

Greystoke

Flood Investigation Report



**Flood Events 15th November 2015
and 5th December 2015**

This flood investigation report has been produced by Cumbria County Council as a Lead Local Flood Authority under Section 19 of the Flood and Water Management Act 2010.

Version	Undertaken by	Reviewed by	Approved by	Date
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Published				

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Executive Summary

Cumbria County Council as Lead Local Flood Authority has prepared this report with the assistance of other Flood Risk Management Authorities, as it considers necessary to do so under Section 19 of the Flood and Water Management Act 2010.

The flooding in Greystoke was caused by the cumulative effect of Storm Desmond and the three preceding storms which exceeded the capacity of drainage features, other causes include runoff from already saturated fields and blocked culverts. The outfall point for the majority of drainage features within Greystoke is into the River North Petteril, it is understood that this was at bank full condition during Storm Desmond.

Reports have been received to suggest at least 15 properties were affected by the flooding on 5th December 2015 across Greystoke. It is understood that at least 5 of the properties experienced internal flooding. There were two separate areas of flooding in Greystoke, the Howard Park area and the Ashburn Croft / Stonegarth, Smithy Court and Church Road area.

In the Howard Park area Poplin Beck was the main cause of the flooding with surface water runoff from the Johnby and Blencowe roads also being a contributory factor of the flooding. Flooding in the Ashburn Croft area appeared to be mainly due to surface water runoff from the fields behind, however, a blocked or under capacity culvert may also be a significant contributing factor.

The report recommends various options with the intent to assist the Making Space for Water group with trying to identify options to reduce the flood risk including identifying sources of funding for possible options.

Any additional information residents and others can provide to the Environment Agency and Cumbria County Council to help develop our understanding of the flooding is welcomed. A lot of information has already been provided, much of which has been used to inform this report. The scale of this report means that not every piece of information can be incorporated into the document. Any additional information should be provided to;

<http://www.cumbria.gov.uk/planning-environment/flooding/floodriskassessment.asp>

Event Background

Flooding Incident

Greystoke is a village and civil parish on the edge of the Lake District National Park in Cumbria, England, approximately 4 miles (6.4 km) west of Penrith and 23 miles (37km) south of Carlisle. Greystoke had a population of 654 in 2011 and the village centres on a green surrounded by stone houses and cottages. Buildings in the village include St Andrew's parish church, which dates from the 13th century; Greystoke Castle, built by Baron Greystock in the 16th century and which stands in a 3,000-acre (12 km²) park; the Boot & Shoe public house; and the Cyclists' Cafe. To the east of the village are three folly farmsteads built about 1789 by Charles Howard, 11th Duke of Norfolk, of Greystoke Castle: Fort Putnam, Bunker's Hill and Spire House.

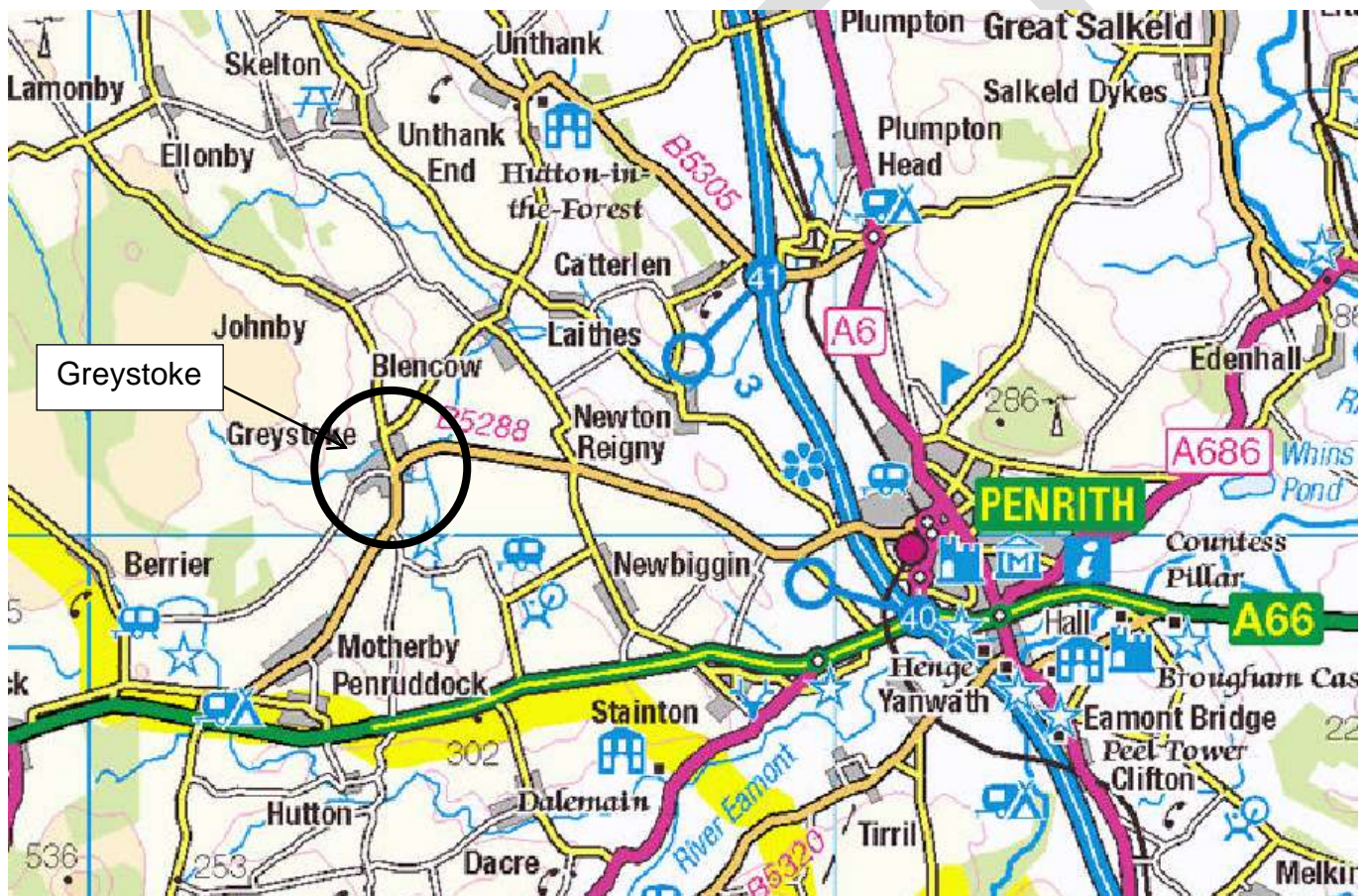


Figure 1: Location plan

Approximately fifteen properties were affected by the flooding on 15th November and 5th December 2015 across Greystoke. It is understood that at least 5 of the properties experienced internal flooding.

There were two main areas of flooding, Howard Park area and the Ashburn Croft / Stonegarth, Smithy Court and Church Road area. There is a long history of flooding within the Howard Park area. The two areas are indicated on the following plan and sources of flooding in each area will be described further in the investigation section of the report.

