

# **Environment Agency**

Post-incident Reporting System for UK Dams

Final Report

February 2007

**Halcrow Group Limited**

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# Environment Agency

## Post-incident Reporting System for UK Dams Final Report

### Contents Amendment Record

This report has been issued and amended as follows:

Issue	Revision	Description	Date	Signed
1	0	First Draft	13/4/06	
1	1	Combined specification and include amendments from Client	19/4/06	
1	2	Incorporate amendments from Client	6/5/06	
1	3	Final draft for comment	29/9/06	
1	4	Final draft	20/12/06	
1	5	Draft for Project Board	24/1/07	
1	6	Final Draft for Project Board sign-off	13/2/07	
1	7	Minor revisions following final Project Board meeting.	22/2/07	

# Contents

<b>1</b>	<b>Introduction</b>	<b>1</b>
1.1	<i>Background</i>	1
1.2	<i>Project Delivery</i>	2
1.3	<i>Aims</i>	2
<b>2</b>	<b>Scope of Post-incident Reporting System</b>	<b>4</b>
2.1	<i>Reservoirs covered by the specification</i>	4
2.2	<i>Definitions and guidance on reportable incidents</i>	6
<b>3</b>	<b>Procedure for Post-incident Reporting</b>	<b>10</b>
3.1	<i>Persons reporting incidents</i>	10
3.2	<i>Environment Agency tasks for identifying incidents</i>	11
3.3	<i>Industry concerns with post-incident reporting</i>	11
3.4	<i>Information for reporters</i>	12
3.5	<i>Post-incident report form</i>	12
<b>4</b>	<b>The Post-incident Reporting Database</b>	<b>14</b>
4.1	<i>Database personnel</i>	14
4.2	<i>Incidents affecting more than one dam</i>	15
4.3	<i>Number of dams associated with each reservoir</i>	15
4.4	<i>Composite dams</i>	15
4.5	<i>Database fields</i>	15
4.6	<i>Software issues</i>	23
<b>5</b>	<b>Post-incident Investigation</b>	<b>24</b>
5.1	<i>Overview</i>	24
5.2	<i>Scope of incidents to be investigated</i>	24
5.3	<i>Scope of the investigation deliverables</i>	25
5.4	<i>Investigation costs</i>	25
5.5	<i>Investigation personnel</i>	26
5.6	<i>Data provided to the investigating engineer</i>	26
5.7	<i>Investigation report</i>	27
5.8	<i>Actions by the Database Administrator</i>	29
5.9	<i>Output, periodic review and quality control</i>	30
<b>6</b>	<b>System Output and Review</b>	<b>31</b>
6.1	<i>Form of output</i>	31

6.2 *Process review* 31

**7 Supplementary Requirements 33**

7.1 *Maximising the completeness of reporting* 33

7.2 *Confidentiality* 33

7.3 *Reporting of output to users of the database* 34

7.4 *External access requirements* 34

**References**

**APPENDICES**

**Appendix A** Defra specification

**Appendix B** Environment Agency fact sheet

**Appendix C** Post-incident report form

**Appendix D** Reservoir Data Sheet

**Appendix E** Database fields

# 1 Introduction

## 1.1

### *Background*

In 2002, Defra appointed Kellogg Brown & Root Limited (KBR) consultants to develop a specification for post-incident reporting relating to UK dams. The aim was to propose a system of post-incident reporting which will be instrumental in helping to identify and quantify trends in the behaviour of UK dams. Such information from such a system will be of use to Defra in determining future research priorities. In the long term it may also serve statistical analyses and quantitative risk assessments of dam safety. Further details of the Defra specification are provided in Appendix A.

The post-incident reporting system will be administered by the Environment Agency's reservoir safety team in Exeter, commencing in January 2007. In July 2005, the Environment Agency appointed Halcrow Group Ltd to develop the Defra specification to meet their particular requirements and to respond to any industry concerns. In particular, extensive development was necessary to ensure that the specification:

- is pragmatic;
- encourages an open approach;
- addresses the constraints posed by voluntary reporting;
- incorporates, as far as practicable, the information on the existing post-incident database administered by the Building Research Establishment Ltd (BRE).

In addition, Halcrow's brief was to assist the Environment Agency in promoting the system by developing a communication strategy to deal with various concerns, including the risk of prosecution arising from post-incident reporting and issues of confidentiality. The elements of the consultation process included:

- A Project Board meeting in May 2006;
- A meeting between the Environment Agency, Halcrow and Dr Hughes on 14 July 2006 to further discuss the specification;
- A meeting with Environment Agency specialists in August 2006 regarding confidentiality issues;

- A Fact Sheet on the proposed reporting system, distributed in September 2006 to the industry (Appendix B);
- A presentation at the British Dam Society conference in September 2006;
- A brochure on the system, scheduled for 2007;
- A second meeting of the Project Board, held on 21 February 2007.

## 1.2

### ***Project Delivery***

The key project team members and contact details are listed below:

- Ian Hope, Reservoir Safety Technical Manager, Environment Agency;
- Roger Lewis, Project Manager, Environment Agency;
- Jonathan Hinks, Project Director and AR Panel Engineer, Halcrow;
- Alan Warren, Project Manager and AR Panel Engineer, Halcrow;
- Paul Tedd, Sub-Consultant to Halcrow, BRE.

A Project Board was established for the project. The current members are:

- Ian Hope, Environment Agency
- Paul Ditchfield, Defra
- Peter Jones, Welsh Assembly Government
- David Seaman/Carolyn Girvan, Scottish Executive
- John Adams, Environment Agency
- Steve Biddle, Environment Agency
- Richard Logan, Environment Agency
- Andy Hughes, Atkins
- Neil Williams, Severn Trent Water

A new database, using Microsoft Access, has been developed by the BRE. Information on incidents, together with some information on dam characteristics, on the existing BRE database has been re-formatted for the new database.

## 1.3

### ***Aims***

#### 1.3.1

#### *Short-Medium Term Aims*

In the short-medium term the aims are:

- To gain broad support from the UK reservoir industry for the principles and objectives of the system through the communication strategy;
- To gain a high level of participation in reporting incidents;



- To establish a robust database with adequately trained personnel to enter data correctly and to deal effectively with general queries and post-incident reporters.
- To establish an effective process for disseminating the key facts and lessons learned from incidents to the industry through the website and special bulletins.

### 1.3.2

#### *Long Term Aims*

The long-term aims of the system are to:

- inform deliberations on reservoir safety research priorities (feedback to Defra);
- identify trends and common causes of incidents;
- provide information on the annual probability of various types of incidents arising, thereby informing reservoir safety quantitative risk assessment (QRA).

## 2 Scope of Post-incident Reporting System

### 2.1

#### 2.1.1

#### *Reservoirs covered by the specification*

##### *Reservoirs outside the ambit of the Reservoirs Act 1975*

The specification allows for the entry of post-incident data on any reservoir in the UK, statutory or non-statutory. This is appropriate as lessons can be learnt from incidents at any dam, irrespective of reservoir size or location within the UK.

However, it should be noted that:

- The owners or users of statutory reservoirs are more likely to be aware of the post-incident reporting system, and the benefits to the wider dams community in reporting incidents. As such, the likelihood of an incident being reported is higher for statutory reservoirs than for non-statutory reservoirs.
- There is more information available on the characteristics of statutory reservoirs (from the existing BRE and RESS databases) than on non-statutory reservoirs.
- Statutory reservoirs have specific monitoring and surveillance provisions under the Reservoirs Act 1975 ('the Act') and therefore any analysis of incidents will need to take this into account.

