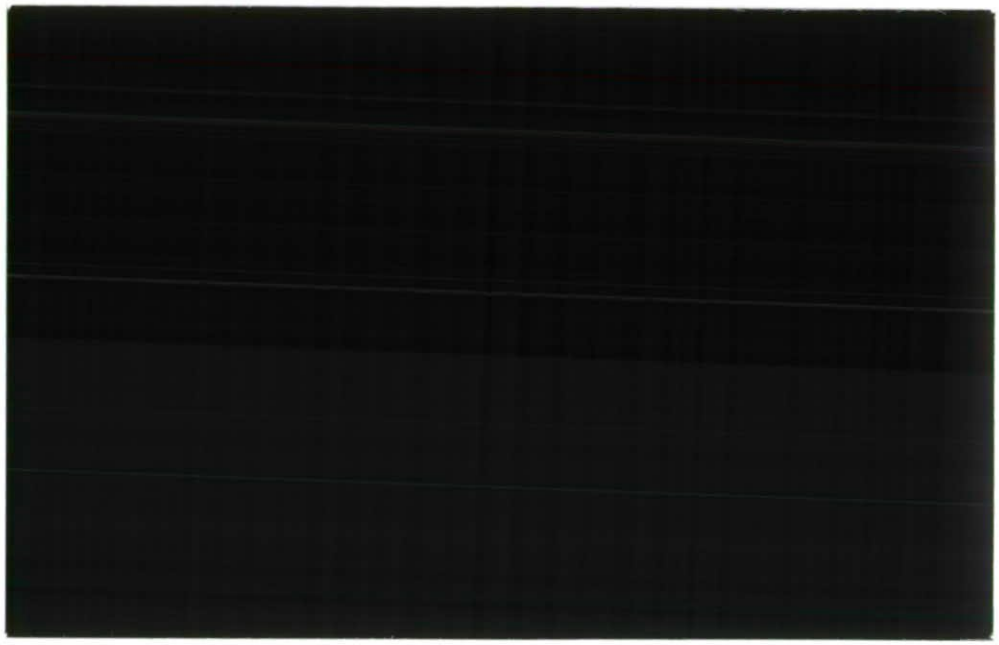
Institute of Hydrology



Natural Environment Research Council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Sandpool Farm Flood Study

Supplementary Report

A report to Hills Aggregates Ltd

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Summary

A previous study found that the proposed development at Sandpool Farm is unlikely to increase flood risk in the Flagham Brook catchment (Institute of Hydrology, 1994). However, it is likely that some flood water which may have in the past been stored on Sandpool Farm will in future events be stored in other areas of the flood plain. The development of the site provides an opportunity to reclaim some of the flood storage which has been lost during previous changes.

A visit was made to Swillbrook Land, to the south east of Sandpool Farm, in order to gain familiarity with the site and to survey its important features. The main pond on the site could provide an estimated 40 000 m^3 of flood storage. A scheme is proposed to utilise this potential in order to relieve flooding in the Flagham Brook.

The scheme seeks to use the gradient in water level between stream and pond as a means for diverting flows from Flagham Brook into Swillbrook Land for flood storage. The pond would provide storage for this flood water until the bankfull level was reached. Excess flood water would then be released as overspill at the southern edge of Swillbrook Land into the Swill Brook or Flagham Brook near their confluence. As the flood receded the water level in the pond would gradually return to normal as water was lost through evaporation and outflow to groundwater. The scheme requires only minimal engineering work and, once in place, storage would be self-regulating. The only design specifications required are those for the installation of an inlet pipe connecting the main pond on Swillbrook Land to the Flagham Brook downstream of the road bridge. Suggested dimensions for the pipe are 15.0 m length and 0.6 m diameter.

There is little potential for flood storage on Sandpool Farm itself although the area of reed beds at the north west corner of the site could be utilised during minor floods. Flood risk on, and upstream of, Sandpool Farm could be reduced to some extent by the removal of a bridge carrying the site access track over the Flagham Brook. There is also a requirement for a 'river corridor' alongside the stream channel to promote conservation and allow access.

Contents

1 Introduction

Sandpool Farm is an area of former gravel extraction near South Cerney in Gloucestershire. The proposed development of the site involves the infilling of gravel pits and construction of a golf course, part of which will lie within the floodplain defined by the March 1947 flood. A study was undertaken to assess the extent to which this development may have an adverse impact on floodplain storage in the catchment of the Flagham Brook (Institute of Hydrology, 1994).This study found that the proposed development at Sandpool Farm is unlikely to increase flood risk in the Flagham Brook catchment.

However, it is likely that some flood water which may have in the past been stored within the area of Sandpool Farm will in future events be stored in other areas of the floodplain. This redistribution of flood storage is the result of changes already made to the site (ie increased elevation of the access road) rather than to further changes involved in the proposed development.