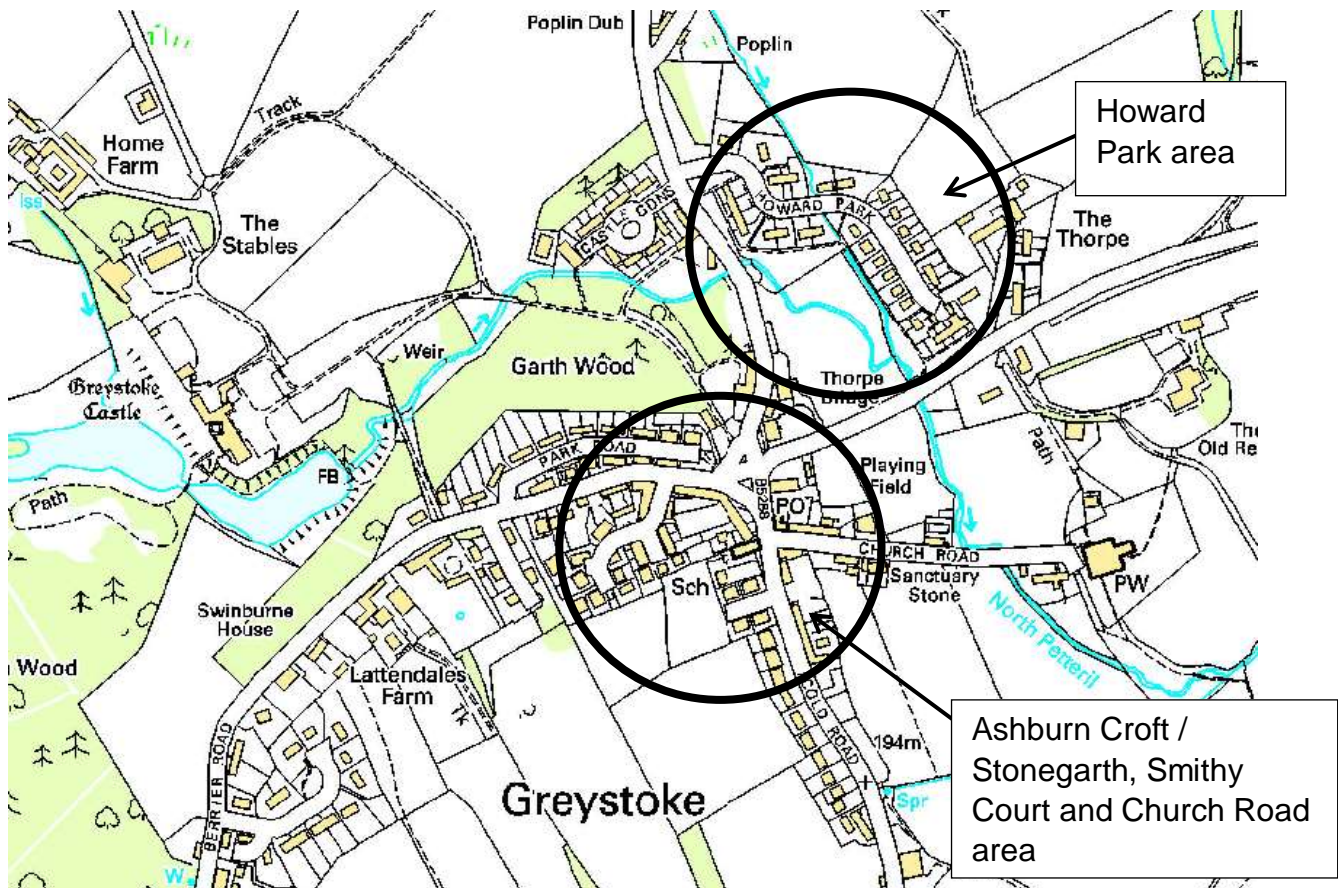


Figure 2: Indication of the two areas affected by flooding

Rainfall Event

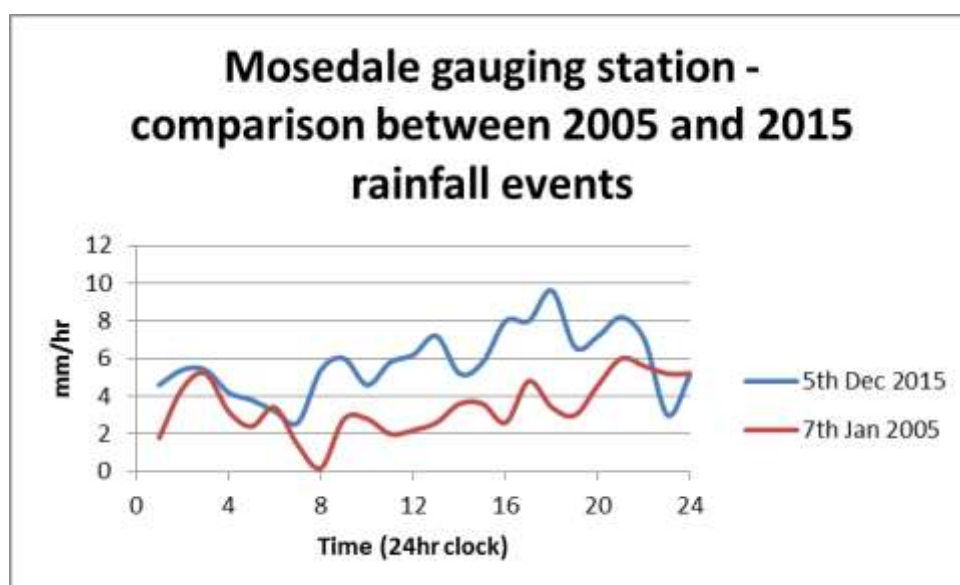
In November to December 2015 slow-moving low pressure systems driven by a sustained moist south-westerly airflow brought prolonged heavy rainfall to northern and western areas with the persistent unsettled weather (including the named storms 'Desmond', 'Eva' and 'Frank') causing widespread and repeated flooding. Based on data released by the Met Office, December 2015 was the wettest calendar month on record (in a series from 1910) with new 24-hour and 48-hour rainfall totals of 341.4mm (Honister Pass, Cumbria) and 405.0mm (Thirlmere, Cumbria), respectively, delivered by Storm 'Desmond'.

Specifically for Greystoke, the two nearest rainfall gauging stations are Newton Rigg (NY 49286 30833) and Mosedale (NY 35642 32149) which recorded rainfall totals of 55.8mm and 138mm respectively on 5 December 2015. The locations of the rain gauges are indicated on the plan below.



Figure 3: Location of rain gauges

The rainfall levels experienced at Mosedale gauging station on the 5 December 2015 are compared with the January 2005 event in Figure 3 below.



Contains Environment Agency information © Environment Agency and database right

Figure 3: Mosedale Gauging Station – comparison between 2005 and 2015 rainfall events.

Investigation

Map of Flow Routes

The following plans show the Environment Agency mapping of the Risk of Flooding from Surface Water and the Risk of Flooding from Rivers and Sea. It can be seen from mapping, particularly the Surface Water mapping that the December 2015 flood event occurred in the predicted risk areas.