The development of a database of **all reservoirs** in the UK is beyond the scope of the proposed system. However it is Defra's wish that the system should be UK-wide. Hence it shall aim to contain information on:

- all statutory reservoirs; and
- non-statutory reservoirs for which characteristics and/or information on incidents are, or become, available.

#### 2.1.2

##### *Reservoirs in Scotland*

There is currently no central database of reservoirs under the Act for Scotland. It is estimated that there are about 680 reservoirs under the Act in Scotland, regulated by 32 enforcement authorities. The Scottish population of dams represents an important component of the total population of UK dams as it includes a large

proportion of relatively high dams and a broad spread of dam construction types including many concrete gravity and buttress dams. In contrast, the population of dams in England and Wales (around 2000 in total) predominantly comprises small embankment dams.

Ideally, the scope of the RESS database would be extended to include Scottish statutory reservoirs to serve the enforcement and surveillance purposes of both the Environment Agency and the Scottish enforcement authorities. There are proposals out for consultation on the creation of a single enforcement authority for Scotland similar to the model adopted for England and Wales, led by the Scottish Executive. Should relevant legislation be passed, this will greatly assist in developing an extended RESS database and, by extension, information for the post-incident reporting database.

Until such time that a comprehensive database of Scottish statutory reservoirs can be developed, information on Scottish reservoirs will have to be gained in the same manner proposed for all non-statutory UK reservoirs; that is, dam characteristics will be recorded on the database as part of post-incident reporting as and when incidents arise and are reported. Some information on Scottish dams is also available on the existing BRE database and this has been transferred onto the new database. It may be possible to gain information on dam characteristics from Section 10 inspection data sheets, as proposed for England and Wales, but this would rely on the cooperation of the numerous existing Scottish enforcement authorities. Alternatively, the use of blank data sheets could be promoted by Defra and the Scottish Executive for use by all inspecting engineers. This would then cover Scotland without the need to involve the existing Scottish enforcement authorities. In the event that a single authority is formed, partially complete data sheets could be sent to the appointed inspecting engineers ahead of Section 10 inspections. The proposals for the Reservoir Data Sheet are described in section 4.5.4 below.

### 2.1.3

#### *Reservoirs in Northern Ireland*

Under Section 30 of the Act, the Act does not extend to Northern Ireland. It is known that there are at least sixty large raised reservoirs in Northern Ireland (Cooper, 1987) and perhaps forty or so further reservoirs comprising mainly old mill ponds and amenity lakes. It is understood that there have been no new impounding reservoirs in Northern Ireland since 1970.

Since the Water and Sewerage Act was passed in 1945, the construction or modification of all public reservoirs of any size has been carried out under the supervision of Panel Engineers within the meaning of the 1930 and 1975 Reservoir Acts. It is understood that most, if not all of the reservoirs in Northern Ireland have a ‘Supervising Engineer’ appointed in the spirit of the Act.

Northern Ireland reservoirs should be included within the scope of the database. However, the fact that the Act does not apply to Northern Ireland is an obstacle to our learning of dam characteristics and the chances of incidents in the province being reported will probably be less than for incidents arising on mainland Britain. However, if incidents at Northern Ireland reservoirs are reported, they should be recorded in the database.

Some basic information on publicly-owned large reservoirs in Northern Ireland is in the public domain (Cooper, 1987) and can be added to the database. However, without a change in legislation, it may be difficult to check and update the information. This issue should be discussed with the relevant government departments in Northern Ireland to explore how the situation might be improved.

#### 2.1.4

##### *Tailings Dams*

Tailings dams are excluded from the scope of the Reservoirs Act 1975 and are covered by the Mines and Quarries (Tips) Act. However, they are normally constructed and monitored as if they are covered by the Reservoirs Act 1975. There is the potential that incidents could arise at tailings dams that will be of relevance to reservoir safety. Therefore such incidents should be included in the database as and when reportable incidents arise. The Environment Agency’s annual meetings with the Health and Safety Executive provide a link to such incidents.

#### 2.2

##### ***Definitions and guidance on reportable incidents***

Incidents shall only be recorded and entered on the database if they are considered ‘reportable’. This section defines what should be considered ‘reportable’.

Three levels of reportable incidents are defined as described in Table 2.1.

<b>Level 1</b>	Failure (uncontrolled sudden large release of retained water).
<b>Level 2</b>	Serious incident involving any of the following: <ul style="list-style-type: none"> <li>• emergency drawdown,</li> <li>• emergency works</li> <li>• serious operational failure in emergency (e.g. failure to operate gates)</li> </ul>
<b>Level 3</b>	Any incident leading to: <ul style="list-style-type: none"> <li>• an unscheduled visit to the reservoir by an Inspecting Engineer;</li> <li>• a precautionary drawdown;</li> <li>• unplanned physical works;</li> <li>• human error leading to a major (<i>adverse</i>) change in operating procedures.</li> </ul>

Table 2.1 Reportable incidents

It is not necessary for the reporter to assign the incident level: this should be carried out by the Database Administrator (see section 4.1). The assignment of an Incident Level for each incident is important for the system management purposes, for example in deciding whether to offer to dispatch an investigating engineer (see section 5). It will also be useful for summary reports to the industry.

Some incidents will inevitably not fall neatly into one of the three categories and some judgement will be necessary on the part of the Database Administrator. Where there is some doubt on whether an incident is reportable, it is suggested that it should be deemed reportable. Dam failure incidents will be rare and will normally not pose a difficulty in assigning them to Level 1. The following guidance is provided for assigning an incident to either Level 2 or Level 3.

<b>Level 2</b>	These incidents will normally result in an emergency situation where the operator spares no time or expense in saving the reservoir from the brink of failure, or re-establishing the safe operation of safety-critical facilities. Level 2 incidents may give rise to persons being evacuated downstream and/or the emergency services being involved.
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<b>Level 3</b>	These incidents result in urgent precautionary measures or works to preserve reservoir safety but within a reasonable timeframe and/or budget. If the reservoir is drawn down, it may be carried out at a controlled rate to avoid failure of the upstream face, and/or the reservoir may be only partially drawn down to preserve storage. These events will normally not be associated with emergency services or evacuation of the public.
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*Table 2.2 Guidance for assigning incidents to Levels 2 and 3*

Routine improvement works arising from routine Section 10 inspections will not normally constitute a reportable incident. Examples might include:

- grouting works;
- dam crest or wave wall raising;
- spillway capacity improvements;
- relining of drawoff pipes.

Such works may be carried out as part of a response to a reportable incident but more commonly are carried out to preserve or improve the safety of a dam structure in response to erosion, long-term settlement, deterioration of materials or changes in reservoir operation, safety guidelines or characteristics. Works declared as necessary to maintain reservoir safety will not normally be considered a reportable incident.

It is possible (but unlikely) that a reportable incident is declared during a routine inspection under Section 10 or 12. Typically, a reportable incident will be declared when, for example;

- there is significant, and increasing leakage from a dam face or foundation;
- there is significant sudden settlement or slippage in the embankment face;

- an earth embankment is significantly eroded or destroyed by a flood wave overtopping the dam;
- there is uncontrolled release of water from a drawoff pipe.

Incidents vary greatly in nature and the above examples are by no means exhaustive.

## 3

# Procedure for Post-incident Reporting

### 3.1

#### *Persons reporting incidents*

Anybody may report incidents arising at dams. If the reporter is the dam owner, or his representative, the information can be used directly. If the reporter is not acting with the knowledge or permission of the dam owner, the Database Administrator should contact the dam owner before acting on the information. The benefits of this approach are:

1. The trust of the industry will not be undermined ('whistle-blowing' should be discouraged);
2. The dam owner may be able to give more detailed and accurate information than the initial reporter.

