Statutory reservoirs: matters of opinion

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SYNOPSIS The question of whether a reservoir falls within the ambit of the Reservoirs Act 1975 is not contentious for the great majority of reservoirs. This paper deals with some particular cases where efforts have been made to form an opinion on the legal status of reservoirs and where difficulties have been encountered. In a number of instances the wording of the Act has led to difficulties of interpretation between panel engineers, the enforcement authority and legal advisors in guiding the case to the most appropriate outcome. The aim of the paper is to highlight the range of issues encountered in the past to share lessons learned and to inform debate on the drafting of future legislation relating to reservoir definition.

INTRODUCTION

Under the current provisions of the Reservoirs Act 1975 (the Act) and the Water Act 2003, the Environment Agency has statutory duties as the enforcement authority for England and Wales to maintain the register of large raised reservoirs (LRRs) and to secure that the undertakers observe and comply with the requirements of the Act. The Environment Agency itself is the largest single undertaker with some 192 LLRs recorded on the register.

Since adopting this responsibility in 2004 the Environment Agency has sought the professional opinion of both lawyers and reservoir safety specialists to assist in its decision-making in relation to the proper maintenance of the register. The aim of this paper is to describe some of the more challenging cases that have been encountered from a long list of cases that have been assessed by panel engineers since 2004. The paper highlights some difficulties that have been encountered in interpreting and applying the Act and this may inform the drafting of secondary legislation for the Flood and Water Management Act 2010. It is important to note that only a court can pass a definitive judgement on matters relating to the Act: the opinions expressed in this paper, and indeed the related guidance in 'The Guide to the Reservoirs Act 1975' (the Guide) (ICE, 2000), are not

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definitive but are simply the opinions of the authors. To date, there have been no court rulings on matters of interpretation of the wording of the Act, although there are rulings on some relevant general principles and on a small number of enforcement and cost-related matters.

The cases described in this paper generally relate to the provisions of Section 1 of the Act and Statutory Instrument 1985 No 177 Schedule 2. Some extracts are given below for ease of reference:

1.-(1) For the purposes of this Act "reservoir" means a reservoir for water as such (and accordingly does not include a mine or quarry lagoon which is a tip within the meaning of the Mines and Quarries (Tips) Act 1969); and-

> *(a) a reservoir is a "raised reservoir" if it is designed to hold, or capable of holding, water above the natural level of any part of the land adjoining the reservoir; and*
>
> *(b) a raised reservoir is a "large raised reservoir" if it is designed to hold, or capable of holding, more than 25,000 cubic metres of water above that level.*

The appropriate upper elevation for the volume calculation is known as the Top Water Level. This is defined in SI 1985 No.177 Schedule 2 as:

> "*in relation to a reservoir with a fixed overflow sill, the lowest crest level of that sill, and for a reservoir the overflow from which is controlled wholly or partly by moveable gates, siphons or otherwise, the maximum level to which water may be stored exclusive of any provision for flood storage."*

The majority of the technical reservoir opinions in this paper relate to:-

- The appropriate level on site to define top water level;
- The appropriate level on site to define the lowest natural level adjoining the reservoir;
- The amount of "water" stored between top water level and the lowest natural level adjoining the reservoir;
- The definition of "water";
- Interpretation of the wording "designed to hold, or capable of holding"
- Interpretation relating to flood storage areas.

The majority of cases fall into one of the groups described in the sections below. The reservoir names and locations are irrelevant and case numbers have been used.

It should be noted that the consequences associated with dam failure are not considered in any of the opinions given in this paper as the Act itself does not differentiate on the basis of dambreak consequence. The threshold of 25,000m³ was however set as a reasonable lower reservoir volume limit that might cause endangerment to society in Britain. More recent incidents and studies have highlighted the fact that smaller reservoirs can pose a significant risk and have informed legislative change. A risk-based approach is currently being addressed through the implementation of the Flood and Water Management Act 2010 which will update the Act.

