



ENVIRONMENT
AGENCY

ADDENDUM TO THE
STANMOOR BANK
FEASIBILITY STUDY
& APPRAISAL
REPORT

LOWER TONE FLOOD DEFENCE
IMPROVEMENTS
PHASE II - STANMOOR BANK

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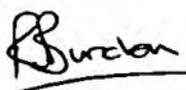
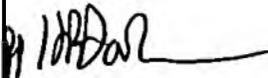
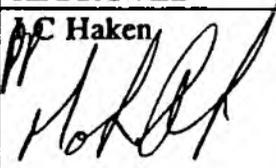
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**THE ENVIRONMENT AGENCY
SOUTH WEST REGION**

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STANMOOR BANK
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APPRAISAL REPORT**

April 2000

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CONTENTS

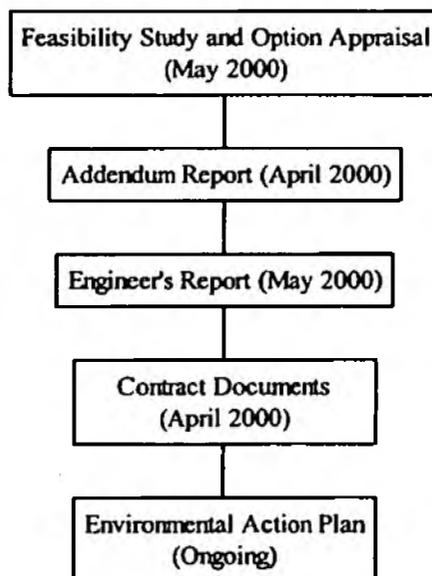
- 1.0 INTRODUCTION
- 2.0 LOCATION
- 3.0 THE PROPOSED SCHEME
 - 3.1 Stanmoor Cut-Off Embankment
- 4.0 ENVIRONMENTAL IMPACT ASSESSMENT
 - 4.1 TEMPORARY IMPACTS OF THE TECHNIQUES DURING CONSTRUCTION
 - 4.1.1 Introduction
 - 4.1.2 Nature Conservation
 - 4.1.3 Fisheries
 - 4.1.4 Landscape
 - 4.1.5 Water Resources
 - 4.1.6 Water and Land Quality
 - 4.1.7 Archaeology and Heritage
 - 4.1.8 Land Use and Ownership
 - 4.1.9 Local Community
 - 4.1.10 Recreation and Amenity
 - 4.1.11 Infrastructure and Access
 - 4.1.12 Planning and Development
 - 4.2 PERMANENT IMPACTS OF THE TECHNIQUES IN THE OPERATIONAL PHASE
 - 4.2.1 Introduction
 - 4.2.2 Nature Conservation
 - 4.2.3 Fisheries
 - 4.2.4 Landscape
 - 4.2.5 Water Resources
 - 4.2.6 Water Quality
 - 4.2.7 Archaeology and Heritage
 - 4.2.8 Land Use and Ownership
 - 4.2.9 Local Community
 - 4.2.10 Recreation and Amenity
 - 4.2.11 Infrastructure and Access
 - 4.2.12 Planning and Development
 - 4.3 IMPACT OF RAISING THE CREST LEVEL
 - 4.3.1 Introduction
 - 4.3.2 Temporary Impacts of Raising the Crest Level
 - 4.3.3 Permanent Impacts of Raising the Crest Level
- 5.0 SUMMARY OF IMPACTS
 - 5.1 Temporary Impacts during the Construction Phase
 - 5.2 Permanent Impacts during the Operational Phase
 - 5.3 On-Line Defence Techniques
 - 5.4 Raising the Crest Level
 - 5.5 Conclusion

1.0 INTRODUCTION

In May 1998, the Stanmoor Bank Feasibility Study and Appraisal Report was issued to statutory consultees for comment. The Environment Agency in considering a range of flood defence options, identified the preferred option as On-line Defence Works, with Crest Level Option A (a maximum crest level raising of 0.08m over a 130m length of the bank). This option and crest level was perceived to provide security against breach and maintained a 1 in 85 year minimum standard of protection against overtopping. It was proved to be viable on engineering grounds and it was the preferred option on economic and environmental grounds.