Irrespective of who reports the incident, it will be necessary to confirm the incident information received with the dam owner (and the reporter, if independent of the dam owner). This process will aim to verify the accuracy of the information.

Defra sent a letter to Panel Engineers in April 2006 on the post-incident reporting system stating that it "...hopes that both panel engineers and undertakers will actively support this initiative." Where post-incidents arise at statutory reservoirs, it is envisaged that the task of post-incident reporting will commonly be delegated to the Supervising Engineer. This is to be encouraged, as Supervising Engineers will usually have both good knowledge of the reservoir and the incident details, and a good technical appreciation of the factors that led to the incident (natural forces, unusual reservoir operation, poor maintenance, ineffective instrumentation, etc). As such, Supervising Engineers should usually provide good quality information for the database. However, Supervising Engineers should only report incidents with the consent of the dam owner.

Where incidents arise at non-statutory reservoirs, it may be desirable to dispatch a panel engineer to gather the information for the database. For particularly complex or serious incidents, this would be the preferred course of action for **both** statutory and non-statutory reservoirs (refer to section 5).



### 3.2

#### ***Environment Agency tasks for identifying incidents***

The Environment Agency will need to be particularly pro-active in identifying incidents arising at non-statutory reservoirs. The owners of non-statutory reservoirs will generally not be aware of the post-incident reporting system, nor of the benefits to them in reporting incidents. It is recommended that the following actions be carried out by the Database Administrator to assist in the identification of reportable incidents.

- 1) Regular searches on the internet and the Environment Agency National Incident Reporting System (NIRS).
- 2) Dissemination of relevant information to Regional and Area Environment Agency offices to promote the use of the system. Where there has been an uncontrolled release of water from a reservoir or an emergency drawdown has been carried out (in England and Wales), the Environment Agency is likely to be involved in some capacity.

### 3.3

#### ***Industry concerns with post-incident reporting***

Dam owners, out of choice, may choose not to report incidents for a variety of reasons, including:

- Fear of prosecution;
- Concerns over implications for business interests or reputation;
- Concerns over the management/confidentiality of the information supplied (e.g. fear of terrorists targeting 'vulnerable' structures);
- Concerns over the time, cost or effort involved in the reporting process.

These concerns have been allayed as far as possible by conducting trials of the proposed system and through the industry communication strategy (Fact Sheet (Appendix B), and a proposed brochure in 2007): relevant information will be on the website. The concern over time/effort concerns are addressed by providing a flexible approach in how incidents are reported (see below) and being pragmatic about the nature of the information sought. There is a balance to strike, especially within the context of a voluntary reporting system, between the level of detail sought and wide industry acceptance of the time/effort required in providing the

information. A successful system requires both detailed information on incidents, and for incident reporters to make contact with the Database Administrator.

### 3.4

#### *Information for reporters*

General information on the reporting system, including an electronic copy of the brochure, will be available on the post-incident reporting website early in 2007. A hard copy of the website information will need to be available to send on request to those reporters without internet access. In some cases the reporters will wish to view this information before volunteering information.

### 3.5

#### *Post-incident report form*

An essential component of the proposed system is the Post-incident Report Form. The form has a structure which facilitates data entry to the database. **All reported incidents should have a completed Post-incident Report Form, completed either by the reporter (and checked by the Database Administrator) or by the Database Administrator.** This form will serve the following purposes:

- Some (but not all) reporters will prefer to communicate the post-incident information using the form to submit the information electronically;
- For reports where the information is received by telephone, e-mail, etc, the Database Administrator should use the form to record relevant information. This process will highlight any areas where no information has been provided and in such cases the Database Administrator would normally contact the reporter to try to fill in the missing information.
- Once finalised, the forms will serve the quality control process to ensure that the information received and confirmed with the dam owner/reporter has been used appropriately in populating the database fields.
- The forms may, in future, be provided to inspecting engineers on their appointment. However, this should not be done whilst the system is on a voluntary basis. The standard letter from the Environment Agency to the inspecting engineer confirming the appointment of the inspecting engineer should however include the current Reservoir Data Sheet (see section 4.5.4 and Appendix D).

The Post-incident Report Form will be available on the website to download as a Microsoft Word file. This file could then either be completed electronically and e-

mailed/posted to the Database Administrator, or printed off and completed in manuscript. There will also need to be a paper version of the form available (with reasonable space available to enter information by hand) for any reporters who wish to complete the form but do not have internet access. Regardless of how the information is received by the Environment Agency, the Administrator must provide an electronic copy of the completed Post-incident Report Form. This will be used to confirm the information with the dam owner/reporter throughout the period when the incident is 'live'. The completed form will serve quality control requirements to check that the information on the database is a reasonable representation of the facts stated on the form.

In the event that a post-incident investigation is carried out (refer to Section 5), the investigating engineer should be sent a copy of the completed form. Having completed his investigation and produced his report, the last task for him to complete will be to further review and update the Post-Incident Report Form, particularly Part C. The updated form will then be used to enter information in the database. The investigation report shall be retained to preserve the full information from which the database information has been extracted. This may serve future research requirements and serve quality control checks on the system.

The proposed Post-incident Report Form is included as Appendix C.

## 4 The Post-incident Reporting Database

### 4.1 *Database personnel*

It is recommended that the management of the database shall require the following personnel:

- A **Database Manager**: This person will normally be the Environment Agency's Technical Manager - Reservoir Safety. He will be responsible for ensuring that the database is correctly operated and adequately resourced. He will also be responsible for:
  - the submission of reports to Defra;
  - periodic reports to industry through the website;
  - special bulletins on safety issues arising from the system.
- A **Database Administrator**: This person will be employed by the Environment Agency and will have experience in dealing with dam safety issues. The Administrator will receive information on incidents, administer the database, deal with queries and work with the Database Manager in procuring specialist support for post-incident investigations. The Administrator will also assist in the preparation of periodic reports.
- There will also need to be a **Database Analyst**, to provide specialist technical support to the Administrator and to carry out statistical analysis of the database. The Analyst will also provide a quality control role for checking the database entries based on the Post-incident Report Form data. It is envisaged that the Analyst will be a reservoir safety specialist, independent of the Environment Agency.

The Defra Specification estimates that, on average, thirteen reportable incidents arise each year (in practice the actual number may vary significantly from year to year). This will not pose an unreasonable burden on the Environment Agency in terms of data management time and clearly the Environment Agency roles described above will be carried out on a part-time basis.

#### 4.2

##### ***Incidents affecting more than one dam***

Some threats to reservoir safety, such as extreme flood events, may affect many dams at the same time. Where reportable incidents arise at several dams, these should not be lumped together on the grounds of common cause but should be reported as separate incidents for each of the dams affected. This is essential as it is important to learn the differences in the response to the common threat arising from different dam conditions and characteristics. If the cause of the reported incident has the potential to affect many other nearby reservoirs (e.g. flood, earthquake), the Administrator should contact the owners of those nearby reservoirs to inquire whether a reportable incident arose at those sites. If a dam has been overtopped but extreme rainfall was not apparent, it would be prudent for the Administrator to check to see if there are any reservoirs upstream that may have breached and to contact the owners accordingly (failure of small, non-statutory reservoirs in the UK is not rare).

Clearly, if dams have failed, or are at clear risk of failure, downstream reservoir owners should be contacted immediately.

#### 4.3

##### ***Number of dams associated with each reservoir***

The database will allow multiple dams to be associated with a single reservoir. This can be achieved by devising a dam identifier number which links with a reservoir identifier.

