Section 19 Flood Investigation

Colnbrook Flooding - February 2014

Slough Borough Council

March 2015 v1.0

Albany Park (11/02/2014)

Notice

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This document has 30 pages including the cover.

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Investigation details

Location of flood event:	Colnbrook
Date of flood event:	January and February 2014
Date flood event was reported to Slough Borough Council:	January 31st 2014
Trigger for S19 investigation	Internal flooding was officially reported at 14 properties. Unofficial reports suggest up to 67 properties could have suffered from internal flooding.
Investigating officer (s):	Tom Boichot & Ian Sivyer
Date of investigation:	November 2014

Outcome of the investigation

Sources of flooding:	Internal flooding of properties in Coleridge Crescent & adjoining Closes was predominantly caused by groundwater. The Albany Park area was predominantly flooded by fluvial flooding from the Cottesbrook Ditch, which is fed by County Ditch. Internal flooding of properties in Cottesbrook Close was predominantly caused by groundwater. Flooding along Mill Street was predominantly caused by fluvial flooding from the Colne Brook however one incident of ground water flooding was reported in the area.
Cause and pathway of flood:	Prolonged rainfall fell over January and February 2014 which saturated the catchment and raised already high groundwater levels. River levels were already high from persistent rainfall, and overland storage at West Lakes was near full. The west penstock (main penstock) on Colnbrook West Lake was open for an unknown period during the event which allowed water to constantly flow into Colnbrook via Hawthorn Ditch and then County Ditch. Due to fast groundwater reaction times the open penstock also kept groundwater levels topped up. The volume of water that passed through the main penstock was exacerbated because water was funnelled into the Lakes and was not passed back into the Colne Brook. Anecdotal evidence suggests water did not pass back because fallen trees and other debris created a head differential between the Colne Brook and the Lakes. At the peak of the event water overtopped Colnbrook West Lake, bypassed the penstocks, and then flowed into Colnbrook village. Coincidentally, if the penstocks had been closed for the full duration of the event water levels in Colnbrook West Lakes would have risen quicker and would have overtopped the embankment earlier.

	High water levels downstream of Colnbrook may affect how water drains through the catchment. During flood conditions Horton Mill Weir could contribute to the backing up of water in Colnbrook. The Wraysbury Offtake is a tilting gate that controls the flow of water into Poyle channel. If the Wraysbury River becomes blocked downstream of the gate, or the gate fails to operate correctly more water can pass into Poyle Channel. If additional water does flow down Poyle Channel, water levels downstream of Colnbrook would be raised. This would in turn make it more difficult for water to drain from Colnbrook. Shortly after the flood event it was suggested that the Wraysbury Offtake was not operating correctly however the Environment Agency have stated that during the flood event the Wraysbury Offtake was operating as designed.
Key solutions:	To effectively manage flood risk an operating procedure should be put in place for the main penstock. At the time of writing a temporary operating procedure is in place. During the winter of 2014/15 the Horton Mill Weir operating conditions were adjusted in line with advice from a local landowner. This change may help to draw down groundwater levels in advance of future floods. This solution will be monitored to establish how effective it is. To reduce the risk of overtopping, trees and other debris in the Colne Brook must be removed and the connectivity between the Colne Brook and the West Lakes investigated. Furthermore, the Colnbrook West Lake embankment level is 9cm below the designed level. To prevent overtopping of the embankment occurring prematurely the embankment level should be raised to the deign height. This could be permanently formalised or done on a temporary basis when extreme weather is forecast using sandbags and or concrete kerbs. By the time of writing the Environment Agency had removed debris along the Colne Brook in the key area.
Risk Management Authorities (RMAs):	Slough Borough Council Environment Agency Thames Water
Number of proposed actions to be completed by RMAs:	31
Number of actions complete at the time of issue (March 2015)	21

1. Introduction

1.1. Section 19 investigation requirement

Under the Flood and Water Management Act 2010 the Lead Local Flood Authority (LLFA) must, to the extent that it considers it necessary or appropriate, undertake an investigation upon becoming aware of a flood incident within its area.

A Lead Local Flood Authority is defined under Section 6(7) of the Flood and Water Management Act as being the unitary authority for that area, or if there is no unitary authority, the county council for the area. Section 19(1) requires that the lead local flood authority must 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.

Section 19(2) requires that the LLFA publishes the results of its investigation and notify the relevant risk management authorities accordingly. The risk management authorities are discussed in Chapter 4.

1.2. Trigger for the investigation

The approach taken by Slough Borough Council (SBC) is that it is necessary and appropriate to investigate a flood event under Section 19(2) if one of the following has occurred:

- Internal property flooding.
- Flooding of transport infrastructure sufficient to require closure or diversion of traffic.
- Flooding of a utility plant resulting in loss of service to customers.

In the Colnbrook area 14 properties claimed for Council Tax relief, which is available to properties who have suffered from internal flooding. This was the official mechanism for determining how many properties have suffered from internal flooding in Slough however unofficial street surveys suggests that up to 67 properties could have suffered from internal flooding[1]. This Section 19 investigation was triggered because more than 1 property in Colnbrook suffered from internal flooding.

This report looks at the flood mechanisms, considers the existing flood defences & how they are operated, and notes the actions that have and are being put into place to make residents more resistant and resilient to flooding.

1.3. Terminology

In this document fluvial flooding refers to water that has passed out of bank from any watercourse. This includes main rivers and ordinary watercourses.

Flood events are defined by their likelihood (probability) of occurrence, whereby a flood event is defined by the chance of that flood being equalled or exceeded in any one year. For example, if a flood event has a 1 in 100 chance of occurring in any one year then it has an annual exceedance probability (AEP) of 1%.

Colnbrook is a village situated roughly 3 miles southeast of Slough. The Colne Brook flows through Colnbrook and is designated as an Environment Agency main river. Old Slade Lake, Orlitts Lake and Colnbrook West Lake lie to the north east of Colnbrook Village and for the purpose of this report are collectively referred to as the West Lakes.

[1] The unofficial number of properties that suffered from internal flooding was estimated by the National Flood Forum who spoke with residents after the flood event.

2. Background

2.1. Investigation area

This Section 19 investigation covers flooding occurring in Colnbrook and the surrounding area that suffered from flooding between January and February 2014. Figure 2-1 shows the investigation area and key features.

2.2. Investigation area characteristics

Colnbrook Village sits in a shallow valley. The ground gently slopes from roughly 22m AOD at Colnbrook West Lake to 20m AOD at Albany Park, to between 19 and 20m AOD at Horton Mill Weir. The village sits on London clay formation overlain with alluvium deposits consisting of clays, sands, and gravel. Water is able to move freely through these types of deposits making the area more susceptible to groundwater flooding.

The River Colne flows from north to south along the western edge of Greater London splitting and re-joining multiple times across its wide and relatively flat floodplain. The gauge weir at Denham is the last gauging station that can gauge the whole river flow in the River Colne, after which the river splits into the Frays River and the River Colne. There are no control structures at any of the splits so flow is determined through each by the downstream water level in each branch. At Uxbridge the river splits again into the River Colne and the Colne Brook. After flowing for a further 6.5km the Colne Brook reaches the investigation area.

