Environment Agency

Post-incident reporting for reservoirs Annual report 2014

We are the Environment Agency. We protect and improve the environment and make it a better place for people and wildlife.

We operate at the place where environmental change has its greatest impact on people's lives. We reduce the risks to people and properties from flooding; make sure there is enough water for people and wildlife; protect and improve air, land and water quality and apply the environmental standards within which industry can operate.

Acting to reduce climate change and helping people and wildlife adapt to its consequences are at the heart of all that we do.

We cannot do this alone. We work closely with a wide range of partners including government, business, local authorities, other agencies, civil society groups and the communities we serve.

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Introduction

In 2007 Defra asked the Environment Agency to collect information on incidents at reservoirs in the United Kingdom. We collect and record information on incidents at raised reservoirs, both large and small. Large raised reservoirs are those covered by the Reservoirs Act 1975.

We use the information that we are sent to:

- Investigate incidents (where appropriate)
- Inform the reservoir industry of any trends and key lessons identified
- Contribute to research into reservoir safety and incident frequency analysis.

All incident data is entered onto the national database which can be used to inform reservoir safety research.

Arrangements for reporting in the UK

England

For incidents at large raised reservoirs (i.e. reservoirs with a volume greater than 25,000 cubic metres above ground level) located in England, incident reporting has been mandatory since July 2013 under the provisions of Section 21B of the Reservoirs Act 1975 and regulation 14 of Statutory Instrument 2013 No. 1677.

As soon as the incident is under control, the reservoir undertaker (i.e. the owner, operator or user) must provide a preliminary report of the incident to the Reservoir Safety team. The preliminary report must contain:

- the date and time of the incident
- the location of the reservoir
- any facts considered important.

Within one year from the day after the incident the reservoir undertaker must send us a final post-incident report, preferably using the form available online. The final report of the incident must contain:

- information about the facts relating to it
- analysis of its circumstances
- particulars to support the conclusions that can be drawn from it
- particulars to support the lessons learned from it.

We will review the final report and seek further clarification if necessary. Key learning points will continue to be reported in these annual review reports.

We classify incidents according to the following levels of severity:

Level 1: Failure (uncontrolled sudden large release of retained water)

Level 2: Serious incident involving any of the following:

  - Emergency drawdown
  - Emergency works
  - Serious operational failure in an emergency

Level 3: Any incident involving:

- A precautionary drawdown
- Unplanned physical works
- Human error leading to a major (adverse) change in operating procedures.

We consider that an incident in any of the above incident categories is covered by the regulations.

Post-incident reporting for *small* raised reservoirs in England remains voluntary.

It is important to note that the above incident reporting process is separate and subsequent to the immediate incident response which should be reported to the emergency services as necessary. For incidents in England the Environment Agency's incident hotline number is 0800 80 70 60.

Wales, Scotland and Northern Ireland

Natural Resources Wales (NRW) is the enforcement authority for the Reservoirs Act 1975 in Wales. Forthcoming amendments to the Reservoirs Act are expected to make post-incident reporting a legal requirement in Wales in the near future. In the mean time, incidents in Wales should be reported on a voluntary basis to NRW reservoirs@naturalresourceswales.gov.uk.

In Scotland, new legislation is in the process of being introduced, which will supersede the Reservoirs Act 1975. This legislation may make post-incident reporting a legal requirement and make Scottish Environment Protection Agency (SEPA) the enforcement authority. Until this time, Scottish local authorities will remain the enforcement authority. Incidents in Scotland can continue to be reported on a voluntary basis to the Environment Agency.

In Northern Ireland, there is currently no reservoir safety legislation nor is there any legal requirement on the owners or managers of reservoirs to report incidents. However, reservoir safety legislation, entitled the Reservoirs Bill, is currently being considered by the Northern Ireland Assembly and contains provision for the reporting of incidents at reservoirs. Until this legislation is enacted in Northern Ireland, reservoir owners or managers may report incidents on a voluntary basis to the Rivers Agency rivers.registry@dardni.gov.uk.

Reported incidents

In 2014 we received information on five incidents. We also received details of a number of incidents that occurred between 2004 and 2013 that had not previously been reported to us. These are also included in this report.

The incident statistics for all incidents reported since 2004 will be presented every five years starting with the annual report covering 2018.