#### 4.4

##### ***Composite dams***

Where incidents arise at compound dam types (e.g. a concrete spillway block with earth embankments either side), the post-incident report should ensure that the post-incident information identifies the relevant dam type associated with the incident. Where the incident arises at the interface between the two dam section types, or due to some other interaction, specialist advice from the Analyst should be sought in completing the database entry.

#### 4.5

##### ***Database fields***

##### 4.5.1

###### ***General***

The database will be a single database which will be adapted and extended from the existing BRE database to suit the specific requirements detailed in Appendix E.

It is convenient to consider the post-incident database with three main components:

1. **Basic reservoir details:** based initially on information from RESS for England and Wales, the BRE database for Scotland (initially), and Cooper's paper for Northern Ireland. Where details of non-statutory reservoirs are available (either due to an incident arising, or otherwise), these should also be added.
2. **Post-incident data:** based on information on the BRE database and new post-incident data from dam owners received from 2007. The source of the information for entering information on new incidents shall be the Post-Incident Report Form. The database fields proposed are represented in 'spreadsheet format' in Appendix E.
3. **Dam characteristics:** based initially on information available from RESS and the BRE database and eventually from Reservoir Data Sheets (see section 4.5.4) normally provided by inspecting engineers as part of statutory inspections. For non-statutory reservoirs a Reservoir Data Sheet should be completed as part of the post-incident reporting process. The sheet is shown in Appendix D and the database fields proposed are represented in 'spreadsheet format' in Appendix E.

#### 4.5.2

##### *Use of RESS*

RESS was designed as an enforcement tool for the Environment Agency. Much of the information on RESS is of relevance and can easily be transferred into the new post-incident database.

The fields available in RESS that relate to physical/statistical data are summarised in Table 4.1 below. The scope of the data is limited as the database was developed to serve a surveillance and enforcement purpose rather than to be used as a research tool. Details of the Undertaker are also available which can be transferred.

	Typical Field Options
<b>Construction Fields</b>	
Reservoir category	Impounding, non-impounding, service
Primary dam type	Earthfill, rockfill, concrete gravity, concrete buttress, brick service, etc.
Watertight element	Concrete, asphalt, rolled clay, puddle clay, earthfill, etc
Outlet type and location	Pipe through core, tunnel through abutment, etc
<b>Statistics Fields</b>	
Year built	
Capacity	
Crest length	
Maximum height	
Reservoir surface area	

Table 4.1 Dam characteristics data available for transfer from RESS database

#### 4.5.3

##### *Use of the original BRE database*

The original BRE database was established to record information on incidents on an *ad-hoc* basis and to provide a national database of dam characteristics. Typically, this database has drawn post-incident information from published papers.

The original BRE database included the fields listed below in addition to details of the Undertaker and dam location.

- Year completed
- Grid reference
- Reservoir type
- Reservoir capacity
- Reservoir surface area
- Structure volume
- Spillway type
- Spillway capacity
- Crest length
- Draw-off capacity
- Altitude
- Height

- Catchment area
- Flood category
- Dam type
- Foundation
- Cut-off
- Outlets (type/location)
- Sealant (core material)
- Upstream protection
- Details of investigations carried out
- Details of problems/incidents
- Details of remedial works
- References

All of the dam characteristics data held on the original BRE database have been retained. The BRE data on incidents and associated investigations, findings and remedial works was not of the form required by this specification and therefore the BRE re-coded this information for approximately 200 incidents for the new database. Not all of the dam characteristics fields are considered necessary for the new database but this information has been retained in the new database rather than discarded.

#### 4.5.4

##### *Reservoir data sheet*

To make the best use of post-incident data, the database should include detailed information on the characteristics of the UK dams. The level of information on the database should augment that currently available from RESS and the existing BRE database. The proposed fields, and the proposed pick-lists for each field, are shown in Appendix E. Much of the information required to populate this database is already readily available for reservoirs under the Act on statutory records held by the Undertakers. In order to transfer this information, together with other information, to the database, it is proposed to use the services of inspecting engineers to complete and return a data sheet as part of statutory inspections under Section 10 of the Act. The benefits of the data sheet approach with respect to Scotland are discussed in section 2.1.2 above.

**The aim is for the database to have, within the next ten years, detailed dam characteristics data for all statutory reservoirs in England, Wales and Scotland; basic characteristics for the sixty or so principal reservoirs in Northern Ireland; and detailed characteristics for all non-statutory UK reservoirs at which incidents have been recorded from 2007.**



The proposed datasheet is shown in Table 4.2 below. It is separated into sections:

- General information;
- Data which should be available from statutory records held by the Undertaker (i.e., from the Prescribed Form of Record);
- Detailed information normally only available from drawings or a site visit to the reservoir.

For statutory reservoirs in England and Wales, the basic information, and some of the information on statutory records will already be available from RESS. It is proposed that the Environment Agency should send out a partially populated data sheet to inspecting engineers at the time of their appointment to check and extend the datasheet information and to then return it to the Environment Agency. This process could be done using paper forms but it would be beneficial to encourage electronic completion. It should then be possible to transfer the information electronically into the database which will save time and reduce the risk of error.

Once the detailed data has been received and entered onto the database, a copy of the information should be sent to the dam owner and, where applicable, the Supervising Engineer. Supervising Engineers should be asked to inform the Administrator of any changes in information as may occur over time. In addition, the data for each reservoir will be reviewed at least once every ten years as part of the Section 10 inspection.

In Table 2.4, it should be noted that where data transfer from the BRE database is indicated, data will not be available in all cases.

The table that will be sent to inspecting engineers is very similar to Table 2.4. A sample table with example input is provided in Appendix D.

Dam Characteristic	Transfer from RESS	Transfer from BRE	Units
<b>Part 1 – General Information</b>			
Reservoir/dam name	Yes	For Scotland	
Grid reference	Yes	For Scotland	
Name and address of dam owner	Yes	For Scotland (name only)	
Flood category	Yes		
Consequence class	Possibly in future		
Type of reservoir (impounding/non-impounding/service)	Yes	For Scotland	
Reservoir capacity at top water level	Yes	For Scotland	m <sup>3</sup>
Reservoir surface area at top water level	Yes	For Scotland	km <sup>2</sup>
Original date of completion	Yes	For Scotland	year
Dam type	Yes, for primary dam	For Scotland	
Material forming primary watertight element	Yes	For Scotland	
Max height of crest above lowest natural ground at embankment toe	Yes	For Scotland	m
Max height of crest above foundation level	Yes	For Scotland	m
Crest length	Yes	For Scotland	m
<b>Part 2 – Additional Information from Statutory Records</b>			
Direct catchment area		Yes	km <sup>2</sup>
Indirect catchment area			km <sup>2</sup>
Standard average rainfall on catchment area			mm
Fetch to dam			m
Fetch direction			degrees
<b><u>Drawoffs</u></b>			
Number of drawoff conduits			
Position of control on primary drawoff			
Position of drawoff relative to dam			
Conduit material			
Effective diameter of conduit			m
Drawoff capacity			m <sup>3</sup> /s
<i>As above for secondary/tertiary drawoffs as may be present</i>			

Dam Characteristic	Transfer from RESS	Transfer from BRE	Units
<b><u>Bottom Outlets</u></b>			
Number of bottom outlet conduits			
Position of control			
Position of drawoff relative to dam			
Conduit material			
Effective diameter of conduit			m
Maximum discharge capacity			m <sup>3</sup> /s
<i>As above for secondary/tertiary bottom outlets as may be present</i>			
<b><u>Spillways</u></b>			
Number of spillways			
Primary spillway type			
Position			
Sill length			m
Any controls (gates etc)			
Source of power supply for controls			
<i>As above for secondary and tertiary spillways as may be present</i>			
<b><u>Details of historical repairs and improvements</u></b>			
Embankment- watertight element			
Embankment- upstream face			
Embankment – shoulders			
Embankment – crest			
Internal drainage system			
Concrete water-retaining structure/dam			
Spillway			
Operational drawoff			
Bottom outlet			
Foundation			
Electro-mechanical			
<b>Part 3 – Further Information</b>			
Total number of dams forming the reservoir.			

