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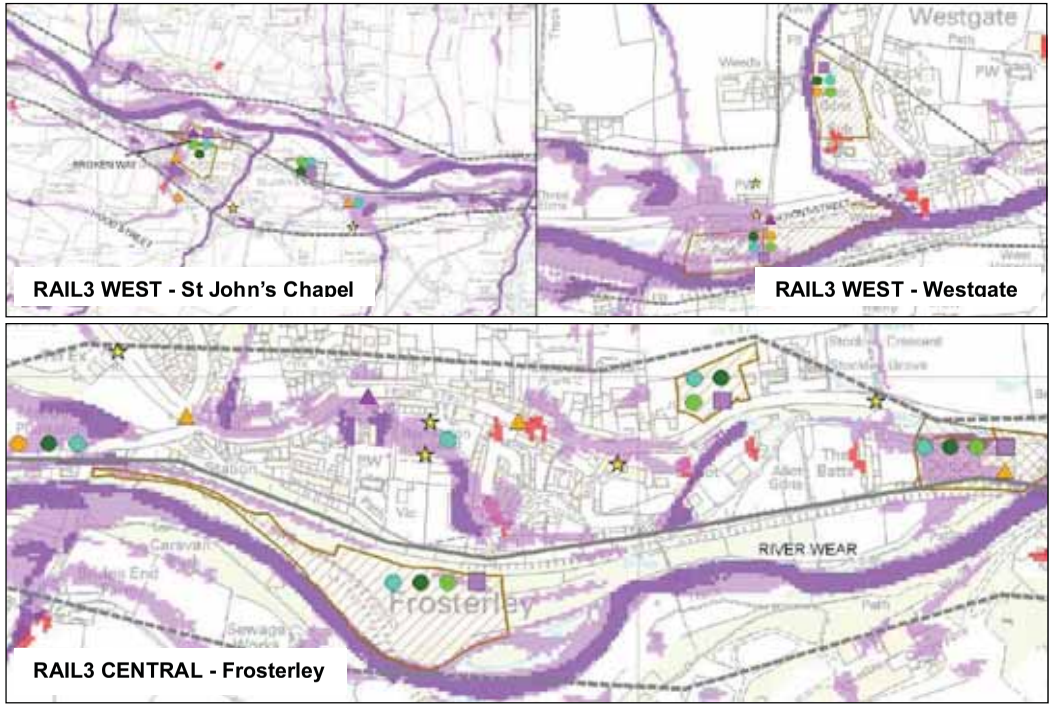
Action Plan: RAIL3 – Ireshopeburn to Blackett's Gill



Brief

RAIL3 is located along a valley, running for 27km in an easterly direction from Ireshopeburn to Blackett's Gill. There are several villages along the railway line at risk from surface water flooding, notably St John's Chapel, Westgate, Frosterley and Wolsingham which this assessment has focused upon.

RAIL3 is surrounded by steep valley sides to the north and less inclined hillsides to the south. The River Wear runs parallel to the railway. Overland flows run into the River Wear in a south easterly direction from the north and a north easterly direction from the south where the railway and villages reside.

There are 30 potential development sites within the SWRA. These SHLAA and ELR sites should be assessed prior to development due to their close proximity to the River Wear, known incidents and future surface water hotspots.

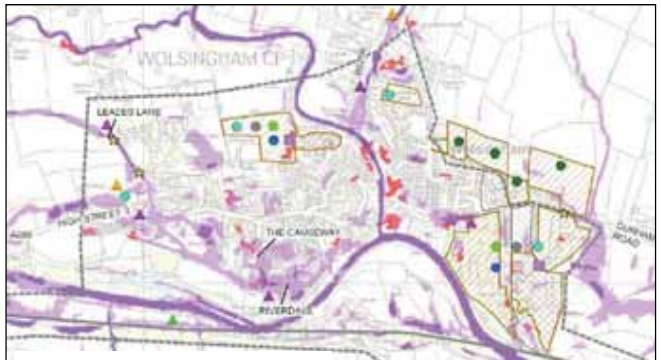
RAIL3 has experienced 26 known flood incidents, the cause of which is a mix of highway issues, overland flow from local fields and overland flow after heavy rainfall. Durham County Council engineers advised that Northumbrian Water has undertaken upsizing of the sewer system and removed Combined Sewer Overflows to alleviate the problems.

384 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £368,000. The railway and three main roads (A689, B6278 and B6296) are critical infrastructure at risk from flooding.

MCA Preferred Option (Score of +8)

- Planning Policies / Development Control

Capabilities on project:
Water



Similarly, the proposed developments within Westgate could formalis
the western side of SHLAA area. Incorporated into future capital ren
area.

Options

The villages will be best managed by intercepting water outside of the village areas and diverting it towards the River Wear, e.g. Leazes Lane and Durham Road in Wolsingham, Hood Street in St John's Chapel and at Front Street in Westgate and Frosterley. Surface water reaching these areas has no formal flow path to reach the River Wear as the presence of roads and urban settlements has interrupted any natural flow path. While sewers and culverts are capable of handling small flows, their capacity can be exceeded (or become blocked) and risk flooding surrounding areas. Therefore, external watercourses should be diverted around vulnerable areas and directed into the River Wear.

RAIL3 WEST

The SHLAA and ELR sites in St John's Chapel and Westgate could be developed to include storage areas, swales, green roofs to help manage the risks of surface water flooding. Alternatively, the development proposed for north of Hood Street in St John's Chapel could be developed to accommodate a formal overland flow path on the western side or storage along the road near the caravan park. This would alleviate the surface water flood risk to the south of Hood Street.