During normal flow conditions the Colne Brook meanders through a small woodland area adjacent to West Lakes (Old Slade Lake, Orlitts Lake, & Colnbrook West Lake). The only barrier between the Colne Brook and the West Lakes is a small embankment which has a varied crest level. During site visits undertaken after the floods in 2014 it was generally noted that the Colne Brook river level was higher than that of the Lakes.

The West Lakes were formed as a result of gravel and sand extraction and have become a wetland habitat regularly used by fishermen. Boyer Fishing offer the fishing facilities at the Lakes and have built a series of fixed level ñswimsò, which are purpose built areas for members to fish from.

Importantly the Lakes also offer flood storage benefits. During times of intense rainfall and high river levels the Colne Brook is expected to overtop the low lying embankment, flow into the West Lakes, and utilise the additional storage. This reduces the volume of water passing down the Colne Brook and should reduce the risk of flooding.

From the West Lakes water can either pass back into the Colne Brook River or it can pass through a set of three penstocks (asset IDs HW1, HW2 & HW3, see Appendix A) at the southern end of the lakes. HW1 and HW3 are highway drains and HW2 is the main Colnbrook West Lake penstock that passes water underneath Lakeside Road and then the A4 (Hawthorn Ditch) before feeding into County Ditch - a small watercourse that travels in a south and then north westerly direction through fields and parkland before gently meandering alongside the north easterly edge of Colnbrook Village.

County Ditch and the Colne Brook River originally converged to the north of Albany Park but a barrage now separates County Ditch and the Colne Brook, which was developed as part of a 2005 flood alleviation scheme. The purpose of the Albany Park barrage is to prevent the higher flows conveyed by the Colne Brook from travelling back up the relatively small County Ditch. After the scheme, flow from the County Ditch now re-joins the Colne Brook to the south of Cottesbrook Close. The interaction of these watercourses with the barrage and penstocks are explained in more detail in Chapter 3.

Figure 2-1 Investigation area and key features

2.3. Predicted flood risk

2.3.1. Fluvial flood risk

The fluvial flood map for the Colnbrook area (see Figure 2-2) indicates the areas that could flood from a river for a 1 in 100 (medium blue) and a 1 in 1000 (light blue) event. The dark blue line represents the Colne Brook River, other interconnecting watercourses, and the series of ditches that flow from West Lakes. Flooding is predicted to occur when watercourses exceed their capacity and overtop. The area predicted to be at greatest risk is Albany Park, but as indicated by the black hatched line, this area should benefit from fluvial flood defences. This area however was one of the worst affected. Further detail on the flood mechanism is provided in Chapter 3. Fawsley Close, Laurel Close, Myrtle Close, Aintree Close, Tall Trees, and Coleridge Crescent are indicated to remain dry during a 1 in 100 fluvial flood event ï however they also flooded during the flood events of January and February 2014.

Information relating to the amount of water flowing into the Colnbrook area is limited to the gauge weir at Denham, which is upstream of multiple bifurcations. To better understand the reaction of the catchment and to provide improved flood warnings it is recommended that an additional gauge is implemented in the Colne Brook upstream of Orlitts Lake.

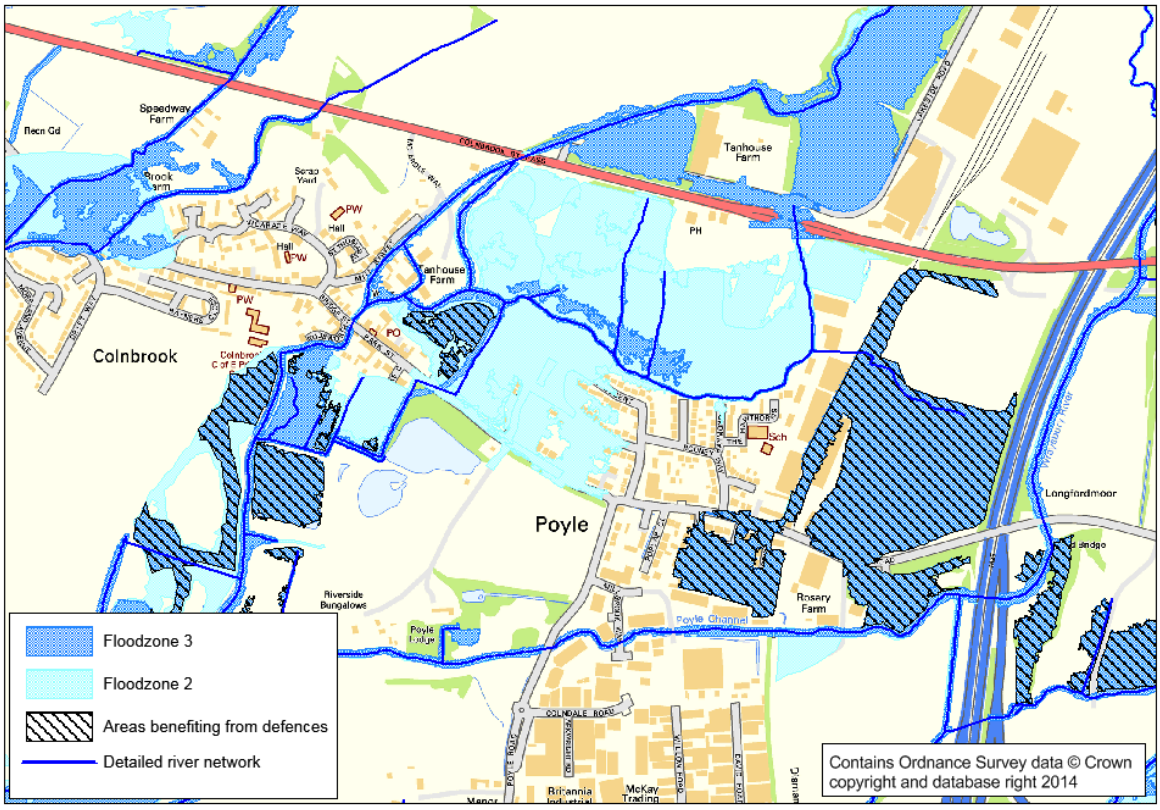


Figure 2-2 Fluvial flood risk mapping

2.3.2. Surface water flood risk

Surface water flooding is caused by intense periods of rainfall, usually over short periods of time, which overwhelm the drainage system, or cannot infiltrate into saturated ground. The updated flood maps for surface water, available on the Environment Agencies website, indicate the areas that could flood from surface water. The areas at greatest risk of flooding from intense rainfall are at the low spots along Fawsley Close, Laurel Close, Myrtle Close, Aintree Close and Coleridge Crescent.

2.3.3. Groundwater flood risk

Groundwater flooding is where abnormally high rainfall falling over a long period of time can result in the emergence of groundwater at the surface. The Environment Agency describes nearly all of Colnbrook Village as being in a major aquifer (high groundwater vulnerability zone; see Figure 2-3), and generally flows from north to south but is significantly restricted by reservoirs and both sealed and unsealed landfills. The alluvium deposits in the Colnbrook area are about 8m deep and are known react quickly to rainfall and high river levels.

Due to the high permeability of the alluvium deposits the water in the river channels and the water in the ground near the river channels is strongly connected. At the time of flooding many residents described the water as coming up and out from the roadside gullies and up through the floor boards, rather than from overtopping the river banks. If the water in the river channels can be reduced then the water able to infiltrate into the ground near the river channels could also be reduced.

