Post-incident reporting for reservoirs

Annual Report 2011

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Foreword

We publish this report so that all those involved in reservoir safety learn from past incidents. By sharing experience we improve safety in the future. Please continue to help by reporting all incidents no matter how small or insignificant they may appear.

I would like to thank all of those within the reservoir industry who have contributed to and support the post-incident reporting system.

Antony Deakin - Reservoir Safety Manager

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1 Introduction

Since 2007 we have collected information on incidents at both large raised reservoirs (those covered by the Reservoirs Act 1975) and small raised reservoirs. We use this information to:

- investigate incidents where appropriate
- inform the reservoir industry of any trends and key lessons identified
- provide information that can contribute to research into reservoir safety and incident frequency analysis.

Our aim is to use post-incident reporting to improve reservoir safety. We will not use any information acquired through this voluntary scheme to retrospectively initiate enforcement action under the Reservoirs Act 1975.

Any requests we receive for information we have gathered relating to reservoir incidents are considered under the Freedom of Information Act 2000, Environmental Information Regulations 2004 and the Data Protection Act 1998.

This report gives details of incidents reported to us in 2011 as well as giving a summary of all the incidents reported to us since 2004.

2 Analysis of reported incidents

You can find the following information in this report:

- the number, type and severity of incidents that have occurred during 2011
- analysis of the threats to reservoirs and the mechanisms of deterioration that are caused by those threats
- the main lessons that have been identified from the incidents reported to us
- a summary of each of the incidents reported to us in 2011
- a summary of all the incidents reported to us since 2004 in Appendix C.

2.1 Severity and number of reported incidents in 2011

Incidents are entered on to our database if they are considered reportable. Table 2.1 shows the three severity levels for reportable incidents.

Incident severity level	Definition
1 (most severe)	Failure (uncontrolled sudden large release of retained water)
2	Serious incident involving any of the following: - Emergency drawdown - Emergency works - Serious operational failure in an emergency
3	Any incident leading to: - an unscheduled visit by an inspecting engineer - a precautionary drawdown - unplanned physical works - human error leading to a major (adverse) change in operating procedures.

Table 2.1 Severity levels for reportable incidents

There were five incidents reported to us during 2011, four that occurred in 2011 and one that occurred in 2009. The 2009 incident has just been reported to us following in-depth investigations into the circumstances surrounding the event.

Tables 2.2 and 2.3, and Figure 2.1 show the number and severity of incidents that have been reported between 2004 and 2011. We have only included incidents where we have been able to gather enough information to assign an incident level.

	2011	2004-2010
Total number of incidents	4	45
Incidents at large raised reservoirs	2	33
Incidents at small raised reservoirs	2	12

Table 2.2 Number of incidents reported between 2004 and 2011

Year	Level 1 incident	Level 2 incident	Level 3 incident	Total
2011	0	3	1	4
2004-2010	3	14	28	45