A dismantled railway to east of St John's Chapel appears to be impacting on preventing overland flow. An additional culvert or demolition of a portion of embankment would alleviate the surface water risk in this area and reduce surface water ponding.

RAIL3 CENTRAL

The three SHLAA sites in Frosterley could be developed to include storage areas, swales, green roofs to help manage the risks of surface water flooding, encouraged through planning policies and development control. Alternatively, the SHLAA site south of the railway lies adjacent to the River Wear and could be used as floodplain storage in the form of ponds or wetlands.

The active railway that runs through Frosterley appears to be impacting on preventing overland flow, causing surface water ponding at a depot. A culvert would allow the water to pass underneath the railway and into the River Wear to the south. The SHLAA area could alternatively be used for storage in the form of a pond or a wetland.

There is the opportunity to provide storage along the roadway at Front Street or storage in the recreation ground and swales along the plantation at Frosterley Bridge. As per RAIL3 West, roadway re-grading and profiling of the carriageway profile would be required to provide overland flow paths out of the area.

RAIL3 EAST

The development sites in Wolsingham could be developed to include green roofs, storage, swales and possibly rainwater harvesting and permeable paving. It may be possible to put swales or filter drains in the residential areas to intercept flows coming off the hill; however the SHLAA sites are not directly linked to the main surface water risk area that affects Leaze's Lane, The Causeway and Riverdale. It may be possible to channel overland flows from the risk area into storage areas in the SHLAA sites.

An alternative is to improve resilience and resistance or storage of water in roads along Leaze's Lane, High Street, The Causeway and Riverdale. Kerbing could be used to contain and attenuate surface waters in these areas until the combined sewer system has capacity. There is also the ability to provide storage between Leaze's Lane and the High Street to alleviate risk in this SWRA.

There is an overland flow path running along the B6296. Two options would include storage of water along the roadway until it feeds into the River Wear, or to utilise the SHLAA site to the east as storage in the form of a pond or wetland.

The railway along Wolsingham is an active line and there is shallow flooding affecting the railway line in the 200 year Flood Map for Surface Water. There is the opportunity to provide a formal overland pathway in the form of a swale or filter drain to the River Wear.

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
RAIL3 - 1	RAIL3 WEST (St John's Chapel and Westgate)	Investigate the potential of the SHLAA sites in St John's Chapel and Westgate to provide source control measures to manage surface water risk.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
RAIL3 - 2		If the development north of Hood Street is brought forward for development planning, assess viability of accommodating a formal overland flow path to alleviate surface water risk.	**Developer** **Durham County Council** Northumbrian Water Environment Agency	Pre-development
RAIL3 - 3		Assess the potential for an additional culvert or demolition of a portion of dismantled railway to the East of St John's Chapel to alleviate the surface water risk in this area and reduce surface water ponding.	**Durham County Council** Environment Agency	0-5 years
RAIL3 - 4		Investigate the opportunity to provide storage along Front Street and a flowpath around the caravan park. Incorporated into future capital renewal surfacing works, this would involve roadway re-grading and profiling of the carriageway profile to provide overland flow paths out of the area.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
RAIL3 - 5	RAIL3 CENTRAL (Frosterley)	Investigate the potential of the three SHLAA sites to provide source control measures or used for storage in the form of ponds or wetlands.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
RAIL3 - 6		Assess the potential for an additional culvert to allow water to pass underneath the railway.	**Durham County Council** Environment Agency	0-5 years
RAIL3 - 7		Investigate the potential for storage along Front Street or storage in the recreation ground and swales along the plantation at Frosterley Bridge. Incorporated into future capital renewal surfacing works, this would involve roadway re-grading and profiling of the carriageway profile to provide overland flow paths out of the area.	**Durham County Council** Northumbrian Water Environment Agency	0-12 months

Capabilities on project:
Water

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
RAIL3 - 8	RAIL3 EAST (Wolsingham)	Investigate the opportunity and logistics of using the SHLAA sites to benefit Wolsingham and the wider area.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
RAIL3 - 9		Determine if storage in the roads, kerbing or storage between Leaze's Lane and the High Street is viable.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
RAIL3 - 10		Assess whether the overland flow path running along the B6296 would benefit more from storage of water in the roadways or to utilise the SHLAA site for storage.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development 1-2 years
RAIL3 - 11		Assess the potential for a swale or filter drain to the River Wear to alleviate risk on the railway line.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
RAIL3 - 12		Improve resilience and resistance measures	**Home Owners** Durham County Council	1-2 years