DEFINITION OF TOP WATER LEVEL

Case 1

The reservoir once had a volume of over 40,000m³ but the elevation of the outlet works was lowered such that the reservoir had an estimated volume of less than 17,000m³. The reservoir is used for stocking non-native fish under a Defra licence. To ensure that fish are retained within the reservoir, a fine steel mesh with a spacing of 2mm was installed over the outlet pipe. Under normal flow conditions, the head loss through the mesh is such that the normal reservoir elevation is considerably higher than the level would be without the mesh in place. With the mesh installed and partially clogged the reservoir volume exceeds 25,000m³. The question was therefore posed as to whether the presence of a substantially blocked screen can change the status of the reservoir to that of a large raised reservoir as defined by the Act.

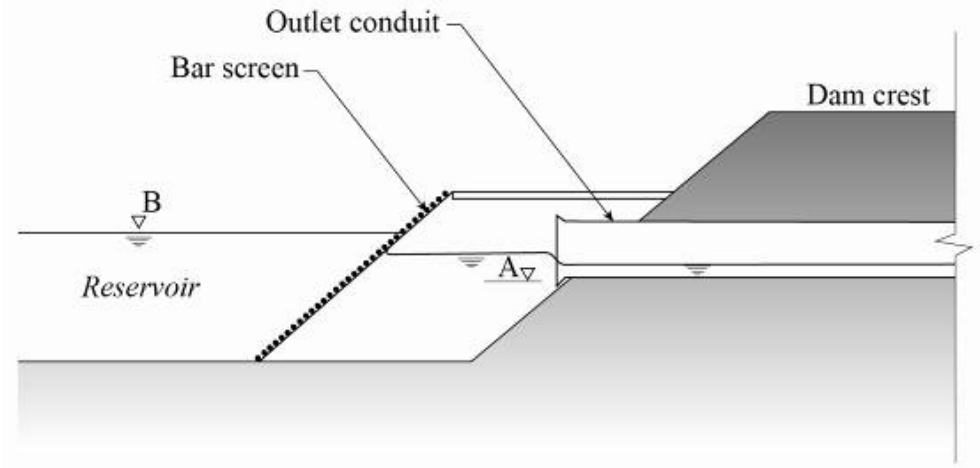

Figure 1. The head loss associated with the outlet works can generate a raised reservoir (below B) significantly greater than the raised volume below outlet sill level A.

The opinion given was that in defining top water level SI 1985 No.177 refers to a fixed overflow sill. Allowance for volume retained above the elevation of the lowest fixed sill by virtue of headlosses associated with the outlet structure, which might include for the effects of reed growth or trash screens, should not be included for in defining the reservoir capacity. The

loss of freeboard associated with a very fine or partially blocked screen should be managed through the workings of the Act (recommendations in statutory reports) where the Act applies.

Difficulties of a similar nature arise where the outlet pipe is very small in relation to inflow. In the case of an irrigation lagoon with a very small diameter low level ungated outlet pipe and pumped inflow, how should top water level be defined? Such matters are usually determined on a case-by-case basis. Where a pipe is so small in relation to the inflow that it is permanently submerged, it is difficult to argue that such a pipe represents an 'overflow'.

Case 2

This case relates to the issue of a moveable outlet gate. At this reservoir the overflow structure does not comprise a fixed sill but has a moveable sill, operated by a handwheel. The gate mechanism comprises a moveable steel plate which slides vertically against a fixed weir (Figure 2). The overflow sill is therefore represented by the top of the gate which is raised and lowered throughout the year to maintain a near constant water level in the reservoir. Normally, during the winter months when the natural inflow rate to the reservoir is relatively great, the sill is kept low. At other times of the year the sill is raised by up to about 300mm in order to maintain the reservoir water level under low inflow conditions to preserve a suitable water depth for fishing. With the moveable plate in the fully raised position, it is not possible for water to pass under it. Water only passes over the sill and the sill elevation is variable.