Whilst the new developments are unlikely to increase flood risk they do, however, represent an opportunity to reclaim some of the flood storage which has been lost during previous changes to the Flagham Brook site. As a supplement to the previous work an investigation has therefore been performed to assess the extent to which additional flood storage can be found within the area of land owned by the developers. This report describes the latest study and presents a scheme for the provision of flood storage. For background to the study and details of earlier work refer to Institute of Hydrology (1994).

2 Site Visit

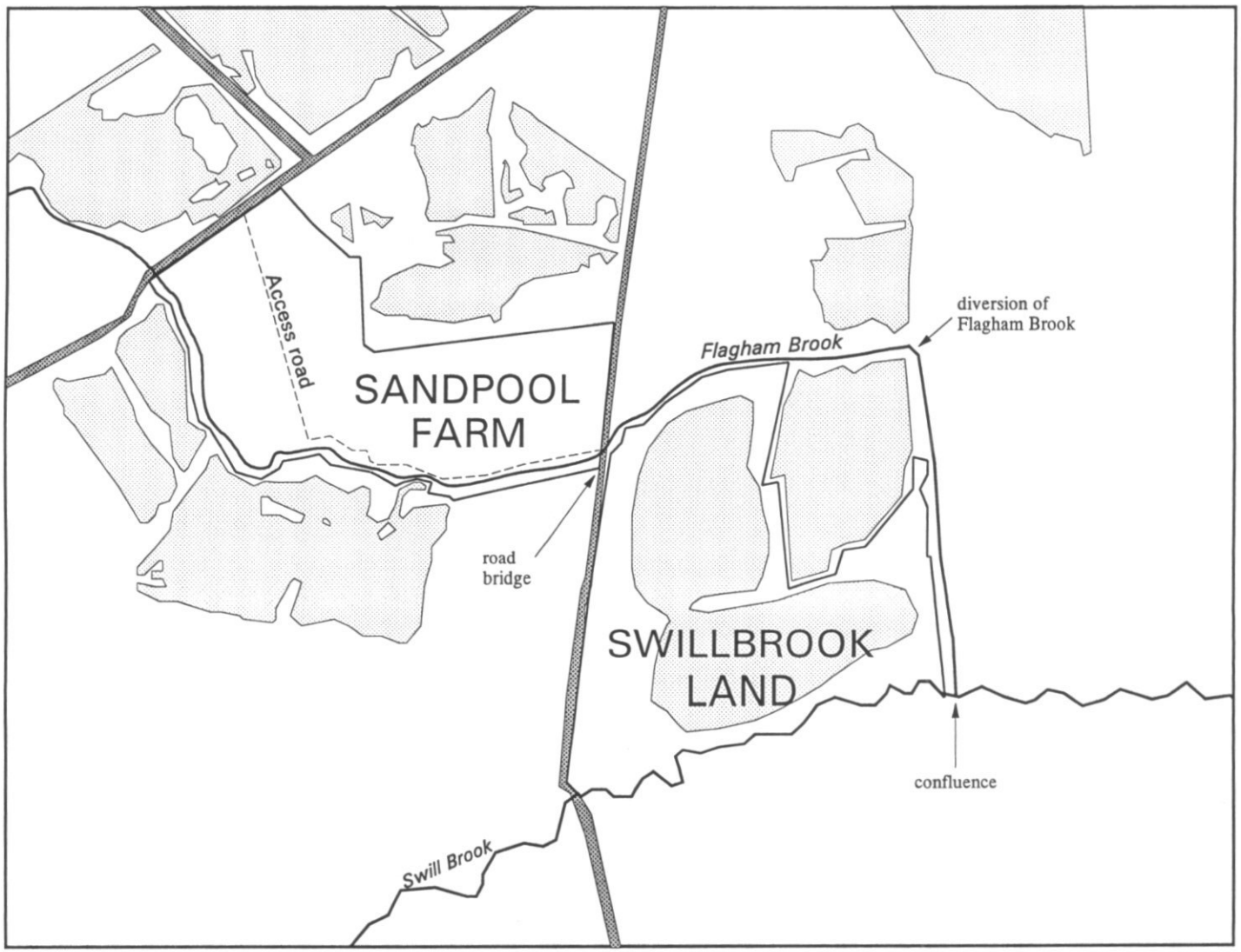
Sandpool Farm was visited twice in July and August 1994 during which the site north of Flagham Brook was surveyed. In addition to this land the developers of the Sandpool Farm site also own an area to the south east known as Swillbrook Land (see figure 1). As part of the present study a visit was made to Swillbrook Land in order to gain familiarity with the site and also to survey its important features.