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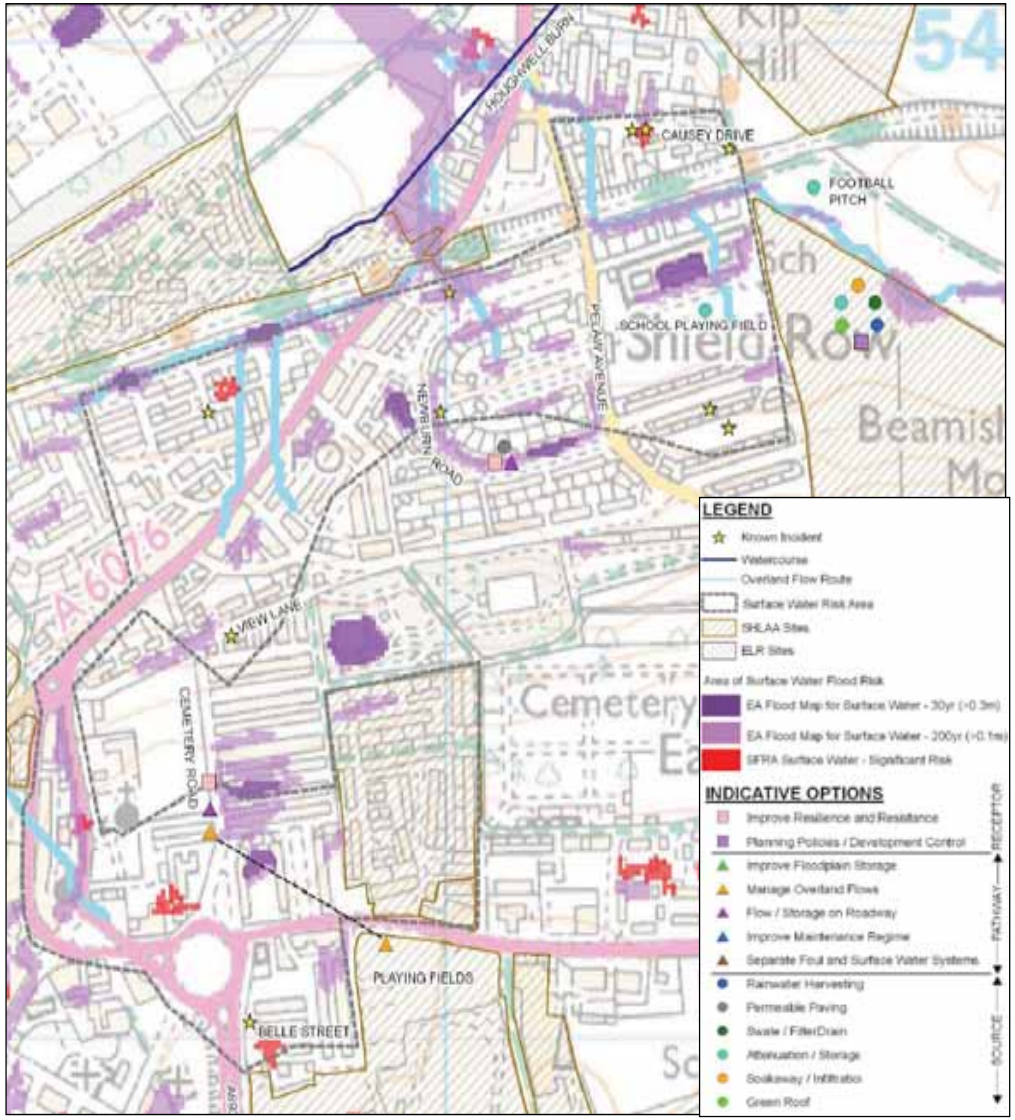
Action Plan: STA3 – East Stanley



Brief

STA3 is located in East Stanley, is over 90% urbanised and 93 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. Whilst parts of STA3 are served by separate sewer systems, the majority is served by combined sewers. 15 known surface water incidences in the area relate to inadequate drainage capacity in the combined sewers. Issues with maintenance have resulted in blocked gullies and collapsed drains. AADs are estimated at £95,000.

The Shield Row area and the streets off Cemetery Road are consistently highlighted as being at risk of surface water. The source of surface water in this area is primarily from the impermeable surfaces throughout the urbanised area, although Beamish Moor to the east of Shield Row will contribute surface runoff to the urban area. There are a number of SHLAA sites in the area that if re-developed could present opportunities to manage the flood risk.

Options

Beamish Moor is a source of surface water that poses a risk to Shield Row. This risk ought to be managed at source or along the pathway before it reaches the receptors in the Shield Row area. Development of the SHLAA site to the east, on Beamish Moor provides an opportunity to manage surface water at source to benefit the wider area. Soakaways, storage ponds or swales could all be installed on the SHLAA site to manage the runoff from the land and prevent it from flowing to the Shield Row area. These measures could be combined with green roofs and rainwater harvesting systems for the new development which could be implemented through planning policies. With an appropriate connection, storage could also be provided on the school playing field immediately to the north of the SHLAA site.

West of Pelaw Avenue surface water flooding could also be a problem but the lack of open space limits the potential to provide storage, nor are there any re-development opportunities. Rather any measures implemented would need to be retro-fitted. In this area the most preferable measures are likely to be improving resilience and resistance or storage of water in the roads. Kerbing could be provided to contain and attenuate surface waters until the combined sewer system has capacity. Retro-fitting permeable pavements may provide some benefit.

The roads off Cemetery Road have little opportunity to manage flood risk. The SHLAA development to the east appears to have already been developed therefore it is hoped that peak discharges have been reduced to as low as possible to ensure that the existing drainage capacity is not overwhelmed. Resilience measures and storage in the roads are the most likely measures. Kerbing could be provided to contain and attenuate surface waters in the roads, until the combined system has capacity. More costly options would be to provide swales or overland flow routes to channel water away from the area, probably to the playing fields located to the south.

MCA Preferred Options (Joint Score of +6)

- Green Roofs
- Soakaways/Infiltration
- Planning Policies / Development Control

Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
STA3 - 1	Shield Row (Beamish Moor)	Investigate the potential of the SHLAA site at Beamish Moor to provide source control measures to manage surface water.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
STA3 - 2		Encourage implementation of source control measures including soakaways, storage ponds swales, green roofs and rainwater harvesting for any new developments. Enforced through planning policies and development control.	**Durham County Council** Northumbrian Water Environment Agency	Pre-development
STA3 - 3		Assess the ability of school playing field north of Beamish Moor SHLAA site to be used as a storage area.	**Durham County Council** Northumbrian Water Environment Agency	0-24 months
STA3 - 4	Shield Row (Pelaw Avenue/ Newburn Road)	Improve resilience and resistance measures	**Home Owners** Durham County Council	1-2 years
STA3 - 5		Investigate retro-fitting Newburn Road providing storage through kerbing, permeable paving, and rainwater gardens.	**Durham County Council**	0-5 years
STA3 - 6	Cemetery Road	Improve resilience and resistance measures	**Home Owners** Durham County Council	1-2 years
STA3 - 7		Investigate retro-fitting Cemetery Road providing storage through kerbing, permeable paving, and rainwater gardens.	**Durham County Council**	0-5 years
STA3 - 8		Investigate the cost of implementing swales and overland flow routes to the playing fields located to the south.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years