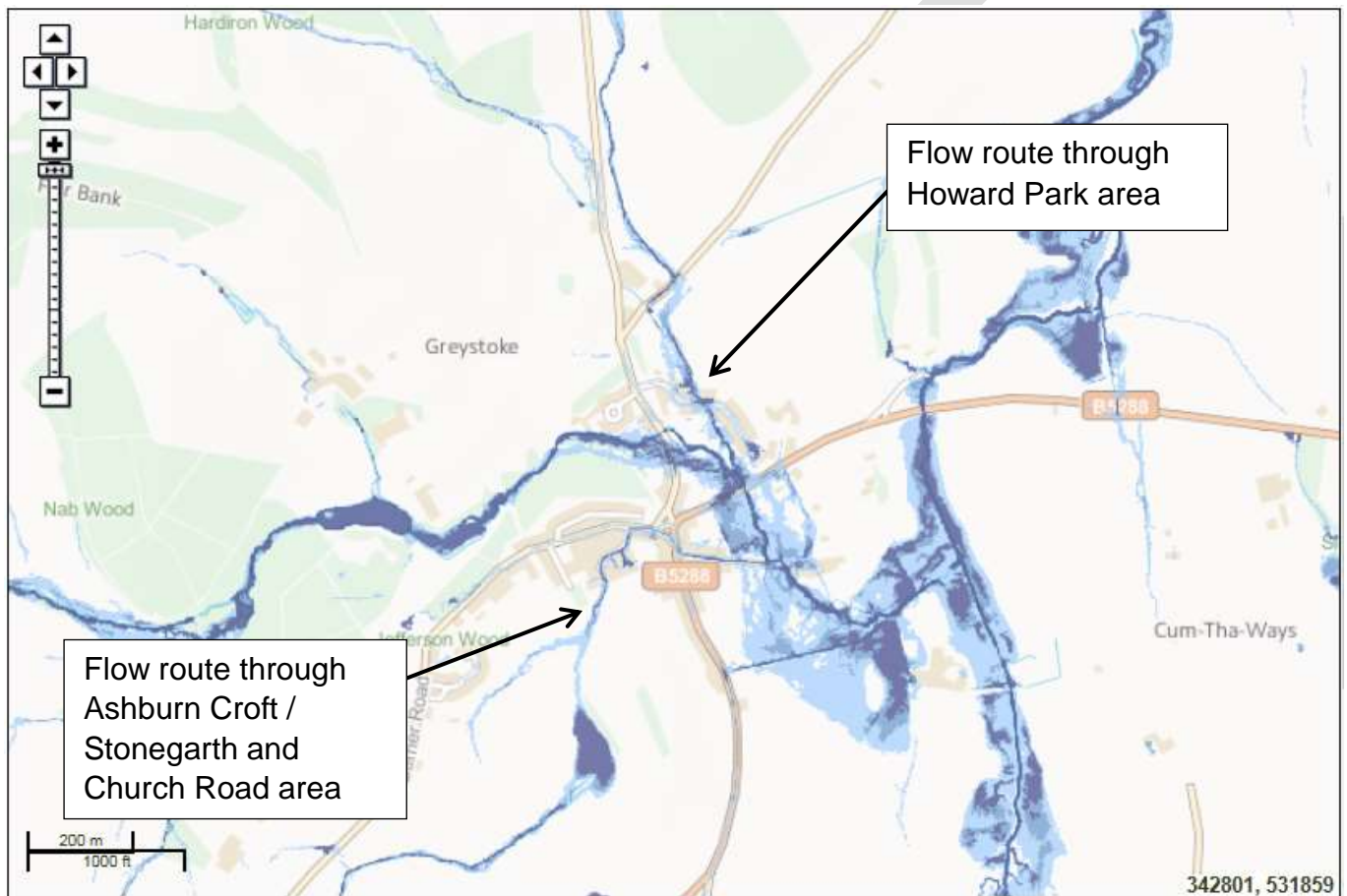


Figure 4: Extract from Environment Agency's Surface Water Mapping for the Greystoke area

The above plan quite clearly mirrors the flow routes that were experienced during the flood events in both areas of the village that were affected by the flooding. The mapping in the Howard Park area clearly indicates the risk areas along the watercourse and at the end of the cul-de-sac. A similar picture is observed in the Ashburn Croft / Stonegarth, Smithy Croft and Church Road area where an area of flooding in the fields above was observed during the event with flood water then running towards the village.

The following mapping indicates the Risk of Flooding from Rivers and Sea. The River Lowther flows through Greystoke and is identified as a potential flood risk within the village but it is understood that it did not play a significant part in any internal flooding of property during the

November and December 2015 events. However, it was noted that the River Lowther did spill on the flood plain in the areas around Church Road.

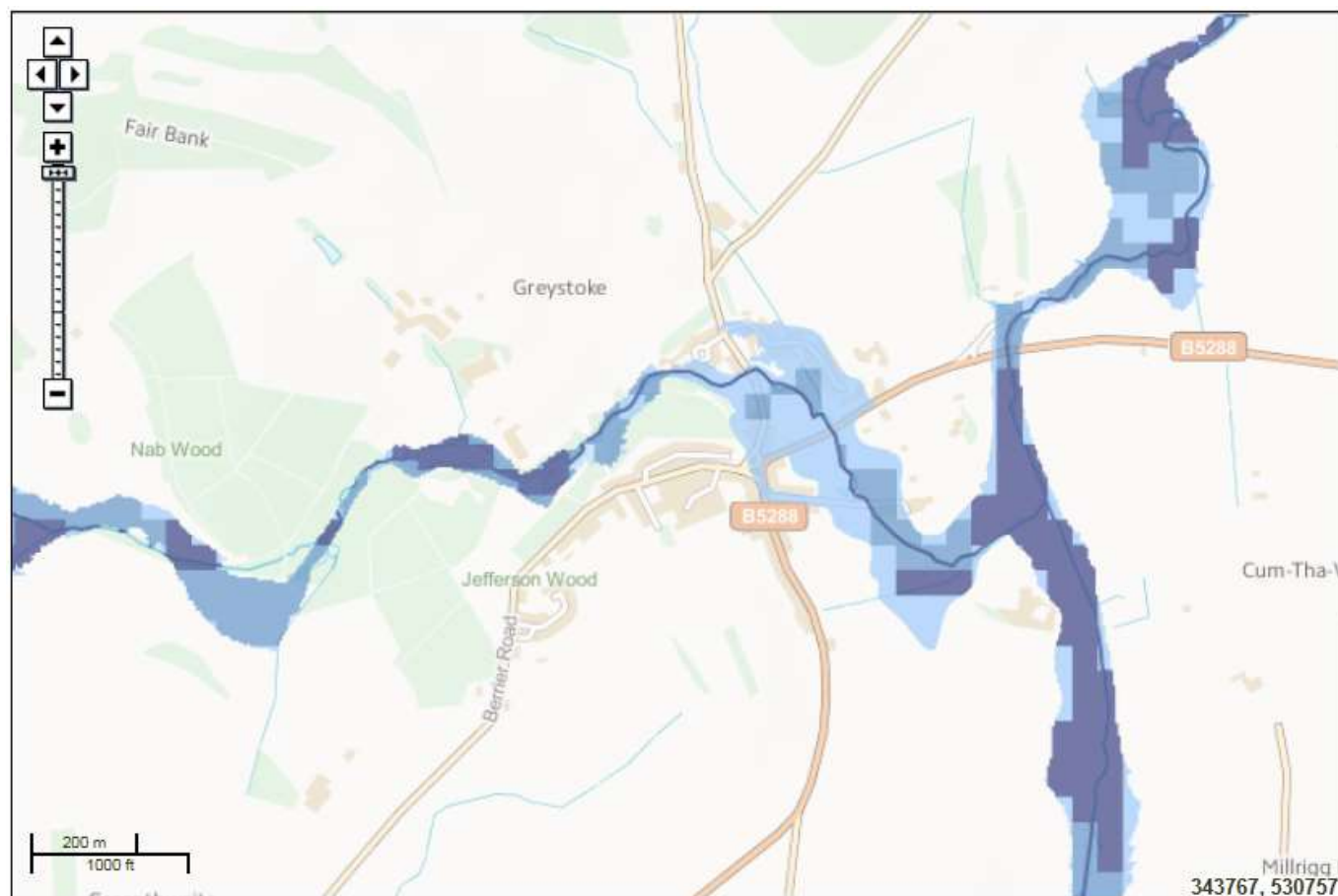


Figure 5: Extract from Environment Agency's Rivers and Sea Flood Risk Mapping for the Greystoke area

The following details provide information on the flooding that has occurred on the 2 events in November and December 2015.

Howard Park area

Significant information has been gathered from the residents who have been affected regarding the flooding that occurred. The following information also provides photographic evidence of the flooding that occurred during the December 2015.

One of the main sources of flooding is from the watercourse known as Poplin Beck. This watercourse which runs through the Howard Park estate collects water from the north of Greystoke close to the hamlet of Johnby. Other watercourses from Greystoke Park on the Greystoke Castle estate also discharge into Poplin Beck adding to the volume of flood water. However, the route through Howard Park is the natural catchment route for these watercourses.

The following plan illustrates the flow routes above and through Howard Park during the flood event.