2014

Incident 410	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	4.7
Incident type	Inflow flood, internal erosion
Incident severity	2

Description

This incident occurred at an on-line flood storage reservoir which had recently been constructed through modification of an existing embankment used to create an irrigation reservoir. The outlet works were modified to allow the owner to operate the reservoir for flood risk management purposes.

The first full impoundment of the reservoir took several weeks. Inspection of the site with the reservoir spilling over the auxiliary spillway revealed seepage at several points near the downstream toe of the dam. Although the flow was running clear, the qualified civil engineer was concerned that the embankment could fail by internal erosion and instructed that the reservoir level should be substantially lowered and a bund of granular material placed against the downstream toe of the embankment. The reservoir drawdown was carried out by operation of a low level sluice gate, supplemented by pumping from the river upstream of the reservoir into an adjacent catchment. The seepage paths through the embankment developed over several weeks with the reservoir full and spilling. The owner intends to seal these defects before the reservoir is brought back into operation for flood storage.

Lessons learned

This incident illustrates the care needed when changing the operational use of a reservoir. The original embankment was not designed under the provisions of the Reservoirs Act 1975 or for use as a flood storage embankment. The defects in the embankment were only revealed by the first impoundment which had a long duration. The case also highlights the particular need for regular and frequent monitoring when reservoirs are not operating under typical water level conditions. The emergency response to the incident was complicated by widespread flooding in the area which demonstrates the need for emergency plans for flood storage reservoirs to consider such conditions.

Incident 411	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	3.5
Incident type	Internal erosion associated with a drawoff conduit
Incident severity	3

Description

The owner opened a bottom outlet to discharge water from the reservoir. Once opened, the outlet could only be closed after some time and with great difficulty. A contractor was asked to carry out improvements to the outlet, but without the involvement of qualified civil engineer.

A desk study to understand the nature of the draw-off structure was not carried out, and the steps taken by the contractor (not recorded) led to leakage and erosion of fine material along the line of the conduit. The supervising engineer attended the site and then called an all reservoirs panel engineer to attend on the same day. Seepage flows were measured by constructing a temporary bund and flow measuring device at the downstream toe. A pump was brought to the site to supplement the available drawdown capacity and the reservoir was lowered to 30% of reservoir depth over three days.

Investigations found that part of the timber roof of the culvert had collapsed, allowing fines from the fill to be washed out. As a result, the outlet was sealed and abandoned.

Lessons learned

Works that could affect the safety of a reservoir should be carried out under the direction of a qualified civil engineer. When planning repair works it is useful to have contingency plans in the event that the conditions encountered differ from those expected.

Incident 392	
Dam type	Earthfill embankment
Reservoir legal status	Non-statutory impounding reservoir
Dam height (m)	4
Incident type	Inflow flood, erosion by overtopping
Incident severity	2

Description

A small embankment dam was overtopped during a flood, damaging the crest and downstream face of the dam. The dam overtopped because a channel designed to divert water away from the reservoir breached into the reservoir during the flood.

Lessons learned

This incident highlights the importance of periodically inspecting any flood diversion works undertaken at any (regulated and unregulated) reservoir.

Incident 409	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	2.2
Incident type	Inflow flood, erosion by overtopping
Incident severity	3

Description

A flood storage reservoir filled and spilled over a reinforced embankment spillway section causing erosion of natural ground immediately downstream of the dam. There was a low spot on the crest of the spillway which is thought to have contributed to the extent of the damage. Emergency works were carried out to reduce any perceived threat to the embankment. The erosion hole was filled and covered using sand bags and plastic sheeting. Subsequent inspection of drawings showed that there were toe piles at the base of the wall which substantially reduced any risk of a breach. Works are planned to level the spillway crest.

Lessons learned

This incident demonstrates the need to monitor crest levels on spillways regularly, not just during the 10 yearly inspection or the annual supervising engineer visits, and to carry out works to correct any significant deformations. During flooding, design conditions can be exceeded if flows are concentrated due to low spots and it is advised to have an inspection carried out after heavy periods of rainfall or a flood event.

Photos show erosion of natural ground downstream of the dam and the temporary protection works.

Incident 391	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	4.5m (nearby dam embankment)
Incident type	Embankment stability, internal erosion
Incident severity	3

Description

Following a very wet period, a sinkhole was noted on the upstream face of a feeder canal embankment approximately 25m from one of the dam embankments forming the reservoir. Failure of the feeder canal embankment would have resulted in the uncontrolled escape of part of the reservoir volume.