Since the Feasibility Study and Appraisal Report (May 1998) the Agency have progressed with outline design and there have been some minor changes to the scheme and the design of the preferred option (as described in Section 3.0). The aim of this Addendum is therefore to inform consultees of these alterations and to identify associated temporary and permanent environmental impacts.

The following flow chart shows how this report (the Addendum Report) relates to the timing of other documentation produced as part of the Stanmoor Bank scheme.



To ensure that the mitigation and recommendations identified in this Addendum report are implemented in the design stage, the construction stage and during the operational stage, an Environmental Action Plan for Stanmoor Bank is currently being prepared.

2.0 LOCATION

Stanmoor Bank runs alongside the south side of the River Tone from Stanmoor Bridge near the confluence with the River Parrett, to a point 150m downstream of Hook Bridge at the village of Curload. The length of the bank is 3.1km. The bank is an earth embankment, with a mass concrete core wall. Stanmoor Bank provides protection against flooding from the River Tone to Stan Moor, the villages of Curload and Athelney and the properties along Stathe Road. Potentially 350ha of land are at risk from flood damage. Stanmoor Bank has been shown to be liable to breach under flood events that can occur more frequently than annually. The bank

is also suffering from increasing rates of seepage, which affects many houses built into, or adjoining the bank.

3.0 THE PROPOSED SCHEME

The Stanmoor Bank scheme will be undertaken during the spring and summer months and will probably be phased over a two year period (2001/2002).

The preferred scheme option (On-line Defence Works) would involve works to alleviate one or more of the following problems:

- Strengthen the flood bank to reduce the risk of a breach
- Reduce seepage through the bank, and;
- Raise the bank to reduce overtopping

With the On-line Defence Works option it is envisaged that the following viable and technically acceptable construction techniques will be used in appropriate locations along Stanmoor Bank (right bank of the River Tone) to improve the flood defences.

- Technique 1 - Sheet piling using a low vibration method
- Technique 2 - Impermeable geotextile membrane to core wall and widening the access track
- Technique 3 - Raise the level of the defence

Technique 3 (Raise the Defence) will be done in three possible ways, depending on the location;

- By providing a pile cap on top of the piles. The top of the pile cap will be at a higher level than the existing bank.
- By placing fill to raise the defence level.
- By attaching a concrete raising to the existing core wall.

The impermeable membrane (Technique 2) will not be installed in piled lengths (Technique 1). Otherwise the three above techniques will be constructed sequentially.

All three techniques were identified and discussed in the Feasibility Study and Appraisal Report (May, 1998). At this stage it is not anticipated that the other techniques considered in the Feasibility Study and Appraisal Report (i.e. piling by the conventional method, stabilising works on landward side of the core wall and stabilising works on riverward side of the core wall), will be used.

It should be noted that there will be a partnering arrangement with the Contractor for the Stanmoor Bank scheme. Alternative construction techniques may be put forward for consideration at a later stage, when the Contractor is appointed. If new techniques are proposed by the Contractor they will be evaluated on both engineering and environmental grounds before, if suitable, being taken forward into the scheme design. Should new techniques be introduced further consultation may need to be undertaken.

A range of crest level options was assessed in the Feasibility Study and Appraisal Report (May, 1998). Each of the crest level options considered would require raising the crest level along some part of Stanmoor Bank. The preferred Crest Level Option in the Feasibility Study and Appraisal Report (May, 1998) was Crest

Level Option A. With Crest Level Option A the linear extent of raising would have been 130m with a maximum crest level raising of 0.08m and an average of 0.04m.

Since the Feasibility Study and Appraisal Report new guidelines for assessing the economic viability of the scheme have come into force. Freeboard, sea level rise and settlement of the riverbank are now being taken into account. Freeboard is the additional height above design water level that provides an allowance for wave action, uncertainty in the modelled design water level and against natural degradation of the defence.