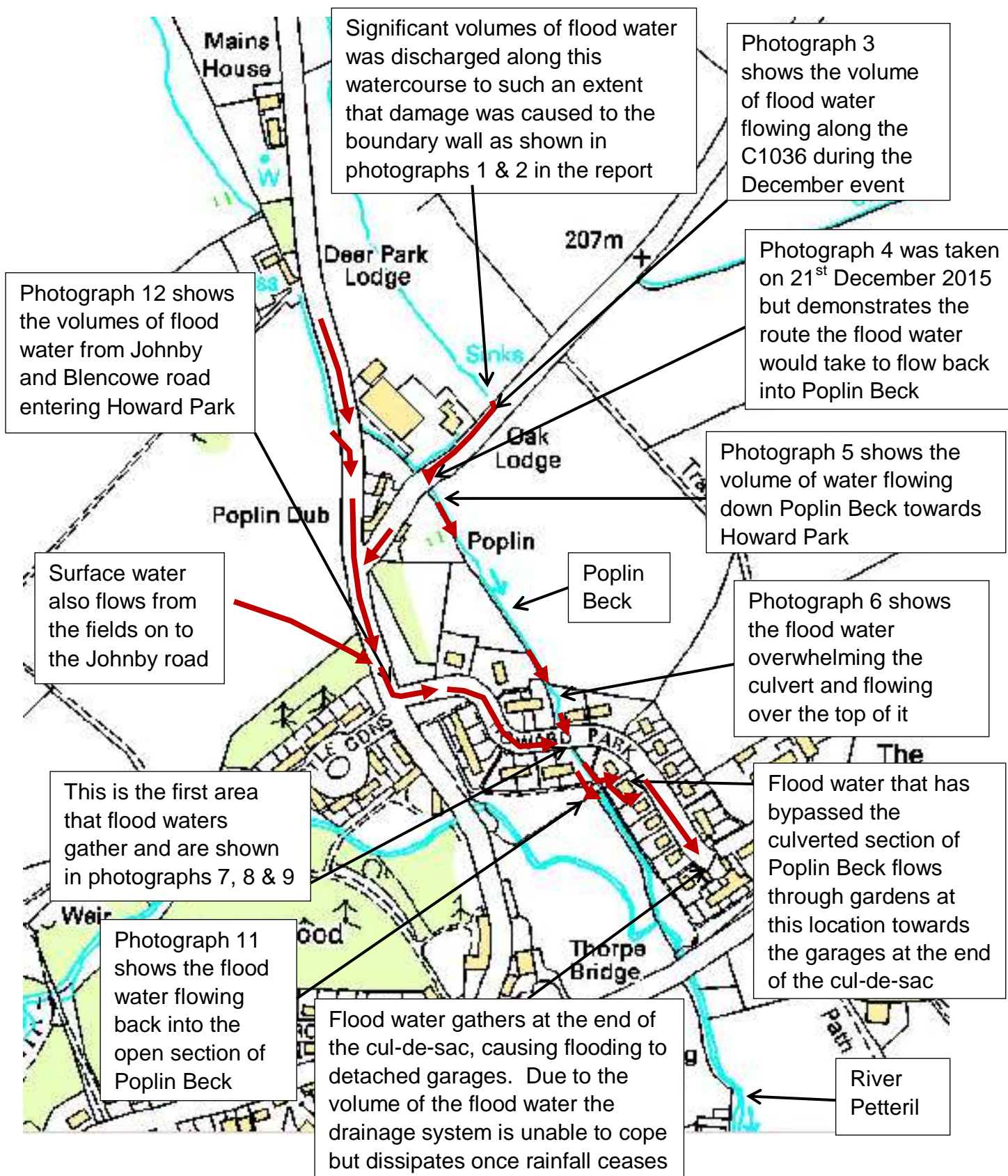
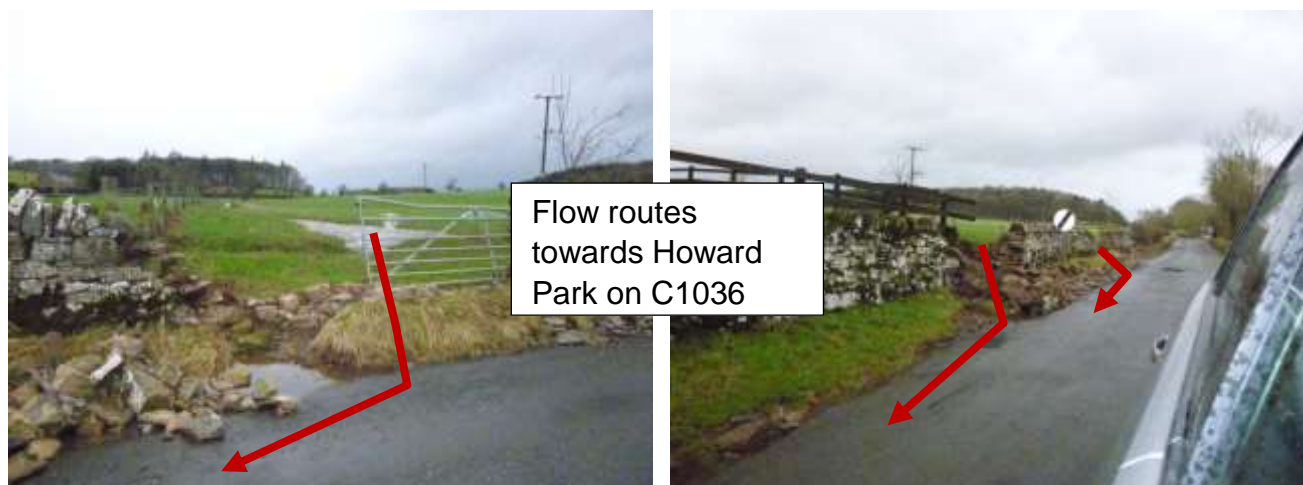


Figure 6: Plan illustrating flow routes during the December 2015 event

The following photographs are taken either during the flooding or demonstrate flow routes.



Photographs 1 & 2: Damage to wall caused by excessive flood water



Flood water overwhelmed the culverted section as it left the field and flooded on to the C1036 (Blencowe road). This caused damage to the boundary wall as shown in the above photographs.

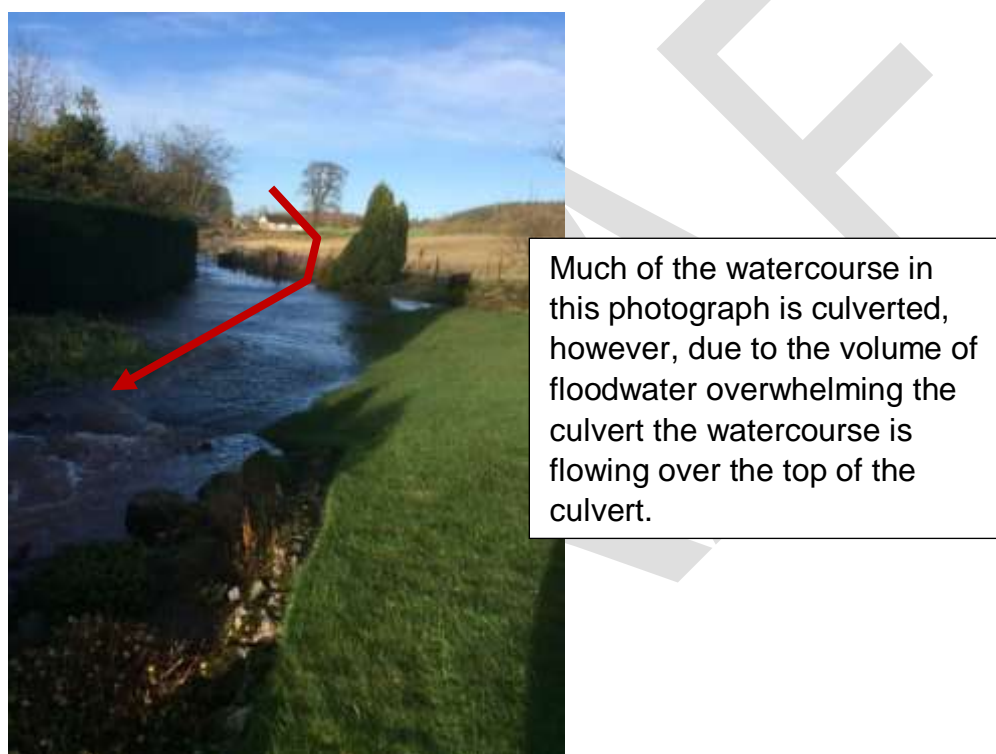
Photograph 3: Flood water during the December event flowing along the C1036



Photograph 4: Flood water running across C1036 on 21st December 2015



Photograph 5: Flood water flowing into Poplin Beck and flowing towards Howard Park