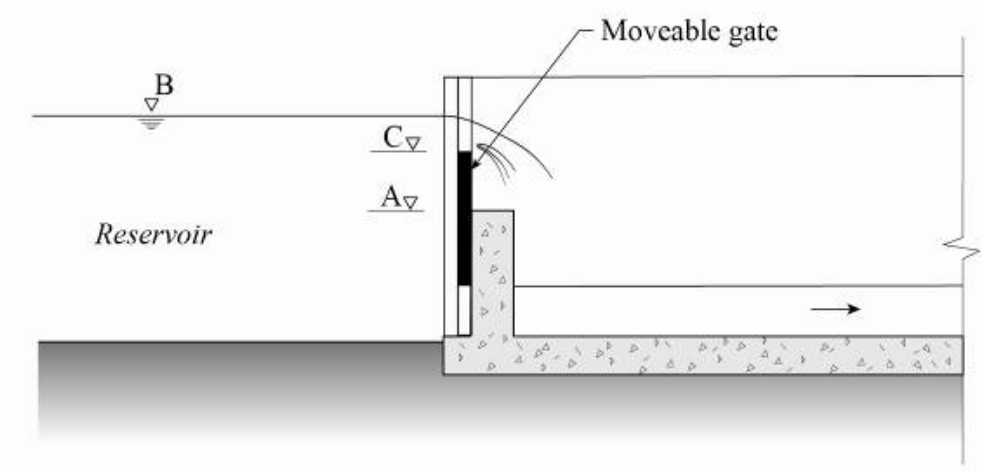

Figure 2. The moveable gate changes the retained reservoir volume from that below fixed sill 'A' to that below moveable sill 'C'. The volume between 'B' and 'C' is treated as temporary storage.

The legal status of the reservoir was contested by the reservoir owner. Surveys and calculations were carried out to assess the reservoir volume for

the range of gate positions. With the gate at the fully lowered position the volume was found to be very close to the 25,000m³ threshold. With the gate raised, the volume to the sill level was found to be over 40,000m³.

SI 1985 No.177 states that in the case of a moveable gate, it is the maximum level to which water can be stored, exclusive of flood storage provision that defines Top Water Level. As the surveyed volume at the maximum practicable gate level was found to be is greater than 25,000m³, and all of the contents were clearly above the lowest adjoining natural ground level, the opinion was given that the reservoir falls within the ambit of the Act.

GEOGRAPHICAL SETTING

Case 3

This case highlights the problem in assessing very small dams in relation to the adjoining ground. In this case the dam was found to be less than 1m high (see Figure 3) but the reservoir surface area was over 55,000m². The precise dam height was therefore critical in deciding whether the reservoir was to fall within the ambit of the Act.

Figure 3. Reservoirs formed by very small dams can pose difficulties

The stream bed immediately downstream of the dam featured cobbles. The question raised at the time of the site survey was whether the stream bed should be taken on top of the cobbles or to the stream bed. Fortunately it was found that even taking the stream bed elevation the dam height was just 0.36m and the estimated volume less than 25,000m³. In retrospect, the top

of the cobbles might reasonably have been treated as representing the natural level. However had a boulder been present in the streambed downstream of the dam, clearly one would have to take the level not of the top of the boulder but of the material at the base of the boulder. Pragmatically (but not necessarily legally), the answer should be to take the elevation of the material which might reasonably remain in place in the event of a dam breach but this requires engineering judgement and cannot easily be defined in legislation.

Case 4

This case discusses the definition of "natural level of any part of the land adjoining the reservoir". This reservoir was constructed on the site of gravel workings. It comprises a non-impounding reservoir used for water sports and is embanked on three sides. The reservoir was constructed under the provisions of the Act but no Final Certificate was ever produced and some years later there was correspondence from the owner's solicitors disputing the legal status of the reservoir. The view of the owner was that the reservoir is below what was once the natural ground profile prior to gravel quarrying and therefore no water had been raised above adjoining natural ground. The volume above the lowest surrounding part of the reservoir was estimated as over 40,000m³.

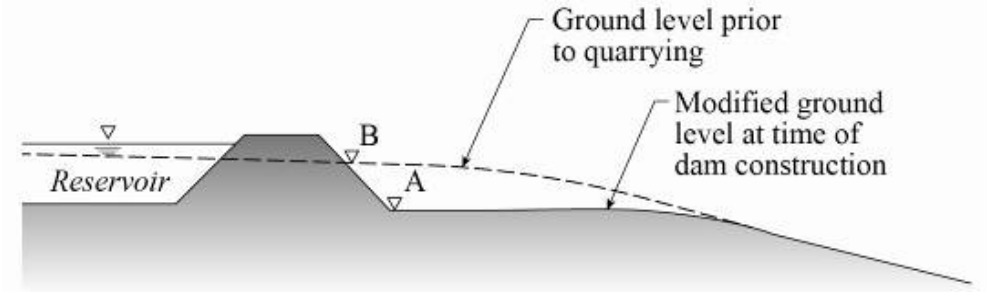

Figure 4. The owner of this reservoir argued that the reservoir volume for the purposes of the Act should be related to level 'B' rather than 'A' as the natural ground level.

