Stockton-on-Tees
BOROUGH COUNCIL

Lead Local Flood Authority
Flood Investigation Report

Tees Tidal Flooding

5th December 2013

Final Report

Revision Schedule

Document	Date	Author
Draft 1.0	3/3/14	J L Salisbury
Draft 2.0	20/3/14	J L Salisbury
Final Report	26/3/14	J L Salisbury

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Executive Summary

On Thursday 5th December 2013, the Borough of Stockton on Tees was again subject to severe flooding. A high spring tide was forecast; the tide at Teesport was due to peak at 1704 hrs. At a height of 2.85m AOD (Above Ordnance Datum). The forecast metrological conditions on that day were a strong off shore wind, with a deep area of low pressure forming in the North Sea; it was this low pressure system that caused the positive surge, on top of the already high tide. The positive surge measured 1.24m above the spring tide, giving a total tide height of 4.09m AOD (Above Ordnance Datum), which exceeded previous historical events.

Flooding can occur from various sources which are outlined in the report. The main source of flooding from this particular weather event was tidal flooding as described above, seeing defences overtopped and a major breach of the flood defence at Greatham Creek.

The incident caused damage and disruption, with up to 32 residential properties recorded as being internally flooded in Port Clarence, along with 20 businesses both large and small, in Port Clarence, Billingham Reach Industrial Estate and Seal Sands. There was also the additional issue of severe transport disruption due to three major highways being flooded, including the closure of the A19 Portrack interchange; this is one of the busiest interchanges in the area, which sees the secondary road network connect to the A19 Trunk Road (North and South). The A178 was completely closed for approximately 2 months, due to the breach of defences at Greatham Creek and the A66 trunk road was also partially closed at Teesside Park.

At the peak of the event approximately 250 residents were evacuated from Port Clarence and taken by bus to Billingham Forum, which had been set up as a rest centre, where they were given food and other essential items. The majority of the residents returned to their properties when it was safe to do so, although up to 20 residents chose to stay for the night at the rest centre.

A flood bank on the Southern side of Greatham Creek, downstream of the A178 failed during the tidal event, leading to a very significant breach in the defences. The Environment Agency mobilised immediately and engaged the military, as there was no access to the breach due to the wide spread flooding. A large area of land was flooded due to the breach which had a significant impact on the local industry and infrastructure but also the wider chemical industry, due to businesses having to shut down and breaking the supply chain.

The Environment Agency has been allocated accelerated funding to build a flood defence scheme at Port Clarence and Greatham South. The scheme is currently being designed and is due to start on site in March 2015.

Under Section 19 of the Flood and Water Management Act 2010, Stockton on Tees Borough Council as the Lead Local Flood Authority (LLFA) is required to investigate flooding incidents within its area, and this report examines five specific locations which satisfy locally agreed criteria. The locations investigated are Port Clarence, Greatham Creek, Billingham Reach Industrial Estate, Portrack Interchange and the A66 at Teesside Park.

1. Introduction

1.1 Lead Local Flood Authority Investigation

The Flood and Water Management Act 2010 (FWMA) gained royal assent in April 2010 and established unitary local authorities as Lead Local Flood Authorities (LLFAs). Stockton Borough Council as LLFA has the duty to investigate a flood event when considered necessary or appropriate under Section 19 of the FWMA.

Section 19 Local authorities: investigations

(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 investigation under subsection (1) it must –

a) publish the results of its investigation, and

b) notify any relevant risk management authorities.

Flood and Water Management Act (2010), S.19, c.29, London: HMSO[3]

The Tees Valley authorities through the Tees Valley Strategic Flood Risk Partnership agreed that an investigation for a flood event, is deemed locally significant and considered appropriate, if one or more of the following is affected by flooding:

- 5 or more residential properties;
- 2 or more businesses;
- 1 or more critical services;
- 1 or more transport links (Impassable for 10 Hours or more).

The severe event, which occurred on the 5th December 2013, resulted in major flooding across many parts of the Country and it has been described as the worst flooding in recent history.

For Stockton Borough Council as LLFA it is necessary to complete an investigation due to the number of properties and businesses that flooded and the major road closures across the Borough.

This investigation report provides a concise review of the roles and responsibilities of all risk management authorities involved, and an outline of their past or proposed actions, if any. Recommendations for a possible way forward will also be detailed.

1.2 Stockton on Tees

The major watercourses in the borough are the River Tees, Lustrum Beck, River Leven, Cowbridge Beck, part of the Old River Tees, Homefleet Beck, Saltergill Beck and Billingham Beck which are all classified as Main Rivers. The main source of flooding in the borough is tidal and fluvial from the river tees and other urban watercourses. Certain areas can also be prone to surface water flooding.

The tidal flood risk is particularly extensive, placing large parts of the industrial area on the north bank of the Tees Estuary and other, more central parts of the Borough, at risk. Tide locking (prevention of fluvial flow discharging due to high tide levels) is also a contributing flood risk factor on many watercourses that flow into the tidal Tees.