Photograph 6: Flood water flowing over the culverted section through Howard Park

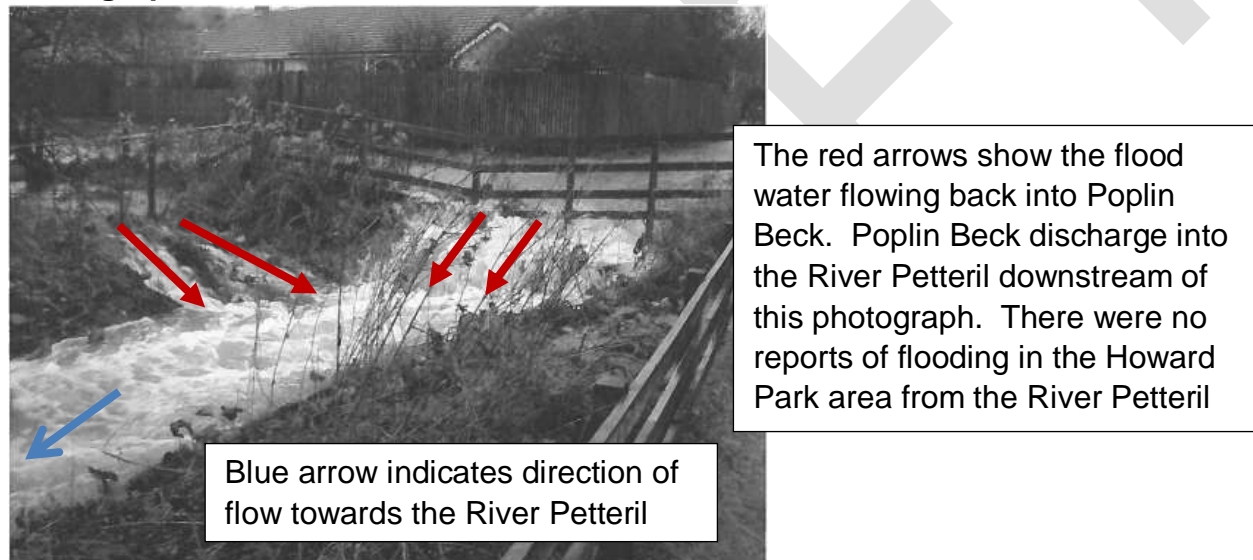


Photographs 7, 8 & 9: Flood water within Howard Park during the December 2015 event

Although the above photographs were not taken at the height of the flooding they do give a good indication of the extent and volume of the flood water that gathers in Howard Park.



Photograph 10: Grassed area over the culverted watercourse and exceedance route



Photograph 11: Flood water entering the open section of Poplin Beck after the culverted section

The above photograph shows the open section of watercourse after the culvert in Howard Park. Although the flow from the culverted section is restricted this photograph demonstrates that the open section could accommodate a greater flow than the culvert. The following photograph illustrates the volume of surface water flowing into Howard Park from the Johnby and Blencowe roads.



Excessive surface water that finds its way on to the Johnby road is conveyed towards Greystock and flows into Howard Park to join the flood water from Poplin Beck

Photograph 12: Flood water flowing into Howard Park from the Johnby and Blencowe road

Ashburn Croft / Stonegarth, Smithy Court and Church Road area

This area was affected by the flooding on both 15th November and 5th December 2015 with 8 properties being affected by the flooding in either one or both of the events. Many of the properties were better prepared during the second event and experienced less damage due to their preventative measures.

The following plan demonstrates the flood routes that affected the flooding in this area.

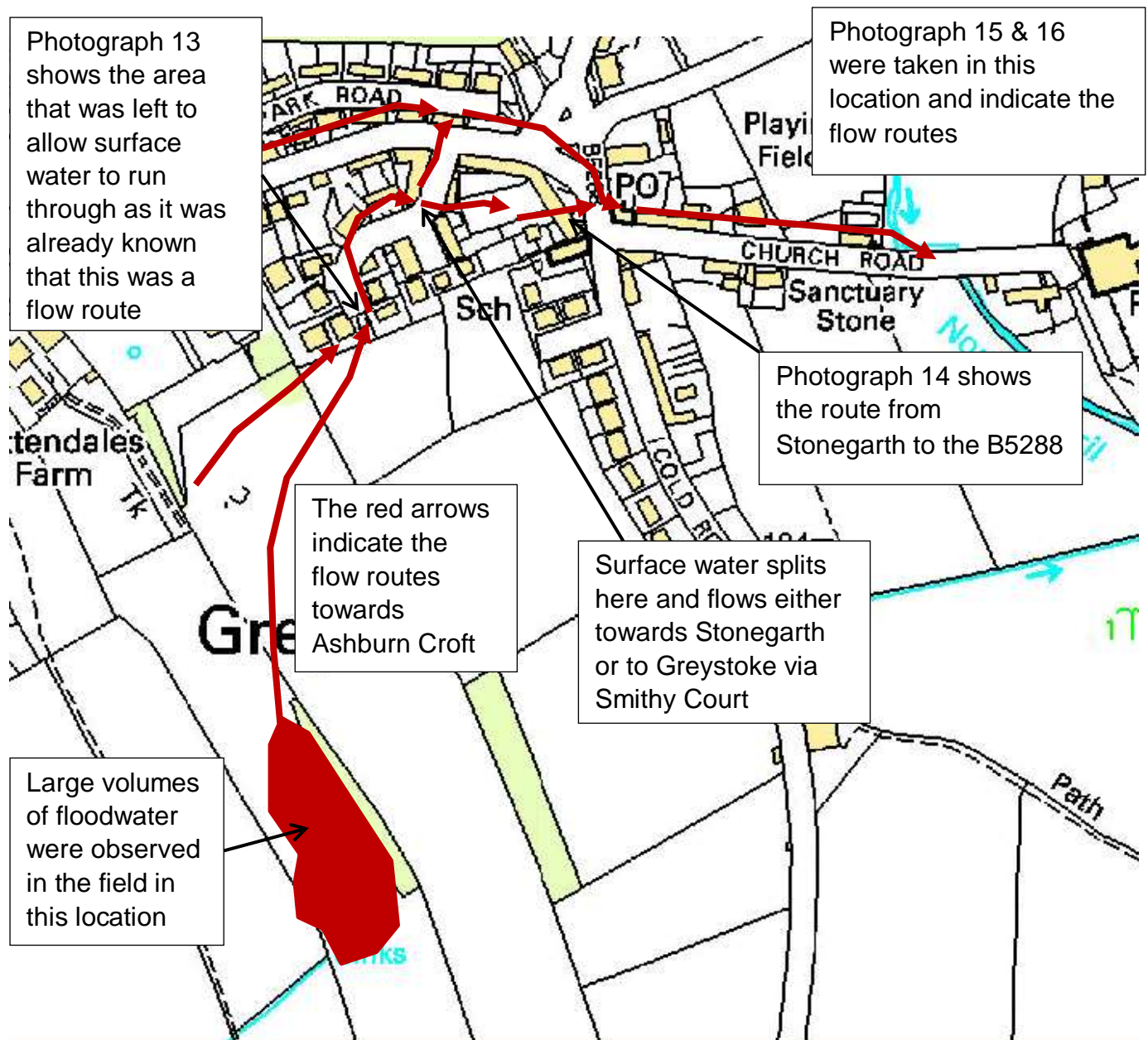


Figure 7: Flow routes through the Ashburn Croft / Stonegarth, Smithy Court and Church Road area

Information from residents has confirmed that a large area of water had formed as indicated on the above plan. This is also indicated on the flood risk map in figure 4. Once the water reached a specific height it started to run towards Ashburn Croft where it was joined by another surface water flow from the fields at the rear of Lattendales Farm.

The flood water enters Ashburn Croft at the end of the cul-de-sac. As it flows through Ashburn Croft it splits with some flow going towards Stonegarth and the remaining flow going towards Smithy Court.