Swillbrook Land is an L-shaped area of land covering approximately 0.25 km^2, lying between Flagham Brook to the north and Swill Brook to the south. The Flagham Brook has been diverted through approximately 90° to the north east of Swillbrook Land (grid ref SU 023940) so that it now also follows the eastern edge of the site. A pipe culvert at this diversion represents a major constriction liable to cause ponding in the channel along the northern edge of Swillbrook Land during high flows. The Flagham Brook and Swill Brook have their confluence at the south east corner of the site.

The area has been subject to extensive gravel extraction in the past resulting in the excavation of pits of an estimated depth of 2-3 metres. Since the cessation of mining activities the pits have flooded due to the influx of groundwater to form a series of ponds. There appear to be two main ponds on the site, one in the north and a larger one in the south. These ponds are joined by a narrow stretch of water, approximately 3 metres in width, and have a common water level. They have therefore been treated as a single pond. The total surface area of the pond is estimated to be approximately 0.15 km^2.

During the visit to Swillbrook Land the surface water level of the main pond was surveyed relative to the levels of the two streams bordering the site. The water level of the pond was found to be around 1.0 m lower than that of the Flagham Brook at the north west corner of the site and approximately 0.5

Map of Sandpool Farm and Swillbrook Land sites



Note: size and location of pond on Swillbrook Land based on field observations

Figure 1

m higher than the stream level at the confluence of the Flagham Brook and Swill Brook at the south east corner (see figure 2). This appears to confirm that there is no direct (ie surface water) connection between the streams and the pond, although it does not rule out possible groundwater flow.

These and other features of the site, such as the elevation of the track running along the northern edge, were also surveyed relative to the road bridge which separates Swillbrook Land from Sandpool Farm (grid ref: SU 017938) where an NRA benchmark nail on the bridge parapet has been taken to have an arbitrary datum of 87 m OD, a level indicated on the 1:25 000 Ordnance Survey map of the area. The size of the pipe carrying the Flagham Brook under the road at this point was also noted for the purposes of later calculations. The pipe has a diameter of 1.2 m.

3 Estimation of Potential Flood Storage

In the previous Sandpool Farm flood study the floodplain storage in the Flagham Brook catchment resulting from the March 1947 flood, which was of estimated return period between 50 and 100 years, was estimated to be around 270 000 m^3 (Institute of Hydrology, 1994). Of this an estimated 65 000 m^3 of flood water was stored on Sandpool Farm land and this volume has since been lost due to subsequent changes to the site.

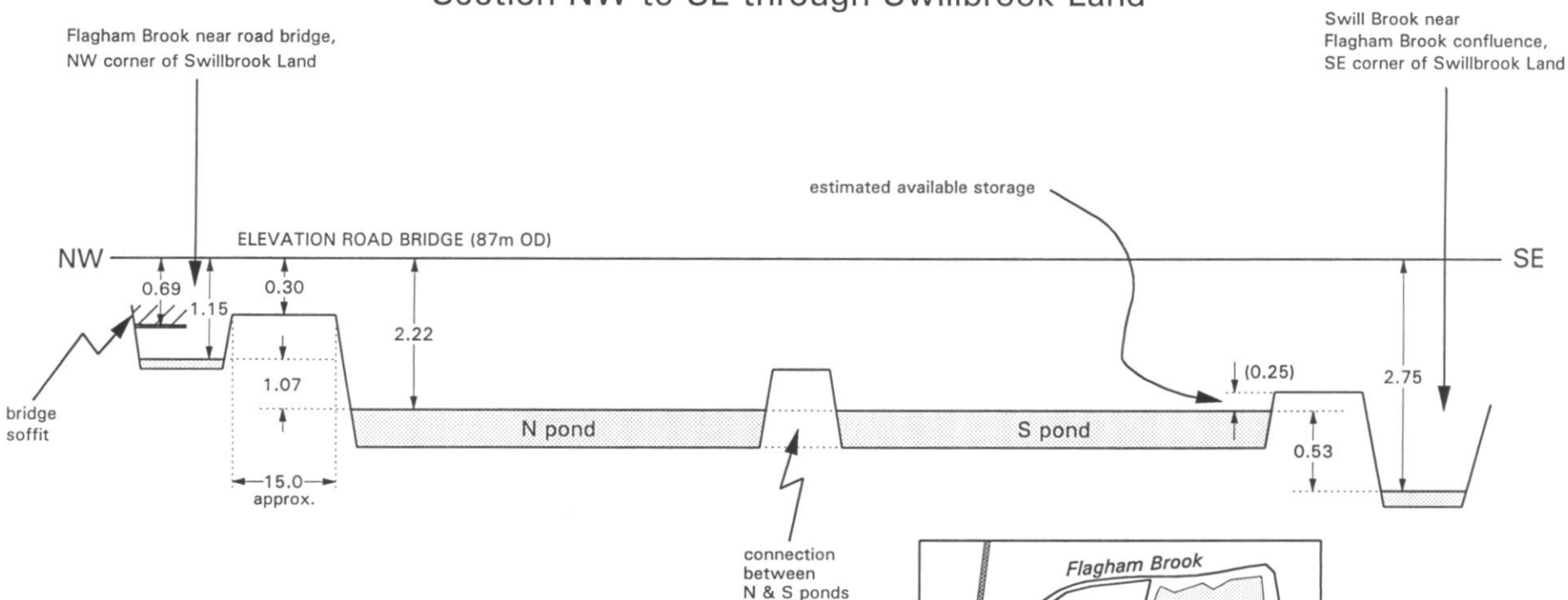
A scheme to create additional flood storage to compensate for this loss should seek to reclaim as much of this 65 000 m^3 as possible. The proposed development of Sandpool Farm to create a golf course does not appear to leave any areas of land of sufficient size for the temporary storage of flood waters of this magnitude. However, a small area at the north end of the site which under the development proposals will be occupied by a small pond and reed beds has some potential for the storage of minor floods.