Dam Characteristic	Transfer from RESS	Transfer from BRE	Units
Are there reservoirs upstream of this reservoir?	Yes/no		
<i>If above response is 'yes', EA to establish the number and names of statutory reservoirs upstream of reservoir from RESS for England and Wales.</i>			
Number of watertight elements			
Position of primary watertight element			
Thickness of primary watertight element at original ground level			m
Head on primary watertight element at original ground level from TWL.			m
Average crest width			m
Typical downstream slope			H:1V
Typical upstream slope			H:1V
Dam foundation type		Yes	
Foundation treatment in original construction		Yes	
Type of wave protection system		Yes	
Average thickness of face protection			m
Wave wall type (none/vertical/curved)			
Design flood return period			
Peak routed outflow			m <sup>3</sup> /s
Stillwater flood rise in design flood event			m
Minimum freeboard to dam crest			m
Minimum freeboard to top of wavewall			m

*Table 2.4 Proposed dam characteristics fields*

The following points should be noted with respect to Table 2.4:

1. The information for Part 1 of the form will often already be held on the database and can be sent to inspecting engineers with these fields completed or substantially completed, at least for statutory reservoirs in England and Wales;
2. For all statutory reservoirs, the information requested for Part 2 will normally be readily available to the inspecting engineer from the Prescribed Form of Record and/or from his site inspection notes. It is anticipated that many of the fields will not require input in most cases.

3. The information requested for Part 3 will generally be readily available from the statutory inspection, geological and hydrological studies and drawing records where available. It is accepted that for some fields the response may be 'not known'.
4. If completed at the time of a Section 10 inspection, it is anticipated that the time required to complete the table should be between 15 and 30 minutes. This typically represents a burden on the reservoir industry of approximately 1 – 2% additional time for a Section 10 inspection.
5. Where incidents arise at non-statutory reservoirs, records will not normally be available on RESS or the original BRE database. A blank data sheet will need to be sent to the dam owner to complete. Under these circumstances the form will often be viewed by the owner as onerous and will probably only be completed in part. If the incident is to be investigated, then the task of completing the form should be given to the investigating engineer. It may be appropriate to develop a simplified version of the data form for non-statutory dam owners to complete.

#### **4.6**

##### ***Software issues***

In the medium/long-term the Environment Agency may use either Oracle or Microsoft Access as the platform for the database. The database will initially be in Access as used by BRE and developed through 2006 to meet the requirements of this Specification. It is understood that there are no significant difficulties associated with the transfer of information from an Access database to an Oracle database should this prove desirable in the future. Similarly, it is understood that data can be transferred from RESS onto the Access database.

# 5 Post-incident Investigation

## 5.1

### *Overview*

Reportable incidents at UK dams are to be classified as Level 1, 2 or 3 as defined in table 2.1. **Level 1 and 2 incidents should normally be investigated by a qualified civil engineer to look into the root cause of incidents without apportioning blame.** The objective is to ensure that the more serious or complex incidents are investigated in a comprehensive manner so that the information captured on the Post-incident Report Form and database is as complete and accurate as possible. A summary version of the report should be placed on the Post-incident Reporting Website and a link to the website would be circulated to panel engineers and registered dam owners. On average, it is anticipated that there will be three Level 1 or 2 incidents each year.

The timing of a post-incident investigation should usually be programmed so that any investigations carried out by the owner, the HSE or other relevant parties, have been completed first. In the case of major incidents, there may be a case for starting the post-incident investigation not more than six months after the time of the incident and to then update the findings once the results of final investigations/reports become available. This would have to be discussed and agreed with the owner. In any event, the post-incident investigation should not interfere with other investigations carried out in response to the incident.

## 5.2

### *Scope of incidents to be investigated*

The Database Administrator should arrange for Level 1 and 2 incidents to be investigated. It is anticipated that in the case of a dam failure (Level 1), especially where lives are lost, the investigation would be run in parallel with separate inquiries, unless the Database Manager is convinced that the needs of the database shall be met by such separate inquiries.

Some Level 3 incidents might also be investigated at the discretion of the Database Manager. In assessing whether to investigate a Level 3 incident, the Database Manager should consider:

- The level of detail provided by the reporter;

- Lack of technical expertise on the part of the reporter to draw any clear conclusions on how the incident arose and developed (this might arise, for example, with reservoirs not under the Act where the owner cannot delegate the task of post-incident reporting to a Supervising Engineer);
- Unusual circumstances by which the incident arose or developed; or unusual means/effectiveness of managing the incident.

### 5.3 *Scope of the investigation deliverables*

The deliverables are described in Table 5.1 below.

Output		Comment/Details
1.	Obtain an improved reliability of the conclusions drawn and any lessons learnt which may have wider significance for the management of reservoir safety.	The conclusions should be drawn solely from the investigator's experience and information provided to him; it should not aim to expand on conclusions drawn by the owner or his delegate.
2.	Assessment of whether the current regime of dam safety management is effective.	The report should not comment on the broader issue of the scope or provisions of the Reservoirs Act 1975, but relevant information (e.g. frequency of surveillance visits) should be included as may be appropriate so that these issues can be picked up in reviews carried out for Output 3 (refer to Table 5.1).
3	Additional output.	The investigation shall aim to provide or update relevant details of the dam characteristics for the subject dam. Accordingly, the investigator shall complete a Reservoir Data Sheet (Appendix D).

Table 5.1 *Scope of Investigation Deliverables*

### 5.4 *Investigation costs*

In cases where the Database Administrator wishes to instigate an investigation, the arrangements for the investigation shall be agreed with the dam owner. The cost of the investigation shall be met by the Environment Agency but shall not include for any time or expenses on the part of the dam owner or his delegate(s).

The time required for an investigating engineer to visit the site and the owner or delegate, and to produce the report and update the Post-incident Report Form will clearly vary considerably depending on the complexity of the incident and the amount of time required for travel, reading investigation reports prepared by the owner, etc. As a guide, it is anticipated that investigating engineers can be expected to take between two and ten days to complete the investigation and report.

### **5.5**

#### ***Investigation personnel***

In the event that the system is eventually provided for by legislation, any investigating engineer would probably have to be independent of the dam owner and have no previous involvement with the reservoir. This principle of impartiality, which is provided for in the Act with respect to dam inspection, construction and refereeing disputed recommendations, should as far as is practicable be adopted in appointing the investigating engineer. Therefore the investigating engineer should ideally be on the appropriate Panel and be independent of the owner and have no previous involvement with the subject reservoir that might prejudice the investigation. However, if the owner prefers that a particular panel engineer be used to complete the investigation then this should generally be accepted rather than miss the opportunity for an investigation.

In some cases, it may be appropriate for the Database Administrator to appoint technical specialists to work with the investigating engineer. Any need for supplementary expertise will normally be instigated by the investigating engineer. However, it is envisaged that this would not be a common requirement.