Table 2.3 Number of incidents showing severity level 2004-2011

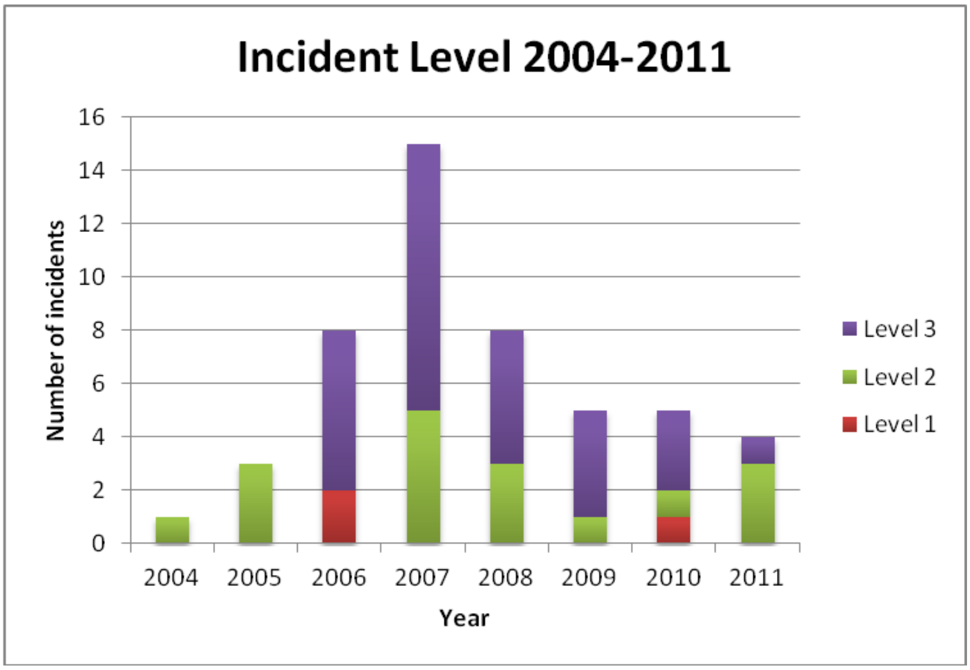

Figure 2.1 Incidents reported 2004-2011 showing severity level

Figure 2.2 shows incident severity level against dam category for 2011 and Figure 2.3 the distribution of incidents against dam category between 2004 and 2011. Dam category definitions can be found in Appendix B.