The Act relates to the escape of water from a raised body of water onto adjoining natural ground. The level of natural ground changes over time both through human activity and natural processes. Where natural ground has been 'worked', it seems pragmatic to adopt the 'worked' level in applying the Act, regardless of whether the ground has been lowered (quarrying, dredging) or raised (fill). There is no provision in the Act to exclude bodies of water that lie below some historical level of natural ground. Modification of the land level surrounding a reservoir could either create a large raised reservoir or effectively provide discontinuance. The reservoir clearly posed a threat of releasing an escapable volume of water

exceeding 25,000m³ onto surrounding ground and the opinion given was that it should be registered under the Act.

The enforcement authority took legal advice on the matter. Counsel advised that 'natural level' in the context of section 1.(1)(a) of the Act simply means the level the ground would have had, but for the artificial construction of the reservoir.

MULTIPLE RESERVOIRS

Case 5

There are two reservoirs at this site. The question was raised as to whether the combined volume held by the two reservoirs constitutes a single reservoir within the ambit of the Act.

The two water bodies are separated by a dividing bund as shown in Figure 5. Water flows over the bund from the upper to the lower pool. The raised volume of the upper pool is over 13,000m³ and the raised volume of the lower pool is about 22,000m³. Valved conduits exist through the dividing bund and a siphon arrangement was periodically used to convey water over the dividing bund.

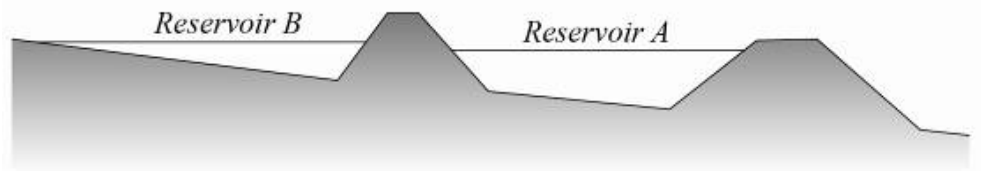

Figure 5. If the dam retaining Reservoir B is incapable of withstanding a breach of the dam retaining Reservoir A, should the statutory volume relate to Reservoir A or A+B?

The dividing embankment has a crest width of 5m and side slopes of 1V:3H. The opinion was given that the dividing embankment should be able to withstand a rapid reduction in water level on the downstream side associated with breach of the lower embankment. Hence in this case the advice was given that the two reservoirs should be treated separately under the Act and as neither volume exceeded the 25,000m³ threshold, neither reservoir should be registered. There is no explicit guidance on this type of arrangement in the Act. Had the central embankment been assessed as unable to withstand the removal in load associated with failure of the downstream embankment, the pragmatic interpretation of the Act would have been to have had the reservoir registered and treated as a single reservoir. This might however have given some difficulty in defining top water level for example.

Case 6

This case involves a group of three reservoirs which were originally constructed within the footprint of a single much larger reservoir. The

original reservoir is shown on a nineteenth century map which shows the reservoir as a pleasure pool. In 1971 the reservoir was substantially modified by the construction of a motorway which dissected the reservoir (see Figure 6).