A range of new crest level options have therefore been assessed;

- **Crest Level Option A** – Designed to a 1 in 50 year return period. The design allows for freeboard, 50 years sea level rise and 50 years settlement of the bank.
- **Crest Level Option B** – Designed to a 1 in 100 year return period. This option will be built in two stages, the first allowing for freeboard, 25 years sea level rise and 25 years settlement of the bank. The second stage will allow for a further 25 years sea level rise and 25 years settlement of the bank. The second stage of construction would take place in 25 years time.
- **Crest Level Option C** – This option is effectively the same as Option B, but all of the crest level raising will be carried out in one go.
- **Crest Level Option D** – Designed to a 1 in 200 year return period. The design allows for freeboard, 50 years sea level rise and 50 years settlement of the bank.

For each option the standard of defence quoted is that which would be existing in 50 years time, i.e. at the end of the design life of the scheme. Therefore, initially upon completion of the works the standard of defence is higher than the design standard.

The majority of the crest level raising will involve raising the bank top with fill material, which it is anticipated can be won locally from silt in the river. However, in some sections the crest level raising will involve raising the height of the existing concrete core wall.

In assessing the range of Crest Level Options the Agency wish to promote a combination of Crest Level Option B and C. Crest Level Option C will be introduced where future access is difficult or other considerations make it desirable. The remainder of the bank will be designed to Crest Level Option B. Under these options the height of the defences over the whole length of Stanmoor Bank will be raised. Table 3.0 shows the average and maximum raising needed. There are two figures for Option B. These refer to the initial raising and the further raising in 25 years time.

Table 3.0
Crest Raising Needed With On-line Defence Works

Crest Level Option	Raising from Existing Crest Level	
	Maximum height (m)	Average height (m) over raised part
B	0.47/0.66	0.17/0.35
C	0.66	0.35

3.1 Stanmoor Cut-Off Embankment

Stanmoor Cut-Off Embankment is located at the upstream limit of Stanmoor Bank and closes from the River Bank into high ground at Windmill Hill (see Drawing F4559/3505). The embankment has been identified by a Panel Engineer of the 'All Reservoirs Committee' as a Category A structure under the Reservoirs Act (1975). Therefore, there is a legal requirement for the bank to be brought up to a certain standard, in terms of its height and strength.

It is proposed that the bank will be raised and given a wider crest, with regular 1 in 4 slopes. The maximum raising will be approximately 300mm over a length of 150m. Where the crest may be degraded by cattle, a form of harder wearing surface will be installed.

It is proposed that these works will be carried out as part of the Stanmoor Bank capital scheme.

4.0 ENVIRONMENTAL IMPACT ASSESSMENT

Sections 4.1 to 4.4 describe the potential environmental impacts associated with the On-line Defence Works option and the three technically acceptable and viable construction techniques described in Section 3.0. The potential temporary impacts during construction are discussed, followed by an appraisal of the potential permanent impacts during the operational phase. Mitigation measures integral to the scheme are noted where appropriate and information that is limited in extent, coverage and/or detail is identified. In addition the potential environmental impacts associated with raising the crest level are appraised.

4.1 TEMPORARY IMPACTS OF THE TECHNIQUES DURING CONSTRUCTION

4.1.1 Introduction

The following sections describe the potential impacts during construction associated with the three viable and technically acceptable techniques proposed for improving the flood defences at Stanmoor Bank.

Impacts for each technique are quantified over a 100m standard length. Where potential impacts are time related, the duration of the works for each technique over a 100m length has been estimated (Table 4.1.1).

Table 4.1.1

Estimated Duration of Works

Technique		Estimated Duration per 100m
1	Low Vibration Piling	2-3 weeks
2	Impermeable Geotextile to Core Wall and Widening the Access Track	2 weeks
3	Raise Defence	2 weeks

The works will begin in 2001 and will continue in 2002, and if necessary 2003. It is expected that the Contractor will work from March to October inclusive, to avoid high water levels in the River Tone.

Construction work in front of any one property should last no more than one month. However, construction activities and access along the bank would be evident throughout the whole construction period. It is also feasible that the Contractor may use the left bank of the River Tone for access during the construction period.