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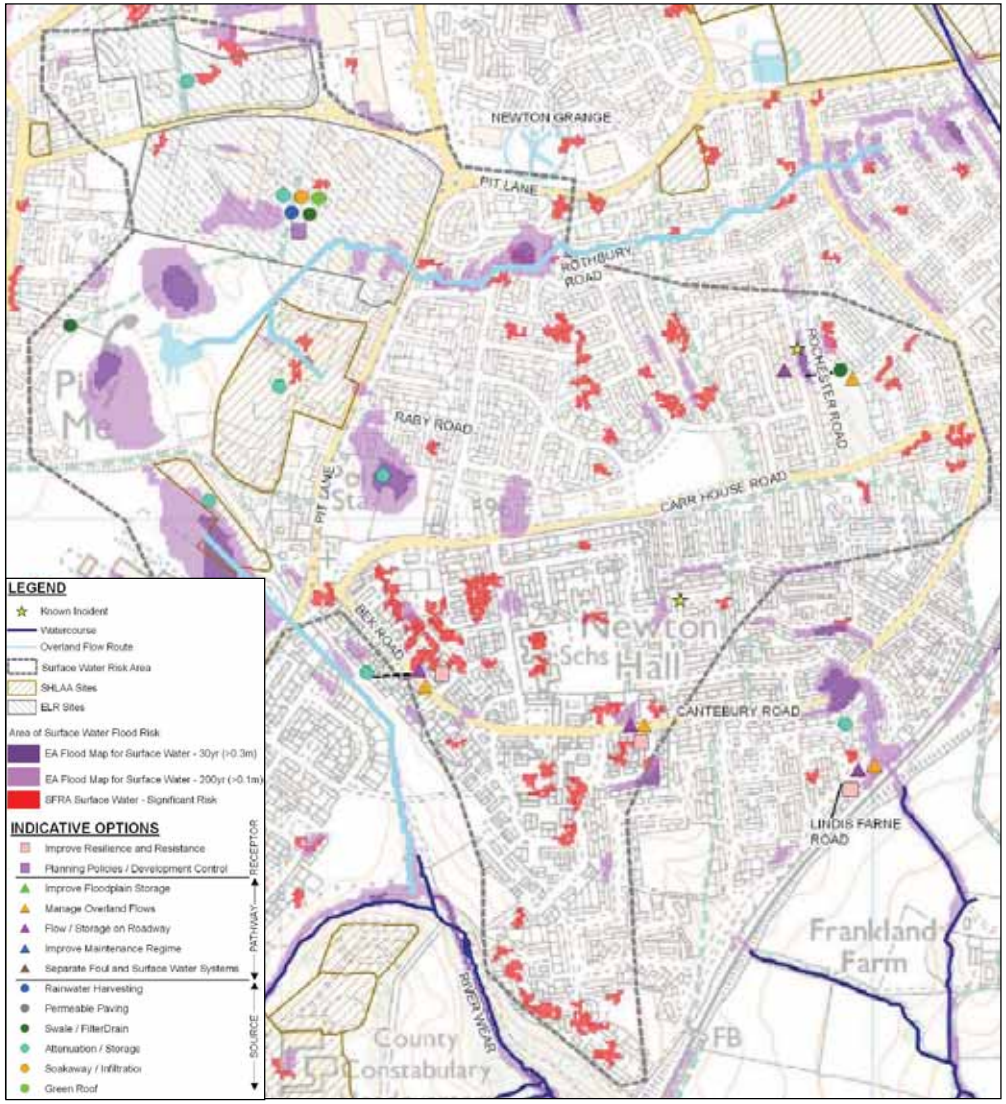
Action Plan: DC1 – Durham City



Brief

Rothbury Road, Raby Road, Rochester Road, Canterbury Road, Lindisfarne Road, Bek Road and two areas off Pit Lane are all at surface water risk. 97 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £108,000.

The Pity Me Nature Reserve in the west could be a potential source of overland flow for areas to the east off Pit Lane. Northumbrian Water has addressed several known surface water incidents in the area and is currently upsizing the sewer system at Newton Grange which is located to the north.

Options

Rothbury Road is a residential area and local low point where surface water is likely to collect. Sources of surface water will be runoff from the local impermeable surfaces. The SFRA modelling indicates a flow path originating to the west at the nature reserve, where works could be undertaken to increase its ability to hold water. If the ELR site between the nature reserve and Rothbury Road is re-developed, steps ought to be taken to limit runoff from the site through the provision of storage, infiltration, soakaways and potentially green roofs and rainwater harvesting. Planning policies and development control could be utilised to enforce this. The public footpath also presents opportunities for the creation of a swale to manage any overland flows.

At Raby Road, the preferable course of action would be to lower the parkland to provide additional storage capacity so that surface water in Raby Road area can drain into the parkland.

Rochester Road has a low spot where surface water is likely to accumulate and has a history of surface water flooding. The source of surface water is likely to be runoff from the impermeable surfaces in the local area. Potential management strategies include holding the excess water in the road until the sewer systems are able to take the water away, or providing an overland flow route to the open land to the east. This would however need to pass between properties and is unlikely to be acceptable.