Slough Borough Council, the Environment Agency and the Parish council have worked together since the flooding and drawn on advice from the previous Horton Mill Weir operator, who has said that ground water levels could be drawn down throughout Colnbrook by changing the operating conditions of the Horton Mill assets. This suggestion is being trialled by the Environment Agency will be monitored over the coming winters.

Information relating to groundwater levels in the catchment is limited to a physical gauge which is read on a monthly basis. Groundwater levels in Colnbrook have a fast reaction so it is recommended that the gauge is replaced with a permanent logger that plots groundwater levels on a daily or sub-daily basis. In combination with the fluvial gauge these gauges will help to understand the reaction of the catchment to rainfall and will help provide improved flood warnings[2].

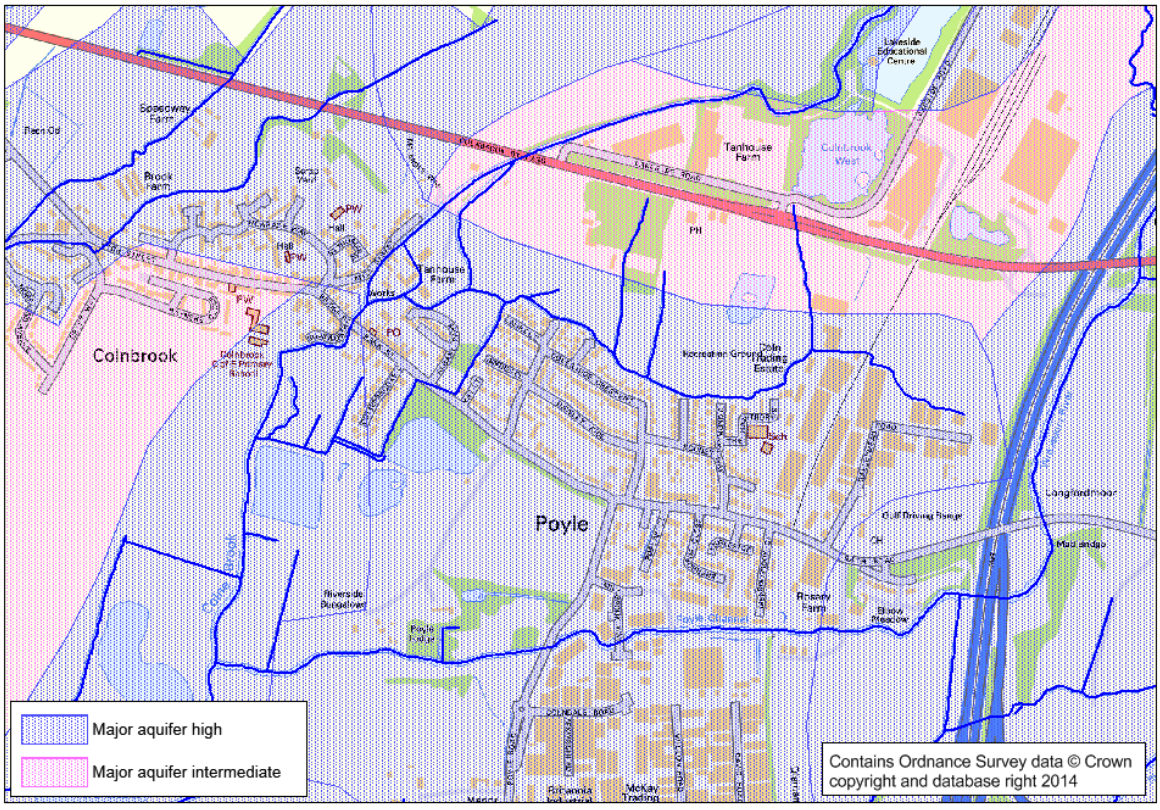


Figure 2-3 Groundwater vulnerability zones

[2] The Environment Agency currently do not provide warnings for groundwater

2.4. Key assets

Figure 2-4 shows the location of the key assets and issues within the investigation area. Colnbrook West Lake penstocks, Albany Park barrage, Horton Mill weir, and Wraysbury offtake (circled in red on the map) are described below.

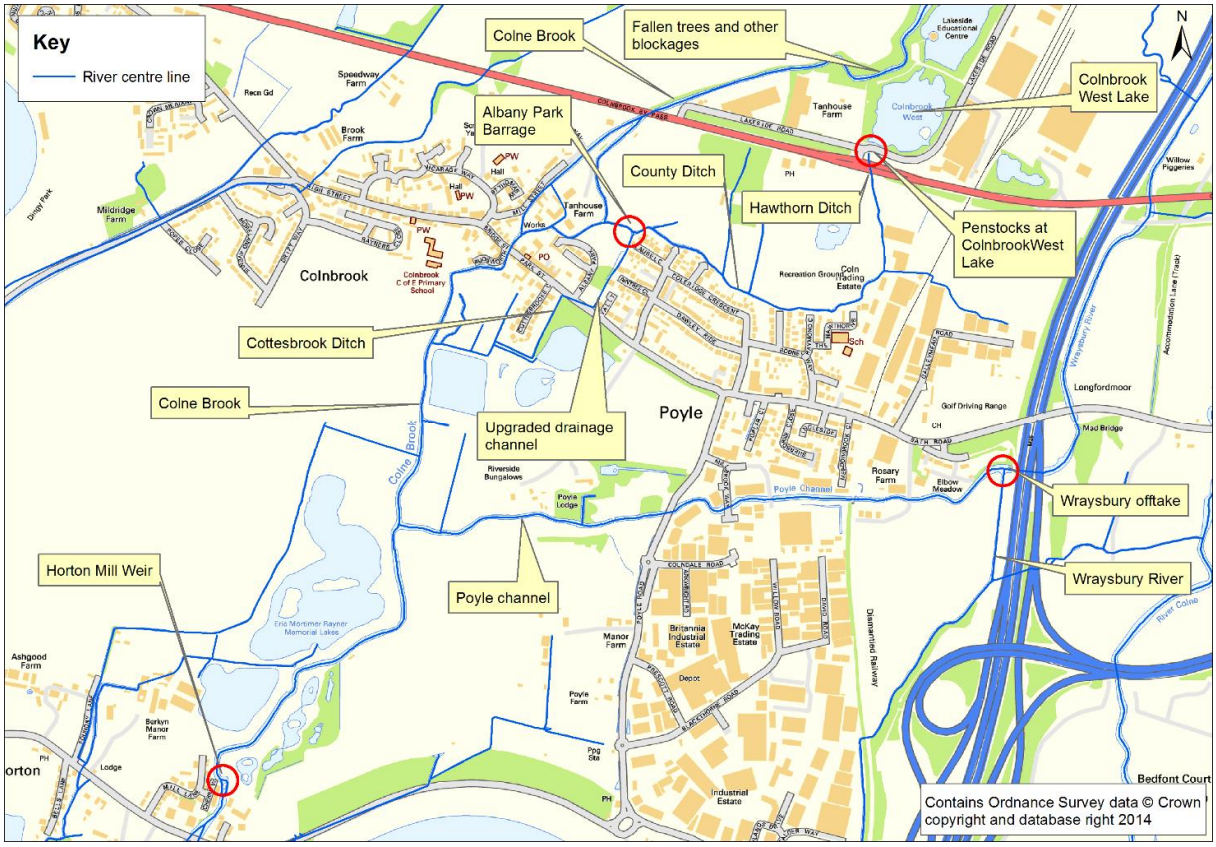


Figure 2-4 Key assets and issues location map

Colnbrook West Lake Penstocks

Fluvial flood levels in the County Ditch should be controlled by the 2005 flood alleviation scheme, which was designed to cope with rainfall falling over the Colnbrook catchment only. To achieve this, flow should not be allowed to enter County Ditch from the Colne Brook during flood conditions. This is achieved by closing the 3 penstocks on Colnbrook West Lake. In doing so the flow into County Ditch is reduced to the rainfall falling in the catchment and any groundwater baseflow.

