Report commissioned by Mr Philip Hutton-Bates

REPORT OF A < 25,000m³ RESERVOIR

RAINFORD RESERVOIR

October 2017

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Building a world of difference.

REPORT OF A RESERVOIR OF CAPACITY LESS THAN 25,000m³

Introduction and terms of reference

This report describes the conditions found and discusses the known history of Rainford Reservoir following an inspection on 11th August 2017 by David Prisk, a Supervising Engineer appointed under the Reservoirs Act 1975.

The reservoir impounds a volume of less than 25,000m^{3}and therefore does not fall within the ambit of the Reservoirs Act 1975 as currently applied within England. Legislation has been put in place to facilitate a reduction in this limiting volume to 10,000m^3, however at the time of this report, this change has not been implemented within England and there are no formal plans to do so. Reservoirs that do not come under the Reservoirs Act should still be maintained in a safe manner to protect the general public from the consequences of an unintended release. It is advised that owners of this type of asset understand their liabilities for negligence in the event of an incident and they must understand that they remain liable under the Health and Safety at Work Act 1974 and under common law (no specific legislation, past precedent). It is common practice under this other legislation, with no other industry guidance available, to rely on the methods and guidance developed under the Reservoirs Act 1975 to demonstrate that good practice has been followed.

This report generally follows the format, including section headings, suggested by the Institution of Civil Engineers (2000) for a Section 10 Inspection under the Reservoirs Act 1975. References to left and right are always related to an observer facing downstream. The inspection was completed by a member of the Supervising Engineer's panel and the subsequent inspection report has been reviewed by a member of the All Reservoirs Panel.

Black & Veatch were asked to inspect the reservoir and provide an update to an earlier report of 2012. This earlier report was issued in draft for client comment. No comments were received and the report was not updated or finalised. The text of this earlier report is amended and brought up to date with the findings of the inspection.

1	**Name and situation of reservoir**	**RAINFORD reservoir** situated in Lancashire, about 5km north of St Helens, National grid reference SD 492 002
2	**Name and address of engineer making the report**	David Prisk Black & Veatch 3rd Floor One City Place Queens Road Chester CH1 3BQ *Tel* 01244 304100 *Email* priskd@bv.com
3	**Panel of which the engineer is a member and expiry date of appointment**	Supervising Engineer 18th July 2021
4	**Name and address of undertaker**	Mr Philip Hutton-Bates 185 Higher Lane Rainford St Helens Merseyside WA118NF *Tel* 07973 801514 *Email* phbates@btinternet.com
5	**Name and address of enforcement authority**	Non-Statutory reservoir (impounded storage less than 25,000m^3)

6	**Date of inspection**	11th August 2017
7	**Name and address of Supervising Engineer**	A SupE is not required to be appointed for this reservoir.
8	**Certificates, reports and previous inspections and other items of information provided to the engineer**	Report of a <25,000m^3 reservoir, Rainford Reservoir, December 2012, Black & Veatch *No other reports or certificates are known to be available.*
	Other documents provided and consulted for this inspection are listed in Appendix A.	*No other documents are known to be available.*

9 General description

No documentary information other than the report of 2012 was made available prior to the inspection. This current report provides an update of the 2012 report and was supported by a new inspection on 11th August 2017.

9.1 Description of reservoir

Rainford reservoir is oriented approximately south west-north east with the dam at the south-western end.

The dam is an embankment, L shaped in plan, with the crest extending some 60m across the valley with a return some 40m long up the right shoulder. The surface length at TWL (top water level, or overflow level) extends approximately 300m from the dam at approximately 30 degrees clockwise from north; for the first 100m from the dam the width remains about 60m, and then narrows for the remaining 200m, giving a surface area of about 12,000m^2. The reservoir depth has been measured in a number of discrete locations recently but the measurements taken have not been provided to support this report. The dam is estimated as some 6m in height. The retained volume within the reservoir is estimated at perhaps 14,000 to 20,000 m^3. The reservoir is unlikely to impound in excess of 25,000m^3 and fall within the ambit 1975 Act.

The reservoir is of less than the capacity to require registration under the Reservoirs Act 1975, but the Flood and Water Management Act 2010 has provision for reducing the capacity limit from 25,000 to 10,000m^3. New requirements under the 2010 Act have not as yet been brought into force and the necessary secondary legislation is still to be issued. If this secondary legislation is made law a survey to confirm capacity may at some time be required. From our initial calculations it is likely that the reservoir would fall under the ambit of the Reservoirs Act 1975 with the reduced capacity limit.

9.2 Geology of dam site

There were no visible geological strata available for examination at or immediately surrounding the site. Geological maps have not been examined for this report.

9.3 Catchment

From examination of the OS 1:25,000 and 1:50,000 mapping the catchment area above Rainford reservoir has been assessed as totalling some 0.7km^2. The catchment is located almost entirely within OS grid SD 49 – 50 east and SD00 – 01 north.

The catchment area is generally located to the north of the reservoir, with maximum extents of about 0.8km north, 0.2km west and 0.8km east. Along the north-eastern boundary the land is virtually flat and the boundary is assumed to be the drainage works that are mapped to outfall to the Black Brook.

The whole catchment is enclosed agricultural land of mostly mixed pasture and arable usage. Woodland and plantation forms perhaps 10% of the total.

It is understood that at the northern catchment boundary there has been a landfill site that is now closed and capped. During the operational phase the drainage from the site was pumped into the Rainford reservoir catchment. Since closure of the site the inflow has significantly reduced which may have increased the siltation at the head of the reservoir.

9.4 Dam details

The dam can be considered as comprising two parts, a closure of the original watercourse extending north-west from the left shoulder, with a return upstream on the right shoulder to the north east. The logic for the return on the right shoulder is not obvious without some understanding of the original topography. The crest length is approximately 100m in total; the main face is 60m in length with a 40m return to the right abutment. The dam was estimated as some 6m high, for perhaps 60% of the 60m crest length, however from the OS 1:25,000 Explorer Map the reservoir and dam are contained between the 50 and 55m contour lines.

No details of the dam construction or the foundation materials are available. The embankment appears to be of an acceptable shape, with a downstream face that is not over-steep. There is a small vertical protective brick wall at the upstream water face extending around the perimeter beyond the apparent limits of the actual embankment.

9.5 Details of modifications, remedial works and history

The present dam is understood to have been built to provide water for washing the sand required for the Pilkington's glass factories in St Helens. It is understood that a significant portion of the water abstracted from the reservoir was recycled back to the reservoir after use. No firm knowledge of the date of construction has been provided but from historic maps the reservoir appears to have been built between 1849 and 1892. Historically there was a further smaller reservoir between the dam and the main road within the existing fishing club car park. This no longer exists and presumably was infilled.

The reservoir is now used as a fishing lake by the Pilkington Angling Association, who lease the reservoir from the current owner. A car park has been constructed below the dam in the location of the former lower small reservoir. Footpaths and footbridges provide access to the full circumference of the reservoir.

The current owner advised that he has previously been told that the dam failed at one time and was re-built, but no details of when this incident occurred, how it happened, or what remedial measures were required were provided.

An additional overflow has been added towards the middle of the dam crest. At the 2012 inspection this comprised a brick chamber forming a three sided weir with the fourth side abutting the dam. The weir level was marginally above the other overflow weir structure at the left bank described below. At the 2012 visit both weirs were spilling. The chamber extended approximately 1000mm along the crest and extending 800mm into the reservoir. It is understood that this additional overflow was made in the early 1990s. The rectangular chamber has now been removed. The outlet pipe from the original chamber is exposed and now forms the primary overflow and drawoff from the reservoir. There is no protection to the pipe inlet.