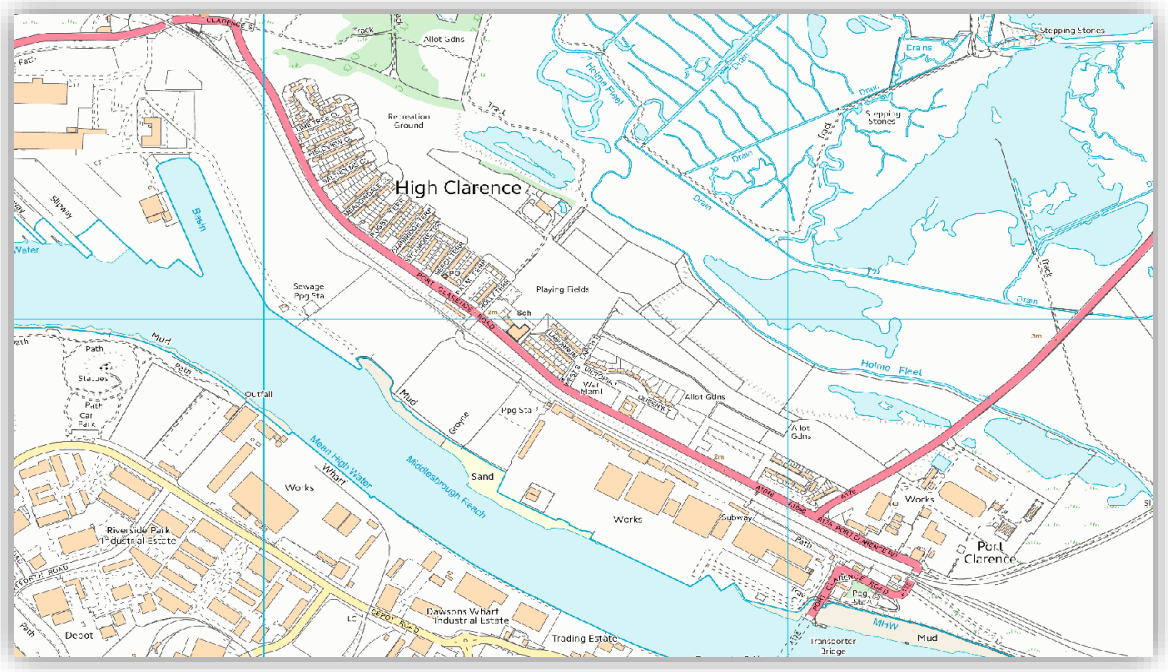
1.3 Site Locations

During the incident on 5th December 2013, the worst affected areas were the community of Port Clarence, Billingham Reach Industrial Estate and the industrial area South of Greatham Creek.

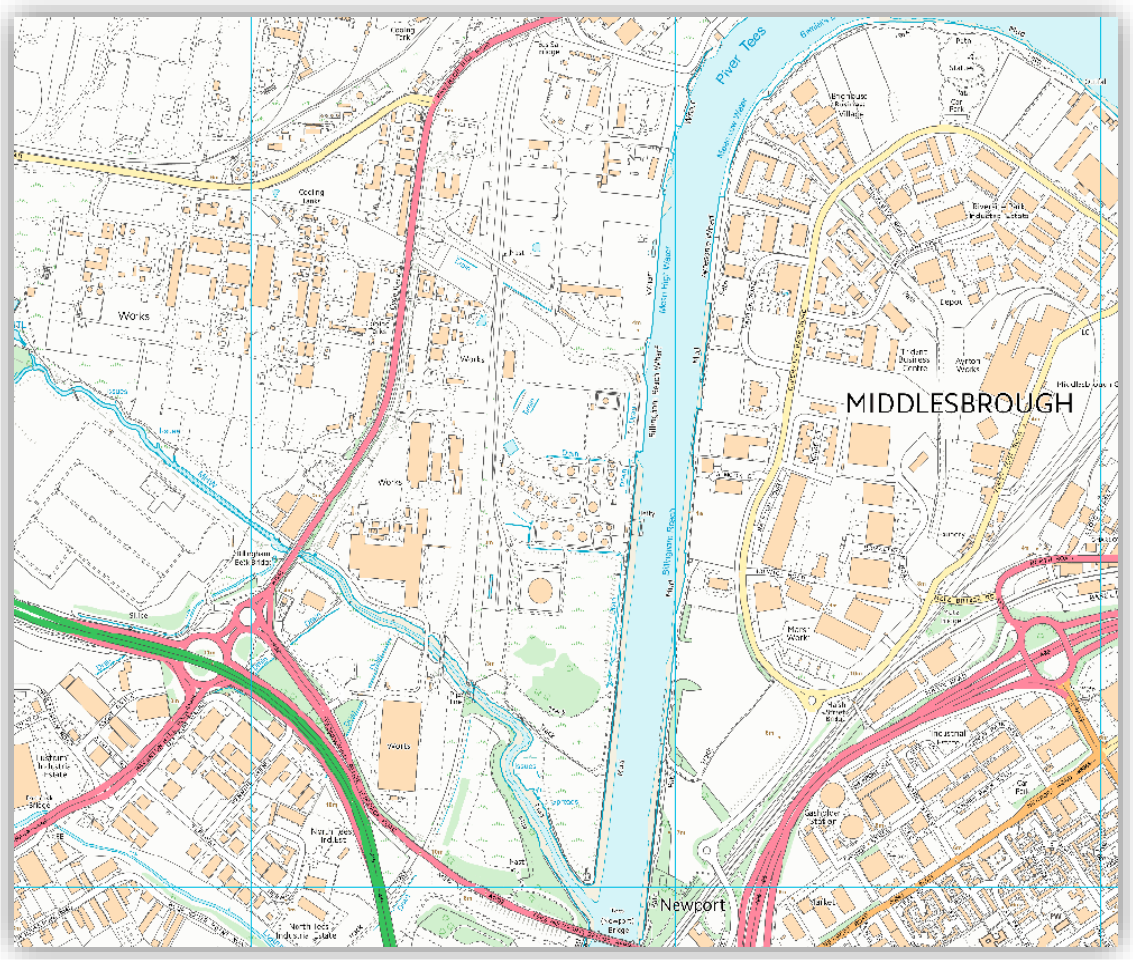
Portrack Industrial Estate was also affected, though the flooding did not affect any businesses or properties internally, the A19 Portrack Interchange was severely flooded, causing closure and severe transport disruption. The A66 near to Teesside Park was flooded, and partially closed, contributing to further transport disruption.