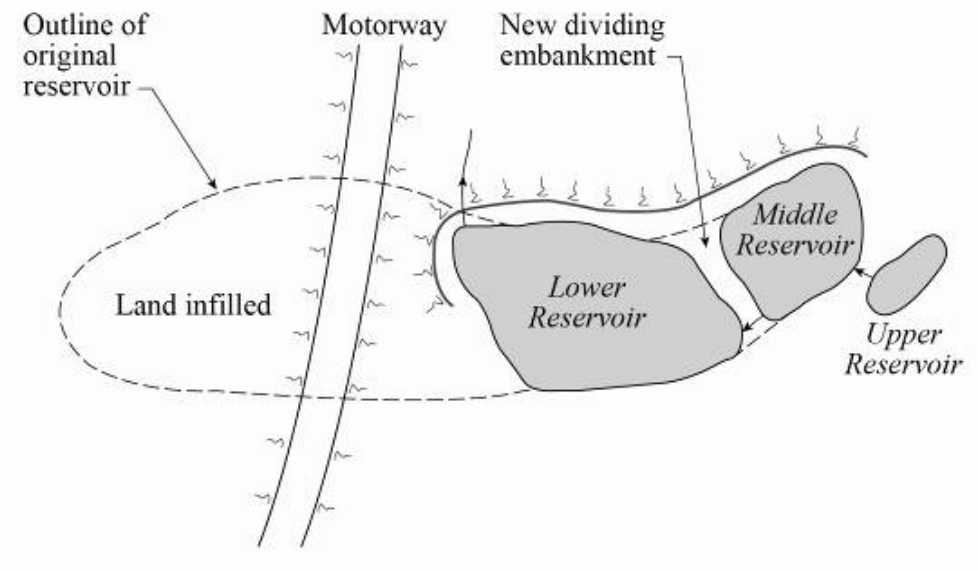

Figure 6. Sketch plan of reservoir complex for Case 6

The portion of the original reservoir to the west of the motorway appears to have been infilled. The portion to the east of the reservoir is believed to have been divided into two separate reservoirs at around the same time as the motorway construction by construction of a dividing embankment. The origin of a third (very small) reservoir, located to the south-east of the eastern reservoir, could not be clearly determined. All three reservoirs are held at slightly different elevations in a cascade arrangement. The two main reservoirs share a common embankment on the northern side. The reservoirs were estimated to have raised volumes of approximately 16,000m³, 10,000m³ and 1,000m³.

Inspection reports under the 1930 and 1975 Acts had been prepared for the two larger reservoirs, treated as a single reservoir, dating from the early 1980's. The reservoirs were first registered in 1986, when the 1975 Act was enacted (there was no register of large raised reservoirs under the 1930 Act). It should be noted that the 1930 Act applies to reservoirs of over 5 million gallons capacity (approximately 22,500m³). The combined volume of the two main reservoirs was estimated at the time as 22,730m³, thereby only just over the 1930 Act threshold. An opinion was sought as to whether the reservoir(s) should remain on the register.

Statutory instrument 1985 No.177 refers to the capacity of the reservoir at top water level. For there to be one value for capacity, there can only be one top water level. The dividing embankment between the two main

reservoirs was designed to hold (and is capable of holding) water in the eastern reservoir at a higher level than the western reservoir and features a separate spillway sill to retain the eastern reservoir water level at a higher elevation. Consideration was given to a possible low level hydraulic connection of low capacity. Had there been a small low level conduit connection between the two reservoirs through the dividing embankment, failure of the common northern embankment retaining either of the two main reservoirs would lead to the release of the combined reservoir volume. No evidence of such a hydraulic connection between the two reservoirs could be found. Site inspection also determined that the dividing embankments between the three reservoirs were all likely to survive rapid downstream lowering through dam breach so a cascade failure scenario (downstream to upstream) did not appear credible.

The opinion given was that the reservoir(s) originally came under the ambit of the 1930 Act but would have ceased to do so following the construction of the motorway and the dividing embankments in the 1970's (note that there was no formal discontinuance process under the 1930 Act). In fact it was erroneously added to the register under the 1975 Act. Under these circumstances, discontinuance under Section 13 of the Act was not deemed necessary: the reservoir(s) was simply removed from the register.

SEDIMENT

The question of how to deal with sediment in relation to reservoir capacity has been a difficult question to resolve. An attempt to clarify the matter is provided in the Guide but the advice given in the guide on this matter has not received universal support, even amongst the contributors to the Guide.

The Guide states:

> *"The status of deposited silt is not defined. The view has been expressed that, if the deposited sediment can flow, there is no reason to consider it to be different from water. The term "escapable contents" has been used in lieu of water and is a reasonable concept."*

The case study below is a case where the advice by an AR Panel engineer not to register a reservoir was contradicted by lawyers advising the Enforcement Authority and the reservoir has subsequently been registered.