At some point after the 2012 inspection the overflow pipe blocked. Water backed up flooding the car park and flooding onto the road. A contractor installed new pipework and two new manholes to either clear the blockage or bypass the blockage; the exact nature of the repair, the original pipe layout and the current pipe layout is unclear. The new downstream manhole, located immediately upstream of the road crossing, forms a T, with flow passing from a side branch and turning left to pass under the road. The pipework appears from the top of the manhole to be half barrel vitrified clay T arrangement with a new black corrugated pipe connected on the downstream outlet. Voids are visible around the pipe and it is all very roughly constructed and liable to catch debris. A large amount of wood branch debris was being caught around the outlet, and the chamber is highly likely to block in the near future. The new manhole just upstream of this forms a 90 degree bend. It is mounted over two blue corrugated plastic pipes that are very roughly joined and also liable to catch debris, although no debris was visible at the visit. The upstream tie in location to the original 24" vitrified clay was not observed at the visit.

9.6 Overflow

There are two overflows from the reservoir that we shall call overflow A and B.

Overflow A is located centrally along the embankment and appears to be a later addition. The overflow is formed of a 225mm internal diameter corrugated plastic pipe mounted close to horizontally through the wave wall and was just spilling at the visit. The pipe invert forms the top water level for the reservoir. Note there are no other operable drawoff features so this overflow is always spilling if the inflow to the reservoir exceeds the evaporation losses. The pipe invert is approximately 660mm below the embankment crest. There is no protection to the pipe inlet to prevent floating debris entering or blocking the pipe.

Overflow B is located to the left (east) of the dam. It is a brick structure some 20m upstream from the dam located in what appears to be natural ground. This provides a side weir inlet overflow leading to a narrow brickwork channel. The overflow weir is unfinished brickwork with exposed joints that mostly likely previously had some form of protection. The weir has probably been lowered at some point. There is a metal screen to prevent floating debris entering the overflow with a further barrier to allow water to pass under the screen preventing the screen from fully blocking. This is a reasonable design but the arrangement is highly corroded and liable to fail. There is a siphon type pipe passing over and partially blocking the weir secured in place with sandbags that also obscure the weir and will reduce it discharge capacity. The downstream channel was measured as 1900mm from outlet invert to coping. The brick coping on the day was 950mm above water level. I did not measure the weir dimensions at the visit and no drawings were provided. The coping is approximately level with the general crest of the dam at the right abutment. The pipe leaving this channel is a 15" clay pipe that is installed within the left shoulder passing through the left abutment and laid in or below the embankment fill to the right (west) of the left mitre.

There are two manholes in the length down the slope that were apparently installed in the early 1990s. The pipes from overflow A and B join in the lower of these two chambers.

There is within the car park a precast concrete manhole that has been raised since it was originally installed. Within this manhole is a 24" vitrified clay drain pipe. A further pipe enters this chamber from the right. There was no flow from this pipe at the visit.

Downstream of this manhole two additional manholes have been constructed on the overflow pipe as described in section 9.5 above. The original and new arrangement through these new manholes is not clear. The overflow pipe then passes under the embankment forming Higher Lane. At the toe of this embankment there is a small masonry headwall around the overflow discharge. The watercourse heads downhill almost due south west.

9.7 Inlet and outlet pipework and valving arrangements

A culverted stream discharges into a channel from the north of the reservoir. This stream forms the only flowing inlet to the reservoir. This channel is heavily overgrown with trees. This channel continues south and enters into the reservoir from the north into a highly silted area. There are two notable other drainage ditches feeding into the reservoir but both are small and were dry on the day of the visit. There are probably a number of other land drainage discharges to the reservoir but none noted at the visit.

There are two cast iron pipes installed through the dam crest and passing through the upstream face of the masonry wave wall of 6" and 8" bore. These pipes are laid above the embankment surface to the upstream face and buried in the downstream face. It is assumed these two pipes form the feed and draw pipes to and from the sand washing facility. The pipe to the sand washing plant must have operated as a siphon. A vent connection is provided at the high point on both pipes and both are currently open and inoperable. It is assumed that the feed is the pipe closer to the additional overflow as it is larger than the pipe closer to the west, right end of the dam. It is also assumed that both pipes extend well down the upstream face: the feed pipe to maximise command of the stored water, the return pipe to avoid scouring the upstream surface of the embankment.

There is no visible or known low level draw off facilities through the embankment. It is possible that the siphons were replacements for the original outlet/inlet pipes; as the water was used for sand cleaning the return water may have silted up the original installations. It is also possible that the natural flow became inadequate for increasing demand for sand and the pipes were installed to permit the re-cycling.

There is a chamber to the downstream foot of the embankment with two pipes and a diagonal cross connection. These appear to be extensions to the two siphon pipes although this was not confirmed. The cover has corroded and disintegrated. This now forms a dangerous void partially hidden in the undergrowth that could cause injury to persons falling into the hidden void.

The direction of these pipes beyond this chamber is not clear and no further features were identified. These inlet and outlet pipes are in an inoperable condition and are unlikely to be in a condition that could be brought back into use.

9.8 Scour

From this inspection there is apparently no separate scour or emergency draw down pipe. There is currently no known means of lowering the water level.

9.9 Instrumentation

There is no instrumentation at the dam.

9.10 Method of recording water levels

There is a no provision for water level measurement and water level records are not collected.

9.11 Access

Vehicular access to close to the dam toe is via an unsurfaced stone track and car park. There is a security fence along the site boundary with the public road, Higher Lane, crossing the valley some 100m downstream of the dam. The entrance gate from the road is set back permitting two cars to park off the public road whilst opening the gate. The car parking area is perhaps 50m x 20m of solid hardstanding. The access track falls from Higher Lane down to the car park area. It would be expected this area would flood as it appears to be a hollow. There may be drainage from this area into the overflow pipe and this may be the inlet to the manhole chamber within the car park described in section 9.6 above.

Foot access from the car park to the dam crest is possible on the left abutment via a steep path with a number of timber steps in the valley side adjacent to the mitre. Foot access to the right abutment of the dam is obtained via a path at the toe of the return of the dam along the right shoulder. This path was recently paved with a tarmac surface to provide improved access for anglers. From the dam crest the path appears to rise slowly up a gulley, but the land to the north-west is little higher than the path. The path emerges at dam crest level at the north end of the dam return. There is a level grassed path along the full length of the dam crest. There is a reasonable path around the full perimeter of the reservoir with a footbridge across the upper limits of the inundated area and across one side ditch. The bridges are formed of scaffolding with plastic imitation wood planking. There are a large number of fishing platforms around the perimeter except upstream of the footbridge.

9.12 Valley downstream of the dam

The aerial image above shows the reservoir to the north, Higher Lane running from top left to bottom right, the downstream water course running towards the bottom left and the old Pilkington sand recycling plant to the bottom left that is now an industrial estate.

Immediately downstream of the dam a car park has been created across the valley floor. The parking area has been created with imported stone. Between the car park and the boundary fence along Higher Lane to the south-west the ground initially appears to rise and provide no natural surface drain route.

The valley downstream of Higher Lane contains a watercourse into which the overflow discharges and that was the original watercourse prior to construction of the dam. The watercourse runs south-west in a straight line between two open fields for some 300m. Beyond the agricultural land there is Rainford Industrial Estate created to the south of a dismantled railway. I understand that the building immediately inside the estate was the sand washing plant fed from Rainford reservoir. This is marked as such on historic maps.

On available maps there is no evidence of the watercourse continuing south-west through, or south-east along the boundary of, the industrial estate, either route is physically possible. To the south-west the land falls perhaps 2-3m for 130m through the estate and a further 300m over level agricultural land to reach the Rainford Brook that flows to the south-east. To the south-east along the line of the boundary to the dismantled railway and present industrial estate it is some 400m to Mill Lane and the possibility of a watercourse between a mill lodge and thus to Rainford Brook. There is no evidence of dwellings within the industrial estate.