1.3.1 Port Clarence

Port Clarence is located North East of Stockton Town Centre and it is situated on the north bank of the River Tees. Port Clarence comprises of a mix of residential, commercial and industrial premises behind the tidal flood defences.



1.3.2 Billingham Reach Industrial Estate



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1.3.3 Greatham Creek

Greatham Creek is a tidal watercourse which flows in a westerly direction, following the Borough's boundary and discharges into the Tees at Seal Sands. The tidal limit extends to a weir, which is 300m upstream of the confluence with Cowbridge Beck, outside of Stockton Borough boundary. The watercourse is crossed by bridges which carry the A178 and the emergency access road to Seal Sands.

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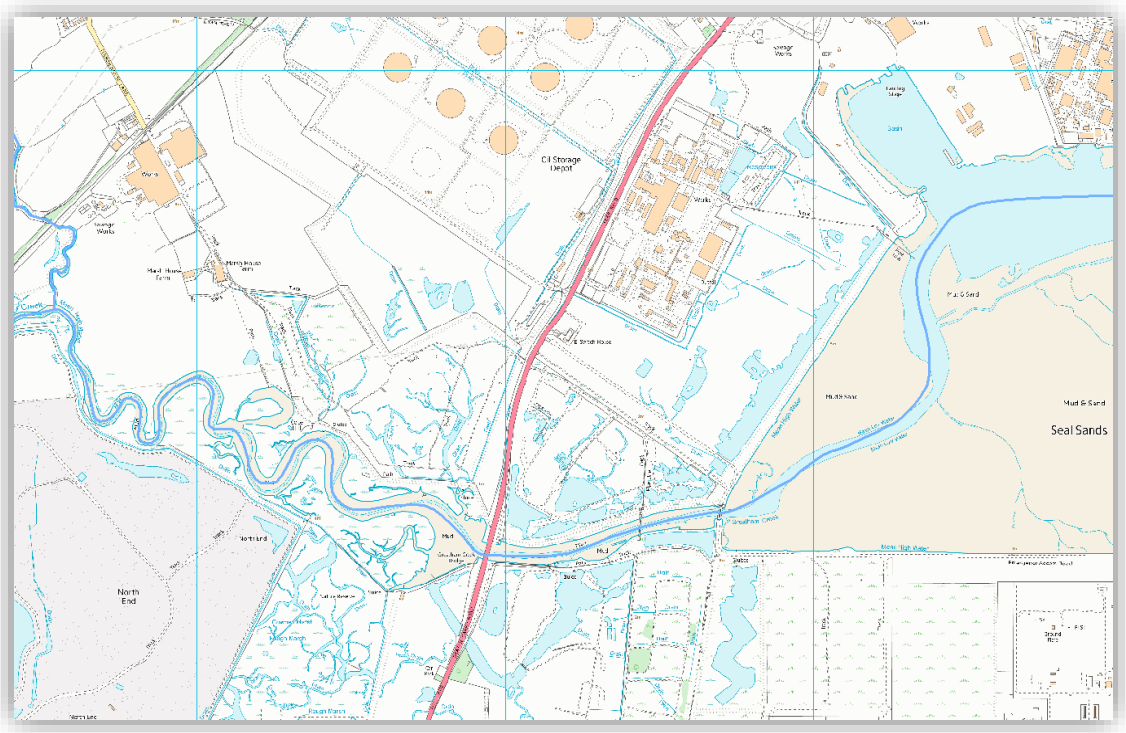

1.3.4 Portrack Interchange

Portrack Interchange lies to the North of Portrack Industrial Estate. The interchange provides essential links to the A19 and A66 trunk roads,