At the time of the flood event there was some uncertainty over which risk management authority should operate the asset. Since then Slough Borough Council and the Environment Agency have worked together to establish temporary operating conditions for all 3 penstocks on Colnbrook West Lake. The main penstock is currently closed and the temporary operating is in procedure in place. Slough Borough Council are also investigating designating the asset and are also considering the needs of Boyer Fishing, who occasionally need to operate the penstock to keep swims open for fishing. This type of operation is safe to do so if correctly managed and protocols are put in place to facilitate this.

Moving forward the temporary protocol will be kept in place and monitored. Slough Borough Council does not have the authority to operate the main penstock on a day to day basis, and the Environment Agency will not manage the operation on a day to day basis either. The 2 other penstocks (HW1 and HW3) will be controlled by Slough Borough Council to stop backflow from the lake travelling to the road. Slough Borough

Council will achieve this by fitting a flap valve in the catchpit upstream of the outfalls (See Appendix A). Note neither Slough Borough Council or the Environment Agency owns the West Lake penstocks or the oil interceptors. It is assumed that they are owned by Goodmans, who is the current land owner.

Albany Park Barrage

The Albany Park Barrage prevents backflow from the Colne Brook River into the County Ditch, while a new upgraded drainage channel allows flow to drain from the area through a culvert under Park Street / Bath Road.

Colnbrook West Lake penstocks

Albany Park Barrage

Upgraded drainage channel

Horton Mill Weir and assets

Horton Mill Weir

Horton Mill Weir, consisting of the weir and 4 sluice gates, influences how water drains from the catchment. Horton Mill Weir is over 1.5km downstream from the Albany Park Barrage but the river slope is very shallow - land only falls by roughly a metre between the barrage and the weir. Due to this shallow slope, and during extreme conditions, it is possible that water levels in Colnbrook could be affected by the operation of Horton Weir and its assets.

Wraysbury Offtake

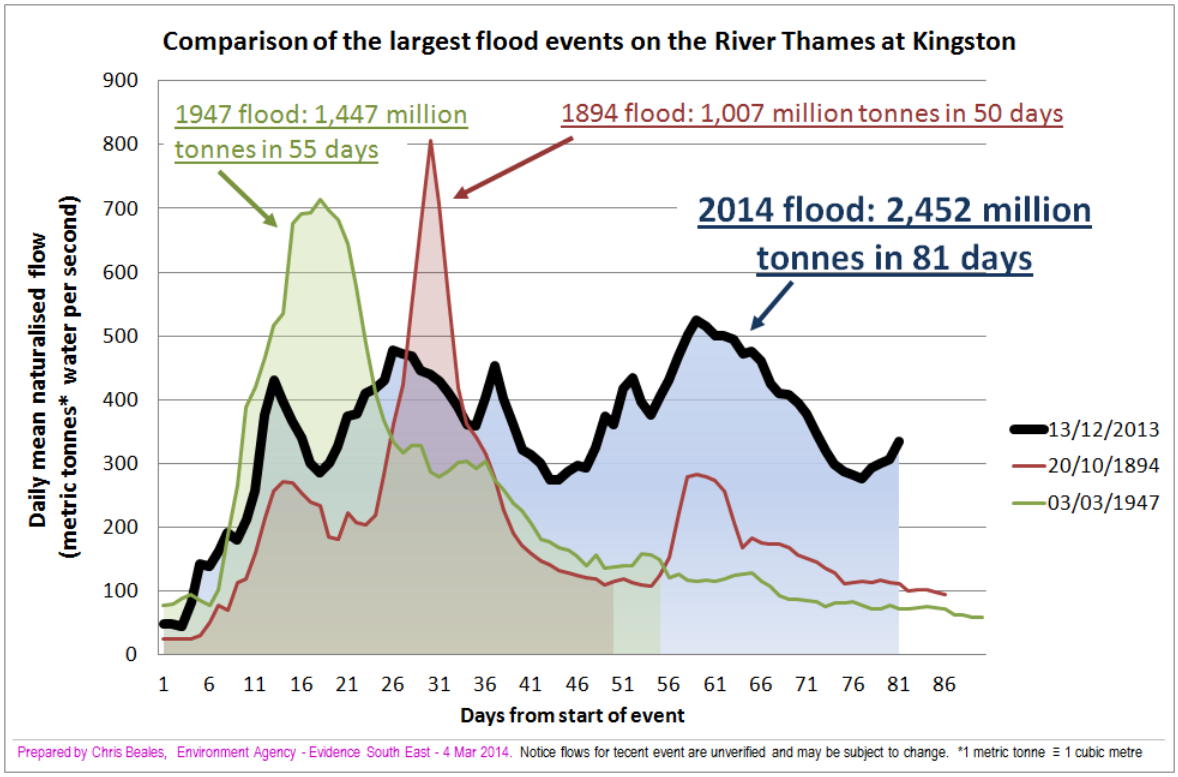
The Wraysbury Offtake is a tilting gate weir that diverts flow down Poyle channel during normal flow conditions. However, the Offtake has not always worked as it should. If it failed during the winter flooding more water would have passed along Poyle channel which could have contributed to water backing up in Colnbrook. However, during the course of this investigation the Environment Agency has stated that during the flood event the Wraysbury Offtake was operating as designed.

3. Analysis of the January - February 2014 event

3.1. Severity of the rainfall event

Over the winter of 2013-2014 the South East of England received 250% of the long term average rainfall. With catchments already saturated at the beginning of December, river levels responded to this rainfall and widespread property flooding was experienced.

Over the period 13th December to 16th February provisional data suggests 409mm of rainfall fell within the Thames Catchment, which is the largest 66 day total since records began in 1883. The long duration and permeable alluvium deposits meant that flood water passed into Colnbrook through the watercourses and overland flow, but also through groundwater.



3.2. Inflow into Colnbrook Village

On the 11th of February Slough Borough Council checked the West Lake penstocks. The 2 penstocks (east) on highway drainage were noted to be fairly well closed (but managed to get a couple of extra turns in). Seatings were obstructed so needed sandbagging to restrict flow to a reasonable level. However the main penstock outlet to the lake was fully opened and completely submerged. The seating was badly obstructed and needed tarpaulin and bagging to obtain a reasonable reduction in flow. The penstocks were confirmed as being open on the 11th February and were sealed on the 12th February 2014 by Slough Borough Council. Residents noted that after the penstocks were closed water levels dropped significantly. This was confirmed by Environment Agency staff that visited Colnbrook Village on the 13th February and noted the observed levels to be lower than they were on previous days. Coincidentally water levels were also observed to drop dramatically over a short period of time in other regions of the River Colne Catchment over the same dates.