Along the north west boundary of the industrial state, from the watercourse to Mill Lane, there is a publicly accessible track for 220m and then 180m of 8m wide public road, Sandwash Close, with pavements to both sides. To the north east there is a single open field for the full distance, with an agricultural hedge boundary on the north east side of the track/road.

At the watercourse from Rainford reservoir there is a concrete headwall around a 24” drain inlet. This drain takes all normal flows beneath the industrial estate, initially in a west south west direction. Immediately within the industrial estate the old sand washing plant building is a substantial barrier to surface water flow into the estate extending for perhaps 60m to the north west and 80m to the south east of the drain inlet. The drain has horizontal bars screening the actual pipe inlet, and a substantial vertical bar screen some 10m upstream. The battered faces of the banks between the headwall and the vertical bar screens had been protected by mass concrete, and the vertical bar frame was cast into the protection. The concrete face protection was noted as severely distressed at the 2012 inspection adjacent to the screen frame with evidence of considerable flows having bypassed the screen frame to either side after blockage of the screen had backed up the stream flow to above the top of the screen. The inspection of 2012 noted that as there was no apparent water damage along the track and field boundary it seems that the capacity of the drain itself was adequate for any flows that had arrived.

Any major flood in the watercourse as a result of a breach of the dam at Rainford reservoir that exceeds the drain capacity would be backed up by the old sandwash building immediately within the estate boundary. This backup would inundate the track and the fields in both the north west and south east directions from the drain inlet, but primarily to the south east. There is a low spot in the track and field some 50m to the south east of the watercourse and after this low spot the track and field appear level all the way to Mill Lane, a further 350m. Once the inundation extends beyond the old sand wash building there are then gaps between buildings to permit surface flow to pass through to the flat industrial estate beyond and on to the south west into the extensive area of flat agricultural land falling gently from the industrial estate to the Rainford Brook. Considering the storage capacity available in the sloping watercourse, the flat track and field along the north east boundary of the Rainford Industrial Estate, the flat industrial estate area and the very gently sloping extensive agricultural area to the Rainford Brook further significant flooding downstream along the brook seems unlikely.

From the above observation it appeared less likely that significant flooding would continue south east from the watercourse to Mill Lane as the track, field and Sandwash Close all appear relatively level. At the junction with Mill Lane the highway rises to the north-east and whilst there are dwellings, these are all at a higher elevation. To the south west Mill Lane appears virtually level, after some 200m there are 12 dwellings, in six pairs of semi detached houses; should the gaps between buildings in the industrial estate cause sufficient obstruction to surface flow through the industrial estate then some part of the flood from a breach might flood these dwellings. Any flood flows along Mill Lane will then reach the Rainford Brook at Mill Lane Bridge some 200m after these dwellings.

After the Mill Lane Bridge the Rainford Brook flows at slack gradient through flat open agricultural land until Crank Road. To the left of the brook, to the north east of the road bridge, Grey House Farm appears to be the only dwelling that may be at risk from a breach of Rainford reservoir. Having regard to the stored volume and the nature of the topography through which the brook flows, the risk appears low.


Rainford Brook at Crank Road

A major release from Rainford reservoir would affect Higher Lane, and some industrial premises within Rainford Industrial Estate but seems unlikely to have a major effect on the dwellings and their occupants in Mill Lane or Crank Road.

10 General description of inspection and conditions found

10.1 General

I made an inspection of Rainford Reservoir on 11th August 2017 and was accompanied by Mr Philip Hutton-Bates the owner of the reservoir.

The weather was intermittently raining. There had been moderate recent rainfall and ground conditions were only slightly wet. The reservoir was overflowing via the newer central overflow only. There was no flow over the older overflow to the left bank. Reservoir water level was perhaps 600mm below the embankment crest level, a depth of say 30 to 60mm into the overflow pipe.

10.2 Catchment

I did not visit any points in the upstream catchment above the reservoir. Details of the catchment are reported from the earlier 2012 report.

The immediate catchment around the water line of the reservoir is heavily wooded with branches hanging over the reservoir. These branches are liable to fall into the reservoir, float towards the overflow, enter and block the unprotected overflow. **I recommend that any branches overhanging the reservoir are removed on a regular basis and a form of protection is provided to the lower overflow and the existing protection to the higher overflow is replaced or repaired.**

10.3 Dam

The downstream face of the embankment dam was covered in a growth of brambles and similar. These obstructed visibility of the dam slopes. The owner used a strimmer to expose an area from the left mitre toe to say 10m towards the centre of the embankment. The exposed surface was wet but this appeared to be surface saturation and did not appear to be soft areas indicative of seepage. I was unable to inspect the face sufficiently to determine if there are any other issues.

There was extensive growth of saplings and a significant number of mature trees growing from the downstream faces and encroaching upon the crest.

The grass along the dam crest was in good order and the saplings and shrubs noted in the 2012 inspection along the upstream water line had been cleared. There were no notable depressions in the crest.

While most of the saplings along the waterline on the upstream face of the dam have been removed following the advice of the 2012 inspection and the grass to the crest is well maintained, none of the trees and other vegetation on the downstream embankment face has been removed. I fully agree with the 2012 inspection comments that the roots from the mature trees and the general saplings and shrubs are undesirable for embankment dams. Trees that are blown down in high winds can create large holes in the embankment face. The root growth can disturb brickwork, and when extensive through the embankment can cause major problems after death of the tree due to the cavities that form as the root decomposes. These problems will only increase by allowing the trees and saplings to grow further and while there is a risk from degradation of the roots after trees are cut there is a greater risk from retaining the vegetation and it growing further. **I recommend complete removal of all tree, sapling and shrub growth of less than 100mm in diameter**

from all surfaces of the dam embankment, to 3m beyond the toe of the embankment and beyond both abutments and from the brickwork bank protection. Trees larger than 100mm in diameter should be coppiced or pollarded where suitable or otherwise thinned. This is to reduce the risk of them falling over under high winds. Sufficient branches should be removed to limit any leaf debris that may inhibit good grass growth and also to allow light through to encourage a good growth of grass across the embankment. Preferably all trees should be removed subject to the depth of their roots and the risk of these roots decaying and forming seepage paths. A tree surgeon should be regularly consulted regarding the health of any remaining trees and their ability to withstand strong winds

I recommend removal of all bramble and similar growth from the dam embankments, and measures be taken to encourage grass growth as soon as possible. The grass should then be maintained on say 3 to 4 cuts per year to develop a healthy grass swarth of between 50mm and 150mm in height. This permits observation of the face of the embankment to provide confirmation that there are no slippages or significant seepage. The grass also reinforces the earth face of the embankment to provide, overtopping protection and to prevent rain erosion of the surface. There is minimal protection to the earth below the existing brambles.

The vertical brick wave walls and capping strips along the full length of the dam crest and a significant part of the reservoir perimeter were in reasonable order. The crest has settled towards the centre as would be expected of this type of embankment but there were no unusual depressions or local failures of the wave wall. The wavewall along the main crest appeared in reasonable order.

Without survey it appeared that the dam crest above the additional spillway and at the end of the dam return up the west side of the reservoir (at the junction between the perimeter path and that up the right (west) side of the dam), were the lowest points of the crest and are where uncontrolled overflow could occur should the present overflow provision prove inadequate. Overtopping of an embankment dam can quickly lead to erosion of the crest and downstream embankment face; if allowed to continue this can lead to breach of the dam with potential for major damage downstream.