Case 7

This case relates to how sediment was treated in determining the legal status of reservoir formed by a 9m high embankment dam featuring a crest road and a masonry retaining wall on the downstream side. The reservoir was believed to have been constructed prior to the 1930 Act but was never registered. The reservoir area has substantially silted up such that the water storage capacity below the Top Water Level is currently a small fraction of the original reservoir capacity. Following concerns for the condition of the

dam in 1990, the local authority sought to clarify the legal status of the reservoir. A bathymetric survey carried out found the reservoir water volume to be less than 18,300m³. In times of flood, floodwater passes over the dam crest and the legal status of the reservoir has once again been assessed.

Panel Engineer's Opinion

The first step was to re-assess the reservoir volume using the "escapable contents" concept. Using the 1990 survey results and some conservative assumptions for the amount of silt that would escape as a result of dam breach, the reservoir volume was still found to be less than 23,200 m^3. Sedimentation within the reservoir over the last 20 years means that a more detailed survey and analysis should find a lesser volume. The opinion therefore centres on the interpretation of the wording from Section 1 of the Act:

> *"a raised reservoir is a "large raised reservoir" if it is designed to hold, or capable of holding, more than 25,000 cubic metres of water above that level.*"

The Guide provides the following advice:

> *" The Act provides two tests for a reservoir to be a raised reservoir: it is designed to hold, or capable of holding. These tests have caused concern in relation to the registration of reservoirs, which have been partially filled with sediment, which is now so dense that it is unlikely to flow.*
>
> *However the tests are alternative. Where it can be shown, by whatever means, that the reservoir was designed to hold more than 25,000 cubic metres of water, then the degree of siltation is immaterial; the reservoir must be regarded as falling within the ambit of the Act. Only where there is no clear evidence about the design capacity should the second test come into play."*

When a reservoir is first constructed, it is capable of holding what it is designed to hold. It can be argued that the inclusion of the words "*or capable of holding*", if they are to have any meaning, are intended to cover instances where there has been a change in the level of risk posed by the reservoir on account of changes in the volume of water retained. Volume changes can come about in a number of ways, for example:

- sedimentation (natural)
- use of the reservoir as a slurry lagoon,
- enlargement of the reservoir volume by quarrying or dredging activities (this can be practicable under certain conditions);

- landslips into the reservoir,
- infilling of parts of the reservoir area with compacted fill (to create islands for example).

The wording of Section 1(1)(b) of the Act is in the present tense ("if it is designed to hold", not "if it was designed to hold") and as this case does not consider the construction of a new reservoir design or enlargement (covered by Section 6 of the Act) then the "water" volume that the reservoir is "*capable of holding"* is the appropriate question. The original design capacity is no longer of relevance. This also appears to be a more pragmatic interpretation of Section 1(1)(b). It is clear that the Act was not intended to impose a regulatory burden on the owners of reservoirs of less than 25,000m³ capacity. Therefore the advice the Environment Agency from the Panel Engineer was that the reservoir should not be added to the register.

Legal Advice

The enforcement authority took legal advice on the matter. Counsel agreed with the interpretation given in the Guide and advised that the phrase 'capable of holding' was probably intended to apply to the situation where it was not possible to know or readily ascertain what amount of water the reservoir was originally designed to hold. For example, in cases of very old reservoirs dating back to the 16th century, it may be difficult to assess what the original design capacity was and, in those circumstances, it would be appropriate to use the amount which the reservoir is 'capable of holding' to determine whether or not the Act applies. Giving priority to the 'designed to hold' test over the 'capable of holding' test gives public safety the benefit of the doubt and is justifiable on that basis. Therefore the Environment Agency decided to register the reservoir as a large raised reservoir.

WATER AS SUCH

Section 1.(1) of the Act, quoted in full above, refers to reservoirs holding "*water as such*".

Case 8

In this case a quarry was excavated horizontally into a hillside to provide rockfill material for construction of roads and structural foundations. After it was fully excavated the narrow steep-sided entry was closed off with an embankment and the rim on the lower side was raised with a fill embankment. The quarry was then filled with saturated peat excavated from the site by tipping at the higher side of the quarry. The peat flowed to form an approximately level surface with some shallow pools of standing water. Three pipes were set into the embankment just above the level of the peat to allow most of the surface water to decant. The volume of the quarry up to the level of the pipes was thought to exceed 25,000m³.