Surface water along Cantebury Road and Lindesfarne Road will again be a result of runoff from impermeable surfaces. With no potential re-development occurring, solutions would need to be retro-fitted. Open land between both roads could potentially be used to provide storage either lowering the area or creating a wetland and subsequently channelling overland flows into this area. Alternatively road re-grading and kerbing could be used to hold the water in the roads rather than properties.

The same situation is found at Bek Road. The preferable measures would be to hold water in the roads using kerbing or create an overland flow path to a storage area which could be the thin strip of land to the west of Bek Road.

MCA Preferred Option (Score of +8)

- Planning Policies / Development Control

Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
DC1 - 1	Rothbury Road	Encourage source control measures such as green roofs and permeable paving, storage ponds and swales for any new developments, notably the ELR site between the Nature Reserve and Rothbury Road. Enforced through planning policy and development control.	**Durham County Council** Northumbrian Water Environment Agency	Pre-development
DC1 - 2		Assess the viability of undertaking works at the Pity Me Nature Reserve to increase its ability to store water.	**Durham County Council** Environment Agency	0-5 years
DC1 - 3		Assess the opportunity for the creation of a swale along the public footpath to manage overland flows.	**Durham County Council** Northumbrian Water Environment Agency	1-2 years
DC1 - 4	Raby Road	Assess the viability of lowering the parkland south of the risk area. This will provide additional capacity and allow the surface water in Raby Road to drain into the parkland.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
DC1 - 5	Rochester Road	Review the viability of holding excess water in the road and providing an overland flow route to the open land to the east.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
DC1 - 6	Cantebury Road & Lindisfarne Road	Assess the potential for retro-fitting source control measures.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
DC1 - 7	Bek Road	Determine the viability of holding excess water in the road and providing an overland flow route to a storage area, such as the thin strip of land to the west of Bek Road.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years

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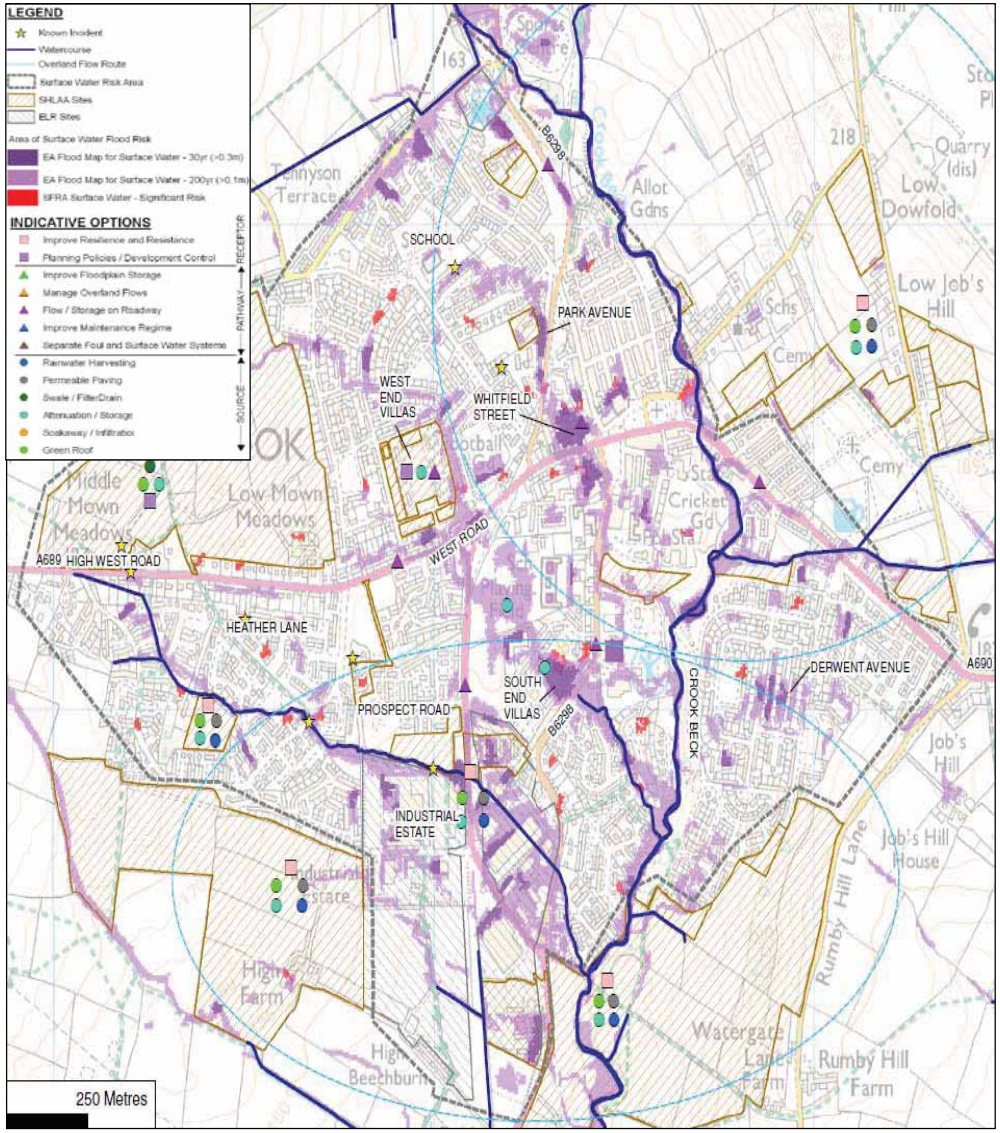
Action Plan: CRO1 – Crook



Brief

The topography of Crook slopes down toward the south east, where Crook Beck is located flowing in a southerly direction. The surface water map illustrates two flow paths which presumably follow topographic low points through the middle of Crook.