10.4 Overflow structures and channels

Overflow B – original overflow to the left bank

While there was no debris collected on the screens protecting the overflow, there is growth of vegetation within the screen partially obscuring the screen. There was also a temporary siphon pipe and sandbags securing this pipe, both of which obscure the overflow and will significantly limit discharge. **I recommend that screens should be cleared frequently, at least once per week, depending on weather and water levels. The screens should be inspected during or soon after heavy rainfall events or strong winds that could cause branches to fall into the reservoir**. While it is normally best practice not to provide full screens over overflow inlets, the arrangement at this overflow allows flow below the screen bypassing the screen and is a reasonable design. Without the screen, the pipes are liable to block downstream on a regular basis. The existing screen is in very poor condition and may fail if it deteriorates further, or if there is a large debris build up, for example during a storm event. **I recommend the screen is replaced in full with a new screen of similar or other appropriate design**.

The brick overflow structure to the left bank has some damage (missing bricks) and no protection to the overflow sill. It appears that the weir was lowered at some point and the lower brickwork left exposed. It is likely that the jointing between the bricks will become damaged and eroded over time. **I recommend that overflow brickwork damage is repaired and a protective mortar applied to the overflow sill.**

I was informed that in the past there has been root growth into the original overflow pipework and that for a time this was removed by drag cutter. I understand that the manholes into the pipe overflow section falling down the embankment were installed at this time. A jetting contractor has been employed to attempt clearance of this pipe but has been unsuccessful. The pipe is not fully blocked as evidenced by the volume of flow visible in a manhole installed in the embankment slope and the new manhole closer to the road. Because the overflow pipework is the only means of protecting the dam from over topping, there is no alternative flow path, this cannot be permitted to continue as the extent of partial blockage will continue to worsen. **I recommend investigation of the original overflow pipe from both directions along the pipe to determine the position and length of blocked/damaged pipe. This section should then be either cleared or excavated and replaced. I recommend that there should then be regular on going CCTV survey of**

the pipe with regular cleaning. This maintenance work should be carried out a minimum of once every two years or as and when any blockage or reduction in flow capacity is noted.

I recommend that, whilst investigating the first length of overflow pipe, the condition and location of the remainder of the original overflow pipe all the way to the outfall on the south side of Higher Lane should be determined. This is necessary to determine whether other work may be required before investing in the overflow structure and blocked pipe. It is also necessary so the location of the pipe is known if emergency pipe clearance work is required to prevent dam overtopping.

There are no drawing records of the dam structure and its critical appurtenances: dimensions, levels, overflows, valvework, pipework routes and access features. **I recommend that the results of internal drain inspection are recorded on survey drawings detailing all physical dimensions of dam embankment and overflow and drawoff (or lack of) structures. Sufficient dimensions should be obtained to permit careful analysis of the present hydraulic capacity of the installed facilities and stored for future use.** This is necessary to properly determine any shortfall in capacity before investing in extensive maintenance of the existing drains.

The outfall from the overflow pipe downstream of the public road has a small stone or brick headwall to support the embankment faces above and to either side. To the right of the pipe outfall there is dry stone/brick protection of the embankment face beneath the outfall of another, smaller, pipe that is probably the discharge from the road drains. **I recommend discussion with the highways authority to determine responsibility for maintenance of the culvert crossing the highway and support of the embankment faces**. While I expect maintenance of this area is the responsibility of the highway authority, this is not clear at present. During high flows and with the small size of the headwall structure and lack of extensive face protection, erosion could occur in this location leading to failure of the road edge. The extent of flow and its ability to cause erosion issues is as evidenced at the next downstream hydraulic structure.

Regarding capacity, insufficient measurements were recorded to estimate the capacity. **A dimensional survey of the overflow structure and the downstream pipework is required to determine a flow capacity**.

Overflow A - Additional overflow located to the centre of the embankment

I understand that the additional overflow on the upstream face of the dam was provided in the 1990s after concerns regarding possible blockage of the original overflow. Certainly without the additional overflow the dam would be in greater risk of overtopping. Concerns were raised regarding the combined overflow capacities at the 2012 inspection. Following that inspection the brick weir around the additional overflow has been removed which will have improved the situation. In doing this work no means of protecting the overflow from the entry of debris or from the overflow entrance being blinded has been provided. The brick weir would have provided some means of protection through its length if nothing else. This risk is evidenced by the large amount of debris found in the final overflow before the road crossing. This is blocking the overflow pipework from both overflows and with time may result in flooding of the road with a risk to the general public. If the blockage is higher up the pipe or at the inlet this could result in overtopping of the dam and failure of the dam. The likelihood of this occurring is extremely high if a means of protection and maintenance is not put in place. The pipes are likely to become blocked and at some point the dam will overtop. There is no other drawoff system from this reservoir and the overflow is continuously flowing (possibly with the exception of drought conditions). If debris floats into the unprotected overflow this could cause a critical blockage during normal weather conditions and does not require heavy rain or “flood” conditions to raise the potential risk level. With no other routes for water to take the dam will eventually be overtopped.

Regarding flow capacity of this overflow, the pipe is a horizontal outlet with its crown only 450mm below the embankment crest; therefore the volume flow rate through the pipe will be limited by the available head over the pipe inlet. The capacity is not likely to exceed 0.1m^3/s at the point at which the dam overtops. The pipe is also likely to suffer from air entrainment that will further reduce its capacity.

Remedial measures

The inspection of 2012 recommended that measures are implemented as soon as possible to lower the reservoir water level to 0.5m below the level of the original overflow weir and I agree with this recommendation.

The overflow at the centre of the embankment has been lowered but this has not lowered the normal water level to 0.5m below the original weir level. **I recommend that this lowering in water level should be instigated as soon as possible and maintained until other measures are in place to provide permanent means of passing flood flows safely.** This lowering provides some additional storage within the reservoir as a safety margin until other actions can reduce the risk of overtopping, and also permits easier investigation of the present pipe condition.

It is likely the flow capacity of the combined overflow arrangement is insufficient to pass a reasonable flood event. Further, the nature of the piped overflows and the lack of any other means of safe overflow or draw down put the dam at risk of overtopping through blockage of pipework or inlet.

I recommend that measures are investigated and implemented as soon as possible to provide permanent means of passing flood flows safely. This will require some further investigation and analysis of the possible flood flows, with detailed analysis of the present pipework after investigation and survey.

10.5 Valve shaft and tunnel

There are no valves shafts or tunnels.

10.6 Inlet and outlet pipework and valves

As noted in Section 9.7, there is no inlet pipework feeding into the reservoir of any relevance to the safety of the reservoir. One of the two siphon pipes may have originally formed an inlet. There is a culvert discharging into the reservoir at the northern end but there are no features of relevance to safety.

The outlet, the original reservoir drawoff, pipework consists of the two siphons that pass over/through the crest; neither of which are in a serviceable condition. One of these, it is unknown which, is likely to have originally been an inlet pipe back from the sand processing plant.

There is no known low level drawoff or scour arrangement. There is no operable means of lowering the water level.

There are no plans in place, recorded methods or facilities readily available to provide a temporary means of drawing down the reservoir.