4.1.2 Nature Conservation

Disturbance to Vegetation

Whilst there is little botanical interest along most of Stanmoor Bank (other than a floristically rich area 200m upstream of Stanmoor Bridge) rutting and compaction of the bank top by construction machinery, the digging of temporary trenches and the widening of the access track will disturb the existing vegetation within the River Tone County Wildlife Site.

Also, the Contractor may use the left bank of the River Tone for access. From the railway, south to the village of Curload, the access track along the left bank is included within the Curry Moor and Hay Moor SPA, Ramsar and Site of Special Scientific Interest (SSSI). Therefore, disturbance to the bank top should be minimal. Also English Nature must be kept informed about the proposed use of the access track which is in part within a SSSI. Agreement from English Nature to use the track will be required.

Removal of trees and scrub vegetation (predominantly planted by residents) along Stanmoor Bank will be avoided wherever possible. Some loss of vegetation is, however, anticipated where it prevents the core wall from being tied to the new piled wall.

Upon completion of the construction works, the bank top vegetation will be reinstated. The right bank will be used as an access track for river channel and flood defence maintenance works and therefore the recommended grass seed mix should be reasonably hard wearing.

The following grass seed mix is recommended;

Perennial ryegrass	60%	(for wear tolerance)
Creeping red fescue	20%	
Browntop bent	10%	
Smooth stalked meadow grass	10%	

The grass seed must be native to the United Kingdom

Disturbance to Vegetation at Stanmoor Cut-off Embankment

The works to Stanmoor Cut-Off Embankment will involve stripping the surface vegetation and topsoil. The topsoil should be stored and replaced upon completion of the works. It is recommended that the embankment is reseeded with the following mix;

Creeping red fescue	50%
Common bentgrass	10%
Smooth stalked meadow grass	20%
Crested dogs-tail	20%

The grass seed must be native to the United Kingdom. The suitability of the grass seed mix must also be agreed with the landowner.

Disturbance to Birds

Noise and activities associated with the construction works may disturb breeding and wintering birds.

Whilst Stan Moor does not support rare species or significant numbers of wildfowl and waders, the adjacent Curry Moor and Hay Moor SSSI does. The 1997 Breeding Wader Survey produced by the RSPB indicates that there are declining numbers of breeding lapwing and redshank on the eastern side of Curry Moor SSSI. Information on breeding and over wintering birds outside the SSSI was not available, although reed warblers (an infrequent species in the Somerset Levels and Moors) are known to breed in the reed along the River Tone.

Disturbance to birds within the SSSI is less likely to be significant if using a low vibration piling method, whereby piles are pushed into the ground rather than driven by percussion or vibration. With low vibration piling methods noise levels are lower and more constant (see *Section 4.1.9*). However, breeding birds in the reeds (e.g. Reed warblers) on the river banks would be affected.

It is recognised that birds can acclimatise to continuous but short-term noise disturbance, if it is located some distance away (200-500m, depending on ambient conditions) and if weather conditions are not severe. In addition, the birds at Stanmoor Bank could move away from the area temporarily, as similar alternative habitats are available in Curry and Hay Moor SSSI, adjacent SSSIs and further afield at West Sedgemoor. Whilst the potential impact is short-term, the following mitigation measures would be considered in the Environmental Action Plan:

- Timing of works (to commence before the nest building season in March).
- Habitat removal on the right bank prior to works (eg. cutting of reeds, scrub removal before the start of the bird nesting season in March).
- Sensitive management of the riverbank upstream and downstream of the works to provide suitable alternative habitat for breeding birds prior to and during construction.

As described in the following section Stan Moor Main Drain and Curry Moor Drain will be enhanced to provide optimal water vole habitat and temporary refuge. It is possible that the sensitive management of these drainage channels would also be beneficial to nesting birds.