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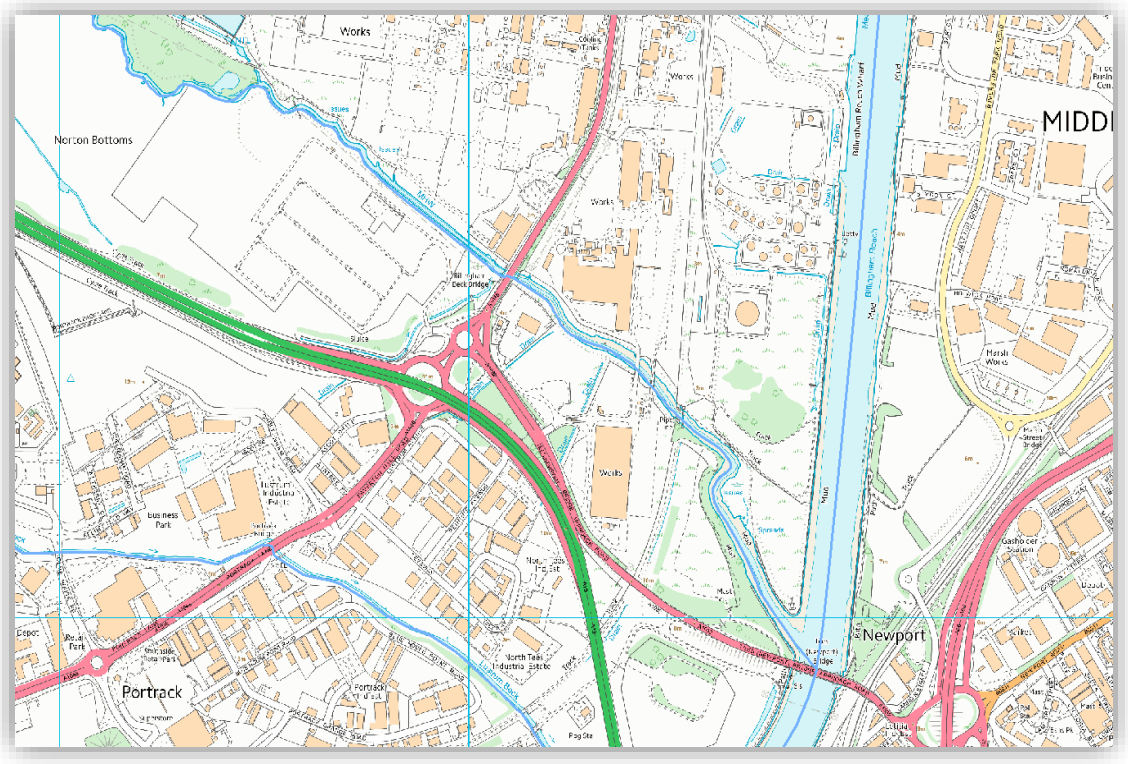
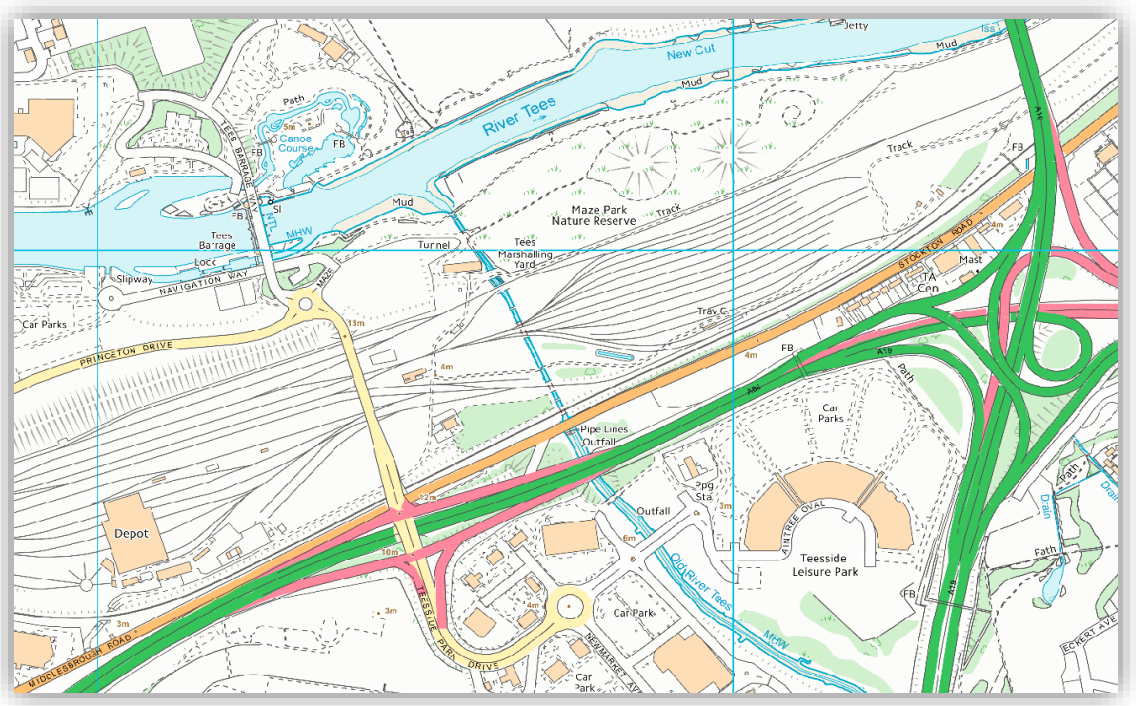


1.3.5 A66, Teesside Park



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2. History

2.1. History of Flooding

This section details the previous flooding history of the sites that were most severely affected during the tidal event of 5th December 2013, provides information on any flood defence features already in place and any maintenance or monitoring systems in place.

The history of tidal flooding form the Tees Estuary dates back as far as 1836, according to the BHS Chronology of British Hydrological Events, there was severe tidal flooding of Stockton on Tees in this year and then again in Middlesbrough in 1903.

2.1.1 Port Clarence

In 1953, an area of low pressure, in conjunction with North Westerly winds and a high spring tide, caused a large tidal surge and flooding of Port Clarence to a depth of 1.2m, the peak water level was 4.01m above ordnance datum (AOD) at the Tees Estuary.

In March 1999 substantial flooding occurred due to heavy rain and peak flows unable to pass through Holme Fleet culvert, which is located to the north of Port Clarence. It was reported that the culvert was blocked at the time by material which had entered the access chambers.

On the 8th November 2000 between 2-4am an intense storm hit the area of Port Clarence, approximately 16 properties suffered from internal flooding with flood water reaching ground floor level. The properties affected included Holly Terrace, High Clarence, Palm Terrace and Laburnum Grove, Port Clarence. There were also a number of properties that suffered flooding to their gardens within the Port Clarence area. It was reported that the flooding occurred due to Holme Fleet Beck overtopping due to heavy rainfall.