Currently the reservoir is not used for any purpose other than a recreational fishing club reservoir. There is no reason to provide a drawoff other than for safety related purposes. I consider that the nature of this embankment dam requires a means of lowering water levels in an emergency situation. **I recommend that a means of lowering the water level is investigated and implemented.** This could comprise a new siphon pipe passed over the crest or sleeved through the existing siphon pipes. There are a number of other alternative methods. **This drawdown should be sized to the Guide to Drawdown Capacity for Reservoir Safety and Emergency Planning produced by the Environment Agency. Alternatively a risk based approach could be used to determine a reasonable drawdown rate for this non statutory reservoir.**

The valve chamber below the reservoir is in a very poor condition. The cover is highly corroded and collapsed. The chamber is partially hidden in undergrowth. This chamber forms a significant hazard to the general public and grounds maintenance operatives. **I recommend that the chamber should be fully exposed and that the existing arrangement should be recorded on a drawing and reviewed to confirm that there are no other features within the chamber that are necessary to the safety of the dam. If the chamber is found to serve no other functional purpose, as I expect, I recommend that this chamber is removed, the valvework removed and disposed of, and the ground reinstated to make the area safe. In the short term a barrier should be erected around the chamber to warn persons of the hazard.**

Following inspection of the downstream valve chamber I do not consider that the two siphons could be easily brought back into service. The dimensions, arrangement, internal condition, location down the downstream face, intake details and control valvework are all unknown and would be difficult to safely determine. The pipework could be used as a conduit and lined with a new flexible siphon pipe. The pipes will each require the addition of valves downstream of the dam toe, to control the release of water and to permit the initial filling of the length of pipe above the valve and up to the dam crest. Sudden opening of the valve may be capable of starting siphonic flow, but a priming header tank or temporary pumps may be needed. The existing valve chamber could be re-purposed to house the siphon downstream valves. Providing the existing pipes remain in place as a continuous unit from low on the upstream slope to the limits of the downstream slope it should be cost effective to modify and use them for water abstraction by siphon action rather than purchasing or hiring mobile pumps together with suction and delivery hoses. Once siphon flows are initiated the running costs should be negligible. A means of priming the siphons as and when required would need to be determined.

Downstream of any new drawoff valves, outlet connections will be required from both pipes to the overflow drain to release the abstracted water safely to the downstream watercourse. Alternatively if the pipes extend in satisfactory condition and can be accessed more easily downstream of the public road crossing, then the valve installation can be remote and the increased differential head may improve the hydraulic performance. At the downstream side of the high point of the existing pipes a smaller diameter accessible connection will be required to use when filling the pipe with water from the reservoir, and for drawing off trapped air to improve hydraulic efficiency.

Provision of a facility to dewater the reservoir is likely to be an essential safety requirement if the reservoir is ever considered to be High Risk under revisions to the Reservoirs Act 1975 brought about by the Flood and Water Management Act 2010.

10.7 Seepages/drainage flows

Conditions were not ideal for observing possible seepage through the dam due to the thick brambles on the downstream face of the embankment. However, there was no discernible flow into the car park area below the dam.

There are no known features to allow seepage or drainage flows to be measured.

As discussed in section 10.3 the owner strimmed a small area at the foot of the dam towards the left mitre. The exposed ground was wet and soft but this may be due to water trapped in the surface vegetation and top soil and not related to seepage. It would not be possible to identify normal signs of seepage on the existing embankment face or immediately downstream of the toe. **I recommend, as previously stated above, that the vegetation is removed from the embankment face and for 3m beyond the toe of the dam and a good swarth of grass be promoted and maintained.** This is to allow signs of seepage to be identified at an early stage.

Some seepage is evident rising on the steps to the left mitre. This would appear to be from broken field drains entering the site from beyond the left abutment and not related to the embankment. It would be advisable to fix these pipes and control this flow before it forms an erosion channel with the footpath or mitre. The broken crowns of field drains were visible on the footpath.

10.8 Settlement and movement

I only saw evidence of minor and expected settlement in the crest of the dam and this did not give cause for concern.

There is cracking across the upstream brickwork slope protection to the left bank just upstream of the dam. This appears to follow the line of the overflow pipe. It is likely that there has either been settlement of the pipe or washout of the pipe bedding or backfill into the pipe causing settlement of the ground above and cracking of the masonry. The cracking could lead to failure of the slope wave protection. It is in the embankment return to the left abutment that is partially protected from wave action by the overflow structure. The movement appears to be long standing and there does not appear to be recent movement. **I recommend the crack is monitored and included on a regular maintenance monitoring schedule. If further movement occurs the masonry should be removed, the backfill reinstated, and the wave protection reinstated. The recommended CCTV pipe inspection should be reviewed to determine if there is loss of material into the pipe in this area and if there is then the pipework should be repaired.**

10.9 Instrumentation

Not applicable.

10.10 Method of recording water levels

Water level has not been recorded at the reservoir to my knowledge. No historic data was made available.

There is no fixed facility to enable measuring water level. **I recommend that a gauge board is fitted to the side of the left bank overflow and that water levels are recorded no less than weekly. The two overflow**

levels, the crest level and the upstream and downstream embankment toe levels should also be measured for use in comparison against this recorded water level.

10.11 Access for maintenance and emergency

I consider that there is adequate access to the reservoir for maintenance and emergencies. There is no vehicular access to the crest in the event that pumps need to be brought to site to reduce the water level. It may be possible to reach the abutment using four wheel drive vehicles or tracked vehicles if this is required. This should be considered against any methods to lower water level.

The two footbridges across the inlet and the drainage ditch to the left bank are in a poor condition. The bridges are formed of scaffold with plastic imitation wood planking. The scaffold tubes are highly corroded and hidden below the planking. They are a safety risk. **I recommend the bridges are replaced or repaired.**

10.12 Control of inflow from direct and indirect catchments

There is no means of controlling inflow from the direct catchment, but this is nearly always the case for impounding reservoirs and is acceptable.

10.13 Movement of surrounding land which might affect the stability of the reservoir

I saw no such movement.

10.14 Area downstream of the dam

The area downstream of the dam is described in 9.12 above. I visited the industrial estate after the inspection and found no material changes have occurred that are not described in the 2012 inspection report.

11 Adequacy and condition of waste weir and overflow and channels in connection therewith

11.1 Flood assessment

Categorisation

As this reservoir is smaller than the limits of the Reservoirs Act 1975, there is no output from the national programme of reservoir inundation mapping undertaken in 2009–10 under the sponsorship of Defra and the Environment Agency. No information has hence been made available to the undertaker regarding the potential loss of life or property damage implied by an inundation analysis.

Guidance for categorisation of dams with more than 25,000m³ of storage may not be fully relevant but is the only guidance at present. This is summarised within Table 1 of “Floods and reservoir safety: an engineering guide, ICE, 4th edition, 2015”. From an examination of the 1:25 000 OS map, a cursory confirmation on ‘Google Earth’ aerial photography and a visit to the Rainford Industrial Estate and Mill Lane, I conclude that, having regard to the relatively small capacity of the reservoir, the reservoir may be placed in Category C, “where a breach would pose negligible risk to life and cause limited damage”. In making this assessment, I have taken account of:

- the public road passing immediately below the dam;
- the extent of ‘critical infrastructure’ implications, notably within the Rainford Industrial Estate;
- the presence of dwellings along Mill Lane that may be subject to some flooding but where lives are unlikely to be endangered and the flat nature of the bankside topography along the Rainford Brook from 500m above Mill Lane Bridge down to Crank Road some 1.5km downstream.

It must be noted that the drainage system below the dam is complex and the direction of any flood flow may be unpredictable without accurate flood mapping. Following inundation mapping it may be found that the reservoir is placed in Category B or possibly A with an increased required standard of protection. This should be fully understood before any related works are completed to the dam to prevent re-work at a later date. If a new overflow is to be provided it may be sensible to size it for the higher category, subject to a review of the cost and impact difference between the two categories.

Freeboard

The dam as inspected had a freeboard of only some 660mm to the overflow weir (pipe inlet invert) located centrally on the embankment. The freeboard was 450mm prior to removal of the masonry weir wall around this pipe inlet. If the water level can be reduced to 0.5m below the left bank weir, and that is about 150mm lower than the central weir, there could be 1000mm of storage available to extend the period until overtopping starts after commencement of a period of heavy rainfall.