Disturbance to Water Voles

In March 1999 a survey by Michael Woods and Associates (wildlife consultants) showed that both banks of the River Tone, within the area affected by the proposed Stanmoor Bank flood defence works, are occupied by water voles. The highest levels of activity were recorded along the right bank (Stanmoor Bank), which is the bank where all of the flood defence improvement works will be carried out. Since April 1998, the water vole has received legal protection through its inclusion on Schedule 5 of the Wildlife and Countryside Act 1981 in respect of Section 9 (4) only. This legal protection makes it an offence to 'intentionally damage, destroy or obstruct access to any structure or place that water vole use for shelter, and to disturb voles while they are using such a place'. It is possible that noise and activities associated with the

construction phase of the flood defence improvement works will disturb the water vole colony and/or damage their habitat. Therefore, prior to commencing on site it will be necessary to implement measures to minimise disturbance. A water vole conservation management strategy has been developed with assistance from Rob Strachan (water vole expert, seconded to the Environment Agency, Thames Region). The management strategy has been discussed with English Nature, in order to obtain the formal consent required to undertake the works.

In principle the management strategy will involve enhancing reaches of riverbank to provide optimal water vole habitat and temporary refuge during the proposed Stanmoor Bank flood defence improvement works.

The following reaches will be enhanced:

- Left bank of the River Tone between Hook Bridge and Stanmoor Bridge
- The River Tone between New Bridge and Hook Bridge
- The River Parrett between Parsonage Farm and Riverside Farm
- Curry Moor Main Drain and Stan Moor Main Drain

In order to temporarily displace the Stanmoor Bank water vole colony the bankside and fringe vegetation will be intensively managed. This will involve a mowing regime that keeps the vegetation short (< 15cm height).

Upon completion of construction the riverbank and fringe vegetation will be allowed to regenerate, to encourage water vole re-colonisation.

From spring 2000 and up until the completion of construction water vole activity within the Stanmoor Bank study area will be monitored to evaluate the effectiveness of the Stanmoor Bank displacement exercise. Standard water vole survey proformas should be used as included in the Water Vole Conservation Handbook (Strachan, 1998). Walkover surveys will also determine whether the riverbanks upstream and downstream, and the left bank of the River Tone (between Hook Bridge and Stanmoor Bridge) are being sensitively managed to provide optimal water vole habitat.

It is possible that the appointed scheme Contractor will want to use the left bank of the River Tone for access and delivery of materials to Stanmoor Bank. It is therefore recommended that the following restraints are enforced in order to minimise disturbance to water voles colonising the enhanced habitat of the left bank of the River Tone (between Hook Bridge and Stanmoor Bridge):

- Access to the left bank should be kept to a minimum.
- There will be a speed limit of 10mph.
- Light vehicles must not use the left bank to gain access to Stanmoor Bank.
- The Contractor should devise a working method to minimise direct damage to the river bank and bank top. No damage to the banks should be sustained which requires repair to areas more than one metre below the crest level.
- No vehicle movements along the left bank will be allowed (other than stationary cranes) when the water level is less than one metre from the bank crest.
- The Contractor will be allowed no more than six points of access across the river. The 'disturbed zone' associated with each access point should be no more than 20m in length.
- No more than two 'disturbed zones' should be in use at any one time.
- Any access points should be made good upon completion of the works. No

- hardening or non-biodegradable geotextile must be used in their repair.
- Any maintenance work required along the left bank must be agreed in advance with the Environmental Impact Assessment Co-ordinator.

Disturbance to Barn Owls

Barn owls have been observed feeding in the Stanmoor Bank study area. During construction, the removal of scrub and tree cover may disturb barn owls, which are protected species. Barn owls rely on the vegetation for providing suitable habitat for its main prey of shrews, voles and mice. As described earlier, all three techniques would result in some form of vegetation removal and could temporarily have an adverse impact on barn owls.

Scrub and trees should be left *in situ* wherever possible (but taking account of flood defence needs) and the vegetation should be re-established along the bank on completion of the works.

Disturbance to Otters

Otter tracks are often seen along the banks of the River Tone within the 3.1km stretch of channel affected by the proposed flood defence works. Disturbance during the construction phase of all three techniques could affect otters in the area. However, otters frequently have large territories (up to 40km along rivers), such that it is likely they would avoid the disturbance by feeding elsewhere in the short-term. The duration of disturbance would depend on the technique (see *Table 4.1.1*).