Following these events Stockton Borough Council de-silted the culvert and improvements were made to the inlet. In spring 2006 a pre-feasibility study was completed and concluded that the risk presented from tide locking of the outfall is insignificant. It was concluded that future operations and maintenance activities along Holme Fleet should be focussed on keeping the culvert free from blockage. In April 2005 Holme Fleet Beck was classified as Main River and became the responsibility of the Environment Agency.

2.1.2 Billingham Reach Industrial Estate

We have no recorded history of Billingham Reach Industrial Estate flooding, however it is expected that it would have flooded during the 1953 event, due to tide levels being higher than embankment levels.

2.1.3 Greatham Creek

In 1953 during the tidal event, there were two breaches of the embankments at Greatham Creek on both the North and South embankment, in the vicinity of the A178. There was a further breach of the defences in January 1978, where both the North and South banks were breached downstream of the A178. In 1983 there was a breach of the Southern flood defence embankment both upstream and downstream of the A178, with a peak tide level of 3.65m AOD.

2.1.4 A19 Portrack Interchange

We have no recorded history of the A19 Portrack Interchange flooding. The interchange was upgraded in 2008.

2.1.5 A66 Teesside Park

In 1953 the Tees Marshalling Yard area was affected by tidal flooding, along with, many of the lower reaches of the tidal River Tees.

3. Incident

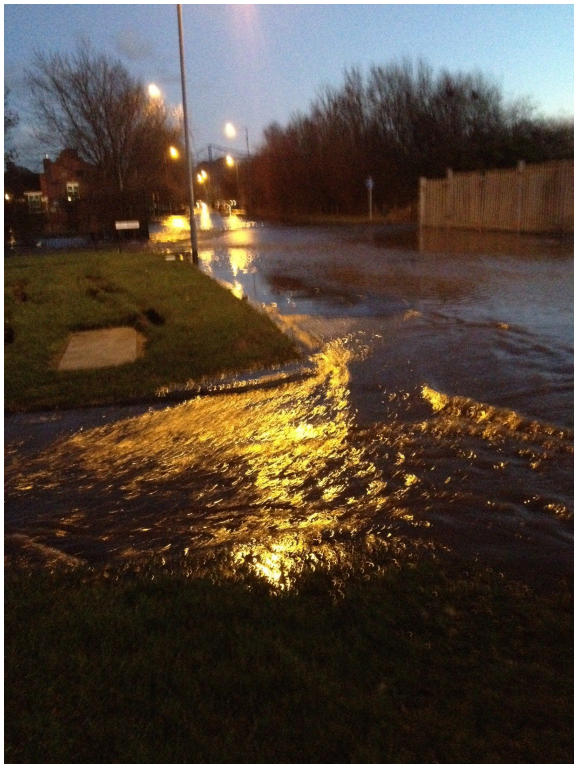
3.1 Incident on 5th December 2013

On the 5th December 2013, high spring tides were forecast; the tide at Teesport was due to peak at 1704 hrs. At a height of 2.85m AOD. The forecast metrological conditions on that day were a strong off shore wind, with a deep area of low pressure forming in the North Sea; it was this low pressure system that caused the positive surge, on top of the already high tide. The positive surge measured 1.24m above the spring tide, giving a total tide height of 4.09m AOD (Above Ordnance Datum), which exceeded previous historical events.

Port Clarence

On the 5th of December, prior to the predicted spring tide and surge, three areas in Port Clarence were sandbagged as a precautionary measure, to interrupt any potential flow routes, even though the forecast levels were not expected to cause any flooding at Port Clarence.

Officers from the Councils Technical Services Division attended site and became concerned about the height of the tide. Following this communication Officers from across the Council put the Emergency Plan into practice with Technical Services Officers setting up a Command Centre within Kingsway House, Billingham and Officers from Direct Services sand-bagging more strategic locations within The Clarence's to prevent inundation in the event of the defences being overtopped. In addition to this Council Neighbourhood Enforcement Officers were deployed to the area and Vela Homes were made aware of the potential emergency situation and attended site.



Port Clarence – Start of Event

Port Clarence – Shopping Parade

As the afternoon progressed, it had been expected that information would be available from the peak tide in Aberdeen to give an indication of any potential surge heights. When the tidal surge 'hit' the lowest defences at Wilton Engineering and Billingham Reach Industrial Estate were overtopped and the site inundated, which led to the decision to evacuate Port Clarence.

Port Clarence - Calor Gas Site

Over the next few of hours, through a combined effort of the Council and Emergency Services, all residents of Port Clarence who wished to be evacuated, were transported to the designated rest centre, which had been set up at Billingham Forum. In addition to this, approximately 100 people who had become trapped at Wilton Engineering were evacuated by the Council, as the flood water had cut off egress points, making it impossible to leave the site in a normal car. Shortly after the defences were over-topped, an electricity substation was inundated with flood water causing a widespread power outage, plunging a large part of the Billingham, Stockton and Middlesbrough areas into darkness. This further complicated the evacuation process.

Port Clarence – Residential Area

At the peak of the event approximately 250 residents were evacuated to Billingham Forum, where they were given food and other essential items. The majority of the residents returned to their properties when it was safe to do so, although approximately 20 residents chose to stay for the night at the rest centre.

Port Clarence – School

In total there were reported to be up to 32 residential properties that suffered internal flooding and 20 businesses both large and small.