Wave surcharge allowance

Following the procedure given in the ICE Floods and Reservoir Safety 4th Edition (2015) I have calculated the appropriate wave surcharge allowance, based on the following primary assumptions and data:

Fetch	300m (bearing approx 30degrees clockwise from north)
50-year wind speed	23m/s
Factored design wind speed	16m/s
Significant wave height (H_s)	0.16m

The significant wave height will be approximately 0.16m (this is the amplitude of the wave from trough to peak). The freeboard above top water level, the overflow inlet lip level, is approximately 0.66m. This may give some protection to the dam with the limited exposure of the dam to wave action. This should be compared with the flood rise calculated for the dam after a sufficient dimensional survey is completed. From calculations into the estimated amount of wave overtopping the available flood surcharge is as little as 200mm above overflow lip level before wave overtopping will commence. The lack of grass or any other protection to the embankment downstream surface makes it liable to erosion from small overtopping flows. A good grass swarth would improve the embankments ability to withstand some wave overtopping flow.

Flood flow capacity assessment

A flood flow assessment was completed for the 2013 inspection report. This is included in full below for information only. The method of calculating the flood flow has been modified since this previous report was completed and a new assessment should be made before any alteration to the overflow is undertaken. An assessment of the flood flow is not within the remit of this current report.

The catchment area was assessed to be some 0.7km². From the graphs provided in Figures 5 and 8 of “Floods and reservoir safety: an engineering guide, ICE, 1989”, using the local rainfall parameter RSMD as 35mm and the peak flow intensity is 14m³/s per km² of catchment, a PMF of 9.1m³/s. For a Category C dam the design flood inflow is 0.3PMF for a 1:1000 year flood, 2.8m³/s.

With the water level at crest level the flow through the central overflow was assessed in the 2012 report to be less than 0.2m³/s. If there were no blockage in the left bank overflow it was estimated that the flow through to the first manhole is likely to be less than 1.4m³/s.

At an inflow of 2.8m³/s the reservoir level will rise at 0.8m/hr. With optimistic estimates of the flow through the present pipes with blockages cleared of 1.6m³/s the rate of rise may reduce to 0.5m/hr. With 1.05m between reduced water level and crest, that suggests overtopping from the design flood in perhaps 1.5 to 2.5hrs, which may be sufficient duration to have passed the peak level before reaching the crest.

The duration of the unit hydrograph for the design flood flow event was not assessed. This would permit assessment of the maximum level rise.

Adequacy of present flood passage arrangements

Taking account of the above, **I consider that a flood study to the current standards should be carried out and expect the findings to confirm the present flood passage arrangements to be inadequate**.

11.2 Alterations to overflow sill

The central overflow has been altered following recommendations of the earlier 2012 inspection. The top water level was previously set by the left bank overflow weir lip level. The top water level is now set by the central pipe overflow invert level which is approximately 660mm below the crest level at what appears to be, without a full topographic survey, the lowest embankment crest level.

This reservoir has no alternative drawdown facility. All incoming flows pass through the current overflow facility. The normal water level within the reservoir is therefore above the overflow sill level. This sill level is the conventional definition of top water level (TWL) as defined within the Reservoirs Act. The depth of water passing through the overflow will reduce the flood freeboard available at the commencement of any flood event.

11.3 Any alteration in level to which water may be stored

I recommend a lowering in the normal water level by a minimum 0.5m from the original left bank overflow weir level, by pumping or siphon action. This should be maintained as continuously as possible until other measures are in place to provide permanent means of passing flood flows safely.

11.4 Efficiency of scour pipe and other means of lowering the water in and controlling the inflow to the reservoir

There is no known scour pipe, and no permanent means of lowering the water level**. I recommend that a method of being able to draw the reservoir down and lowering the water level in the event of an incident is investigated and implemented.**

There is no means of controlling inflows to the reservoir from its direct catchment, but this is normally the case for impounding reservoirs and is acceptable.

Conventional methods of lowering the water level are often by: installation of a low level drawoff which may not be feasible in this instance; by siphon which is anticipated to be the most appropriate in this instance; by installation of a lower opening in the overflow weir (a sluice gate in the left bank overflow weir wall) which may be a feasible option; or by temporary or permanent pumping which carries long term operating costs and may not be reliable.

12 Seismic risk

Following the guidance by the Institution of Civil Engineers (1998), the reservoir can be classified for seismic risk as follows:

Capacity classification (<0.1 x 10^6 m^3):	0
Height classification (<15m)	0
Evacuation requirement classification (1–100)	4
Potential downstream damage classification (moderate)	8

giving a total classification factor of 12 and hence a seismic category of II. This requires an SEE (safety evaluation earthquake) of return period 3000 years, which would (according to Figure N1 of the ICE guidance) have a peak ground acceleration of less than 0.2*g*. For a Category II embankment dam with a height less than 15m, the ICE guidance calls for an E_b safety evaluation, which is defined as follows (Table N5):

'E_b look for features particularly vulnerable to earthquake damage and undertake seismic analyses only if such features [are] found'

An embankment dam is fundamentally highly stable and not vulnerable to catastrophic failure under seismic loading. There are no single features that are potentially more vulnerable other than potentially the left bank overflow masonry chamber. Failure of this masonry weir would reduce the reservoir water level and should have no further immediate consequence; although there is a low risk that it may lead to blockage of its outlet pipe. I consider that no further seismic evaluation is required.

13 Supervision provided by the undertaker

No formal supervision is provided. The reservoir is regularly used by members of the Angling Association.

While the regular visits by the anglers do provide some form of monitoring, it is unlikely to capture slow degradation issues and does not enforce actions such as ensuring good grounds maintenance. **I recommend that the reservoir is visited weekly and that a schedule of monitoring records is prepared and maintained no less than monthly. Water levels should also be recorded monthly.**

14 Correctness of particulars in the prescribed form of record required to be kept under Section 11 of the Act

While there is no legislative requirement to store records as prescribed under the Reservoirs Act 1975, **I recommend that efforts are made to obtain such records and that these are stored in a known location to make them available in the event of an incident.**

15 Findings and recommendations of the engineer

15.1 Recommendations in the interests of reservoir safety

I recommend the following:

1. I consider the present flood passage arrangements to be inadequate. I recommend that a flood study is carried out. I recommend that measures are investigated and implemented as soon as possible to provide permanent means of passing flood flows safely;
2. That measures are implemented as soon as possible to lower the reservoir water level to 0.5m below the level of the original left bank overflow weir. This reduction should be maintained as continuously as possible until other measures are in place to provide permanent means of passing flood flows safely;
3. I recommend that a method of being able to draw the reservoir down and lowering the water level is investigated and implemented. This drawdown system should be sized to satisfy the Guide to Drawdown Capacity for Reservoir Safety and Emergency Planning produced by the Environment Agency. Alternatively a risk based approach could be used to determine a reasonable drawdown rate for this non statutory reservoir;
4. A screen should be provided to prevent debris entering the central overflow or blocking its inlet. This should be installed as soon as possible. The screen should be designed such that it provides an underflow bypass allowing water into the overflow in the event the screen grillage itself becomes blocked. The top of this screen must give a suitable freeboard to the embankment crest;
5. That the left bank overflow intake screen is replaced retaining the current ability to have an underflow bypass. The top of the screen should provide a suitable freeboard to the embankment crest. That the left bank overflow brickwork damage is repaired and the upper surface of the weir is protected with a suitable protective mortar;
6. Complete removal of all tree, sapling and shrub growth of less than 100mm in diameter from all surfaces of the dam embankment, to 3m beyond the toe of the embankment and beyond both abutments and from the brickwork bank protection. Trees larger than 100mm in diameter should be coppiced or pollarded where suitable or otherwise thinned. This is to reduce the risk of them falling over under high winds. Sufficient branches should be removed to limit any leaf debris that may inhibit good grass growth and also to allow light through to encourage a good growth of grass across the embankment. Preferably all trees should be removed subject to the depth of their roots and the risk of these roots decaying and forming seepage paths. A tree surgeon should be regularly consulted regarding the health of any remaining trees and their ability to withstand strong winds;