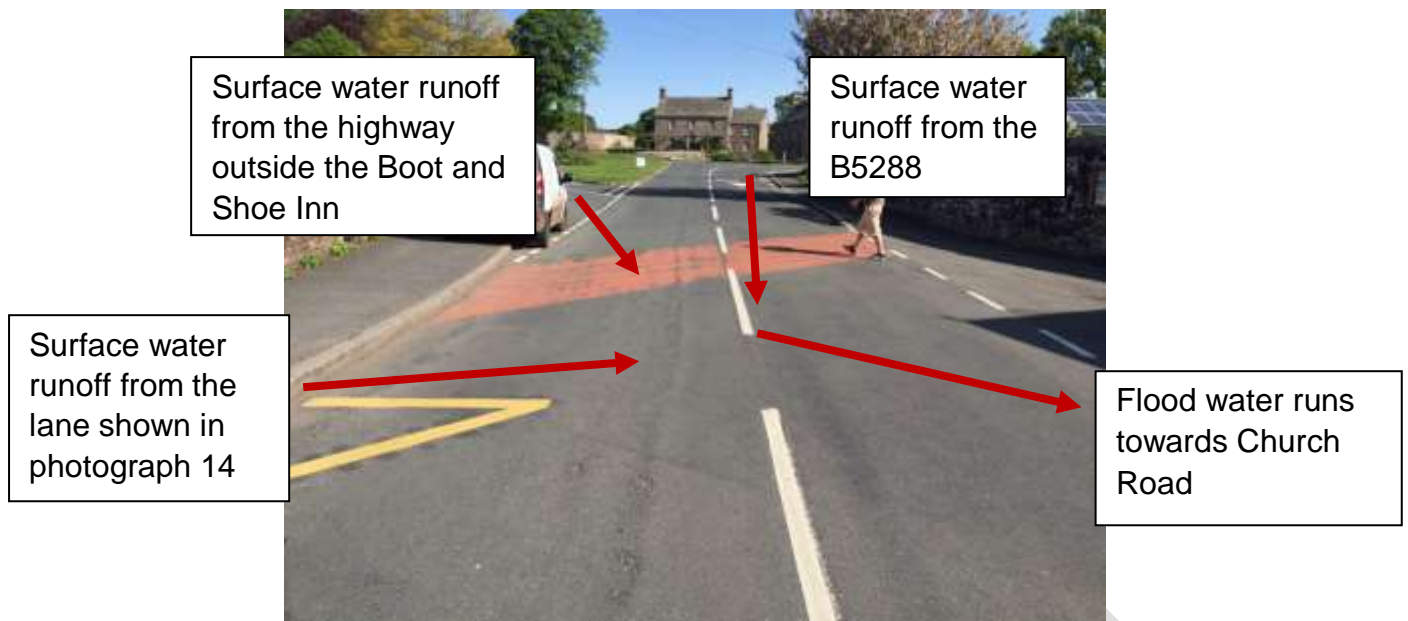
Photograph 13: End of cul-de-sac at Ashburn Croft, Greystoke

Photograph 13 above depicts a pre-planned flood route through Ashburn Croft in Greystoke. The end of the highway has deliberately been left without development to allow the flow of water through the development from the fields to the south.



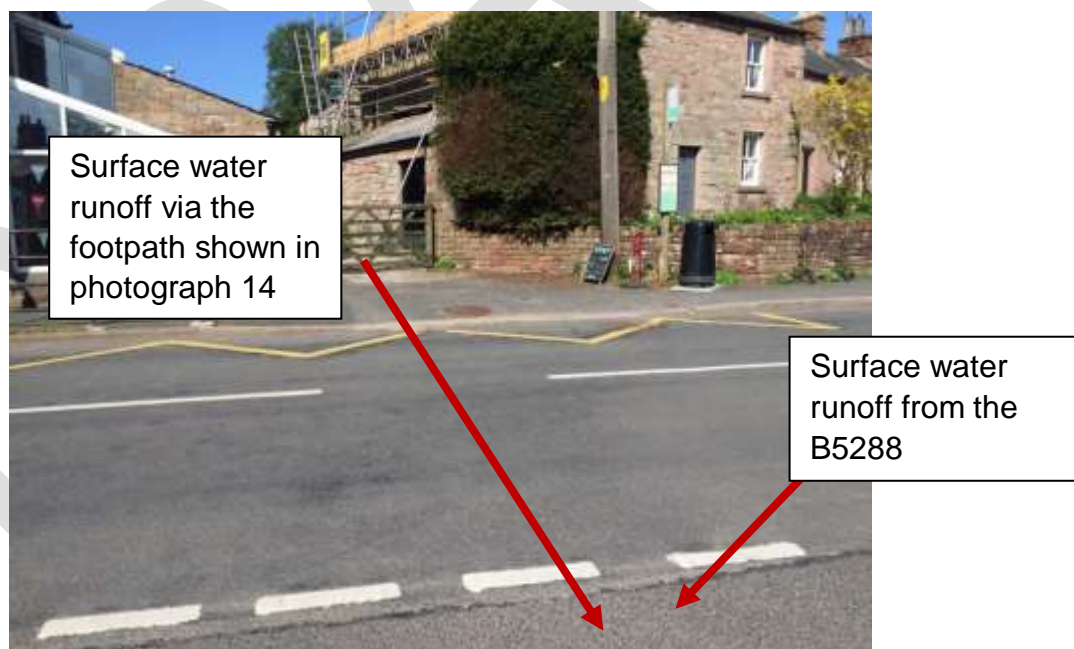
Photograph 14: Footpath which runs parallel to Greystoke School and onto the B5288

Photograph 14 above depicts a footpath which runs parallel to Greystoke School and exits onto the B5288. This route acts as a funnel and a flow route for the surface water runoff from the fields.



Photograph 15: B5288 which runs through the centre of Greystoke

Photograph 15 above depicts the centre of Greystoke village to the south of the Boot and Shoe Inn. Surface water flows from the north along the B5288 where, during Storm Desmond, the highway drainage was insufficient to cope with the volume of rainfall being received in this area and the excessive surface water runoff from the fields via Ashburn Croft. To compound this, the outfall for the drainage is into the River Petteril which was at bank full condition. Therefore the outfall for the surface water would be compromised and be reduced the capacity.



Photograph 16: Footpath exit onto the B5288 in Greystoke

Photograph 16 above depicts the exit of the footpath which runs parallel to Greystoke School. The surface water flows from the Ashburn Croft area flow from the footpath which acts as a channel which transports water into the centre of Greystoke. Once the water is within the footpath it contributes towards the flooding of properties and then flows onto the B5288. This water is then joined by surface water runoff from the B5288 as explained within Photograph 15.

The flood water then flows from the B5288 along Church Road before flowing to join the North Petteril. Although there have not been any reports of flooded properties from the North Petteril it has been reported that the floodplain downstream of Church Road was flooded.

Some properties in this area also experienced groundwater flooding. At the time of writing the draft report it is unclear what the cause of the flooding is but the properties affected are in an area of limestone and there is a fault very close by. Further investigations are required to identify the cause of the flooding but the geology of the area is complex. The BGS geology map is included as part of Appendix 4.

Likely Causes of Flooding

The extreme weather event was the major cause of the flooding experienced in Greystoke on both the 15th November and 5th December 2015, however, there were contributing factors in both locations of Greystoke that had a contributing factor to the flooding.

Howard Park

After the rainfall event, the most significant factor of the flooding was the restriction caused by the culverted section that runs through Howard Park. The culverted section is identified in the following plan.



Figure 8: Plan identifying the culvert through Howard Park

The culvert runs through private land, under highway and then through open space before it discharges into an open section of the watercourse. It is apparent that the culvert changes in size as it runs through Howard Park. Further investigations of the capacity of each section is required to determine if there is only a restriction on one section of the culvert or if it is the total culvert that is causing the restriction. Residents have reported that the grid at the entrance to the culvert is also an area where debris is often trapped.

As this area of Greystoke has been the subject of flooding for many years there have been various efforts made to try to reduce the risk of flooding by the various organisations in the MSfWG. Works carried out by organisations within the MSfWG have included new grids at the culvert entrance, dropping the pavement to create a flood route, new gullies, and a swale over the grassed area but to date these have not had a significant effect on flood reduction.

Although the culvert is a major contributing factor to the flooding experienced surface water runoff from the Johnby road and the Greystoke Park area also played a significant part.

Ashburn Croft / Stonegarth, Smithy Court and Church Road area

The following plan details the perceived cause of the flooding in the above area.



Figure 9: Location of culvert in fields south of Ashburn Croft

The major cause of the flooding in the Ashburn Croft, Stonegarth, Smithy Court and Church Road area is either the lack of capacity or a blockage in the culvert that runs through the fields as indicated in figure 9. In normal circumstances the culvert is able to cope with any flows from the catchment above but during the two extreme events this became overwhelmed. An action of this report is to CCTV survey the culvert to ensure it is not damaged or blocked.

The other surface water route from the rear of Lattendaes Farm also contributes to flood water entering Ashburn Croft.