Port Clarence Railway Bridge approach to Transporter Bridge – SBC HV Pump

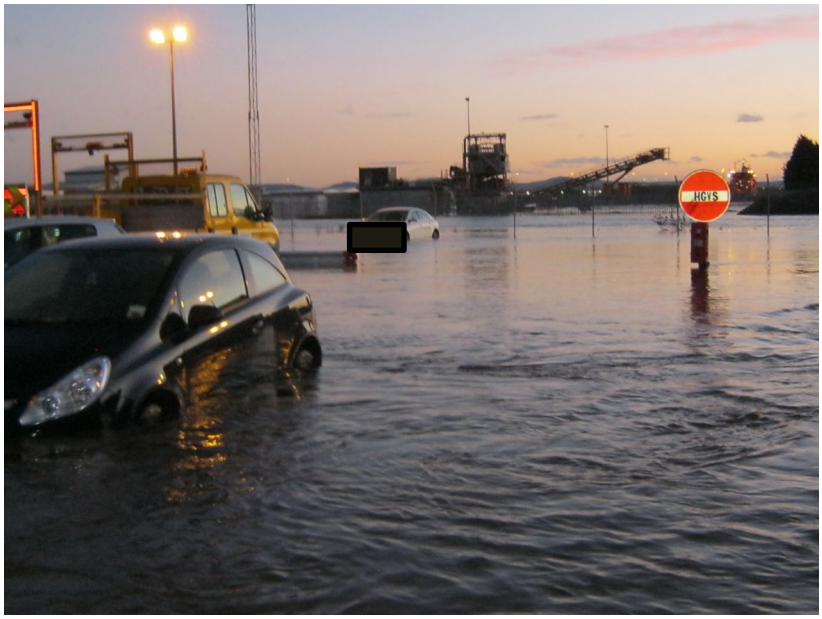
Billingham Reach and Haverton Hill

A number of businesses along the banks of the River Tees, in Port Clarence and the vicinity of Greatham Creek were affected by the tidal surge.

The businesses struggled to evacuate staff due to the speed of the surge and the fact they were not expecting it, due to the late issue of flood warnings. Most of the businesses were aware they were in a flood zone, though the probability of a tidal event such as this was deemed to be low. There is CCTV footage of the inundation in a number of locations before the power outage; this shows the speed and power of the surge, including the capability to move any large item in its flow path.

Sir Robert McAlpine Autolink Premises

A large amount of damage was caused to individual business premises and a large number of vehicles were written off at various locations, due to the speed of the surge the vehicle owners were unable to remove them in time. The repairs to businesses are still on going and the economic costs are still rising and likely to be many millions of pounds.



Sir Robert McAlpine Autolink Premises

Greatham Creek

A flood bank on the Southern side of Greatham Creek, downstream of the A178 failed during the tidal event, leading to a very significant breach in the defences.

The Environment Agency mobilised immediately and engaged the military, as there was no access to the breach due to the wide spread flooding. A large area of land was flooded due to the breach which had a significant impact on the local industry and infrastructure but also the wider chemical industry, due to businesses having to shut down and breaking the supply chain.

The Environment Agency, their contractors and the Military worked around the clock to seal the breach as quickly as possible due to the threat from further high tides, leading to a worsening of conditions. An Acoustic Radio Controlled Boat was used to carry out an underwater survey of the breach. This revealed the depth of the breach to be -4.8m AOD, the visible extents of the breach above ground were approximately

50m in length. The A178 was flooded due to the breach and remained fully closed for several weeks while the temporary works were undertaken and site prepared for the permanent work. Thousands of tonnes of rock, stone and clay had to be imported to site and the work is still on- going at the time of writing of this report. Though, the road has now re-opened, temporary traffic management restricting vehicular flows still remain in place.

Improvements to the flood bank are being considered as part of the project for Port Clarence and Greatham South.

A19 Portrack Interchange

The tributaries of the River Tees and Billingham Beck were also affected by the surge, backing up and causing flooding of the A19 Portrack Interchange up to approximately 1 metre deep. This interchange is one of the busiest in the area and the flooding coincided with the evening peak traffic flows, causing widespread traffic disruption across Stockton and beyond.

A19 Portrack Interchange

A66 Teesside Park

The Old River Tees which flows past Teesside Park and underneath a bridge carrying the A66, outfalls to the River Tees and was also affected by the tidal surge.

The water level spilled over the parapet and onto the carriageway causing a lane closure on the A66, further adding to the transport disruption in the Borough.

A66 Teesside Park – Eastbound

3.2 Event Data, Weather and Flood Warnings

Incident Details

(Timings taken from CCTV footage at locations at Haverton Hill, the full incident lasted longer at Port Clarence and Greatham Creek, where the tide receded slightly later and pumping continued late into the evening)

Event commenced: *5/12/13 at 15.37hrs (First reported overtopping of defences)*

Event ended: *5/12/13 shortly after 20.00hrs (Tide began to recede from affected areas)*

Duration: *Approximately 5 Hours*

Total surge height: *1.24m*

In the days preceding the event, teleconferences chaired by the Environment Agency with all North East Emergency Responders took place. The purpose of these teleconferences is to advise all emergency response organisations of the tidal and weather forecasts, in order that necessary emergency procedures can be put in place.

Environment Agency Area Incident Room (AIR) Timeline

- The first flood advisory service telecon with risk management partners took place on Tuesday 3rd December 2013.
- The AIR was opened at 0600hrs on Thursday 5th December 2013.
- Sandbagging of defence at Port Clarence started at 0900hrs on Thursday 5th December 2013.
- Further sandbagging undertaken at strategic locations 1430hrs.
- Reports of flooding were received between 1600hrs and 1830hrs in the AIR.
- Port Clarence was evacuated at approximately 1630hrs
- The AIR was closed at 1800hrs on Monday 9th December 2013.