15.2 Recommendations in respect of records

1. It is important to ensure that any available information about the reservoir and its history is permanently secured against accidental disposal and remains available to the undertaker and future inspecting engineers. To that end, I recommend that efforts are made to obtain historic records for the reservoir and good quality copies of any available historic documents and drawings should be kept by the undertaker in a permanent secure store. Records may be available with local resident, with local libraries and historic societies, with the original owners or with members of the long standing angling association;
2. That the results of internal drain inspection and a dimensional survey of the dam are recorded on survey drawings detailing all physical dimensions of dam embankment and overflow structures; These should be used to permit analysis of the present hydraulic capacity of the installed facilities. These records should be safely stored for future use;

3. Discussion with the highways authority to determine responsibility for maintenance of the culvert crossing the highway and support of the embankment faces;
4. The redundant valve chamber below the dam should be fully exposed, the existing arrangement should be recorded on a drawing and reviewed to confirm there are no other features within the chamber that are necessary to the safety of the dam;

15.3 Matters of maintenance and safety of personnel/public

1. That any obstruction of the additional weir and/ or original overflow chamber should be removed as soon as possible. That overflow screens should be cleaned frequently, at least once per week, depending on weather and water levels. The screens should be inspected during or soon after heavy rainfall events or strong winds;
2. Any bushes or saplings that start to grow anywhere on the dam embankments or in the vicinity of drains should be promptly removed. Any vegetation growth on the dam and close to the dam toe and mitres should be kept trimmed;
3. Removal of trees or tree branches that overhang the reservoir waterline to reduce leaf and dead branch fall into the water that provides material for blockage of screens and pipes. This requirement may be omitted dependant on the design of new overflow screens or the installation of a new overflow system that does not include a piped overflow;
4. Removal of all bramble and similar growth from the dam embankments, and measures be taken to encourage dense grass growth as soon as possible. This grass should then be maintained at no less than 4 times per year or as necessary to produce a health swarth of between 50mm and 150mm in height;
5. Investigation of the original overflow pipe by CCTV from both directions along the pipe to determine the position and length of any blocked/damaged pipe. As these pipes form the only means of passing flow this investigation by CCTV should be completed no less than every two years and in the event of any signs of blockage. That, whilst investigating the first length of overflow pipe, the condition and location of the remainder of the original overflow pipe all the way to the outfall on the south side of Higher Lane is determined;
6. Significant infestations by burrowing animals close to the dam embankments should be dealt with when necessary;
7. If the redundant valve chamber is found to serve no other functional purpose, or is not to be re-purposed for use in another measure above, I recommend this chamber is removed, the valvework removed and safely and disposed of and the ground reinstated to make the area safe. In the short term a barrier should be erected around the chamber to warn persons of the hazard;
8. That the two footbridges, at the inlet and across the left bank drainage ditch, are replaced or made safe;
9. That chamber covers should be kept in place with all openings protected.

15.3 Matters to be watched by a person responsible for monitoring the condition of the reservoir

The following would partly fall within the Supervising Engineers duties if the reservoir fell within the Ambit of the Reservoirs Act 1975. The reservoir currently does not fall within the ambit of the Act but it is recommended a responsible person monitors the reservoir condition.

1. I recommend that the reservoir should be regularly monitored by adopting a weekly walkover of the dam and environs, looking out for any damage or changes that should be brought to the attention of a suitably qualified engineer;
2. I recommend that a schedule of items to be watched be prepared and this should be updated on a monthly basis. It should include monitoring water level, inspecting both overflows for blockage, and the general condition of the embankment;
3. I recommend that the overflow manholes and the discharge headwall downstream of the overflow weir are inspected no less than every three months or after any significant storm or high winds and in the event of any signs of blockage at the two inlets;

4. That the crack over the left overflow pipe through the wave protection brickwork is monitored and included on regular maintenance monitoring schedule. If further movement occurs the masonry should be removed, the backfill reinstated and the wave protection reinstated. The recommended CCTV pipe inspection should be reviewed to determine if there is loss of external material into the pipe in this area and if there is then the pipework should be repaired or replaced;
5. I recommend that a gauge board is fitted to the side of the left bank overflow and that water levels are recorded no less than weekly. The two overflow levels, the crest level and the upstream and downstream embankment toe levels should also be measured for use in comparison against this recorded water level;

16 Signature of Engineer and date of report

David Prisk BEng, MSc, CEng, MICE, SupE Res Act.

Supervising Engineer's Panel expiry 18th July 2021

Draft report reviewed by John Christopher Ackers, All Reservoirs panel engineer, Black & Veatch, 2nd October 2017

Appendix A Documents and references

Other reports and documentation relevant to the reservoir

BLACK & VEATCH (2012), Report of a <25,000m^3 reservoir, Rainford Reservoir

References

INSTITUTION OF CIVIL ENGINEERS (1996)
Floods and reservoir safety, 3rd edition
Thomas Telford (London)

INSTITUTION OF CIVIL ENGINEERS (2015)

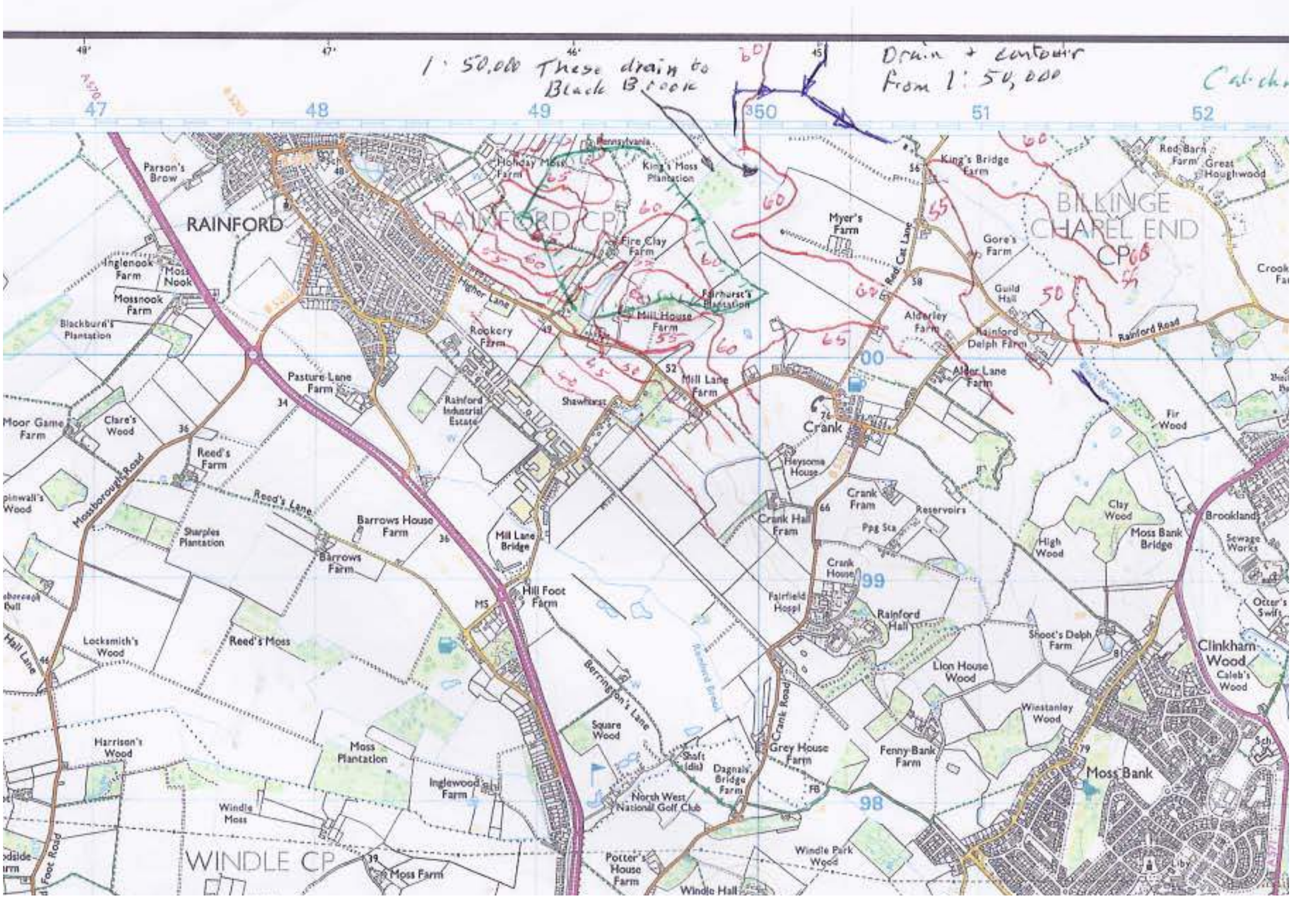
Floods and reservoir safety, 4th edition