A precautionary drawdown of the reservoir water level was carried out. Water was observed emerging from a nearby culvert outlet and running along the toe of the dam embankment. Dye testing confirmed that this water was connected with the sinkhole. Repairs to the canal were successful in sealing the leakage.

It is thought that poor quality of the materials used to form the canal embankment, together with the unusually high and sustained water levels, led to the internal erosion and leakage occurring.

Lessons learned

This incident highlights the need to inspect all structures which affect reservoir safety regularly, especially during wet periods when high water levels can initiate internal erosion.

Photo, courtesy of the Canal and River Trust, shows sinkhole on the feeder embankment.

2013

Incident 393	
Dam type	Concrete gravity
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	1
Incident type	Foundation deterioration
Incident severity	1

Description

The reservoir has two small mass concrete spillway structures to raise the loch level. Over a period of approximately ten years, erosion at the base of both of the structures induced seepage and eventually complete failure of the structures through the foundation. Given the very low height of the structures, the release of water was not catastrophic. Designs for remedial and improvement works had been prepared but not implemented.

Lessons learned

This incident is an example of where a defect was identified many years prior to dam failure but was not addressed promptly. Investigations showed that the concrete overflow structures had been sited on erodible foundation material. The original design was apparently not suitable for the ground conditions at the site. This incident emphasises the need to review and act on reservoir safety matters in a timely manner.

2012

Incident 407	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	8
Incident type	Human error
Incident severity	2

Description

A contractor was carrying out works to a supply main. The dam embankment was excavated at the downstream toe to expose the pipework. The excavation was left unsupported which threatened the stability of the embankment. The reservoir was not partially drawn down before the works started and the scour outlet pipework had been disconnected as part of the same contract. When the situation was discovered, the excavation was secured but it was not possible to lower the reservoir level.

Lessons learned

The contractor started excavation into the dam without submitting method statements for review by the client and the supervising engineer. Any works carried out at reservoir sites should be referred to the supervising engineer. A qualified civil engineer should oversee any works that could affect reservoir safety.

Photo, courtesy of Scottish Water, shows unsupported excavation into the dam embankment.

2011

Incident 395	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	29
Incident type	Ice, damage to spillway
Incident severity	3

Description

Ice loading on a spillway crest led to damage to coping stones and opening of the horizontal joint between the copings and the mass concrete supporting structure.

Lessons learned

Where reservoirs are particularly prone to freezing conditions, the design of the spillway structure with respect to ice loadings should be reviewed, and the structural condition improved or ice loadings reduced as appropriate.

Incident 398	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	12
Incident type	Wind, waves, deterioration of upstream face protection
Incident severity	3

Description

Severe gales caused wave damage to masonry pitching on the upstream face of the embankment dam.

Lessons learned

Upstream face protection should be kept in good condition to prevent progressive deterioration during storm events. Reservoirs need to be visited promptly following major storms to check for deterioration.

Incident 396	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	11
Incident type	Wind, waves, damage to upstream face protection
Incident severity	3

Description

The dam has a history of problems with the face protection, and concrete slabs had been used to replace the pitching in some areas. Following a severe gale, damage was noted to the masonry pitching on the upstream face of the embankment just below the wave wall. Further damage could have led to the undermining and collapse of the wave wall and overtopping of the embankment. A temporary repair was undertaken using sandbags until a permanent repair could be completed.

Lessons learned

The gaps between the pitching blocks were filled periodically with granular material until about 20 years before the incident when the practice stopped. Pointing with no-fines concrete about 3 years before the incident failed to prevent the progressive loss of bedding material through the joints in the pitching. The incident demonstrates the need to review the effectiveness of maintenance activities on a continuous basis.

Photo, courtesy of Scottish Water, shows damage to face protection.

2010

Incident 404	
Dam type	Earthfill embankment
Reservoir legal status	Non-statutory impounding reservoir
Dam height (m)	8
Incident type	Seepage, instability
Incident severity	3

Description

Excessive flow or seepage on the downstream mitre of an embankment appears to have caused or contributed to instability of the downstream shoulder. The dam was substantially removed through a process of staged water lowering, using a vertical stack pipe for effective silt control.