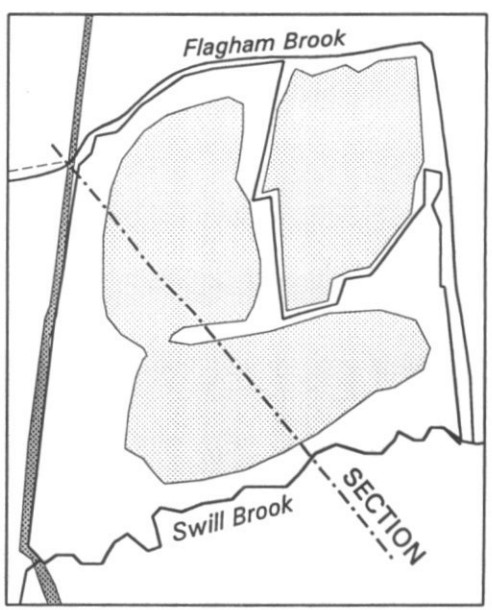
In view of this lack of potential on Sandpool Farm attention has been focused on Swillbrook Land and in particular on the main pond which occupies much of the site. The total surface area of this pond is estimated to be 0.15 km^2. During the site visit to Swillbrook Land it was observed that there was significant variation in the height of the banks of the pond above the level of the water surface. Whilst at the north end of the site the bank was almost 2.0 m above the water level this declined to around only 0.25 m at the southern bank. This latter depth defines the maximum increase in water level that could be contained within the pond.

The potential flood storage that could be contained in the main pond on Swillbrook Land is estimated to be approximately 40 000 m^3 with an increase in water level of 0.25 m. This estimate is based on the assumption that the water level of the pond prior to a flood event does not vary significantly from that surveyed, even during periods of high stream flow. If this assumption is relaxed then allowance must made for higher pond levels due to upwards movement of the water table during times of heavy rainfall. In such circumstances the estimate of potential flood storage in the pond will clearly be somewhat reduced. However, following the exceptionally wet winter of 1994/95, the assumption that the levels observed are typical of most pre-flood conditions seems reasonable.

One other existing area of flood storage is the lake immediately to the south of the Flagham Brook opposite to the Sandpool Farm site (grid reference of centre of the lake SU 013 937). The current level of this lake is approximately 0.5 to 1.0 m above that of the Flagham Brook water level, indicating no direct hydraulic interconnection between the two. During periods of high flood flows however, the Flagham Brook would naturally back up along a small ditch between the eastern boundary of the lake

Section NW to SE through Swillbrook Land





All units in metres (not to scale)

Figure 2

and a field belonging to Clattinger Farm. This water would eventually find its way into the lake and on to the flood meadows of Clattinger Farm, both of which would provide natural flood storage.

4 Proposed Flood Storage Scheme

It is evident from figure 2 that a gradient exists from the water level of the Flagham Brook at the north west corner of Swillbrook Land through the main pond to the confluence of the Flagham Brook and Swill Brook at the south east corner. The scheme proposed here seeks to use this gradient as a means for diverting flood flows from Flagham Brook into Swillbrook Land for flood storage. Flow above a specified level would be transferred from the Flagham Brook to the main pond at the north west corner of Swill Brook land. The pond would provide storage for this flood water up to a maximum corresponding with the bankfull condition in the pond. Excess flood water would be released as overspill at the south east corner of Swillbrook Land into the Swill Brook or Flagham Brook near their confluence. As the flood recedes the water level in the pond would gradually return to normal as water was lost through evaporation and outflow to groundwater.