The Environment Agency have stated that they did shut the penstock before the event so it is not known for how long the main penstock was open or why it was open. It was important for the main Colnbrook West Lake penstock to be closed off however it should also be noted that due to the large volume of water passing down the Colne Brook if the main penstock had been shut for the duration of the event water would have overtopped the West Lake embankment earlier and flood water still would have flowed towards Colnbrook.

SBC sealing the main penstock at Colnbrook West Lake.

Because the main penstock was open County Ditch and Cottesbrook ditch drained an area greater than the local runoff collected in the Colnbrook catchment[3]. Experienced engineers on site at the time estimated the flow through the penstocks to be about 500l/s increasing to 1000l/s at peak of the overflow. And, because of the fast groundwater reaction time, it is possible that the open penstock kept groundwater levels topped up.

The managers of Colnbrook West Lake observed water spilling into the West Lakes from the Colne Brook but unconfirmed evidence suggests water could not flow back as anticipated. Trees and other debris were in the Colne Brook at various locations along the channel which might have created a sufficient head differential to prevent water from being able to pass back in. Instead of passing back into the Colne Brook water was forced over the downstream embankment of Colnbrook West Lake and down towards Colnbrook. Furthermore part of the crest of the embankment was built 9cm below the design level and so water was able to overtop sooner.

Water from West Lakes overtopping Lakeside road and draining into Hawthorn Ditch

[3] The 2005 Colnbrook flood scheme was only designed to drain local runoff collected in the Colnbrook catchment.

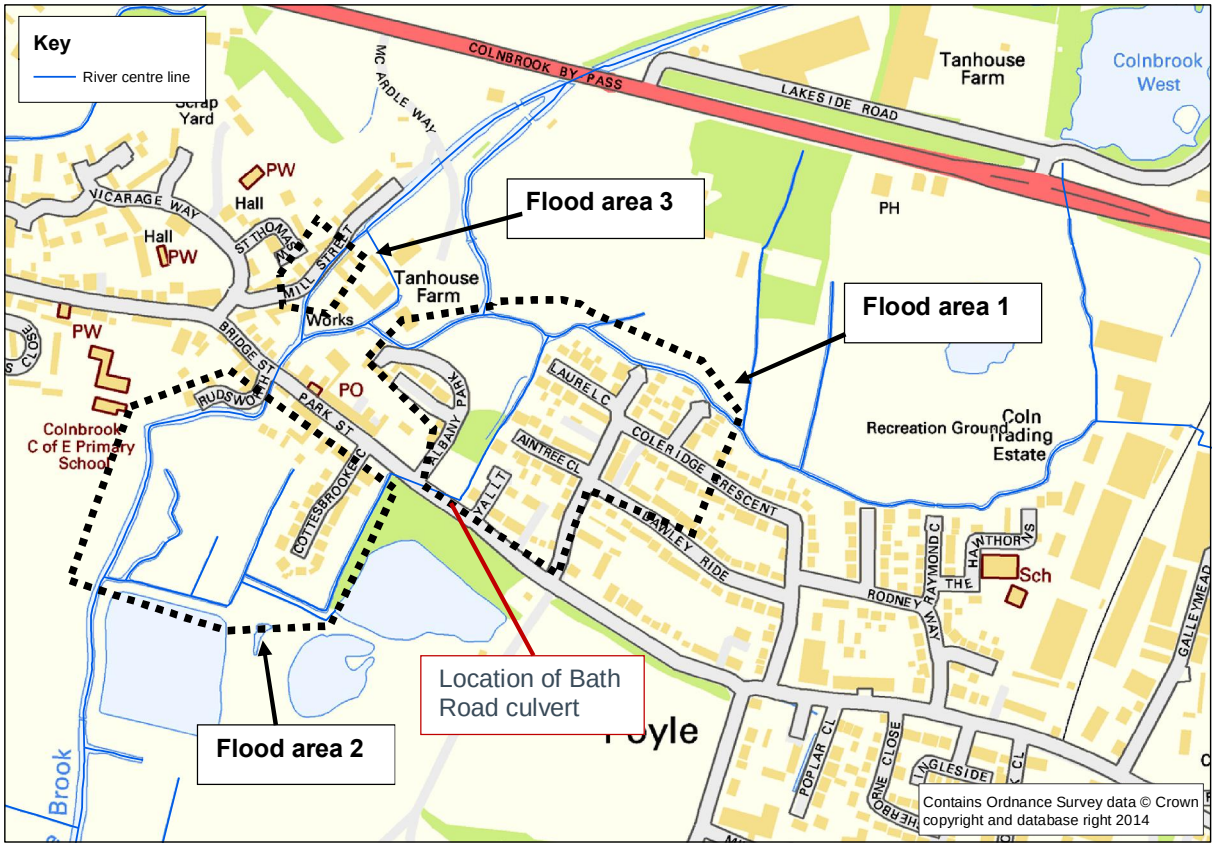
In summary:

- Over the period 13th December to 16th February provisional data suggests 409mm of rainfall fell within the Thames Catchment, which is the largest 66 day total since records began in 1883.
- The long duration and permeable alluvium deposits meant that flood water passed into Colnbrook through the watercourses and overland flow, but also through groundwater.
- Water passed into the West Lakes but did not flow back into the Colne Brook due a low West Lake embankment crest height and possibly due to fallen trees and debris in the Colne Brook.
- All of the flood storage at West Lakes was used up and the West Lake embankment overtopped. A higher West Lake embankment crest height would have retained more water.
- The Environment Agency have stated that they closed the West Lake penstocks prior to the event, but on 11th February 2014 the main penstock was open. This allowed a constant flow of water into Colnbrook from the County Ditch. It is not known for how long the penstock was open for.
- It is possible that due to the high permeability of the alluvium deposits the open penstock kept groundwater levels topped up in Colnbrook.
- It should be noted that if the main penstock had been shut water would have overtopped the West Lake embankment earlier and flood water still would have flowed towards Colnbrook.

3.3. Flood incident areas

In Colnbrook Village there were three key areas of flooding as shown in Figure 3-1.

Figure 3-1 Flood incident areas



Flood Area 1

According to Flood Data Reports the Environment Agency first attended flood area 1 on the 31st January when Fawsley Close and Albany Park reported flooding. The local source of flooding could not be determined on site but has since been deemed to be a combination of groundwater and fluvial flooding. Direct rainfall falling on drains full to capacity may have exacerbated the situation.

Residents commented that water came up through the floorboards on Laurel, Aintree, Fawsley and Myrtle Close. Residents also commented that water was flowing up from the surface water drains at Fawsley, Myrtle, and Laurel Close as well as at Tall Trees. The majority of the surface water drains are connected to soakaways but those closest to the watercourses are understood to discharge directly into the river.

Flooding in the car park at Tall Trees where residents noted water was coming out of the drain.

At Albany Park Environment Agency staff observed water flowing onto the road from the Park area on the 1st February suggesting that water was coming from the County Ditch (or Cottesbrook Ditch). This area is downstream from the West Lakes. Had the water in the West Lakes been able to pass back into the Colne Brook this area would probably have flooded to a lesser extent. Had the Colnbrook West Lake penstock been shut this area might also have flooded to a lesser extent. However if the West Lake penstock had been shut water would have overtopped the Colnbrook West Lake embankment sooner and flood waters would still have reached the area. Direct rainfall falling on drains full to capacity may have exacerbated the situation.