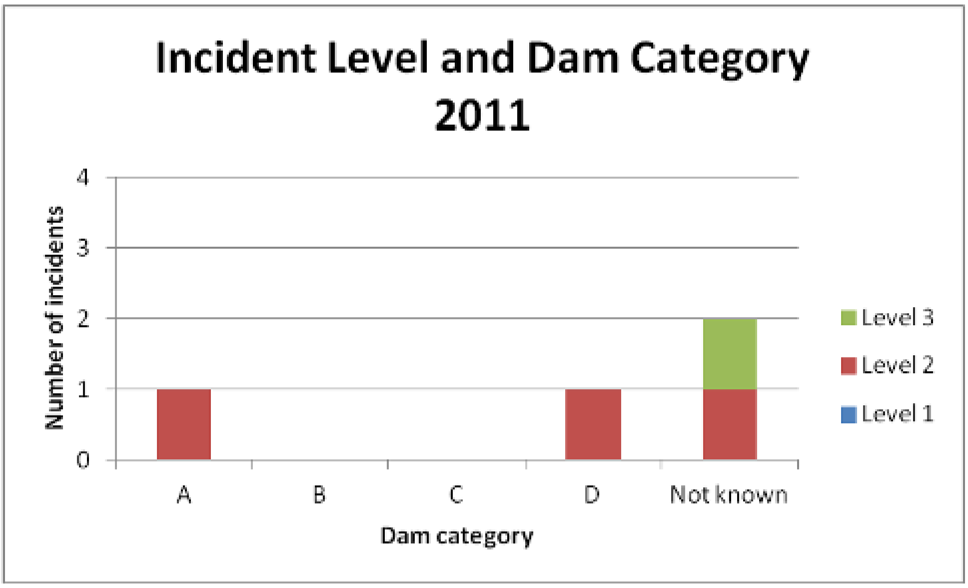

Figure 2.2 Incident level and dam category for 2011

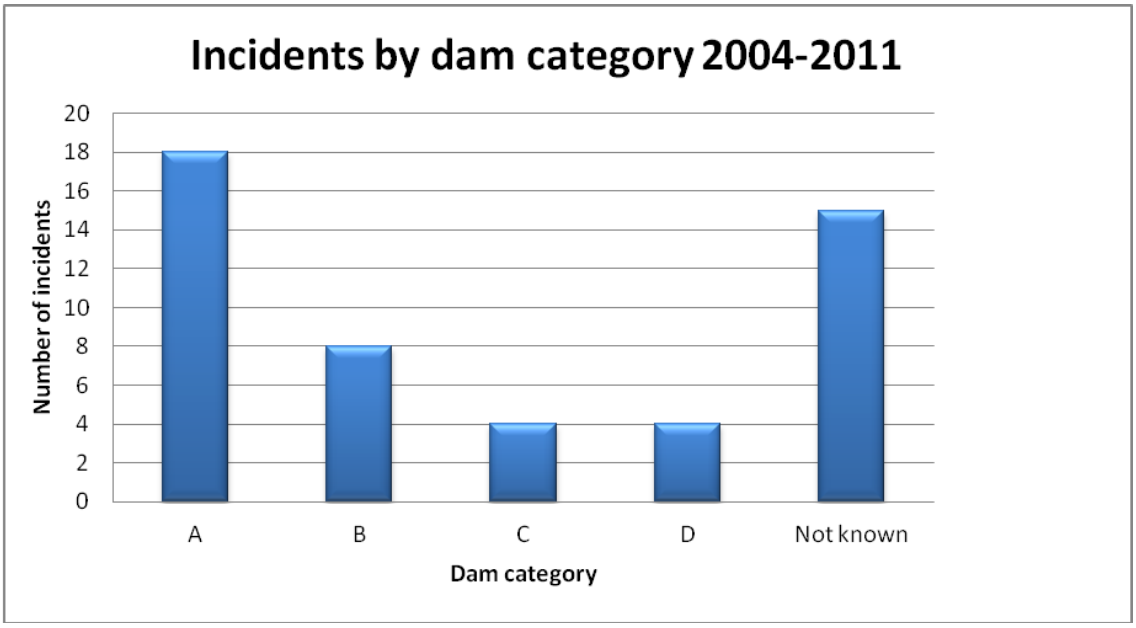

Figure 2.3 Distribution of incidents by dam category 2004-2011

2.2 Threats and mechanisms of deterioration

Summaries of all the incidents reported to us since 2004 can be found in Appendix C.

We have analysed the reported incidents in terms of threats to dams, and the mechanisms of deterioration resulting from those threats. The threats have been broadly divided into internal and external threats (see Appendix B for details). A summary of incidents for 2011 and 2004-2010 in terms of threats and mechanisms of deterioration is given in Tables 2.4, 2.5 and 2.6

External threats	2011	2004-2010
Inflow Flood	0	15
Mining	0	1
Wind, trees	0	1
Animals	0	1
Vandalism	0	1
Human error	1	1
Other	0	4

Table 2.4 Summary of external threats

Internal threats	2011	2004-2010
Internal - Embankment stability	3	15
Appurtenant works stability	0	3
Abutment stability	0	1

Foundation stability	0	1
Material deterioration	0	1
Vegetation	0	2

Table 2.5 Summary of internal threats

Mechanism of deterioration	**2011**	**2004-2010**
Erosion by overtoppng	0	14
Internal erosion through embankment	0	8
Internal erosion adjacent to appurtenant works	0	5
Internal erosion - other	2	1
Pipework/culvert deterioration	0	2
Deterioration of foundation	0	1
Deterioration of gates/valves/equipment	0	1
Damage to safety critical structures	0	1
Pore water pressure increase mass movement	0	2
Settlement	0	2
Wind damage - trees	0	1
Other	1	3
Not known	1	2

Table 2.6 Mechanism of deterioration

Embankment stability remains the main threat to dams covered by the Reservoirs Act, with internal erosion the most common mechanism of deterioration. Erosion by overtopping is the most common mechanism of deterioration for reservoirs too small to be covered by the Reservoirs Act. Many of the incidents at small reservoirs reported to us have followed a period of intense rain leading to an unexpected flow of water into the reservoir.

2.3 Types of lessons identified

We gather information on the lessons identified from incidents and where appropriate we may carry out further investigations and research into these.

One incident in 2011 was the result of human error which highlights the importance of making sure everyone working with or near a reservoir is aware of how it operates.

Incidents recorded on our database are classified on the basis of the type of lessons identified. The lessons identified are split into five categories as shown in Table 2.7 and Figure 2.4 below. Categorising the lessons identified in this way makes it easier to highlight trends.