Flood Warnings

The following flood warnings were issued by the Environment Agency in the Borough of Stockton on Tees on 5th December 2013. Maps of the warning areas are found in Appendix 1,2 & 3.

121FWT568 - Tees Estuary at Billingham
Industrial properties in Billingham Reach Industrial Estate.
05/12/13 08.20hrs
1 property in warning area
1 property warned (100%)

121FWT557 – Port Clarence and Haverton Hill
Residential, commercial and industrial premises behind tidal flood defences at Port Clarence. As well as residential properties and small industrial units at Haverton Hill
05/12/2013 – 16.25hrs
361 properties in warning area
192 properties warned (53%)

121FWT562- Tees Estuary at Portrack, Stockton-on-Tees and Middlesbrough
Commercial units at Portrack, including Lustrum, North Tees and Portrack Industrial Estates. Undefended areas of Stockton-on-Tees, including Bramlett's Wharf. In Middlesbrough commercial units at Vulcan Street, Commercial Street and Dock Street.
05/12/13 – 16.25hrs
143 properties in warning area
76 properties warning (53%)

Flood warnings are issued based on the maximum forecast tidal surge. The surge developed and the actual levels recorded were almost half a metre higher than predicted. Unfortunately this led to the scale of the event being under-estimated and the flood warnings being issued late for certain areas including Port Clarence and Haverton Hill, and Portrack.

The number of properties warned is dependent on the number of properties signed up to FloodLine to receive warnings.

4. Types of Flooding

4.1 Tidal flooding

Tidal flooding is flooding from the sea and tidal rivers, which is a particular risk when very high tides and inclement weather combine, a large industrial area of the Borough is at risk from tidal flooding, along with the community of Port Clarence. **This was the source of flooding on 5th December 2013.**

4.2 Main River flooding

River flooding also known as fluvial flooding occurs when levels from the river become so high that they over top or breach their banks or flood defences, if any are installed. Main rivers are usually the larger streams and rivers, but some are small watercourses of local significance, they are shown on the Environment Agencies Main River Map. The Environment Agency is the risk management authority for main rivers, they have duties and powers relating to them. In Stockton, The Tees, The Leven, Lustrum Beck, Billingham Beck, Cowbridge Beck, Holme Fleet Beck, Saltergill Beck and part of the Old River Tees are all classified as main rivers.

4.3 Ordinary Watercourse flooding

Ordinary watercourses are every river, stream, ditch, sluice or drain, where water flows but are not main rivers (as described above). The local authority is the risk management authority for ordinary watercourses and has similar powers to the Environment Agency. Flooding can occur when the flows in the watercourse become too great for its capacity, if the watercourse becomes obstructed or it cannot discharge into a main river because the levels in the main river are too high.

4.4 Sewerage flooding

Flooding from sewers can originate from several sources; surface water, foul and combined sewers and rivers flooding into the sewerage network. The main causes of sewerage flooding are; blockages, defects such as collapsed sewers, mechanical failure such as pumping failures or overloaded sewers (flows are too great for the size of the sewer).

Sewers are designed to discharge into watercourses during rainfall events. These discharges can be from outfalls from surface water only systems or from overflows on combined sewer systems. Sometimes during long periods of wet weather or very heavy rainfall, these outfalls cannot discharge due to the raised level of the receiving watercourse.

4.5 Highway drainage

Highway drainage is the network of gullies, pipes and culverts that drain water from roads and footpaths. This system may connect to the sewerage system operated by Northumbrian Water or it may discharge into watercourses or retention facilities such as balancing ponds. Highway drainage can flood from blockages, defects such as collapsed drains, lack of capacity in the system or due to the inability to discharge into a watercourse or balancing pond due to the levels in that body of water being too high.

4.6 Culvert issues

A culvert is a covered channel or pipe, a culvert allows the watercourse to flow along its natural path without obstruction by construction of any infrastructure for example a highway. Some culverts have trash screens or ‘grids’ at either end to prevent obstructions entering the culvert and unauthorised access. These trash screens collect debris and require regular maintenance or in themselves can become a cause of flooding.

4.7 Run off

Run off from land or over land flows of water can be a cause of flooding, particularly in situations of prolonged rainfall where ground becomes saturated, or the natural water table is high and also in extreme events where the rainfall is so intense the ground is unable to drain, the water follows the natural topography of the land and will collect at a low point.

5. Duties and Responsibilities

5.1 Lead Local Flood Authority

The Lead Local Flood Authority (LLFA) is the unitary authority or if there is no unitary authority then the County Council for the area. Stockton Borough Council is the Lead Local Flood Authority in its area. The LLFA has powers and responsibilities for flood risk management. The Technical Services Division of Stockton Borough Council has responsibility for Flood Risk Management and carrying out the LLFA role, which includes investigation of flooding incidents under Section 19 of the Flood and Water Management Act 2010. The LLFA have powers over ordinary watercourses, and not main rivers as these come under the jurisdiction of the Environment Agency.

5.2 Stockton on Tees Borough Council

Stockton on Tees Borough Council is the Highway Authority and as such has a duty to maintain the highway under Section 41 of the Highways Act 1980 and have responsibilities for highway drainage. Stockton Council's Direct Services Division are responsible for highway drainage and clearing trash screens on highway culverts, all trash screens receive regular inspections and maintenance is carried out as necessary. There is also a wet weather list of problem areas, whereby screens are checked when a warning of severe weather is received. Direct Services operates a 24 hour call out service and will respond to flooding incidents.

Stockton Council's Technical Services Division is responsible for Highways structures, which are routinely inspected once every two years.