Flooding at Albany Park looking across the Albany Park space to the residential road.

On 1st February the Environment Agency looked for ways to alleviate the flooding in flood area 1. They checked for differentials in levels at the Albany Barrage and found 800mm freeboard downstream, which

suggested that there was capacity to pump over the barrage to draw down levels in Cottesbrook Ditch and the County Ditch. The pump arrived on 1st February and remained pumping for a number of days. Pumping at the barrage is an effective way to reduce the risk however the effectiveness can be improved by closing the Colnbrook West Lake penstocks.

Observations at Bath Road culvert during the early part of the flood event (1st February) indicated that it was not flowing freely. This culvert is critical to draining flood area 1. At the time it was thought that the culvert was blocked so the Environment Agency used a pole to check for blockages and found none. The downstream culvert outlet was then checked to determine if there was any difference between the upstream and downstream levels. Although a slight difference was seen the Bath Road Culvert was assessed as not being blocked. This view is supported by the observed subsurface flow seen upstream. Instead slow flow through the culvert could have been caused by the backing up of water levels downstream. Since the flood, water levels have also been observed collecting at the culvert inlet. Investigation of the flow routine through this culvert should be undertaken to ensure water is able to flow freely during all flow conditions.

Flooding at Fawsley Close looking towards County Ditch.

Flood Area 2

Cottesbrook Close was visited by the Environment Agency on 1st February 2014. Several gardens and roads were noted as being under water. A number of residents described water coming up from the floorboards, suggesting that the source of flooding was again from groundwater. Sewers were being tankered at the end of the Close to relieve pressure on the Thames Water pumping station further downstream however this had been a problem before the peak of the flood event.

Flooding at Cottesbrook Close looking southwards. Photo taken at about 13:30 on February 4th 2014

Flood Area 3

Flow was reported to be in bank at Mill Street on the 1st February 2014 apart from a section of road that flooded because a small defect hole in the raised brickwork channel wall allowed water in. River levels were reported to be high in the Colne Brook River. However during the duration of the event no internal flooding was reported. After the event 1 property reported flooding as a result of groundwater. As the event intensified the flood envelope along Mill Street broadened, but no properties reported fluvial flooding and the flood waters eventually subsided. Mill Street is deemed to have flooded from flow from the Colne Brook River. Groundwater levels in flood area 3 were high and 1 property reported flooding of this nature. However it should be remembered that river levels and groundwater levels near to the river are strongly connected.

Flooding on Mill Street

4. Risk Management Authorities

4.1. Identification of relevant RMAs

The following Risk Management Authorities (RMAs) had risk management functions during January and February 2014 in Colnbrook Village:

- Lead Local Flood Authority (Slough Borough Council)
- The Environment Agency
- Thames Water

Lead Local Flood Authorities (LLFAs) are responsible for developing, maintaining and applying a strategy for local flood risk management in their areas. As part of this, the LLFA liaises regularly with the Environment Agency as well as the other RMAs to ensure that all sources of flooding in their area are being properly managed, and filling in any gaps in responsibility where the relevant RMA is unclear. They need to produce reports when there is a reported flood, and they have to keep a register of their flood management assets. They also have lead responsibility for managing the risk of flooding from surface water, groundwater and ordinary watercourses. Ordinary watercourses are rivers which are not designated as ôMain Riversô

The Environment Agency is responsible for taking a strategic overview of the management of all sources of flooding and coastal erosion in England and Wales. They have prepared strategic plans which set out how to manage risk, provide evidence (for example their online flood maps), and provide advice to the Government. They provide support to the other RMAs through the development of risk management skills and provide a framework to support local delivery. The Environment Agency also has operational responsibility for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea, as well as being a coastal erosion risk management authority. Main rivers are defined through an agreed map which is updated annually. These tend to be the larger rivers in the country.

4.2. Flood risk management functions

Each RMA must perform the relevant risk management functions.

With regard to flood risk Slough Borough Council must:

1. Coordinate emergency support with their own functions
2. Deal with emergencies on ônon main riversô
3. Coordinate emergency support from the voluntary sector
4. Deal with environmental health issues, such as contamination and pollution
5. Manage public health issues
6. Provide advice and management of public health
7. Provide support and advice to individuals

The Environment Agency must:

1. Issue flood warnings and ensure systems display current flooding information
2. Provide information to the public on what they can do before, during and after a flood event
3. Monitor river levels and flows
4. Work with professional partners and stakeholders and respond to requests for flooding information and updates
5. Receive and record details of flooding and related information
6. Operate water level control structures within its jurisdiction and in line with permissive powers
7. Flood event data collection
8. Arrange and take part in flood event exercises

9. Respond to pollution incidents and advise on disposal
10. Assist with the recovery process, for example, by advising on the disposal of silt, attending flood surgeries etc.

4.3. Incident response

The Environment Agency opened their incident room to respond to the increasing flood risk in the area on 23rd December 2013. The focus of the flood event moved onto Colnbrook Village and surrounding areas in January.

- 4th January 2014 ï Flood Alert issued for the ñThe Colne Brook at Iver and Colnbrook including Fulmerò
- 9th January 2014 ï EA issued Flood Warning ñThe Colne Brook at Colnbrook, including Horton and Wraysburyò
- 31st January 2014 ï Flood Alert issued for ñThe Colne Brook at Iver and Colnbrook including Fulmerò
- 31st January 2014 ï Flood Warning issued for ñThe Colne Brook at Colnbrook, including Horton and Wraysburyò

The table below details some of the actions taken by the risk management authorities and other local parties over the course of the incident.

Table 4-1 Incident response

Date	Actions taken
31st January	• The Environment Agency had staff on the ground monitoring the situation.
1st February	• The Environment Agency installed a pump at the Albany Park Barrage on the 1st February and distributed some sandbags at this time. • The situation was monitored on site over subsequent days.
4th February	• Slough Borough Council and the Environment Agency issued press releases and advice with regards to what to do. Delivered letters to the affected roads and those most at risk of flooding, including Albany Park, Tall Trees, Coleridge Crescent, Aintree Close, Cottesbrooke Close and Laurel Close.
5th February	• Slough Borough Council suspended refuse and recycling collections until safe for waste trucks to access the affected roads. • Albany Park was closed to vehicles. • The emergency services were informed. • The councilôs adult social care team is in touch with GPs about the medical needs of residents in hard to reach areas.
6th February	• Slough Borough Council delivered letters to residents in the affected areas to inform them about the suspension of waste and recycling collections. • Adult social care workers contacted all of their clients in the area, although no-one required immediate help. However, home care agencies were alerted as a precaution. • Slough Borough Councils public health team were in touch with GPs and local