Disturbance to Badgers

Construction work along Stanmoor Bank may temporarily disturb badgers and their habitat. There are two active, single entrance outlier setts, within 30m of the proposed construction works. Under the Protection of Badgers Act (1992), construction works within less than 30m of these setts will require a MAFF disturbance licence. The licence will allow construction works to be undertaken outside of the breeding season (July to October inclusive).

In order to minimise potential impacts during the construction phase, the following procedures should be followed and will be detailed in the Environmental Action Plan.

- Use of a badger specialist to re-survey the river banks for signs of badger activity. The survey should be carried out in the spring prior to the start of construction. It is recommended that the survey also includes the area immediately surrounding Stanmoor Cut-Off Embankment.
- Obtaining a disturbance licence from MAFF in good time.
- Timing of construction works in the vicinity of the two outlier setts, to avoid disturbance to pregnant or nursing sows (i.e. construction will be prohibited between November and June inclusive).
- The Contractor should be made aware of any badger setts before starting on site, in order to minimise general disturbance and accidental damage.

4.1.3 Fisheries

It is unlikely that the techniques considered in this option would have an adverse impact on the fisheries and invertebrate communities within the River Tone. Direct disturbance to the channel and aquatic vegetation is not anticipated. Impacts from potential siltation resulting from run-off from the bank during construction are considered in *Section 4.1.6*.

4.1.4 Landscape

During construction, the works would be visible from: the houses on Stanmoor Bank and Curload Farm; from the farms and Curry Moor Pumping Station on the left bank of the River Tone; from the five bridges (including the public footpath at Hook Bridge) and from the tourist viewpoint on Burrow Mump in Burrowbridge. Visually intrusive elements may include: mechanical plant; security fencing; site offices; temporary haul roads; disturbed ground; and storage areas. The visual disturbance represents a short-term impact associated with the duration of the construction works.

The extent of the disruption could be minimised by working in sections of limited length and limiting the storage of equipment and materials on Stanmoor Bank. Screening of the works is unlikely to be successful due to the immediate proximity of the houses and their windows.

4.1.5 Water Resources

The construction phase would not be anticipated to have an impact on the groundwater resources, or the identified surface water abstractions within the area. During construction there would be no impact on the operational regime of Curry Moor Pumping Station, (as it is on the opposite side of the channel), or Stan Moor Pumping Station (on the River Parrett).

4.1.6 Water and Land Quality

Deterioration in Water Quality of the River Tone

The water quality of the River Tone may be affected by run-off of muddy waters from disturbed areas on the banks, haulage routes and from the discharge of any dewatering waters (pumped out of the trenches during construction). In addition, there is a risk of spillage when constructing the concrete pile cap and raising the crest level of the defences.

The Environment Agency's standard Pollution Prevention Guidelines (PPG5: Works in, near or liable to affect watercourses, and PPG6: Working at demolition and construction sites) should be adhered to at all times (NRA, 1992 and 1993). This extends to the need for regular cleaning of nearby roads used by construction traffic to prevent the washing of excess silts into watercourses (e.g. River Tone at Athelney Bridge).

Uncovering Foul and Surface Water Drainage

Construction works may uncover foul and surface water drainage systems. Observations on site indicated that there are a number of surface water drains (principally from roof drainage) which pass over Stanmoor Bank and discharge to

the River Tone. Foul drains, (eg. septic tank discharges and soakaways) are also known to be in the vicinity of the bank, serving the residential properties along Stanmoor Bank. Disruption to these drainage systems would be short-term.

Disturbance of Contaminated Land

Construction works may disturb potentially contaminated land within the vicinity of the railway and the garage on Stanmoor Road.

A site investigation of potentially contaminated sites should be undertaken prior to the construction works. Mitigation measures will be implemented (according to standard Environment Agency procedures) if contaminated areas are to be disturbed.