Crook is predominantly well developed, with room for extensive development around the periphery. 15 SHLAA sites and two ELR sites have been identified in and around Crook. 560 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £626,000.

There have been eight known flood incidents, a number of which appear to be attributable to inadequate drainage into the watercourse running along Prospect Road which resulted in flooding to school playing fields and neighbouring gardens around Heather Lane. The A689, B6298, and A690 converge in the centre of Crook which act as barriers to the flow of surface runoff and cause surface water to back up behind these roads, affecting properties in Park Avenue, Whitfield Street, West Road and South End Villas.

Options

The SHLAA site located to the north west of Crook on Low and Middle Mown Meadows provides significant opportunities, e.g. green roofs, storage basins and swales, to manage surface water runoff before it enters the urban area. The SHLAA sites to the north of West Road also present opportunities to manage surface water runoff. This would likely require formal overland flow paths being created along the roads to facilitate drainage away from residential areas. Development control and planning policies ought to implement these measures.

The runoff from Low and Middle Mown Meadows makes its way through Crook in the form of two overland flow paths following the topographic low points. South End Villas is identified as being particularly badly affected and in response to the risk it is proposed that the open green space at South End Villas ought to be landscaped so as to be able to provide storage during extreme events to limit water affecting properties. Additional potential opportunities would be to provide upstream storage in the playing fields to the north.

The area surrounding Whitfield Street is also identified as a key risk area, however unlike South End Villas there is a lack of open space to be able to provide storage. Consequently the only real viable option would be to store water in the roads.

MCA Preferred Option (Score of +8)

- Planning Policies / Development Control

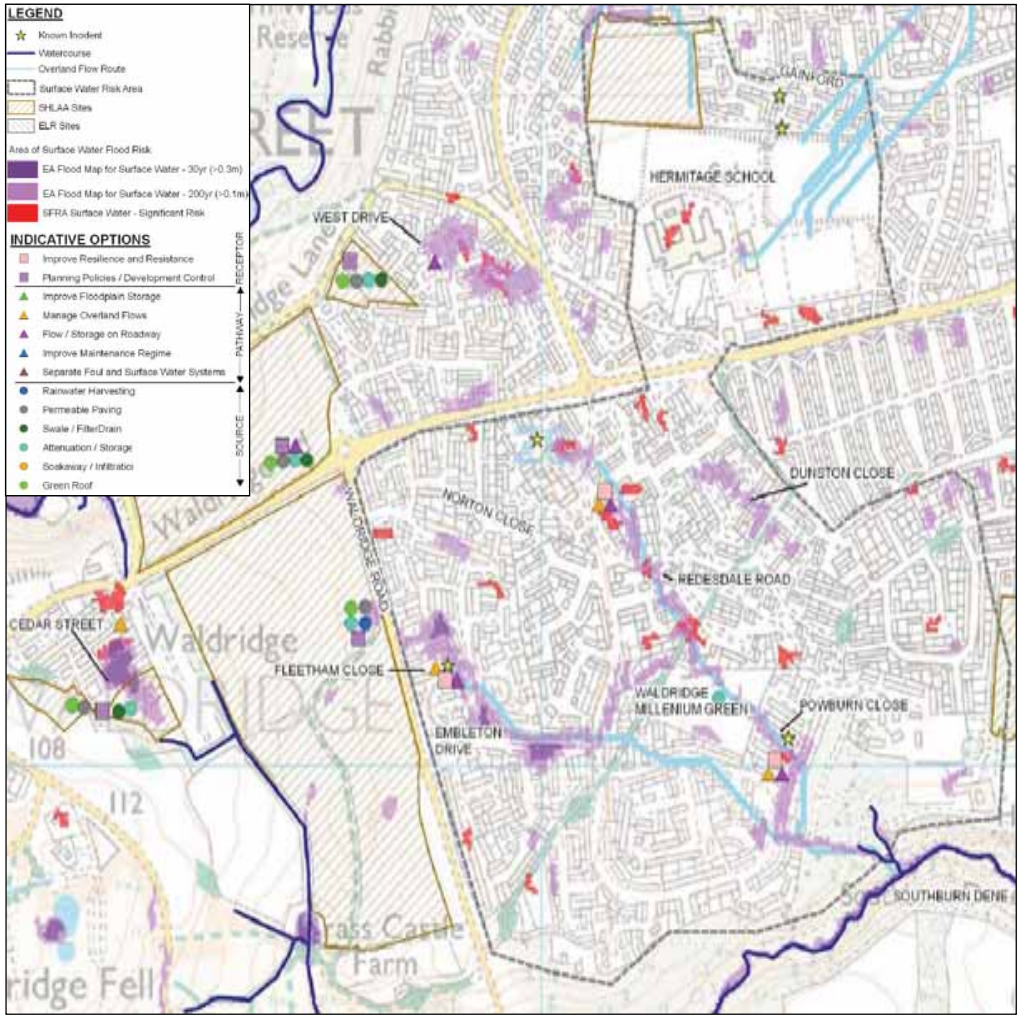
Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
CRO1 - 1	Low and Middle Mown Meadows	Investigate the potential of the SHLAA sites to the north west of Crook and north of West Road to provide source control measures to manage surface water risk. Implemented through development control and planning policies.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
CRO1 – 2	South End Villas	Assess the viability of South End Villas to be landscaped so as to provide storage against using the playing fields to the north as storage.	**Durham County Council** Northumbrian Water	0-5 years
CRO1 - 3	Whitfield Street	Investigate the option of using the road to store water.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years

* It is assumed that the lead Partner pays for the action in question. Where there is more than one Partner per action there is the potential for co-ordinated investment.