Date	Actions taken
	health centres to ensure anyone who requires medication could get it.
7th-8th February	• The situation was continued to be monitored.
9th February	• The Environment Agency, assisted by Slough Borough Council, delivered more than 750 sandbags to locations in Colnbrook Village identified in the emergency flood plan. At the time concerns were expressed by residents about where and how sandbags were being distributed. As identified in the emergency flood plan sand bags were delivered to the high risk areas and areas that would benefit from sand bags.
10th February	• Slough Borough Council opened an Emergency Operation Centre to deal with the flooding issues. • Issues identified with residents not able to use toilet facilities. • Critical infrastructure was protected via sandbags. In particular, efforts were made to protect electricity supplies. • Road closure was issued for Colnbrook High Street. • Temporary waste bins were placed at ends of roads that refuse vehicles could not access. • Neighbourhood enforcement officers in Colnbrook spoke to residents and offered advice. • Adult social care workers continued efforts to ensure vulnerable residents were helped where needed.
11th February	• Slough Borough Council delivered additional sandbags to key areas (800 bags). • The council installed portable toilets including washing facilities in the area of Coleridge Crescent. • Parish Council provided assistance to elderly residents in Coleridge Crescent to move belongings up to top floors. • Vulnerable people assessed for requiring assistance in being removed from the area. • Sandbags delivered by charity. Slough Borough Council contractual staff were made available to assist in the distribution of sandbags. • Penstocks at West Lake confirmed as open. Slough Borough Council seek to confirm responsibility and ensure they are closed. • Action taken: Slough Borough Council fully closed both highway penstocks (Eastern) as best as possible and sandbagged both, water too high to locate western one (Main outlet).
12th February	• Indication that Slough Borough Council (not SBC in RBWM area) or the Environment Agency cleared Horton Mill sluice gates. • Slough Borough Council and the Parish Council set up an information desk at the Village Hall, Vicarage Way.

Date	Actions taken
	• The main penstock at Colnbrook West Lake was located, shut and sealed with tarpaulin and bagging by Slough Borough Council staff entering deep water. • Call received from Highways advising water levels dramatically reduced in Colnbrook. Tall Trees almost clear; Albany Park maximum depth 6.5 inches; Aintree, Dawley; Coleridge Crescent now clear - Fawsley and Laurel - max depth 5 inches.
13th February	• Tanker sent to mop up isolated puddles. • Tree down on Mill Street ï the Environment Agency were informed and advised it would be removed by lunchtime. • Continued offers of assistance from Businesses and the Community. • Decision made to shut incident room.
14th February	• Floods continued to recede. Residents who had their homes flooded and would like to get rid of flood damaged items were advised by Slough Borough Council to leave the items in their front gardens for collection.

4.4. Post flood response

After the flooding in February 2014 various groups were set up by Slough Borough Council to address flooding in the area, examine options to improve resilience and see what could be done in the future by the RMAs to try and alleviate future flood risk. These meetings were attended by affected residents, the National Flood Forum, the Parish Council, Slough Borough Council, the Environment Agency and Thames Water.

The following groups were set up following the January-February 2014 flood:

- Technical flood group - Attended by the National Flood Forum, Slough Borough Council, the Environment Agency, Parish Council, and Thames Water. Over time this group has developed and is now called the ñTask and Finish Groupò This group met on a quarterly basis during 2014, with more frequent meetings should the situation require.

- Colnbrook pathfinder community group ï Originally set up by the National Flood Forum this group is attended by residents and the National Flood Forum. The community flood group arrange their own meetings independently of the National Flood Forum. This group has been developed through the Pathfinder project and aims to make residents more resilient flooding and encourages action and discussion amongst those who live in the village.

- Colnbrook pathfinder multi-agency meetings ï Originally set up by the National Flood Forum this group is now organised by the residents. It is attended by the residents, the National Flood Forum, the Environment Agency, Thames Water, and Slough Borough Council to address actions highlighted by the pathfinder community group.

- Meeting with the former operator of Horton Mill Weir ï A meeting has been held with the former operator of Horton Mill Weir whose has a great deal of experience with the catchment and how it drains. He suggested changing the operating conditions of Horton Mill Weir assets which have been taken on board by the Environment Agency (the current weir operator). The suggestions have been actioned and will be monitored over the coming winters.

Through these groups a number of actions to reduce flood risk have been identified and implemented. These proposed and exercised functions / actions are listed in the following section.

4.5. Flood risk management functions

The functions that have been proposed and exercised by the relevant RMAs are listed in the table below.

Table 4-2 Flood risk management functions

Risk management authority	Activity date	Proposed action	Action exercised? (Yes / No)
SBC, EA, TW	April 2014	**Set up flood surgery** Event attended by residents affected by the winter flood event.	Y
SBC, EA, TW	June 2014	**Set up technical flood group** Set up and attended by all RMAs. Also attended by the Parish Council and the National Flood Forum.	Y
SBC	June 2014	**Set up community flood group** Set up and attended by the National Flood Forum. Also attended by local residents.	Y
SBC	June 2014	**Set up multi agency meeting** Set up and attended by the National Flood Forum. Also attended by local residents, all RMAs and the Parish Council.	Y
TW	May 2014	**Disconnect gullies from the foul sewer** Thames Water to consider disconnecting the miss-connected gullies in Cottesbrook Close. Residents to register complaints to Thames Water directly to speed up action.	N
SBC, EA	May 2014	**Assess if dredging along Cottesbrook ditch would reduce flood risk** Dredging would not sufficiently reduce flood risk	Y
TW	May 2014	**Is a drainage area plan scheduled to be done for the Colnbrook area?** Not yet confirmed.	N
EA	May 2014	**Submit FCRM project proposal for additional flood risk study** Proposal submitted. A new study has been scheduled into the 6 year plan.	Y
EA	May	**Survey low points between the Colne Brook and the**	N

Risk management authority	Activity date	Proposed action	Action exercised? (Yes / No)
	2014	**lakes** Needed to increase understanding of flood mechanism and improve future flood modelling.	
EA	May 2014	**Review EA flood model** Latest modelling indicates Colnbrook West Lake would overtop for an event with a return period of less than 1 in 50 years.	Y
EA	May 2014	**Review Wraysbury Offtake weir data** The Environment Agency have stated that the Wraysbury Offtake operated as it was designed to.	Y
SBC	May 2014	**Confirm where sand bags were issued** Sand bags were only issued at strategic locations.	Y
SBC	May 2014	**Advertise repair and renew grant** Advertised through the community flood group. Additional information has also been sent by the National Flood Forum to key properties.	Y
SBC	May 2014	**Can inflatable boats be stored for use in floods rather than 4x4 vehicles?** Bow waves from vehicles cause unnecessary flooding, however inflatable boats will not be issued by the council.	Y
SBC	May 2014	**Investigate gully connectivity** Gullies closest to the river are connected to the watercourse.	Y
SBC	October 2014	**Review sand bag policy in the emergency plan** Policy reviewed and considered appropriate. Sand bags will not protect homes from ground water flooding. However they could lessen the impact of bow waves caused by vehicles driving through the flood waters. There is scope to deploy sandbags for strategic defence.	Y
SBC	TBC	**Sandbag policy inclusion** Slough Borough Council will not include additional strategic sandbag locations for inclusion in the emergency plan. Additional sand bags provided during the flooding did not provide additional benefit because flooding was predominantly from groundwater. These sand bags also became contaminated and were expensive to dispose of.	Y