The scheme requires only minimal engineering work and, once in place, storage would be self-regulating. The only design specifications required are those for the installation of an inlet pipe connecting the main pond on Swillbrook Land to the Flagham Brook downstream of the road bridge (see figure 3). The derivation of suggested pipe dimensions is given below whilst the dimensions themselves are summarised in table 1.

Table 1 Suggested dimensions for inlet pipe from Flagham Brook to Swillbrook Land main pond.

Design feature	Specification
Pipe length	15.0 m
Upstream elevation of base of pipe	86.4 m OD
Downstream elevation of base of pipe	86.1 m OD
Pipe slope	0.02
Pipe diameter	0.6 m

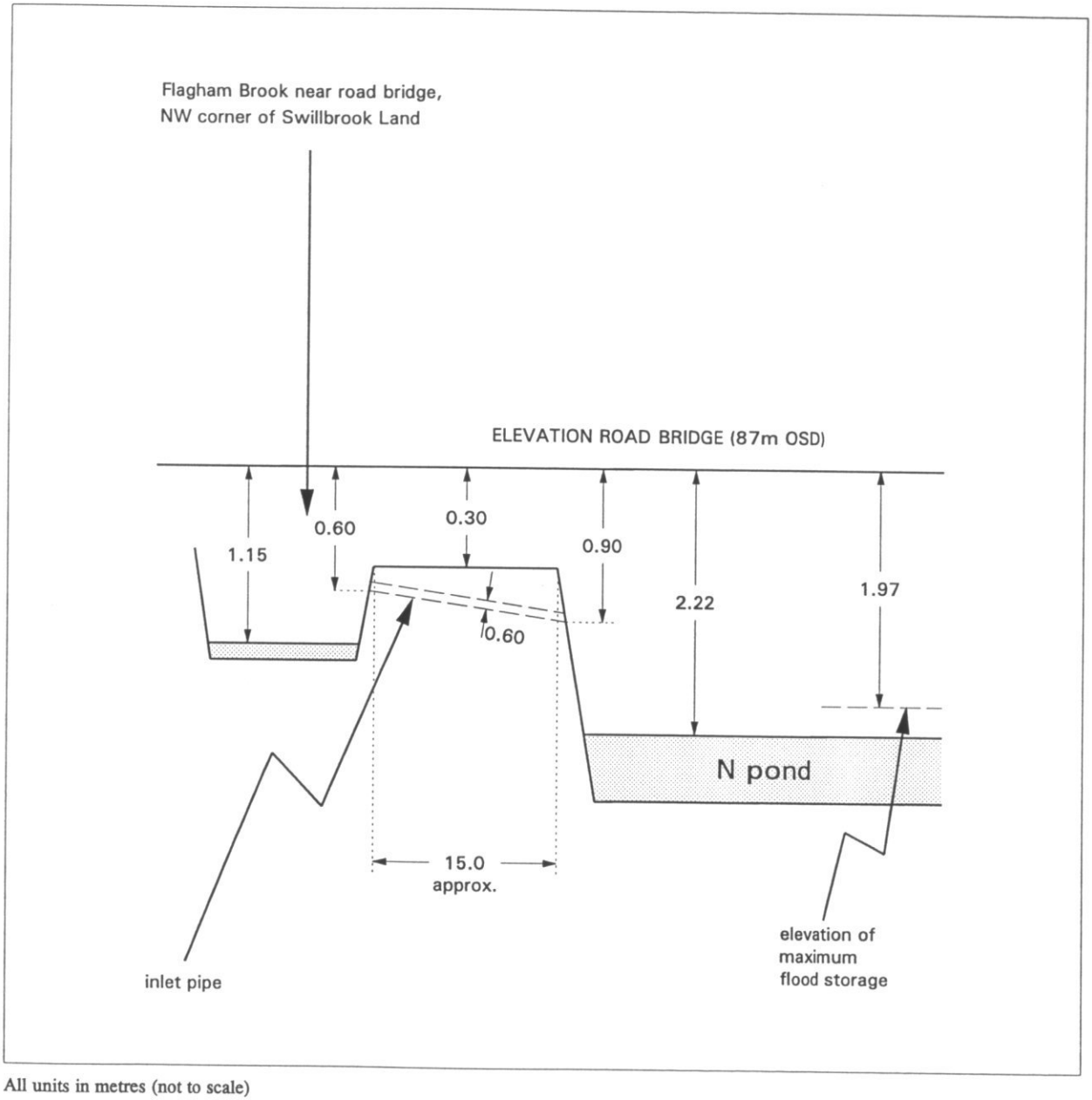
Pipe location

The pipe should connect the Flagham Brook to the main pond at the northern edge of Swillbrook Land where the distance between the stream and the pond is least. The likely length of pipe required is estimated to be around 15.0 m.