When the site was handed over to the operating company they sought an opinion from a Panel Engineer so as to be as certain as possible that they were not taking over an unregistered reservoir. The opinion given was that this was not a reservoir under the Act since the saturated peat was not "*water as such"*, which is a key part of the definition of a reservoir under the Act. The opinion took into account that the quarry was dry when filled, unlike some ash lagoons which are registered under the Act because they start water-filled and are subsequently in-filled with ash slurry, at which time they can be de-registered.

FLOOD STORAGE AREAS

When the Act was first introduced there was some question as to whether flood storage reservoirs which are drained by a low-level draw-off were reservoirs under the Act or not. This is clarified by the Guide which states that:

> *"These structures are designed to retain water temporarily, and their failure could result in uncontrolled escapes of water. Thus they are considered to be within the ambit of the Act."*

Nevertheless, there are still questions about this in some cases, particularly relating to off-line storages.

Case 9

How can an island be a flood-storage area? It can be when it is surrounded by embanked rivers above natural ground level. The layout of the flood storage area in Case 9 is shown on Figure 7 and in this case both river channels are navigable waterways. Section 1 of the Act specifically states that:

> "*For the avoidance of doubt it is hereby declared that the expression "reservoir" does not include a canal or inland navigation..."*

The storage area is open farmland. It can be filled either by water spilling over the grassed embankment from the upper channel or by opening the sluice connecting the storage area to the lower channel if floods cause unsafe water levels to be reached during tide-lock at the downstream sea outfall. Once opened to flood the storage, the sluice is left open to allow the storage to drain as the lower channel water level drops and is then closed to prevent refilling after the water has drained.

An opinion was requested as to whether or not this flood storage area should be registered as a large raised reservoir. The volume within the storage area significantly exceeds 25,000m³, but all the river embankments which enclose the storage are specifically excluded from the Act by being navigable waterways. The opinion given was that, since the water was not retained in the storage above the water level in the downstream channel, the

water was being "*held*" by the water level downstream and effectively formed part of the river rather than being held within a reservoir. The opinion also noted that there was no purpose served by considering this area to be a large raised reservoir.

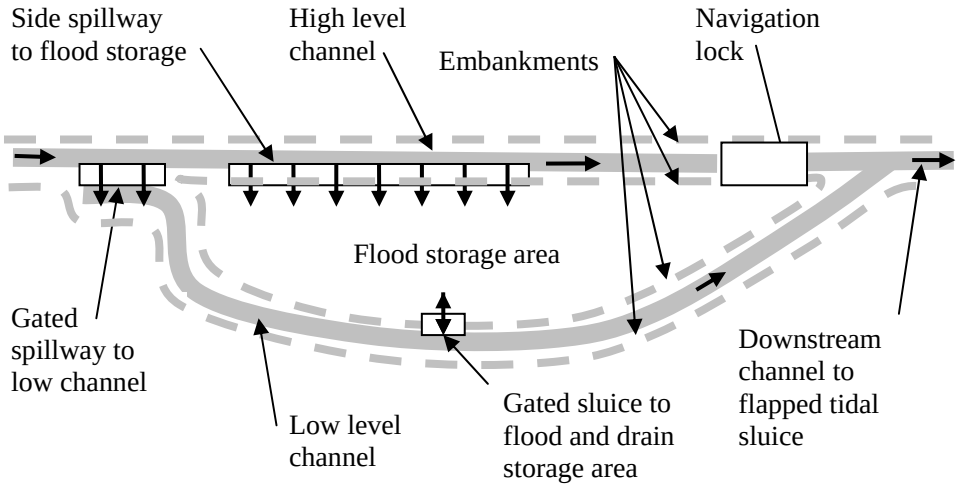

Figure 7. Layout of Case 9 flood storage area between embanked river channels.

Case 10

The other flood storage case presented is where a natural flood plain area has previously been protected from flooding by river embankments, but has subsequently been modified for use as flood storage. The layout is shown on Figure 8 below.