Risk management authority	Activity date	Proposed action	Action exercised? (Yes / No)
SBC	October 2014	**Set up resident association to take action over road and drainage maintenance** Requires assistance from the National Flood Forum. The resident association has not been set up, however the issue has been discussed in the multi-agency meetings. Road and drainage maintenance follows an appropriate regime with gully pots being cleaned on an annual basis. The timing of the gully pot clearance is set at a time when groundwater levels are generally low allowing ease of access for cleaning. When leaves cover the gully grids in the autumn, and if it is safe to do so, residents are encouraged to take a stick and push the leaves aside, which will allow the water to drain freely.	Y
SBC	October 2014	**Review emergency phone line procedure** Slough Borough Council will ensure consistent messages are fed to the EA. This will be achieved by adding Colnbrook to the ñExtended Floodline Serviceò. This service will provide information on flooding that is relative to the local situation.	Y
EA	October 2014	**River cleaning** Cottesbrook ditch cleaned. County Ditch (Pippins Park) tree removed from the channel.	Y
Riparian Owner	October 2014	**River cleaning** Remove trees and other debris from the Colne Brook. Trees and other debris have been removed in the Colne Brook between Orlitts Lake and the A4 Colnbrook by-pass bridge by the Environment Agency. This was a priority which is why the debris was removed by the Environment Agency. This river reach should remain clear in the future. Riparian owners must take responsibility for keeping this reach clear in the future. RMAs will not be available to clear the ditch in the future.	Y
EA	October 2014	**Ensure Wraysbury Offtake is operating correctly** The Environment Agency have stated that the Wraysbury Offtake is working correctly.	Y
EA	October 2014	**Change Horton Mill Weir asset operating conditions** Operating conditions of Horton Mill Weir have been changed	Y

Risk management authority	Activity date	Proposed action	Action exercised? (Yes / No)
		to draw down ground water levels in advance of the winter.	
SBC, EA, TW	October 2014	**Consider proposed investigations in the area** Colnbrook scheme included in the FCRM 6 year plan. All RMAs to consider possible schemes for the area.	Y
SBC, EA	October 2014	**Formalise Colnbrook West Lake penstock operation manual** All parties have been made aware of the issue. A temporary agreement was put in place at the end of December 2014 between the EA, SBC, and Boyer Fishing whereby the gate remained closed over winter. Only to be opened by permission from the RMAs. The Environment Agency have agreed to make the main penstock safe to operate when water levels are high. Remaining steps are: • Formalise penstock operation manual considering the needs of all stakeholders. Modelling from the EA study could be used to inform this decision. • The potential to designate the asset under the Flood and Water Management Act is being investigated. NOTE: The main penstock is to the west and is well hidden. Its location is now highlighted by a permanent bollard on the road side of the fence.	N
SBC, EA	February 2015	**Investigate Bath Road culvert flow routine** Water appears to back through the culvert. The cause of this backing up should be investigated to check if the flow routine can be improved for all flow conditions.	N
SBC, EA	February 2015	**Add fluvial gauge upstream of Orlitts Lake** Add a gauge to improve understanding of the catchments reaction to inflows and to provide better flood warnings upstream of Orlitts Lake. This gauge will also help to inform the main West Lake penstock movements.	N
EA, SBC	February 2015	**Update Colnbrook groundwater gauge to log daily or sub-daily levels** The Environment Agency do not provide warnings for groundwater, however updating the gauge to log daily or sub-daily levels would provide a better understand groundwater movements and could provide a flood warning function. This gauge will also help to inform the main Colnbrook West Lake penstock movements.	N

Risk management authority	Activity date	Proposed action	Action exercised? (Yes / No)
SBC	February 2015	**Flap to be fitted to West Lake penstock chamber CP110** The flap valve is to be fitted in chamber CP110 to prevent backflow from the lake to the road. The flap valve is yet to be fitted however provisions have been set aside by Slough Borough Council.	N
SBC	February 2015	**Review Emergency Flood plan and update with recommendations resulting from this Section 19 report** Review the emergency flood plan and update if necessary.	N
SBC, EA	February 2015	**Water levels in the County Ditch have been observed rapidly rising and falling despite the West Lake Penstock being closed. Investigate why** Does the water level rapidly rise and fall because of groundwater? Is water entering the County Ditch from an unknown source, for example the railway cesses? Could the water be from local surface water runoff? Etc.	N

5. Investigation Outcome

The outcomes of the investigation are summarised in Table 5-1 below and are repeated on the front page of this document.

Table 5-1 Investigation outcome

Sources of flooding:	Internal flooding of properties in Coleridge Crescent & adjoining Closes was predominantly caused by groundwater. The Albany Park area was predominantly flooded by fluvial flooding from the Cottesbrook Ditch, which is fed by County Ditch. Internal flooding of properties in Cottesbrook Close was predominantly caused by groundwater. Flooding along Mill Street was predominantly caused by fluvial flooding from the Colne Brook however one incident of ground water flooding was reported in the area.
Cause and pathway of flood:	Prolonged rainfall fell over January and February 2014 which saturated the catchment and raised already high groundwater levels. River levels were already high from persistent rainfall, and overland storage at West Lakes was near full. The west penstock (main penstock) on Colnbrook West Lake was open for an unknown period during the event which allowed water to constantly flow into Colnbrook via Hawthorn Ditch and then County Ditch. Due to fast groundwater reaction times the open penstock also kept groundwater levels topped up. The volume of water that passed through the main penstock was exacerbated because water was funnelled into the Lakes and was not passed back into the Colne Brook. Anecdotal evidence suggests water did not pass back because fallen trees and other debris created a head differential between the Colne Brook and the Lakes. At the peak of the event water overtopped Colnbrook West Lake, bypassed the penstocks, and then flowed into Colnbrook village. Coincidentally, if the penstocks had been closed for the full duration of the event water levels in Colnbrook West Lakes would have risen quicker and would have overtopped the embankment earlier. High water levels downstream of Colnbrook may affect how water drains through the catchment. During flood conditions Horton Mill Weir could contribute to the backing up of water in Colnbrook. The Wraysbury Offtake is a tilting gate that controls the flow of water into Poyle channel. If the Wraysbury River becomes blocked downstream of the gate, or the gate fails to operate correctly more water can pass into Poyle Channel. If additional water does flow down Poyle Channel, water levels downstream of Colnbrook would be raised. This would in turn make it more difficult for water to drain from Colnbrook. Shortly after the flood event it was suggested that the Wraysbury Offtake was not operating correctly however the Environment Agency have stated that during the flood event the Wraysbury Offtake was operating as designed.

Key solutions:	To effectively manage flood risk an operating procedure should be put in place for the main penstock. At the time of writing a temporary operating procedure is in place. During the winter of 2014/15 the Horton Mill Weir operating conditions were adjusted in line with advice from a local landowner. This change may help to draw down groundwater levels in advance of future floods. This solution will be monitored to establish how effective it is. To reduce the risk of overtopping, trees and other debris in the Colne Brook must be removed and the connectivity between the Colne Brook and the West Lakes investigated. Furthermore, the Colnbrook West Lake embankment level is 9cm below the designed level. To prevent overtopping of the embankment occurring prematurely the embankment level should be raised to the deign height. This could be permanently formalised or done on a temporary basis when extreme weather is forecast using sandbags and or concrete kerbs. By the time of writing the Environment Agency had removed debris along the Colne Brook in the key area.
Risk Management Authorities (RMAs):	Slough Borough Council Environment Agency Thames Water
Number of proposed actions to be completed by RMAs:	31
Number of actions complete at the time of issue (March 2015)	21

Appendix A. Figures