It is intended that the fill material required to widen the access track or raise the bank defence level will be taken from the River Tone. For a 100m length of bank raising and/or widening it is estimated that an average of 70m³ of fill material will be required. The fill material will be taken from the centre of the channel and not the berm to avoid affecting bank stability and potential water vole habitat. The Contractor will be responsible for testing the river silts for possible contamination, in accordance with guidelines set out by the International Committee on the Reclamation of Contaminated Land (ICRCL). This mitigation should be incorporated into the Stanmoor Bank Environmental Action Plan.

Fill material will need to be imported to raise the crest level of Stanmoor Cut Off Embankment and possibly to firm up the access track along Stanmoor Bank. Again the Contractor will be responsible for testing the fill material for contamination, in accordance with the suite of tests recommended by the ICRCL. This mitigation should be incorporated into the Stanmoor Bank Environmental Action Plan.

4.1.7 Archaeology and Heritage

Damage to Archaeological Features

Known archaeological features of interest are unlikely to be affected by the construction works associated with any of the viable techniques, as they lie outside the potential area of disturbance. In addition, disturbance of the river bank has occurred on numerous occasions in the past during the construction and maintenance of the flood defences. Therefore, further archaeological finds (even within this archaeologically rich area) are not anticipated. English Heritage and the County Archaeologist recommend that provision is made for a watching brief during excavation works along Stanmoor Bank.

Damage to Buildings of Heritage Interest

It is unlikely that the Stanmoor Bank flood defence improvements will affect Curload Farm which is a listed building.

Excavation work and piling may, however, affect houses along Stanmoor Bank, of which at least 38 are between 100-350 years old and are therefore of heritage interest. However, risk of damage to houses will be minimised through appropriate detailed design and selection of working methods (see Section 4.1.9). In addition, a structural and condition survey of the houses will be undertaken prior to the

commencement of construction. A post-construction structural and condition survey should also be undertaken and any construction related defects should be made good.

4.1.8 Land Use and Ownership

The construction of On-line Defence Works would not impact upon land use in the wider context, namely the surrounding arable and grazing land. Riparian owners may, however, experience disruption for the duration of the works (see *Table 4.1.1*; see *Sections 4.1.9* and *4.1.11*).

It is estimated that the Stanmoor Cut-Off Embankment construction works will take about six weeks to complete. During this time and until the grass has fully re-established the farmer will not be able to graze cattle in the field.

4.1.9 Local Community

Construction Noise

Noise nuisance during the construction phase of the On-line Defence Works would mainly be associated with construction plant activities (such as excavation, piling works and the delivery of concrete) and the traffic movements along the local road network. At least 26 of the houses along Stanmoor Road immediately abut the core wall at Stanmoor Bank. A further 10 houses are less than 10m away, and the remaining houses along Stanmoor Road are within 100m of the proposed works. Whilst background noise measurements have not been recorded, the area could be described as generally peaceful, disturbed only by trains and the occasional agricultural vehicles along Stanmoor Road and Stathe Road (resulting in periodic noise levels reaching approximately 70-85 decibels dB(A)).

BS 5228 "Noise Control on Construction and Open Sites" (BSI, 1992) indicates that account should be made of the existing noise climate. However, daytime operations are likely to be considered acceptable if the levels of noise at the nearest residents do not exceed 60-70 dB L_{Aeq} (continuous equivalent noise level in decibels) during daylight hours. Average noise levels for conventional piling are in the range 85-120 dB L_{Aeq} , whilst for low vibration piling (Technique 1) noise levels are likely to be less than 40 dB L_{Aeq} . The remaining techniques (install the impermeable geotextile membrane against the core wall, widen the access track and raise the level of defence) are unlikely to cause significant levels of noise disturbance over and above general construction disruption and traffic movements associated with concrete deliveries and the transport of materials. The level of disturbance to residents would also be related to the duration of the works (see *Table 4.1.1*).

In addition to the selection of the technique, the noise impact can be mitigated in a number of other ways. These measures will be described in the Environmental Action Plan and implemented as part of the Environment Agency's normal procedure. Such measures would include:

- Ensuring construction only takes place during reasonable hours (Monday to Friday 7.00am to 6.00pm and Saturday 8.00am to 6.00pm. Alternatively the Environmental Health Officer may stipulate working hours).