Town A was prone to flooding from the river upstream of the historic bridge. A study showed that the best way to relieve this was to lower the existing river banks to allow flooding of agricultural land downstream of the bridge. The existing flapped drainage outlet was satisfactory to drain the flood plain, but a high level outlet spillway was added at the downstream end of the flood plain to control maximum water level in the storage to below river bank level at the downstream end. The river water level at the outlet normally drains freely, but under flood conditions can be raised by the backwater effect from high tides downstream. The village at B was partially protected from flooding by the original river embankment and it was recognised that the scheme would increase the flood risk to a number of houses, a farm and a caravan park at the margins of the village. A new, higher embankment was therefore included in the scheme to protect these properties.

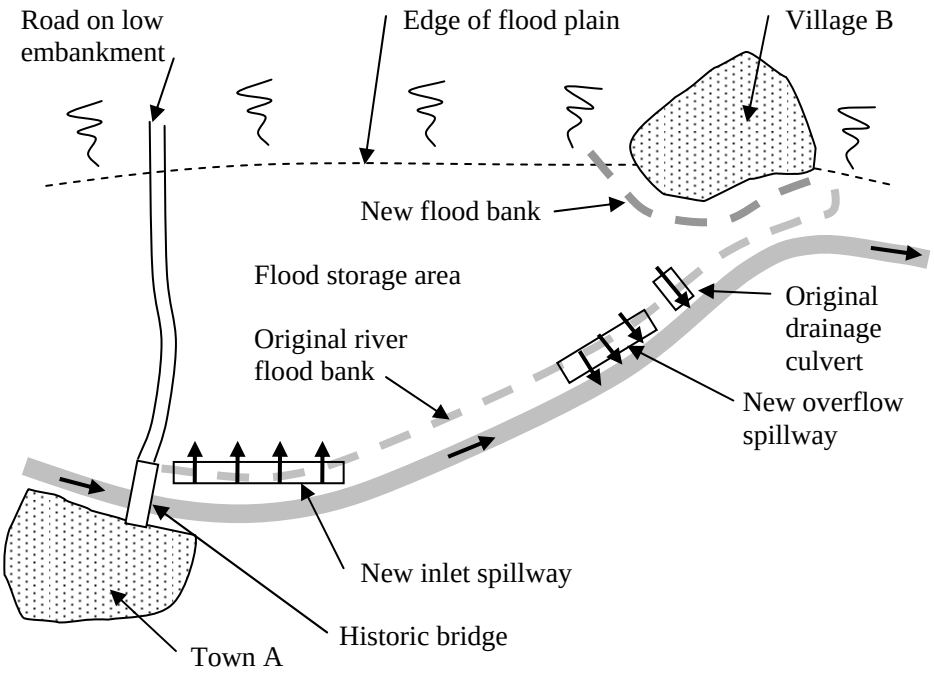

Figure 8. Layout of Case 10 flood storage area.

It was unclear to the designers whether the scheme should be considered as a reservoir under the Act and opinions were sought from two AR Panel Engineers, who gave different opinions. One considered that it should be registered, based on the advice in the Guide that:

> *"River embankments which are constructed close to the river to limit flooding are not considered to be included in the Act. However where an extensive washland area is provided with an embankment remote from the river it is likely that this embankment may fall within the ambit of the Act."*

The other considered that since the storage area was not originally a reservoir, the construction of two spillways on the existing river banks and a flood bank to exclude, rather than hold water should not make it a reservoir and the scheme should best be considered as the managed retreat of the river flood bank.

In view of the conflicting opinions the Enforcement Authority chose to register the scheme as a reservoir, following the precautionary principle.

CONCLUSIONS

To date the Act has proved effective in protecting properties and lives from the threat of dam failure. The wording of the Act has, in a minority of cases, caused some difficulties in interpretation. This paper has attempted

to highlight some of these difficulties which ultimately can only be resolved through court cases. The absence of case precedents, normally available to assist in deciding an issue of interpretation are not available and therefore a commonsense, reasonable and pragmatic approach has been adopted whilst preserving the intention behind the Act which is one of public safety. Clearly, it is hoped that the drafting of secondary legislation under the Flood and Water Management Act 2010 will take into consideration the issues highlighted by the above case studies.

ACKNOWLEDGEMENTS

The authors would like to thank the Environment Agency for permission to describe and discuss the reservoir opinions prepared on its behalf.

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