Lessons learned

This incident occurred at a non-statutory reservoir for which the ownership was in doubt for a long period of time. The exact cause of the mitre drain flows leading to the instability were not investigated as the dam was subsequently removed by notching through the embankment.

2006

Incident 400	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	18
Incident type	Wind, waves, deterioration of upstream face protection
Incident severity	3

Description

Damage occurred to the upstream face protection of an embankment dam during a storm event. The damage was noted by the owner's staff but was not communicated to the supervising engineer immediately. Following the supervising engineer's visit, urgent repairs were carried out with the water level held down.

Lessons learned

Any damage to safety-critical reservoir structures should be communicated to the supervising engineer at the earliest opportunity.

Incident 397	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	13
Incident type	Internal erosion adjacent to spillway structure
Incident severity	3

Description

Leakage was identified on the embankment downstream mitre adjacent to the masonry spillway chute. A precautionary drawdown of the reservoir level was carried out. Grouting works were carried out to the floor of the masonry spillway and were successful in arresting the leakage. This showed that the leakage originated from the masonry-lined spillway, further up the spillway channel, not from the reservoir dam embankment.

Lessons learned

Masonry spillway channels are prone to deterioration which can lead to leakage paths developing close to the spillway. Regular surveillance is important to identify any signs of spillway deterioration.

Photo, courtesy of Scottish Water, shows leakage which was coming from the masonry-lined spillway chute.

Incident 405	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	10
Incident type	Human error, unauthorised excavation into dam fill
Incident severity	3

Description

An excavation of dam fill material along the downstream toe was carried out by a private landowner who believed he had the right to improve his access by carrying out the excavation. The owner had recently bought the property and the deeds appeared to indicate that he owned the toe area. The reservoir owner carried out a precautionary drawdown of the reservoir and monitored the downstream shoulder for instability using survey pegs. The excavated area was reinstated shortly afterwards to preserve the stability of the dam.

Lessons learned

Where areas adjoining a dam structure are not in the ownership of the undertaker, it is important to engage with landowners to make them aware of basic reservoir safety matters. In this case, there was no fence marking the property boundary at the downstream toe and a new owner believed he had the right to excavate into the dam structure.

Photo, courtesy of Scottish Water, shows excavation along the toe of the embankment.

2004

Incident 408	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	11
Incident type	Inflow flood, gate malfunction, overtopping erosion
Incident severity	3

Description

Internal erosion was revealed by seepage and transport of eroded material into the spillway channel and a sink hole on the dam crest. The embankment had a history of problems: a sink hole on the crest had been filled with granular material six years earlier.

Under the direction of an inspecting engineer, investigations were carried out which revealed that the seepage reduced considerably with the reservoir partially drawn down. Site investigations were carried out and the granular fill material was replaced with a bentonite-soil mix. Grouting of the clay core was undertaken three years later.

It appears that there was fractured rock at the base of the puddle clay cutoff trench which led to the seepage. The seepage rate was probably limited by fissures in the rock either side of the cutoff trench, but soil fill material was being transported and the dam could have failed through collapse of the crest and overtopping if interventions had not been made. Following a further increase in seepage rate in 2009, the reservoir spillway level was permanently lowered to reduce further the risk of internal erosion.

Lessons learned

This incident shows how poor dam construction can give rise to problems a long time afterwards. In this case it appears likely that poor preparation of the cut-off trench gave rise to problems 150 years later. When the reservoir was full, the seepage through the base of the core was sufficient to erode the dam material. Grouting works arrested the internal erosion but ultimately a permanent lowering of the reservoir was considered necessary to preserve the safety of the reservoir. The incident also demonstrates the value of reservoir monitoring and surveillance in identifying indicators of internal erosion.

Incident 401	
Dam type	Earthfill embankment
Reservoir legal status	Statutory impounding reservoir
Dam height (m)	3
Incident type	Inflow flood
Incident severity	2

Description

During a flood, the screen covering the outlet pipe from the overflow chamber blocked causing the reservoir level to increase to within 100mm of the dam crest. The blockage was cleared and the level reduced. The screen, which had a narrow bar spacing and was prone to blockage, was replaced with a more suitable design.

Lessons learned

The dam almost overtopped because of poor design. Screens, if essential, should be designed to minimise the risk of blockage and ease of cleaning. The incident also highlights the value of visiting reservoirs during flooding, especially where the safety of the reservoir relies on screens being clear of debris.

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