Type	Examples	Possible implications
Surveillance	Inadequate surveillance or processing of instrument observations	Reservoirs require more or better monitoring and surveillance
Operation	Malfunction or misuse of reservoir control facilities	Reservoirs require more or better trained staff or security against misuse
Physical (current condition)	Inadequate performance due to deterioration of a design element by erosion, wear, weathering, corrosion, vandalism, poor maintenance etc.	Reservoir components require better or more frequent maintenance
Physical features (intrinsic)	Inadequate performance due to the original design and/or construction of a structure, or through changes in the loading (structural or hydraulic) experienced	Reservoir components should be designed and built to meet current physical conditions
Emergency planning	Incidents relating to the application of emergency planning provisions (alarms, evacuations, etc)	There is a need for more effective use of emergency planning provisions at reservoirs

Table 2.7 Types of lessons that can be identified

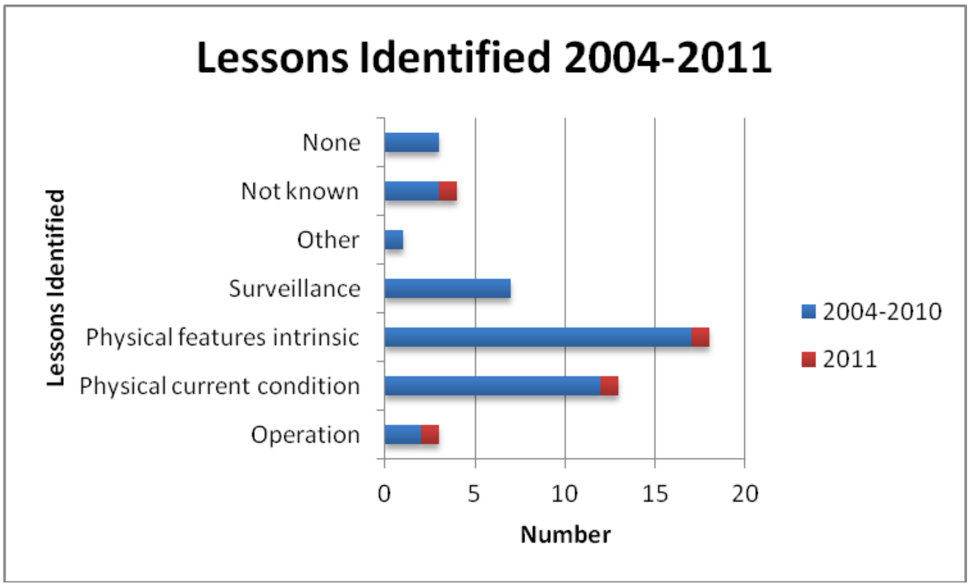

Figure 2.4 Lessons identified 2004-2011

There were two incidents in 2010 for which the details are currently incomplete and under investigation. We hope to report on these incidents in the next annual report. We will also include an update on any research and development that we have done.

3 Incidents reported in 2011

The four reportable incidents that occurred in 2011 are described below. An incident which happened in 2009 is also included. This was not included in the 2009 report because the undertaker carried out a full investigation before reporting the incident to us.

Incident 352 (2009)	
Dam type	Earthfill embankment
Reservoir legal status	Reservoir under the Act
Dam height (m)	10
Incident type	Stability of surrounding land
Incident severity	3

A member of the public told the reservoir undertaker about land movement that had taken place above a public footpath around the reservoir. The supervising engineer was consulted and the decision was taken to close the track to the public and draw the reservoir down by 0.5m. The land surrounding the reservoir was surveyed. Engineers calculated the impact of the land slipping into the reservoir and what size wave would be caused. The calculations showed that any potential landslide would not cause the dam to breach. After discussions with an inspecting engineer it was decided that the reservoir water level should be returned to normal.

The undertaker was concerned about the land around the reservoir and commissioned a survey in 2001. This survey and the associated photographs proved useful in the investigation of this incident. It allowed the engineers to see how much movement had happened in the eight years since the survey was carried out.

The undertaker carried out a full investigation before reporting the incident to us and has now modified their routine surveillance to include the area that was affected.