Action Plan: CLS3 – Chester-le-Street



Brief

CLS3 has experienced six known flood incidents many of which can be attributed to inadequate drainage, notably in Gainford and Waldridge. 82 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £81,000.

There appears to be low spots creating overland flow paths through the Embleton Drive, Redesdale Road and Powburn Close areas down towards Southburn Dene. Other notable areas of flooding occur in Waldridge on Cedar Street and surrounding streets and in the West Drive area.

Options

Runoff from the fields to the west of Waldridge Road and the inundated highway drainage are believed to be the cause of several previous surface water incidents. The SHLAA site to the west should introduce source control measures such as green roofs, permeable paving, attenuation storage and rainwater harvesting. A geotechnical investigation should investigate the feasibility of infiltration measures such as soakaways, permeable pavements and filter drains. Development of this SHLAA site should require peak discharges to be maintained to greenfield rates. Surface water flows should be controlled, either through diversion to the Southburn Dene, along Waldridge Road or collected and stored.

At Fleetham Close, Redesdale Road and Powburn Close areas, it may be possible to provide an overland flow route across the existing pavement surface. Incorporated into future capital renewal surfacing works, this would involve roadway re-grading and profiling of the carriageway profile to provide an overland flow path out of the area. Storage of this water could be provided in Millennium Green or the open space between Powburn Close and Southburn Dene. In areas where surface water flood risk cannot be reduced, resilience and resistance measures may be appropriate.

Cedar Street is likely to be a cause of flooding in the Embleton Drive area. It is likely that the source of surface water is overland runoff from the open land immediately to the south. The two SHLAA sites present several opportunities to manage the potential risk in this area by reducing runoff from the sites themselves but also addressing the risk posed to the existing developed area. In addition source control methods such as green roofs and permeable paving, storage ponds and swales could capture runoff draining north, or the runoff could be diverted towards the allotments to the east of the residential area and the tributary of Southburn Dene.

At West Drive, the source of flooding is thought to be runoff from land to the west which ponds in low spots. The SHLAA sites further to the west present opportunities to prevent runoff reaching the residential areas by storing it on site or diverting it northwards onto the Rabbit Banks and down to Chester Burn. Alternatively it may be possible to store water in the roads.

MCA Preferred Option (Score of +8)

- Planning Policies / Development Control

Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
CLS3 - 1	Embleton Drive, Redesdale Road & Powburn Close	Investigate the feasibility of source control measures on the SHLAA site to the west of Waldridge Road.	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
CLS3 - 2		Investigate further the drainage capacity/ problems in the area.	**Northumbrian Water** Durham County Council	1-2 years
CLS3 - 3		Investigate the cost of providing an overland flow route across the existing pavement surface and storage options, e.g. at Millennium Green.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
CLS3 - 4		Improve resilience and resistance measures	**Home Owners** Durham County Council	1-2 years
CLS3 - 5	Waldridge	Encourage source control measures such as green roofs and permeable paving, storage ponds and swales for any new developments.	**Durham County Council** Northumbrian Water Environment Agency	Pre-development
CLS3 - 6	West Drive	Encourage source control measures such as green roofs and permeable paving, storage ponds and swales for any new developments.	**Durham County Council** Northumbrian Water Environment Agency	Pre-development
CLS3 - 7		Improve resilience and resistance measures	**Home Owners** Durham County Council	1-2 years

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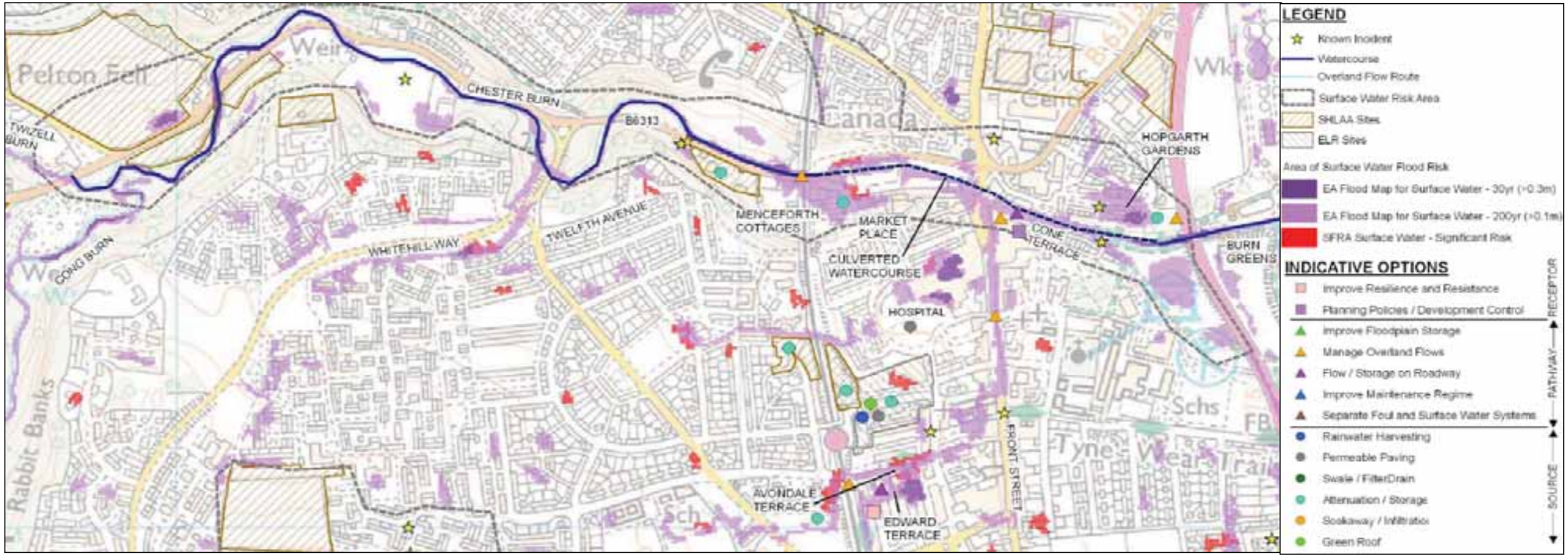
Action Plan: CLS2 – Chester-le-Street



Brief

CLS2 has experienced a number of known flood incidents and due to development pressures in the area the Environment Agency considers that the frequency of flooding is expected to increase. There are three SHLAA sites that could provide opportunities to manage the surface water flood risk. 35 properties fall within the Environment Agency's Flood Map for Surface Water for the 200 year event. AADs have been estimated to be £45,000.