Thomas Telford (London)

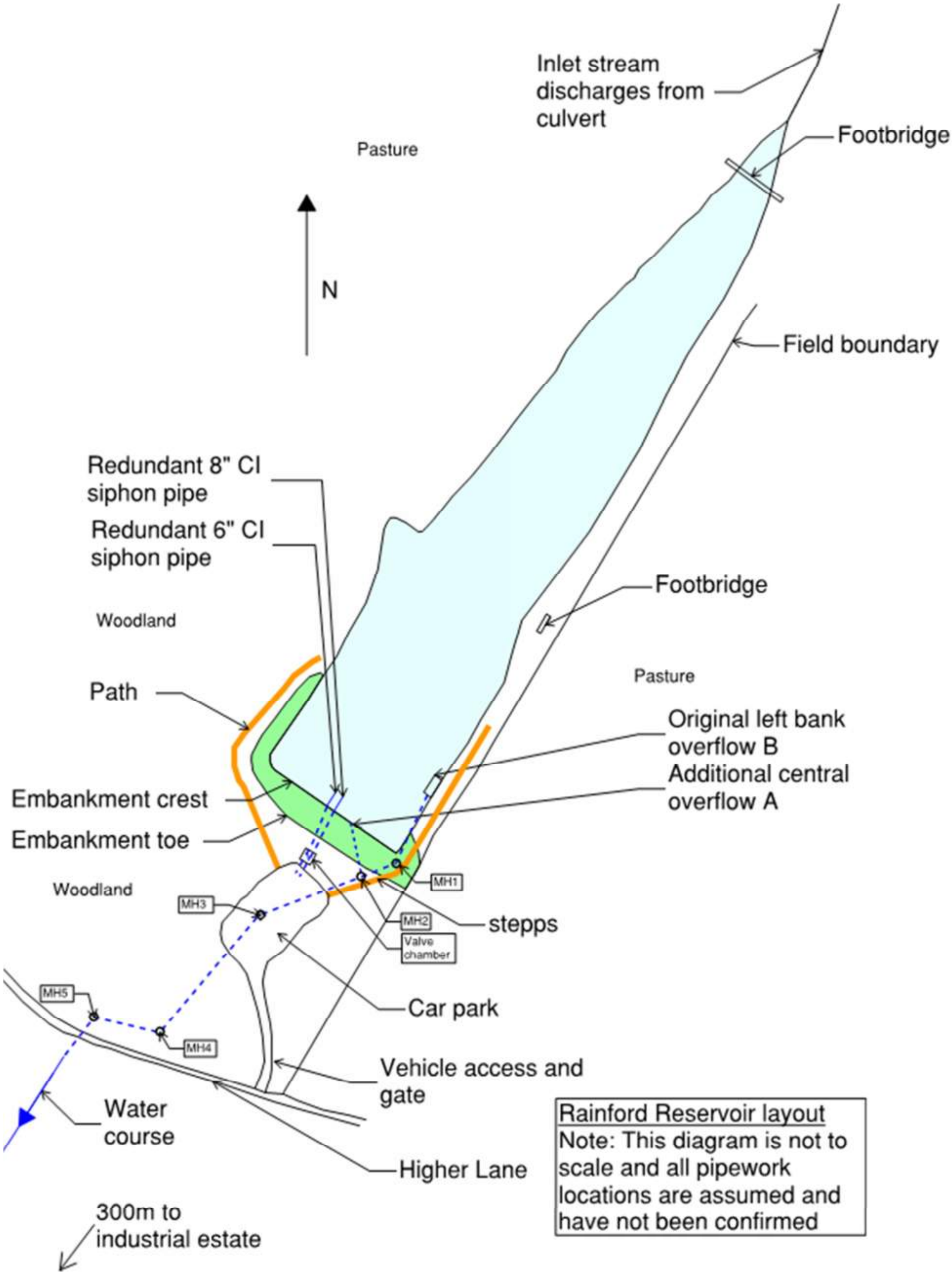
INSTITUTION OF CIVIL ENGINEERS (1998)
An applications note to 'An engineering guide to seismic risk to dams in the United Kingdom'
Thomas Telford (London)

INSTITUTION OF CIVIL ENGINEERS (2014)
A guide to the Reservoirs Act 1975, 2nd edition
Thomas Telford (London)

Appendix B 1:25000 OS map of catchment and area downstream of dam



Appendix C Sketch Plan of Reservoir Dam and Overflow Pipe Route



Appendix D Photographs


1 – Upstream embankment crest from right


2 – Downstream embankment crest from right


3 – Upstream embankment crest from left


4 – Downstream embankment crest from left


5 – Left abutment return embankment


6 – Right abutment return embankment

7 – Downstream embankment face from right

8 – Embankment face at right mitre

9 – Embankment face to left with footpath from right abutment and car park in distance. Valve chamber is within trees

10 – Embankment downstream face at right return, the right abutment is in the distance

11 – Embankment upstream face

12 – Upstream waterline around the reservoir

13 – Overflow A - inlet

14 – Overflow A – from left

15 – Overflow B – inlet screen, siphon and weir

16 – Overflow B – chamber outlet

15 – Overflow B to left and A to right

16 – Overflow B to left and A to bottom right


17 – Crack in brick wave protection downstream of overflow B, which is to the immediate right.


18 – Siphon 6”


19 – Siphon 8”


20 – Drawoff siphon valve chamber overgrown

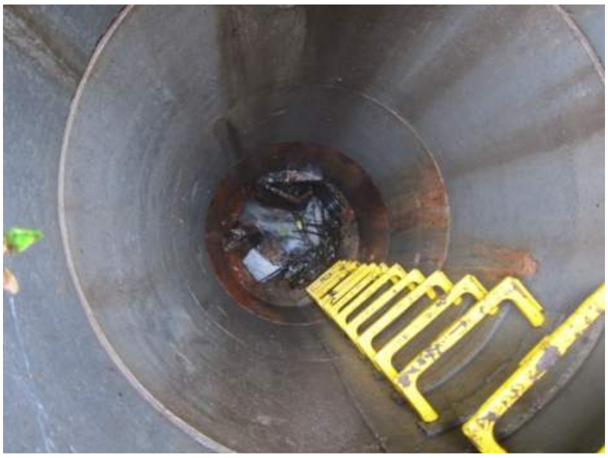

21 – Drawoff siphon chamber internals


22 – MH1 no flow from overflow B


22 – MH2 overflow A flowing and entering existing pipe from overflow B


23 – MH3 within car park


24 – MH4 new manhole, mitred bend liable to catch debris but currently appears clear, flow enters from right


25 – MH5 new manhole immediately upstream of road crossing, flow enters from upper left


26 – Discharge headwall downstream of road


27 – Water course downstream of headwall