Some of the properties in Smithy Court were flooded due to ground water. The cause of this is currently unknown. Further investigation is required to identify if the ground water is occurring due to the geology of the area or if an unknown damaged drainage system runs under the properties.

Flooding History

Howard Park

There is a long documented history of flooding within the Howard Park estate. The estate was constructed during the 1970's with the first flood being reported in December 1977. Normally approximately 3 floods per year occur with it being estimated that flooding has occurred approximately 117 times since 1977.

This has affected properties to varying degrees depending on the severity of the flooding. In less significant flood events this creates inconvenience with regard to access to properties within the estate as the flood water runs over the estate road. In extreme events the flooding has caused flood water to flood into the voids beneath properties and damage apparatus, flood garages and gardens. It is understood that 20 properties have been affected to varying degrees, 4 are understood to have suffered from flooding to the voids under their properties and up to 12 garages have been flooded at various times.

Residents have liaised with various organisations over 39 years to attempt to reduce the risk of flooding. These organisations have included Eden District Council, Parish Council, the Environment Agency, Cumbria County Council (Highways), Rory Stewart and Eden Rivers Trust.



Photograph: Flooding during 1977 in Howard Park

Ashburn Croft / Stonegarth, Smithy Court and Church Road area

The Making Space for Water Group have less information on historic flooding in this area but from discussions with local residents it is obviously locally known that there is a risk of flooding in this area. It is understood from locals that the gravelled area at the end of Ashburn Croft was created to allow a flow route for surface water to flow through during heavy rainfall events as this was a known flow route prior to the construction of the houses in this estate. Anecdotal information from locals has also indicated that there have been flooding issues with the properties that were demolished to create the Smithy Court properties.

Recommended Actions

The following table details recommended actions for various organisations and members of the public to consider using the Cumbria Floods Partnerships 5 Themes: Community Resilience, Upstream Management, Strengthening Defences, Maintenance, and Internal Drainage Boards (IDB's). Some of these recommendations may have already been carried out and or are ongoing.

Cumbria Flood Partnership Theme	Action by	Recommended Action	Timescale
Maintenance	LLFA	Howard Park - CCTV the culverted section of watercourse and associated gullies and drainage	Summer 2016
	LLFA	Howard Park - following the CCTV survey LLFA to assess the capacity of the culverted section of watercourse	Summer 2016
	MSfWG	Howard Park - investigate the possibility of de-culverting the watercourse under Howard Park and replacing the road culvert with a bridge (and / or upsizing the culvert)	Unknown as this will depend on landowner permissions and budget provision
	LLFA	Ashburn Croft / Stone Garth area – CCTV survey culvert in the fields to the south of Ashburn Croft	Summer 2016
	LLFA	Ashburn Croft / Stone Garth area – following the CCTV survey LLFA to assess the capacity of the culverted section of watercourse.	Summer 2016
		Ashburn Croft / Stone Garth area - investigate the possibility of de-culverting the watercourse	Unknown as this will depend on landowner permissions and budget provision

Upstream Management	MSfWG	Howard Park – investigate the possibilities of improved upland management of surface water run-off, eg potential attenuation, soil aeration, tree planting etc	Unknown as this will depend on landowner permissions and budget provision
	MSfWG	Ashcroft / Stone Garth area – investigate potential areas for surface water attenuation and ways to reduce the surface water runoff	Unknown as this will depend on landowner permissions and budget provision
Community Resilience	Residents	Investigate property level protection for affected homes (flood doors, concrete floors etc). Grants available via District/Borough Council	2016
	Community	Consider the formation of a Community Action Group to assist vulnerable within the community	Timescale to be dictated by the community need and their requirements

* The Cumbria Local Resilience Forum includes emergency services, Local Authorities, Cumbria County Council, Environment Agency, Maritime Coastguard Agency and health agencies along with voluntary and private agencies. Under the Civil Contingencies Act (2004) every part of the United Kingdom is required to establish a resilience forum.

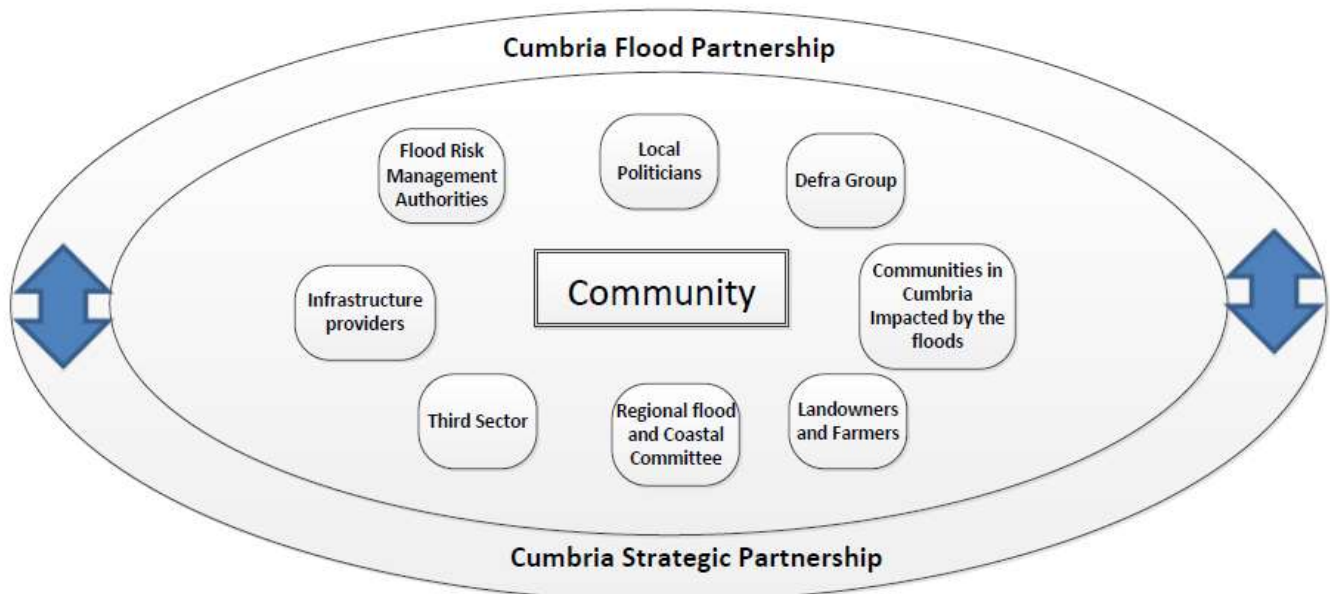
Residents and property owners who are aware that they are at risk of flooding should take action to ensure that they and their properties are protected. Community resilience is important in providing information and support to each other if flooding is anticipated. Actions taken can include laying sandbags and moving valuable items to higher ground, to more permanent measures such as installing floodgates, raising electrical sockets and fitting non-return valves on pipes. Anyone affected by flooding should try to document as much information about the incident as possible.

Next Steps

The Cumbria Floods Partnership has brought together a wide range of community representatives and stakeholders from a variety of sectors to plan and take action to reduce flood risk. The Cumbria Floods Partnership, led by the Environment Agency, is producing a 25 year flood action plan for the Cumbrian catchments worst affected by the December 2015 flooding, including Carlisle. The plan will consider options to reduce flood risk across the whole length of a river catchment including upstream land management, strengthening flood defenses, reviewing maintenance of banks and channels, considering water level management boards and increasing property resilience. The Cumbria Floods Partnership structure below details how these 5 themes are being delivered in the Flood Action plans which will be completed in July.

The 'Cumbria Floods Partnership' was set up by Flood Minister Rory Stewart following December's floods and includes all of Cumbria's Flood Risk Management Authorities. They are working alongside the existing 'Cumbria Strategic Partnership', which was formed as part of the Flood and Water Management Act and comprises of the county's Flood Risk Management Authorities (RMAs) including the Environment Agency, Cumbria County Council, Local Authorities and United Utilities. Both partnerships are working with communities, businesses and relevant stakeholders to understand and reduce flood risk across Cumbria.