There are two key flood risk areas where a number of properties would be affected by an extreme surface water flood event; Market Place and Hopgarth Gardens. There is also an area of flooding outside the SWRA boundary, at Avondale Terrace / Edward Street which links to flooding on Cone Terrace via Front Street.

Options

Around Avondale Terrace / Edward Street a significant flow path would be required to encourage water to drain onto Front Street and down towards Chester Burn. Road re-grading and landscaping could facilitate this. Interceptor grids could subsequently allow the water to drain into the culvert. Chester-le-Street hospital falls off Front Street and access must be maintained at all times. The hospital itself is surrounded by flood water and action ought to be taken to ensure that this can be managed, potentially within the car parks via permeable paving.

"Street architecture" could be employed to channel surface water away from the Avondale Terrace / Edward Street area. Either along Front Street (without posing a constraint to access to the hospital) or immediately to the north where the redevelopment of SHLAA and ELR sites may present opportunities to store water in ponds/wetlands and contribute to the wider green infrastructure networks. Utilising part of the site for storage will place constraints on the viability of the development sites. Runoff from these development sites would also need to be managed on site to avoid contributing to problems elsewhere.

Capabilities on project:
Water

West of Avondale Terrace / Edward Street runs a railway line. It is recommended that a storage area to the west of the railway is implemented to capture runoff that which would otherwise impact on Avondale Terrace / Edward Street and could pass forward onto Front Street.

In the heavily developed area of Avondale Terrace / Edward Street there are limited opportunities to implement measures other than local storage in roads or improved resilience and resistance of individual properties. Storage of water on Front Street would present issues for the hospital however; storage in the road along Cone Terrace may be more feasible. Incorporated into future capital renewal surfacing works, this would involve roadway re-grading and profiling of the carriageway profile to provide overland flow paths out of the area to reach Front Street and Cone Terrace.

A playing field to the east of Hopgarth Gardens presents an opportunity to store the water that would otherwise affect Hopgarth Gardens. This could be in the form of a wetland to promote biodiversity or simply lower the level of the area to retain its current social function. In addition to the storage area it would be necessary to provide a formal overland flow path out of the residential area into the storage area.

There are several car parks and green areas which could be used for flood storage around the Market Place to alleviate the surface water issue. Alternatively, given the sites proximity to Chester Burn it would be practical to drain excess runoff into the watercourse, although the presence of the culvert is likely to limit the feasibility of this, although interceptor grids may make this possible.

There are only a limited number of re-development opportunities in and around the three problem areas however, redevelopment should ensure that peak runoff from the sites is reduced as much as possible and if possible, additional storage should be provided. This could include source control measures such as green roofs, permeable paving, attenuation storage and rainwater harvesting.

At Market Place, Hopgarth Gardens and along Cone Terrace, Chester Burn has been culverted for a length of 630m. The culvert has reduced opportunities for surface runoff to reach Chester Burn, which could consequently pond on the surface. Opening up the culvert is not technically or economically viable due to the considerable development that has occurred on top of the culvert, therefore this measure has been rejected. An alternative would be to provide some form of interceptor grids that would allow surface water to drain into the culvert.

MCA Preferred Options (Joint Score of +6)

- Planning Policies / Development Control
- Improve Resilience and Resistance

Capabilities on project:
Water

Actions

Ref	Location	Action	Partners (lead in bold*)	Timetable for Implementation
CLS2 - 1	Avondale Terrace & Edward Street	Investigate the potential of roads to provide storage of flood waters and profiling of the carriageway to provide overland flow paths out of the area to reach Front Street and Cone Terrace.	**Durham County Council**	0-5 years
CLS2 - 2		Investigate the potential of using the SHLAA and ELR sites to provide storage and contribute to the Green Infrastructure networks	**Developer** Durham County Council Northumbrian Water Environment Agency	Pre-development
CLS2 - 3		Assess the viability of a storage area to the west of the railway to capture runoff that would otherwise impact the area.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
CLS2 - 4		Improve resilience and resistance measures	**Home Owners** Durham County Council	1-2 years
CLS2 - 5		Assess the potential for retro-fitting permeable paving at the hospital car parks to reduce surface water risk.	**Durham County Council**	0-5 years
CLS2 - 6		Assess the cost and benefit of employing “street architecture” without posing a constraint to access the hospital and surrounding area.	**Durham County Council**	0-5 years
CLS2 - 7	Hopgarth Gardens	Assess the viability of the playing fields to store water area, e.g. wetland, to capture runoff that would otherwise impact the area. Include the cost of an overland flow path out of the area.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years
CLS2 - 8	Market Place	Investigate the option of using the car parks as flood storage.	**Durham County Council** Environment Agency	0-6 months
CLS2 - 9		Assess whether interceptor grids is a viable alternative to storing the water in the car parks.	**Durham County Council** Northumbrian Water Environment Agency	0-5 years

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