### **5.6**

#### ***Data provided to the investigating engineer***

The following data shall be provided to the investigating engineer:

- A copy of the Post-incident Report Form based on information provided by the reporter;
- A copy of the Reservoir Data Sheet with information currently available from the post-incident database;
- Contact details for the dam owner.

For incidents at statutory reservoirs the information should also include:



- Details of the Supervising Engineer and the previous Inspecting Engineer; and
- A copy of the last Section 10 report (this should be requested from the Undertaker if a copy is not held with the Environment Agency). Note: the approval of the Undertaker to release the inspection report will be sought at the same time that agreement to investigate the incident is reached.

### 5.7

#### ***Investigation report***

The investigation report contents shall have the structure shown in Table 2.2 below.

<b>Section</b>		<b>Details/Remarks</b>
1	Introduction	Include general details of how the investigation was carried out.
2	General description of the dam	This must not include any information on dam identity or location. Include the frequency/type of monitoring and surveillance prior to the incident.
3	Initial information	Explain what information was made available by the contributor(s).
4	Cause of incident	Describe why and how the incident arose, the mechanism(s) of deterioration, how the incident was declared.
5	Post-incident management	Describe what was done to bring the incident under control; how bad did the situation get at its peak; how effective were the measures in bringing the incident under control. Consider, if possible, how close the dam came to failing and how it probably would have failed had corrective action not been taken.
6	Lessons learnt	Describe any lessons that might be learned. Consider issues of surveillance, reservoir operation, physical conditions/materials, and emergency planning. Were the provisions of the Act (if applicable) in place? How should/could monitoring and surveillance be improved? Are there any implications for other dams of this type or of similar arrangement?

Section		Details/Remarks
7	Actions taken	Describe what has been done since the incident was brought under control. Were physical works completed? Were studies or investigations completed? What was the change, if any, on the surveillance frequency or monitoring provisions?
8	Research issues	Are there any contributory factors which you feel might benefit from further research or amendment of current engineering guides?
9	Further actions	Detail any outstanding actions for the Database Administrator. If additional physical works are planned for the future, these should be stated here so the Administrator can contact the owner at an appropriate time to discuss and record their effectiveness and update the record sheet and database accordingly.
10	Conclusions	Confirm the incident level assigned by the Administrator. State whether the incident can be considered closed and, if not, why not (e.g. on-going corrective physical works). If the incident cannot be considered closed at the present time, what is the anticipated timeframe for closing the incident?
<b>Annexes (to be marked "Confidential")</b>		
A	Comments on the investigation process	State if there were any difficulties encountered in gaining relevant information. State any proposals you may have for improving the process of investigating incidents, based on your experiences with this investigation.
B	Investigation details	Summarise how/when the investigation was carried out, the persons spoken to and the information gleaned.
C	Dam details	Provide information on the dam name, location, owner, Panel Engineers (if appropriate), and complete or update the Reservoir Data Sheet.
D	Photographs	
E	Drawings/supporting information received	

Section		Details/Remarks
F	Information from third parties.	Include any information received from third parties (affected persons, other dam owners etc). Include any information in the media.
G	Supplementary information	This annex may be used by the investigating engineer to add any further information that he considers would be useful for the Database Administrator.
H	Report summary	<p>Provide suitable draft text for the Administrator to use for the post-incident reporting website. This should include a summary of:</p> <ul style="list-style-type: none"> <li>• The dam type/height;</li> <li>• How the incident developed;</li> <li>• How the incident was detected;</li> <li>• How the incident was managed to render the reservoir safe;</li> <li>• What was done after the incident to improve safety or to investigate the incident;</li> <li>• What are the main lessons to learn.</li> </ul> <p>The summary report should aim to be less than one side of A4 in length.</p>

*Table 5.2 Standard Content of Post-incident Investigation Report*

### 5.8

#### ***Actions by the Database Administrator***

The Database Administrator should review the report and check that the identity of the dam, its location and owner, are reasonably withheld from the information provided in the main body of the report. Once an incident has been closed and a final draft of the investigation report received, the Administrator should carry out the following tasks:

- Review, and amend as necessary, the information held on the Post-incident Report Form and on the database;
- Update the dam characteristics fields in the database using the Reservoir Data Sheet;
- Consider, in consultation with the Database Manager, whether any aspects of the incident should be the subject of a special bulletin to the industry to raise awareness (note that this would be advertised by an e-mail to the industry and panel engineers).

- Arrange for the summary report (Annex H of the report) to be published on the investigation area of the post-incident reporting website after gaining the consent of the dam owner;
- Copy the full report to Defra, the dam owner and the Supervising Engineer, together with a copy of the updated Post-incident Report Form and Reservoir Data Sheet.

Where reports are distributed or published electronically, they should be in a non-editable format.

Requests to view a full post-incident investigation report (without annexes) should be referred to the Database Manager.

## 5.9

### ***Output, periodic review and quality control***

A summary of the post-incident investigations completed annually should be included with the annual report to dam owners and Panel Engineers (refer to Table 6.1). This will summarise the number of incidents investigated, and include the summary reports.

It is important to carry out periodic reviews of the effectiveness of the investigation process. This review shall be carried out in parallel with Output 4 (Table 6.1) and shall consider:

- The level of voluntary co-operation provided to the investigating engineers and any other issues which have impeded the effectiveness of the investigation in determining incident root causes and other details;
- Any need to revise the standard report structure as described in Table 5.2, with particular reference to material provided in Appendix G of the reports submitted.

Any change to the standard conditions under which the Database Administrator instigates an investigation.

## 6 System Output and Review

### 6.1 *Form of output*

The Environment Agency will produce reports to summarise the information provided by the post-incident reporting database. Additional reporting is appropriate in relation to post-incident investigations (see section 5). The report requirements are summarised in Table 6.1.

### 6.2 *Process review*

It will be important to periodically review the performance of the post-incident reporting process.

The Database Manager shall prepare a report for Defra/WAG as and when deemed appropriate, but not exceeding intervals of 3 years, on the operation of the reporting system. The report shall include:

- An assessment of the level of success of voluntary post-incident reporting and the obstacles encountered.
- Any suggested improvements to the database and details of the likely measures or costs of implementing the improvements.
- Any notable developments in post-incident reporting from other industries or other countries and the possible implications or opportunities for the system.
- The results of independent reviews of quality control carried out in conjunction with work for Output 3 (see Table 6.1).

Output		Deliverables	Report Frequency (years)	Datasets	Variables
No.	Description				
1	Identify the nature of the lessons learnt over the last year. Summarise post-incident investigations (refer to section 5.9).	An annual report to dam owners and Panel Engineers.	Annual (1 <sup>st</sup> January)	All reservoirs on RESS; all reservoirs under the Act: 'in service' and in 'wear-in' (see note 1).	Type of lessons learnt (See note 2) against time for the last five calendar years.
2	Trends in the number and nature of incidents	An annual report to dam owners and Panel Engineers.	Annual	All reservoirs on RESS; reservoirs under the Act: 'in service' and in 'wear-in'.	Incident level against primary mechanism of deterioration, type of dam, consequence class/flood category (where known), and operational consequence (see note 3).
3	Identify whether common causes to incidents can be identified that could lead to recommendations for improvements in reservoir safety.	A report to Defra/WAG detailing the analysis and interpretation of incident data and common linkages between threats, mechanisms of deterioration and dam characteristics. Results of independent quality reviews of the database.	3-yearly	All reservoirs on RESS; reservoirs 'in service' and in 'wear-in' under the Act.	Mechanisms of deterioration for different dam types and other key dam characteristics.
4	Statistics on the annual probability of incidents to assist in quantitative risk assessment and to meet any other specific research requirements that may arise.	A report on the annual probability of incidents, for the purposes of Defra/WAG or other approved end users. The frequency of such work would match the specific demands from industry.	5 to 10-yearly to match specific industry research requirements	Reservoirs 'in service' and in 'wear-in' under the Act and/or specific sub-divisions of reservoirs to suit research requirements.	Frequency of threats and mechanisms of deterioration for various dam types and incident levels.