This diagram below helps demonstrate how the two partnerships are working together:



Appendices

Appendix 1: Glossary

Acronyms

EA	Environment Agency
CCC	Cumbria County Council
UU	United Utilities
LLFA	Lead Local Flood Authority
LFRM	Local Flood Risk Management
MSfWG	Making Space for Water Group
FAG	Flood Action Group
FWMA	Flood and Water Management Act 2010
LDA	Land Drainage Act 1991
WRA	Water Resources Act 1991

Appendix 2: Summary of Relevant Legislation and Flood Risk Management Authorities

The Flood Risk Regulations 1999 and the Flood and Water Management Act 2010 (the Act) have established Cumbria County Council (CCC) as the Lead Local Flood Authority (LLFA) for Cumbria. This has placed various responsibilities on CCC including Section 19 of the Act which states:

Section 19

- (1) On becoming aware of a flood in its area, a lead local flood authority must, to the extent that it considers it necessary or appropriate, investigate—
- (a) which risk management authorities have relevant flood risk management functions, and
 - (b) whether each of those risk management authorities has exercised, or is proposing to exercise, those functions in response to the flood.
- (2) Where an authority carries out an investigation under subsection (1) it must—
- (a) publish the results of its investigation, and
 - (b) notify any relevant risk management authorities.

A 'Risk Management Authority' (RMA) means:

- (a) the Environment Agency,
- (b) a lead local flood authority,
- (c) a district council for an area for which there is no unitary authority,
- (d) an internal drainage board,
- (e) a water company, and
- (f) a highway authority.

The table below summarises the relevant Risk Management Authority and details the various local source of flooding that they will take a lead on.

Flood Source	Environment Agency	Lead Local Flood Authority	District Council	Water Company	Highway Authority
RIVERS					
Main river					
Ordinary watercourse					
SURFACE RUNOFF					
Surface water					
Surface water on the highway					
OTHER					
Sewer flooding					
The sea					
Groundwater					

Reservoirs					
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The following information provides a summary of each Risk Management Authority's roles and responsibilities in relation to flood reporting and investigation.

Government – Defra develop national policies to form the basis of the Environment Agency's and Cumbria County Council's work relating to flood risk.

Environment Agency has a strategic overview of all sources of flooding and coastal erosion as defined in the Act. As part of its role concerning flood investigations this requires providing evidence and advice to support other risk management authorities. The EA also collates and reviews assessments, maps and plans for local flood risk management (normally undertaken by LLFA).

Lead Local Flood Authorities (LLFAs) – Cumbria County Council is the LLFA for Cumbria. Part of their role requires them to investigate significant local flooding incidents and publish the results of such investigations. LLFAs have a duty to determine which risk management authority has relevant powers to investigate flood incidents to help understand how they happened, and whether those authorities have or intend to exercise their powers. LLFAs work in partnership with communities and flood risk management authorities to maximise knowledge of flood risk to all involved. This function is carried out at CCC by the Local Flood Risk Management Team.

District and Borough Councils – These organisations perform a significant amount of work relating to flood risk management including providing advice to communities and gathering information on flooding.

Water and Sewerage Companies manage the risk of flooding to water supply and sewerage facilities and the risk to others from the failure of their infrastructure. They make sure their systems have the appropriate level of resilience to flooding and where frequent and severe flooding occurs they are required to address this through their capital investment plans. It should also be noted that following the Transfer of Private Sewers Regulations 2011 water and sewerage companies are responsible for a larger number of sewers than prior to the regulation.

Highway Authorities have the lead responsibility for providing and managing highway drainage and certain roadside ditches that they have created under the Highways Act 1980. The owners of land adjoining a highway also have a common-law duty to maintain ditches to prevent them causing a nuisance to road users.

Flood risk in Cumbria is managed through the Making Space for Water process which involves the cooperation and regular meeting of the Environment Agency, United Utilities, District/Borough Councils and CCC's Highway and LFRM Teams to develop processes and schemes to minimise flood risk. The MSfWGs meet approximately 4 times per year to cooperate and work together to improve the flood risk in the vulnerable areas identified in this report by completing the recommended actions. CCC as LLFA has a responsibility to oversee the delivery of these actions.

Where minor works or quick win schemes can be identified, these will be prioritised and subject to available funding and resources will be carried out as soon as possible. Any major works requiring capital investment will be considered through the Environment Agency's Medium Term Plan or a partners own capital investment process.

Flood Action Groups are usually formed by local residents who wish to work together to resolve flooding in their area. The FAGs are often supported by either CCC or the EA and provide a useful mechanism for residents to forward information to the MSfWG.

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Appendix 3: Useful contacts and links

Cumbria County Council (Local Flood Risk Management):

lfrm@cumbria.gov.uk, www.cumbria.gov.uk, tel: 01228 221330

Cumbria County Council (Highways):

highways@cumbria.gov.uk, www.cumbria.gov.uk, tel: 0845 609 6609

Out of hours emergencies should be reported via the Police on 101

Cumbria County Council (Community Development Team)

tracey.moran@cumbria.gov.uk, www.cumbria.gov.uk, tel: 01768 812661

United Utilities: www.unitedutilities.com, tel: 0845 746 2200

Eden District Council

Customer.services@eden.gov.uk, www.eden.gov.uk, tel: 01768 817817

Flood and Water Management Act 2010:

<http://www.legislation.gov.uk/ukpga/2010/29/contents>

Water Resources Act 1991:

<http://www.legislation.gov.uk/all?title=water%20resources%20act>

Land Drainage Act:

<http://www.legislation.gov.uk/all?title=land%20drainage%20act>

Highways Act 1980:

<http://www.legislation.gov.uk/all?title=highways%20act>

EA – ‘Living on the Edge’ a guide to the rights and responsibilities of riverside occupation:

<http://www.environment-agency.gov.uk/homeandleisure/floods/31626.aspx>

EA – ‘Prepare your property for flooding’ how to reduce flood damage including flood protection products and services:

<http://www.environment-agency.gov.uk/homeandleisure/floods/31644.aspx>

Appendix 4: BGS Geology information

The following information is taken from the BGS data. The Smithy Court area is represented by the black dot.

DRAFT

Greystoke



























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Geolindex Onshore Data Sources: NERC, Natural England, English Heritage and Ordnance Survey

Map Key

Linear features 1:50,000 scale

- Coal_seam_Inf
- Drumlin_Line_at_base
- Fault_Inf_Downthrow_unspecified
- Fault_Obs_Downthrow_unspecified
- ↔ Glacial_meltwater_channel_Centre_Undiff

Bedrock geology 1:50,000 scale

-  EYCOTT VOLCANIC GROUP - TUFF
-  WHIN SILL COMPLEX - QUARTZ-MICROGABBRO
-  EYCOTT VOLCANIC GROUP - ANDESITE
-  ALSTON FORMATION - MUDSTONE, SILTSTONE AND SANDSTONE
-  FIFTH SHALE MEMBER - SANDSTONE, SILTSTONE AND MUDSTONE
-  FOURTH SHALE MEMBER - SANDSTONE
-  FIFTH SHALE MEMBER - SANDSTONE
-  ALSTON FORMATION - LIMESTONE, SANDSTONE, SILTSTONE AND MUDSTONE
-  ALSTON FORMATION - LIMESTONE
-  FOUR FATHOM LIMESTONE MEMBER - LIMESTONE
-  LITTLE LIMESTONE - LIMESTONE
-  GREAT LIMESTONE MEMBER - LIMESTONE
-  FIFTH LIMESTONE (CUMBRIA) - LIMESTONE
-  MELL FELL CONGLOMERATE - CONGLOMERATE
-  EYCOTT VOLCANIC GROUP - LAPILLI-TUFF
-  FIFTH LIMESTONE (CUMBRIA) - SANDSTONE
-  EYCOTT VOLCANIC GROUP - DACITE
-  STAINMORE FORMATION - MUDSTONE, SANDSTONE AND LIMESTONE
-  EYCOTT VOLCANIC GROUP - BASALTIC-ANDESITE (TAS)
-  WINTERTARN SANDSTONE MEMBER - SANDSTONE
-  ALSTON FORMATION - SANDSTONE
-  STAINMORE FORMATION - SANDSTONE
-  RAVENSTONEDALE GROUP - LIMESTONE AND [SUBEQUAL/SUBORDINATE] ARGILLACEOUS ROCKS, INTERBEDDED
-  HARESTONES RHYOLITE - RHYOLITE

Translation services

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