5.3 Environment Agency

The Environment Agency has powers and responsibilities for flood risk management on the main river network (main rivers are defined in paragraph 4.1) and also the sea. This includes providing a flood warning service. The Environment Agency can carry out flood risk management work, such as installation and operation of flood alleviation measures on main rivers, an example of this are the flood gates at Yarm. The EA maintains flood risk assets such as flood banks to manage water levels and ensure flood water can flow freely. The EA can also carry out work to prevent environmental damage to watercourses or to restore conditions. If a main river becomes blocked by an obstruction then, once notified the EA will remove it.

5.4 Northumbrian Water

Northumbrian Water Ltd is the water distribution and sewerage company in Stockton on Tees. Northumbrian Water is responsible for all combined drainage and sewerage systems and a number of surface water systems. Following sewerage flooding Northumbrian water can arrange for the area to be inspected and if necessary decontaminate.

5.5 Highways Agency

The Highways Agency is responsible for the Trunk Road network and associated drainage which includes culverts under Trunk Roads and balancing ponds. In the case of this report the Highways Agency are responsible for the A19 and A66. The A66 is operated by Aone on behalf of the Highways Agency and the A19 is operated by Autolink on behalf of the Highways Agency.

5.6 Riparian Landowners

Riparian landowners are those who own land adjoining a watercourse. As detailed with the EA document 'living on the Edge', riparian landowners have certain right and responsibilities, including the following:

- They must maintain the bed and banks of the watercourse, and also the trees and shrubs growing on the banks;
- They must clear any debris, even if it did not originate from their land. This debris may be natural or man-made;
- They must keep any structures that they own clear of debris. These structures include culverts, trash screens, weirs and mill gates;
- If they do not carry out their responsibilities, they could face legal action.

Riparian landowners must understand and act upon these responsibilities[2].

5.7 Residents

Residents who are aware that they are at risk of flooding may be able to take action to help ensure that they are safe and their properties are protected, without taking unnecessary risks.

Community resilience is important in providing information and support to Neighbours, if flooding is anticipated.

Actions which could possibly be taken by residents include installing sandbags and moving valuable items upstairs and vehicles to higher ground. More permanent measures such as installing floodgates, raising electrical sockets and fitting non-return valves on pipes, may also be possible depending on individual properties.

It is helpful for anyone who is affected by flooding to try to document as much information about the incident as they can, and if possible take photographs. This is particularly helpful if residents are proposing to make an insurance claim.

Where properties are located near to main rivers residents are advised to sign up to the Environment Agencies Flood Warning System. **Floodline 0845 988 1188** and also report any incidents to the Environment Agency on **Incident Hotline 0800 80 70 60 (24 hours)**

6. Flood Alleviation Scheme

The Environment Agency has been allocated £9m 'accelerated delivery' funding, from Flood Defence Grant in Aid (FDGiA), to deliver a flood alleviation scheme for Port Clarence and Greatham South.

This is additional funding from central government to bring flood defence schemes forward in the medium term programme. An appraisal is currently underway to look at different options. Including improvements to the flood defence assets at Greatham South and providing a flood defence for the Port Clarence residential area.

Initial site investigations and consideration of options commenced in November 2013 and discussions with stakeholders such as Network Rail and Natural England are in progress. Emergency repairs are currently underway and are planned to be completed within the next two months. The emergency repairs are not part of the flood alleviation scheme.

The required site investigation will commence in April 2014. This will compose of a number of boreholes along the line of the proposed defence adjacent to the railway. Community engagement around options for the defence will take place after the investigation is complete which we aim to start. The Environment Agency is expecting to submit a planning application in July 2014 and begin construction in March 2015. It is anticipated that the construction of the defence through Port Clarence will take 8 months to complete.

The new defences will provide an increased standard of flood protection to 351 residential properties, 21 commercial properties, transport links and environmental designations. The scheme aims to improve the standard of protection to withstand a flood event with a 1 in 100 (1%) chance of occurring in any given year"

7. Recommendations

7.1 Recommendations

1. It is recommended that the Environment Agency use the allocated Flood Defence Grant in Aid, to fund an appropriate scheme which delivers the highest possible flood risk benefits to residents and businesses in the flood risk area. The scheme must be delivered in line with the agreed timescales.

2. It is recommended that Stockton Borough Council and all risk management partners review their response to the incident and identify any areas for improvement. This includes investigation of temporary protection measures where appropriate.

3. It is recommended that the Environment Agency engage with businesses in Billingham Reach Industrial Estate, to assess the best way forward in protection from future incidents.

4. Residents who are at risk of flooding should also consider how they can prepare for future incidents and how they could protect their properties.

5. It is recommended that the warning process for the incident is reviewed by the Environment Agency, and where possible improvements to the service are made. It is accepted that the warnings issued are based on the meteorological forecast, and therefore subject to the accuracy of this forecast. However the process for using and sharing actual event data from other parts of the UK, as a situation develops (i.e. when the tide peaked in Aberdeen) should be explored to see if there is a method of providing a more accurate estimate. Although only giving a small amount of extra time, it could be enough for businesses to move plant, equipment and evacuate, if necessary. Also residents would have further time to move property to a higher level and evacuate, if necessary.

6. Residents and businesses who have not signed up to the Environment Agency's flood warning service (Floodline **0845 988 1188),** should consider signing up to receive warnings.

Appendices

1. Flood warning area 121FWT568
2. Flood warning area 121FWT557
3. Flood warning area 121FWT562
4. Location of Greatham Creek Breach
5. Plan showing worst affected residential area in Port Clarence