*Table 6.1 System Reports*

**Notes**

1. 'In service' reservoirs are those where more than five years have passed since their first filling.
2. The main lessons learnt shall be categorised as relating to either physical works (design and/or construction issues); surveillance; operations or emergency planning.
3. The possible operational consequences include loss of life, damage, loss of reservoir asset and 'no consequences'.
4. Outputs 1 and 2 would be prepared by the Database Manager and could be combined in a single report. Outputs 3 and 4 would be prepared by the Database Analyst.

# 7 Supplementary Requirements

## 7.1 *Maximising the completeness of reporting*

Success in gaining industry participation in this initiative can be promoted by:

- Promoting the benefits of the initiative to the industry (presentations, papers, brochures, etc);
- Carrying out trials and providing example investigation summary reports on the website;
- Building confidence with potential reporters by ensuring that they understand why the information requested is important, how the information will be used, how it will not be used, and addressing any concerns raised as far as possible.
- By effectively disseminating Outputs 1 and 2 (see Table 6.1) to the industry to demonstrate that good use is being made of the information provided and to promote a sense of community in routinely learning from incidents.

The completeness of the reporting will rely on the skills of the Database Administrator and/or the investigating engineer in teasing out details of the incident without abusing the trust of the owner/reporter or undermining his confidence in the rationale for the process. That trust should be enhanced by copying to the owner the information to be used for the database so that there is no mis-understanding of the information sanctioned.

## 7.2 *Confidentiality*

A policy statement on the issue of confidentiality with respect to the system has been prepared by relevant Environment Agency information specialists. This was used for the Fact Sheet issued in September 2006 and is repeated below.

“We are responsible for providing information under the Freedom of Information Act 2000 and Environmental Information Regulations 2004 subject to certain exemptions and we take our responsibilities very seriously. Each time we consider a request to release information we

check it very carefully against the statutory rules that we have to follow. These rules are designed to ensure a fair and proper balance is sought between the need to keep various kinds of information confidential and the public interest in open access to information. We also consult with third parties (for example, for post-incident reporting the Undertaker) for their view before we make a decision. They then have the opportunity to object to us disclosing the information.”

It is proposed to include this policy on the post-incident reporting website.

### **7.3**

#### ***Reporting of output to users of the database***

It is not necessary to limit access to the database reports: the reports should be freely available on the Environment Agency website. The reports available should include Outputs 1 and 2, and selected information from Outputs 3 and 4.

An e-mail should be sent to major dam owners and panel engineers with a link to the webpage whenever the site contents are updated. There is unlikely to be a need to disseminate the information by paper copy.

### **7.4**

#### ***External access requirements***

Access shall be provided to de-identified information from the database via the database administrator. Charging (or not) will be in accordance with the Environment Agency’s policy.



## References

Brown A.J., and Gosden J.D., 2004, An Interim Guide to Quantitative Risk Assessment for UK Reservoirs, Defra/KBR Consultants, Thomas Telford.

Cooper G.A., 1987. The Reservoir Safety Programme in Northern Ireland; proceedings of IWES.

# **Appendix A**

## **Defra Specification**

## Appendix A: Defra Specification

The Defra Specification (DS) was prepared by KBR consultants. It was finalised in 2005 and was presented in three volumes:

- Volume 1: Manual for Contributors (those reporting incidents at UK Dams);
- Volume 2: Specification for Incident Database;
- Volume 3: Specification for Incident Investigation.

The Defra Steering Group comprised Jim Millmore (Jacob Babbie), David Dutton (British Waterways), Andrew Robertshaw (Yorkshire Water) and Nick Reilly (Independent AR Panel Engineer). Volume 1 of the Specification is currently available on the Defra web site.

Some elements of the DS follow a structure developed for the 'Interim Guide to Quantitative Risk Assessment' (QRA), as acknowledged in Volume 2, Section 1.2 and Table 1.2 of the DS. The level of acceptance in the Interim Guide within the UK reservoir industry is currently under review and the guide will be subject to further review and development. One of long-term aims of post-incident reporting is to inform quantitative risk assessment, although many years of data are needed before practical use of the information can be made. The Interim QRA Guide provides a valuable model of separating threats and indicators which has merit in understanding how incidents arise and develop. This model is reflected in the development of the new post-incident database.

The DS was used as the foundation for the development of this specification. The DS has however been extensively reviewed and developed to prepare this specification, particularly with respect to:

- Simplification of database fields (mostly deletions) and comprehensive review of pick-list options;
- Associated simplifications of the requirements for the Post-incident Report Form and development of the Reservoir Data Sheet;
- Greater flexibility in reporting arrangement options;

- Inclusion of reservoirs in the 'wear-in' period;
- Clarification on the issue of confidentiality;
- Reduction/simplification in the proposed database personnel arrangement;
- Specific requirements for agreeing all post-incident data with the dam owner;
- Development of the arrangements for instigating, carrying out and reporting on post-incident investigations.

# **Appendix B**

## **Environment Agency Fact Sheet**

# **Appendix C**

## **Post-incident Report Form**

## **Appendix C: Post-incident Report Form**

The purpose of the post-incident report form is to provide the mechanism by which the relevant information regarding the incident can be captured from the contributor by the Database Administrator for the purposes of populating the database. The information on the form will be the sole basis of the database entries: this is important in controlling and monitoring the quality of the database. Post-incident investigation reports, where provided, will be used to review and update the information on the form for the purposes of the database – the form should not be by-passed by using the investigation report as the source of material for the database.

Extensive use is made of text boxes. This is to allow maximum freedom in communicating the events experienced.

The form may initially be completed either by the reporter or by the Database Administrator by transferring information received by telephone, e-mail, etc. In all cases the information is to be reviewed by the Administrator. Where information is missing, the reporter should be contacted and prompted to provide the additional information as far as possible. Where little information can be provided on, for example, the reasons for the incident, the Administrator should take this into account when deciding whether to attempt to instigate a post-incident investigation.

# Post-incident Reporting for UK Dams: Post-incident Report Form

## Part A: Dam and Contributor

### 1 About you

Your name

Address

Phone

Date this report form completed

Your role in relation to the dam

E-mail

### 2 Dam owner details (if different to above)

Name

Address

Phone

E-mail

### 3 About the dam

Dam/reservoir name

Dam grid ref.

(e.g. AB 123 456)

## Part B: Notification

### 4 Declaring the incident

The incident was recognised as being of great significance on

at (time)

date

am / pm

### 5 Provide details of the observations which triggered declaration of the incident.

Such observations might be leakage, slope instability, cracks, instrumentation readings, material failure, overtopping of the dam, etc. If there was more than one trigger, please give additional details. Please quantify the indicators (e.g. leakage rates, crack widths as far as possible).

### 6 If no action had been taken, how do you think the dam would have eventually failed?

Examples for embankment dams include external erosion, internal erosion and foundation failure. If you also wish to speculate on the likely time to failure had action not been taken, please do so.

### 7 What immediate physical actions were taken at the reservoir to manage the incident?

Include a description of any arrangements that were made to lower the reservoir water level, and comment on the perceived effectiveness in reducing the threat to the dam. Also include details of evacuations if appropriate. Information on medium to long-term measures to repair the dam or render the reservoir safe should be entered in section 12 below.