Pipe elevation

The pipe should allow inflow to the pond before out of bank flooding occurs from the Flagham Brook

Section showing suggested inlet pipe dimensions for flood storage scheme



All units in metres (not to scale)

Figure 3

along the northern edge of Swillbrook Land. However, all outflow from the pond should be along the southern edge of the site and no reverse outflow should occur through the inlet pipe. The pipe must therefore be at a level below the bankfull elevation of the Flagham Brook along the northern edge of the site but above the bankfull elevation of the pond at its southerly limit. The proposed elevation of the pipe base at the inflow from Flagham Brook is 86.4 m OD whilst that at the outflow to the pond is 86.1 m OD. Assuming a pipe length of 15.0 m this gives a pipe slope of 0.02.

Pipe capacity and diameter

In estimating pipe capacity it was assumed that the scheme will allow for the storage of 40 000 m^3 of water during a flood event with the remaining flow carried in the Flagham Brook. It was therefore necessary to generate an inflow hydrograph with a total volume of 40 000 m^3. The peak flow of this hydrograph defines the required capacity of the inlet pipe.

Synthetic flood hydrographs were generated from the catchment characteristics of the Flagham Brook using the Institute's MicroFSR flood estimation software. Details of the techniques involved are given in Institute of Hydrology (1994). Hydrographs were estimated for floods with return periods of 10, 20 and 50 years. Analysis of each hydrograph was performed to identify the threshold above which the volume of flow was 40 000 m^3 (see figure 4). The flow above this threshold was assumed to represent inflow to the pond with peak flow above the threshold determining pipe capacity. The required pipe capacity associated with each of the 10, 20 and 50 year flood events are presented in table 2 along with the estimated pipe diameter required to carry this flow. The diameter of the inlet pipe was estimated using standard hydraulic charts (Hydraulic Research Station, 1969) with discharge equal to the required pipe capacity in each case, a slope of 0.02 and a roughness factor of 0.3 mm.

Table 2 Inlet pipe capacities and diameters estimated from inflow hydrographs derived from 10, 20 and 50 year flood events.

Return period (years)	Pipe capacity (m^3s^{-1})	Pipe diameter (m)
10	0.94	0.57
20	1.03	0.59
50	1.18	0.62

A inlet pipe with diameter of around 0.6 m will allow inflow of up to 40 000 m^3 into the pond assuming an inflow hydrograph of the shape shown in figure 4. In flood events with inflow hydrographs of higher magnitude or longer duration the storage capacity of the pond will be exceed and over flow will occur to the Swill Brook and Flagham Brook along the south and east of the site.

It should be noted that this analysis of synthetic flood hydrographs was performed solely to provide estimates of peak flows associated with a flood volume of 40 000 m^3. No claim is made that during any of a 10, 20 or 50 year event exactly 40 000 m^3 of water will enter storage or that the scheme will prevent flooding of other land adjacent to the Flagham Brook.