Photograph of the land movement, incident 352. Courtesy of the Canal & River Trust (formerly British Waterways)

Lessons identified
Although the stability of the slope above the reservoir had been assessed before the incident the supervising engineer was unaware of it. This incident highlights the need to record and communicate known threats to reservoir safety to everyone who needs to know. In the case of statutory reservoirs the records should include any unusual threats that may not be obvious in case staff, engineers or ownership of the reservoir changes.

Incident 351	
Dam type	Earth embankment
Reservoir legal status	Reservoir not under the Act
Dam height (m)	5
Incident type	Embankment stability
Incident severity	2

Water was seen spurting from the downstream masonry face of an earthfill embankment. The reservoir overflow facilities were found to be inadequate to control the level of the water. A sewage treatment plant downstream of the dam was evacuated while the water level in the reservoir was reduced using a temporary spillway.

Photographs showing the temporary spillway arrangements

Lessons identified
This incident shows how important it is to make sure that adequate spillway facilities are provided and that dams are maintained and repaired. The leak was spotted by professional personnel visiting the site for other reasons and the dam could have failed if the situation had not been spotted.

Incident 353	
Dam type	Earth embankment
Reservoir legal status	Reservoir not under the Act
Dam height (m)	1.5
Incident type	Embankment stability
Incident severity	3

A slip in the upstream shoulder of a small embankment threatened the stability of the dam. There was evidence that previous dam repairs had been attempted using concrete.

Photograph showing a hole in the embankment with water flowing through

Lessons identified
This incident shows the importance for all dam embankments to be designed, constructed and maintained in consultation with professional engineers.

Incident 354	
Dam type	Earthfill embankment
Reservoir legal status	Reservoir under the Act
Dam height (m)	13
Incident type	Embankment stability
Incident severity	2

Unusual leakage flows were detected at the downstream toe of the embankment. These flows were spotted early due to the regular supervision by the undertaker. The reservoir water level was drawn down as a precaution and an inspecting engineer called. Further investigations found an earthenware pipe 100mm in diameter through the dam which was leaking into a drain. The purpose of the pipe wasn't known and it wasn't shown on any of the available drawings. The undertaker decided to seal the pipe by grouting works.

Lessons identified
This incident highlights the importance of regular, thorough surveillance. It also demonstrates that threats can be posed by design features unrecorded on construction drawings and that drawings cannot always be assumed to be complete and accurate.

Incident 356	
Dam type	Earthfill embankment
Reservoir legal status	Reservoir under the Act
Dam height (m)	3
Incident type	Human error
Incident severity	2

A gate that allows reservoir outflow to pass through had been closed by mistake. This caused unusually high reservoir levels which threatened buildings close to the reservoir.

Lessons learned
This incident shows the importance of training and only allowing authorised and trained personnel to operate reservoir outlet structures.

Appendix A: Reporting an incident

We deliberately use the term 'post-incident reporting' so that it is clear that this system does not include incident management. If a problem arises at a reservoir you should follow the procedure outlined in the flow chart below.

We can receive post-incident information by phone or email. Our contact details are below. We suggest that you contact us as soon as possible after the incident is under control while the facts are still fresh in your mind. If the problem is likely to take some time to resolve, please let us know and we will call you back at a later date to find out more about the actions you have taken, and how effective they were.

Reservoir Safety Team
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Email: reservoirs@environment-agency.gov.uk
www.environment-agency.gov.uk/reservoirsafety

Emergency event or incident
(For example high rainfall/flood, uncontrolled overtopping, structural failure, slumping, increased or new seepage or any other abnormal signs).

Contact your supervising engineer
If you have a supervising engineer, contact him/her, as he/she will be able to advise you what to do next.