**8 Add any other information on the incident which you consider may be relevant.**

Consider whether there is any other information that you consider should be recorded to help others to learn from your experiences in **managing** the incident.

**Part C: Assessment**

This section should be completed when the dam owner is satisfied that the cause of the incident has been reasonably well established, and when any permanent remedial/improvement works have been completed and assessed.

**9 What studies or investigations, if any, were carried out to establish the cause of the incident and/or to determine the scope of remedial/improvement works?**

Studies might include flood safety assessments, seismic studies, risk assessments, drawdown studies, site investigations, hydraulic model studies, slope stability studies, etc

**10 What was the main factor(s) which led to the incident?**

Possible factors might be flood, internal erosion, slope instability, vandalism, earthquake, settlement, deterioration of materials or equipment, instrument malfunction and human error. Provide brief details.

**11 How effective was the instrumentation leading up to the incident?**

If the dam was monitored using instruments (crest surveys, piezometers, etc), describe the instrumentation used (type/location), the frequency at which readings are usually taken, and the time that elapsed between the last set of readings and the time of the incident.

**12 Describe any actions that were taken some time after the incident to improve the safety of the dam. Include brief details of physical works, changes in reservoir surveillance, improvements in instrumentation and any changes in reservoir operation. Please include information on the typical surveillance frequency before and after the incident, and the date of the inspection prior to the incident.**

**13 Consider whether there are any lessons that could be learned regarding, for example, the routine surveillance of the dam, instrumentation, operational conditions, physical conditions or particular features of the dam.**

**14 Add any further information on how the cause(s) of the incident was assessed and how effective were the permanent remedial measures in improving the reservoir safety. Would you consider doing anything differently for:**

- Post-incident assessment;
- Providing permanent remedial works/measures, if a similar incident arose again?

The following example relates to a real post-incident at a non-statutory reservoir that was investigated by a panel engineer. In this case the table would be completed based on the findings of the investigation report submitted.

## Post-incident Reporting for UK Dams: Post-incident Report Form

### Part A: Dam and Contributor

#### 1 About you

Your name	A C Morison		
Address	Halcrow Group Ltd, Burderop Park, Swindon, SN10 5BP		
Phone	01793 812479	E-mail	morisonac@halcrow.com
Date this report form completed	29/9/06		
Your role in relation to the dam	Investigating engineer		

#### 2 Dam owner details (if different to above)

Name	[Provided]		
Address	[Provided]		
Phone	[Provided]	E-mail	[Provided]

#### 3 About the dam

Dam/reservoir name	[Provided]	Dam grid ref.	[Provided] (e.g. AB 123 456)
--------------------	------------	---------------	---------------------------------

### Part B: Notification

#### 4 Declaring the incident

The incident was recognised as being of great significance on	22/5/06	date
at (time)		am / pm

#### 5 Provide details of the observations which triggered declaration of the incident.

Such observations might be leakage, slope instability, cracks, instrumentation readings, material failure, overtopping of the dam, etc. If there was more than one trigger, please give additional details. Please quantify the indicators (e.g. leakage rates, crack widths as far as possible).

The downstream face of the dam was eroded by water overtopping the dam. The erosion cut upstream through the downstream shoulder of the dam until the dam failed. About 6-7000m<sup>3</sup> of water was released.

#### 6 If no action had been taken, how do you think the dam would have eventually failed?

Examples for embankment dams include external erosion, internal erosion and foundation failure. If you also wish to speculate on the likely time to failure had action not been taken, please do so.

Not applicable – the dam failed in about 15 minutes through external erosion due to flooding.

**7 What immediate physical actions were taken at the reservoir to manage the incident?**

Include a description of any arrangements that were made to lower the reservoir water level, and comment on the perceived effectiveness in reducing the threat to the dam. Also include details of evacuations if appropriate. Information on medium to long-term measures to repair the dam or render the reservoir safe should be entered in section 12 below.

Telephone calls were made to bank-side residents. Fire brigade was called. No physical measures were taken to reduce the likelihood of failure.

**8 Add any other information on the incident which you consider may be relevant.**

Consider whether there is any other information that you consider should be recorded to help others to learn from your experiences in **managing** the incident.

None.

### Part C: Assessment

This section should be completed when the dam owner is satisfied that the cause of the incident has been reasonably well established, and when any permanent remedial/improvement works have been completed and assessed.

**9 What studies or investigations, if any, were carried out to establish the cause of the incident and/or to determine the scope of remedial/improvement works?**

Studies might include flood safety assessments, seismic studies, risk assessments, drawdown studies, site investigations, hydraulic model studies, slope stability studies, etc

None.

**10 What was the main factor(s) which led to the incident?**

Possible factors might be flood, internal erosion, slope instability, vandalism, earthquake, settlement, deterioration of materials or equipment, instrument malfunction and human error. Provide brief details.

Poor design and construction of a non-statutory reservoir embankment. The provision for passing floods without overtopping was inadequate. The dam material, by its nature, had not been properly compacted during construction of the embankment in 2005 and the crest was uneven. Vandalism at the downstream toe may also have contributed to the external erosion once the embankment had been overtopped.

**11 How effective was the instrumentation leading up to the incident?**

If the dam was monitored using instruments (crest surveys, piezometers, etc), describe the instrumentation used (type/location), the frequency at which readings are usually taken, and the time that elapsed between the last set of readings and the time of the incident.

No instrumentation was installed.

**12 Describe any actions that were taken some time after the incident to improve the safety of the dam. Include brief details of physical works, changes in reservoir surveillance, improvements in instrumentation and any changes in reservoir operation. Please include information on the typical surveillance frequency before and after the incident, and the date of the inspection prior to the incident.**

The owner intends to re-build the embankment.

**13 Consider whether there are any lessons that could be learned regarding, for example, the routine surveillance of the dam, instrumentation, operational conditions, physical conditions or particular features of the dam.**

The embankment had not been designed to best practice with respect to dam design. Spillway facilities were inadequate. This led to overtopping and failure of the embankment.

- 14 Add any further information on how the cause(s) of the incident was assessed and how effective were the permanent remedial measures in improving the reservoir safety. Would you consider doing anything differently for:**
- **Post-incident assessment;**
  - **Providing permanent remedial works/measures,**
- if a similar incident arose again?**

The cause of the failure is well-established. The remedial measures will not be carried out under the provisions of the Reservoirs Act 1975 as the reservoir is non-statutory.

# **Appendix D**

## **Reservoir Data Sheet**

# **Appendix E**

## **Database Fields**

## **Appendix E: Database Fields**

There are two main components of the database: post-incident data and dam characteristics. These are considered separately in this appendix. Information for the database will initially be by transfer from existing databases (RESS, BRE). Thereafter, information will be added from Post-incident Report Forms (Appendix C) and Reservoir Data Sheets (Appendix D).

With respect to post-incident data, the database aims to capture information on how the incident came to occur and develop; how it was detected; how bad did the situation get; what was done to manage the situation; how effective were the response measures; what are the lessons to learn; what has been done at the dam since the incident? The (minimum) contents of the Access database are shown in Table E1, presented in spreadsheet format, including the proposed 'pick-lists' that will be available to the Administrator in transferring information from the Post-incident Report Form and Reservoir Datasheet onto the database.

The second component deals with capturing information on dam and reservoir characteristics. When this database has been populated, it will serve as a very powerful research tool for the industry. With this in mind, a small number of fields have been added which have no obvious link to post-incident reporting. An example would be the inclusion of catchment area in the database. The contents of this component of the database are shown in Table E2.