Synthetic 10-year flood hydrograph

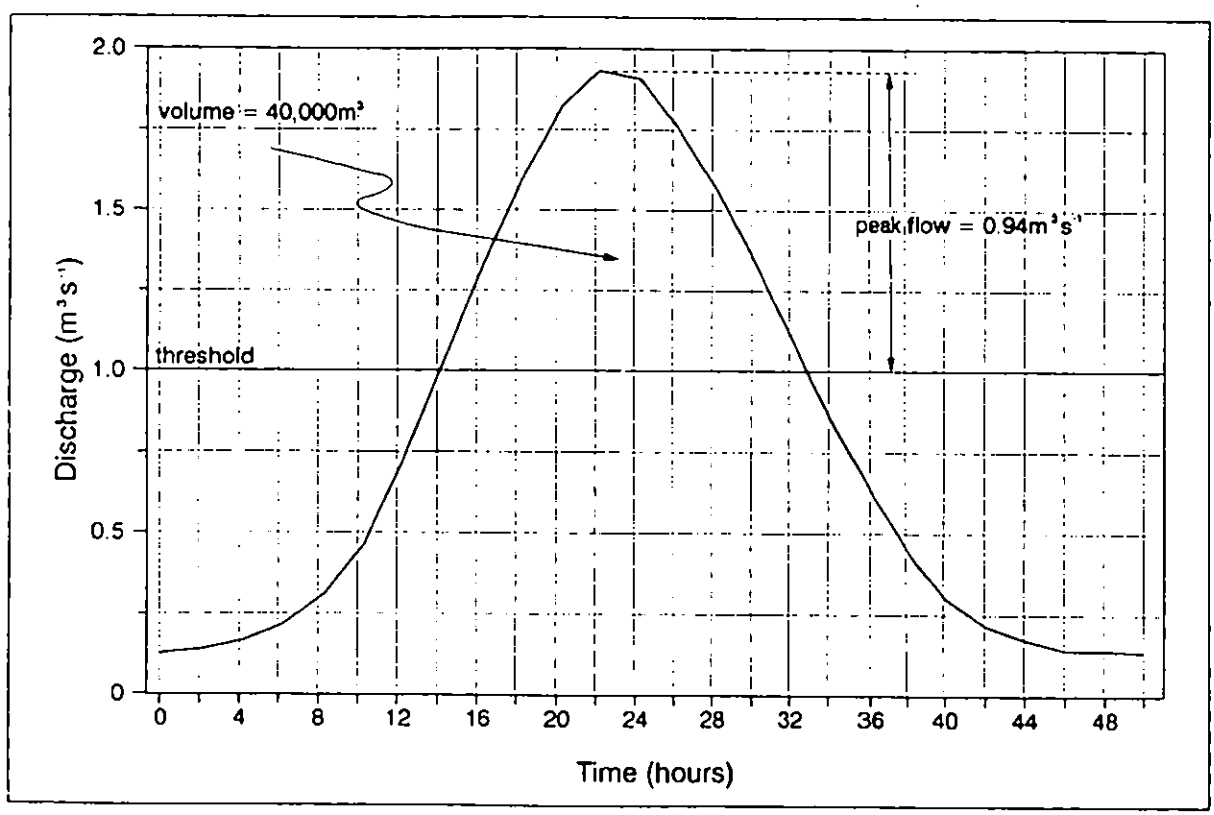


Figure 4

5 Limitations of Proposed Scheme

The proposed scheme does not provide the estimated 65 000 m^3 of floodplain storage which has been lost due to the past development of Sandpool Farm. At best the pond on Swillbrook Land can contain an estimated additional 40 000 m^3 of water. Given the uncertainty surrounding the lake levels in times of flood the actual volume of available storage on Swillbrook Land may be greater or less than this figure for any individual flood. During large flood events there may also be direct flooding on to Swillbrook Land as a result of overspill from the Swill Brook to the south. The NRA flood level map of the March 1947 flood shows that Swill Brook land was almost entirely under water (see figure 5). In repeat circumstances it is clearly unlikely that Swillbrook Land could provide an additional 40 000 m^3 of storage on top of any direct flooding.

An additional constraint which must be considered is the capacity of the pipe carrying the Flagham Brook under the road bridge between Sandpool Farm and Swillbrook Land. The discharge capacity of the pipe was estimated using standard hydraulic charts (Hydraulic Research Station, 1969). As noted previously the diameter of the pipe is 1.2 m. The slope of the pipe was assumed to be consistent with the channel slope downstream. This was estimated from maps and survey data to be around 0.0015. Assuming an appropriate roughness factor of 0.3 mm the discharge through the pipe when running full is 1.35 m^3s^{-1}.

As part of the earlier study the mean annual flood of the Flagham Brook upstream of the road bridge was estimated to have a peak flow of 1.18 m^3s^{-1} (Institute of Hydrology, 1994). The capacity of the pipe under the road bridge is therefore likely to be exceeded on average once every 3 or 4 years. Ponding of the Flagham Brook upstream of the road bridge would appear to be a relatively frequent event. The road bridge represents a significant constraint on the transfer of high flows along the Flagham Brook and will continue to pose a threat to flood control regardless of any flood storage scheme downstream or any developments upstream. It should be noted that any flooding upstream of the road bridge is likely to concentrate on the land south of the Flagham Brook, given the lower elevation of this land compared to the access road bordering the southern edge of Sandpool Farm.