Reporting the incident
If necessary, call the Environment Agency's Floodline on **0845 988 1188** or
Incident Hotline on **0800 807060**
(Available 24 hours a day, 7 days a week)

Post-incident reporting
As soon as possible after the incident is under control, please contact the Reservoir Safety team on **01392 442001**
(Between 9am and 5pm Monday to Friday)

Appendix B: Dam and threat categories

Dam category (from 'Floods and Reservoir Safety', Institution of Civil Engineers, 1996, 3rd edition)

Dam category	**Potential effect of a dam breach**
A	Where a breach could endanger lives in a community*
B	Where a breach could endanger lives not in a community or result in extensive damage
C	Where a breach would pose negligible risk to life and cause limited damage
D	Special cases where no loss of life can be foreseen as a result of a breach and very limited additional flood damage would be caused

* A community in this context is considered to be 10 or more persons

The internal threat categories in the database are:

- Instability associated with internal erosion of an embankment dam
- Slope instability associated with slip of an embankment dam
- Instability associated with appurtenant works
- Instability of the dam foundation
- Material deterioration (for example, corrosion)
- Vegetation (for example, tree roots)

The external threat categories used in the database are:

- Inflow - flood
- Inflow - direct rainfall
- Inflow - failure of upstream reservoir
- Seismic event
- Snow/ice
- Aircraft strike
- Vandalism
- Wind (wave generation) and Wind (tree damage)
- Human error, Animals, and Mining

Appendix C: Summary of reported incidents

The following tables show a summary of all the incidents reported to us since 2004.

Incident No	Incident Date	Incident Severity	Date Built	Dam Height (m)	Dam Category	External Threat	Internal Threat	Mechanism of Deterioration
35	Nov 2004	2	1931	13	A	n/a	Embankment stability	Internal erosion through embankment
29	Jun 2005	2	1910	6	A	Inflow flood	n/a	Erosion by overtopping
30	Jun 2005	2	1882	20	A	Inflow flood	n/a	Erosion by overtopping
31	Jan 2005	2	1911	27	A	n/a	Embankment stability	Internal erosion adjacent to appurtenant works
301	Oct 2006	3	1956	15	A	n/a	Embankment stability	Settlement/deformation
303	Dec 2006	3	1815	11	A	n/a	Embankment stability	Internal erosion adjacent to appurtenant works
304	Jun 2006	3	1927	17	A	n/a	Embankment stability	Internal erosion through embankment
305	Jul 2006	3	1750	4	D	n/a	Vegetation	Internal erosion adjacent to appurtenant works
306	Dec 2006	1	Not known	2	Not known	Other	n/a	Other
307	Jun 2007	2	1875	14	A	Inflow flood	n/a	Damage to safety critical structures
308	Jun 2007	2	1975	4	B	Inflow flood	n/a	Erosion by overtopping
309	Jun 2007	3	1963	5	B	Inflow flood	n/a	Erosion by overtopping
311	Apr 2006	3	1974	20	A	n/a	Appurtenant works stability	Pipework/culverts deterioration
312	Jun 2007	3	1800	3	D	n/a	Embankment stability	Internal erosion adjacent to appurtenant works

315	Jul 2007	3	Not known	7	Not known	Inflow flood	n/a	Pore water pressure - increase mass movement
317	Feb 2006	3	1998	9	A	Mining	n/a	Other
323	May 2007	3	1879	9	Not known	n/a	Embankment stability	Internal erosion adjacent to appurtenant works
324	Feb 2007	3	1820	3	D	n/a	Embankment stability	Internal erosion through embankment
326	Oct 2007	3	1800	3	C	Wind damage	Vegetation	Wind damage - trees
327	Aug 2007	3	1760	6.5	B	n/a	Embankment stability	Internal erosion through embankment
328	Jan 2008	3	1950	3	A	Animals	n/a	Internal erosion through embankment
329	Jan 2008	3	1808	9	B	n/a	Embankment stability	Not known
330	Mar 2007	3	1969	20	A	n/a	Embankment stability	None - wet area was found not to relate to the reservoir
332	Aug 2008	3	1815	11	A	n/a	Appurtenant works stability	Pipework/culverts deterioration
333	Sept 2008	3	1815	6	A	n/a	n/a	n/a
337	Aug 2008	3	1963	24	A	n/a	Embankment stability	Increased internal water pressure causing instability
341	Feb 2009	3	1962	5	B	n/a	Embankment stability	Internal erosion through embankment
342	Nov 2009	2	1875	4.5	B	Inflow flood	n/a	Erosion by overtopping
343	Jan 2010	2	1875	4.5	B	Inflow flood	n/a	Erosion by overtopping
345	Jan 2010	3	c. 1930	7	Not known	Vandalism	Foundation stability	Deterioration of foundation
347	Apr 2010	3	c. 1995	6	Not known	n/a	Embankment stability	Internal erosion - other
348	Dec 2010	3	Not known	5	C	Human error	n/a	Erosion by overtopping
352	Dec	3	1837	10	A	Other	n/a	Erosion by overtopping