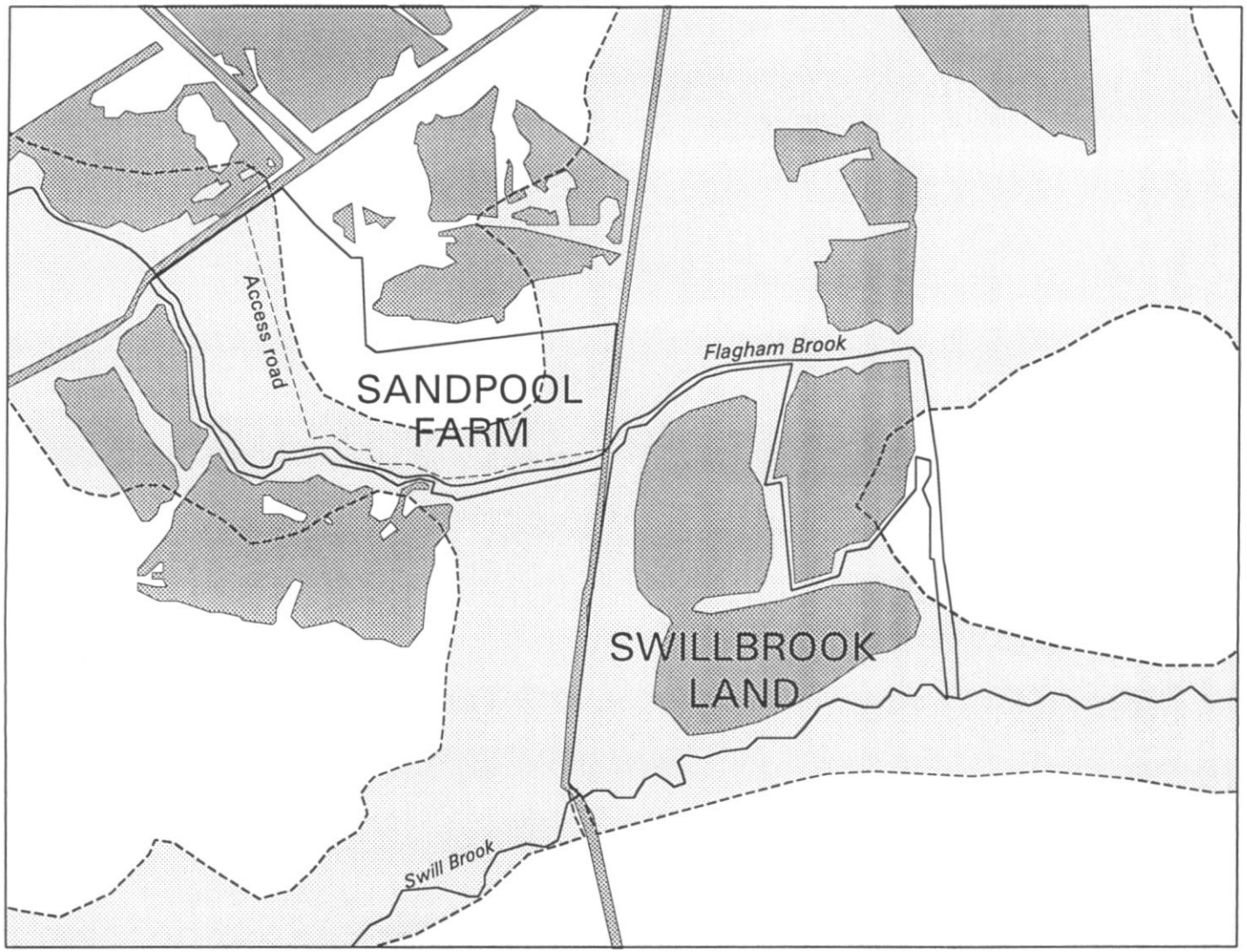
However, the provision of flood storage on Swillbrook Land will help to reduce the flood risk associated with the diversion of the Flagham Brook downstream of the road bridge. Ponding of high flows caused by this constriction will be relieved to some extent under the proposed scheme by inflow into the pond on Swillbrook Land. This diversion of water into the Swillbrook land pond will increase the water slope through the road bridge culvert and hence increase its capacity.

In the light of these limitations it is important that the proposed scheme for flood storage on Swillbrook Land is recognised as a solution which may help to relieve relatively small scale flooding. During larger flood events the scheme will provide partial relief within the confines of the site locality but is unlikely to prevent significant flooding elsewhere in the catchment.

6 Other Considerations

It was noted in section 3 that although there is little land available for flood storage on Sandpool Farm an area of reed beds in the north west corner could be utilised during minor flood events. Installation of a small diameter pipe culvert (say, 0.3 m diameter) would facilitate natural use of this area.

Map showing maximum extent of flooding in March 1947



Note: size and location of ponds on Swillbrook Land based on field observations

Flood limits based on NRA flood maps of upper Thames catchment

Figure 5

In order to reduce flood risk on Sandpool Farm it has been suggested by NRA Thames region that the bridge which carries the access track over the Flagham Brook (in the direction of Lower Moor Farm, grid ref SU 011939) is dismantled. The NRA feel that this bridge represents a significant constriction in the stream channel and that its removal would help to reduce flooding upstream currently influenced by backwater effects from this point.

The NRA have also stated their requirement that a 'river corridor' be maintained alongside the Flagham Brook partly to conserve the stream bank habitat but also to allow access to the channel. The corridor should have a minimum width of 10.0 metres and should ideally be some 20.0 m wide although it is recognised that the future use of the site as a golf course may not allow this along the full length of the stream.

References

Hydraulics Research Station, 1969. *Charts for the Hydraulic Design of Channels and Pipes*. Hydraulic Research Paper No 2, Third Edition (Metric Units). London:HMSO, 46pp.

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