	2009							
354	Jun 2011	2	1859	12.8	A	n/a	Embankment stability	Internal erosion - other
356	Dec 2011	2	1995	1	D	Human error	n/a	Other

Table 2.8 Summary of reported incidents at reservoirs under the Reservoirs Act 1975

Incident No	Incident Date	Incident Severity	Date Built	Dam Height (m)	Dam Category	External Threat	Internal Threat	Mechanism of Deterioration
302	May 2006	1	1800	3.5	Not known	Inflow flood	n/a	Erosion by overtopping
310	Jul 2007	3	Not known	1.5	Not known	Inflow flood	Abutment stability	Internal erosion through embankment
313	Jul 2007	3	Not known	4	C	Inflow flood	n/a	Erosion by overtopping
316	Jun 2007	2	1920	5	Not known	Other	n/a	Erosion by overtopping
321	Jul 2007	2	1920	5	Not known	Inflow flood	n/a	n/a
322	Jun 2007	2	1620	5	Not known	Inflow flood	n/a	Erosion by overtopping
325	Jan 2008	2	Not known	13	A	Inflow flood	n/a	Erosion by overtopping
334	Sept 2008	2	Not known	5	Not known	Inflow flood	n/a	Erosion by overtopping
335	Aug 2008	2	1850	9	B	Inflow flood	n/a	Erosion by overtopping
338	Jul 2009	3	Not known	4	C	n/a	Embankment stability	Settlement/deformation
340	Jun 2009	3	1994	2	Not known	n/a	Appurtenant works stability	Internal erosion through embankment
346	Jan 2010	1	Not known	10	Not known	n/a	Material deterioration	Deterioration of gates/valves/equipment
351	Jun 2011	2	Not known	5	Not known	n/a	Embankment stability	Internal erosion - other
353	Jun 2011	3	Not known	Not known	Not known	n/a	Embankment stability	Not known

Table 2.9 Summary of reported incidents at reservoirs not under the Reservoirs Act 1975

Appendix D: Further reading

Charles J A (2005). Use of incident reporting and data collection in enhancing reservoir safety. Dams & Reservoirs, vol 15, no 3, November, pp29-35

Environment Agency (2007) Learning from Experience: Post-incident reporting for UK Dams. Environment Agency, Bristol

Environment Agency (2008) Learning from Experience: Post-incident reporting for UK dams 2007 Annual Report. Environment Agency, Bristol

Environment Agency (2009) Learning from Experience: Post-incident reporting for UK dams 2008 Annual Report. Environment Agency, Bristol

Environment Agency (2010) Learning from Experience: Post-incident reporting for UK dams 2009 Annual Report. Environment Agency, Bristol

Environment Agency (2011) Post-incident Annual Report 2010. Environment Agency, Bristol

Environment Agency (2011) Lessons from historical dam incidents. Environment Agency, Bristol

Environment Agency (2011) Modes of dam failure, and monitoring and measuring techniques. Environment Agency, Bristol

Gosden J D and Brown A J (2004) An incident reporting and investigation system for UK dams. Dams & Reservoirs, vol 14, no 1, March, pp21-28

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Tedd P, Skinner H D and Charles J A (2000). Developments in the British national dams database. Dams 2000. Proceedings of 11th British Dam Society Conference, pp181-189. Thomas Telford, London

Warren A L and Hope I M (2006). A new incident reporting system. Proceedings of 14th British Dam Society Conference, Durham, pp27-36. Thomas Telford, London

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