- Controlling the movement of vehicles to and from the site. For instance, vehicles should not be revved or allowed to stand idle outside residences wherever possible.
- Locating the site offices and compound away from residential areas where possible.

In addition, all people involved in construction should be made aware of the need to keep noise to a minimum. Good public relations and early warning of noisy activities (which could be achieved by the distribution of leaflets, provision of information boards and by undertaking presentations at public meetings prior to the works) should be maintained with local people to ensure the noise impact is not unacceptable. Whilst these mitigation measures should reduce the potential impacts, a residual noise and disturbance impact is anticipated.

Vibration

Construction activities may cause detectable levels of motion in the ground (at least in the immediate vicinity of the activity). At Stanmoor Bank, at least 26 houses lie immediately adjacent to the core wall. Many of these houses are more than 100 years old and some houses along the bank show evidence of settlement. There is therefore concern that structural damage could occur.

The recommended techniques to be used during construction (low vibration piling, raising the core wall, installation of an impermeable membrane against the riverside face of the core wall and widening the access track) would be unlikely to cause vibration at levels which could cause structural damage. However, a pre and post construction structural and condition survey of the houses along Stanmoor Road will be undertaken and any construction related defects will be made good.

Stock Piling of Fill Material

Fill material dredged from the bed of the River Tone should not be removed from Stanmoor Bank and should only be stock piled along the bank top. Any stock piling should be sympathetically arranged so as to cause minimum nuisance to residents. Individual piles should be no more than 0.75m in height.

Disturbance to Gardens

In some places along the bank garden scrub and hedgerows will have to be removed to gain access to the core wall. Any physical disturbance to gardens during these works will be rectified. The design should be discussed and agreed with the landowners prior to commencing on site with the works.

The Environment Agency are currently negotiating with a number of landowners along Stanmoor Bank, the possibility of using private gardens and orchards to gain access to the bank from Stanmoor Road. Any damage after use of the accessway will be made good.

Mud and Dust on Roads

The importation of construction materials, and the movement of construction traffic on and off the construction site, could lead to the deposition of mud (and subsequent dust creation) on the local roads. Environment Agency standard procedures will

require the works Contractor to clear such mud from the roads. The impact will be minimised through the successful implementation of this mitigation measure.

Unauthorised Access to Construction Sites

Site compounds and on-site works may attract children and other unauthorised people, during and outside construction working hours. Procedures require work areas and machinery to be secure against unauthorised access, with the aim of providing public safety. No impact is therefore anticipated.

4.1.10 Recreation and Amenity

Disruption to Angling

During construction disturbance to informal recreational fishing along the River Tone would be anticipated. The duration of the disturbance would vary for each technique from between 2-3 weeks per 100m (see *Table 4.1.1*). Taunton Angling Club estimate that approximately 5-6 fisherman are present along the banks at weekends, with less fishing activity during the week. It is believed that fishing is predominantly from the left bank (opposite the proposed flood defence works), which is served by a public footpath.

It is possible that the Contractor may decide to use the left bank for access. This would cause greater disruption to the anglers.

In order to minimise potential disturbance to anglers during construction, liaison with Taunton Angling Club should be undertaken in advance and a warning notice should be placed at Stanmoor Bridge, Athelney Bridge and Hook Bridge.

Diversion of Footpaths

Although there are no public footpaths along most of the right bank of the River Tone at Stanmoor Bank, there is a short stretch (approximately 200m) downstream at Hook Bridge. Potential short-term disruption to the use of the footpath would be anticipated during the construction phase, particularly if this area is used as a materials storage area or a turning point for lorries.

If the Contractor decides to use the left bank of the River Tone for access, it would possibly result in the temporary closure of sections of the footpath which runs along the left bank.

Disruption to users of the footpath should be reduced through identification and signing of an appropriate diversion route prior to works commencing (in line with the requirements of Somerset County Council's Public Rights of Way Officer).

4.1.11 Infrastructure and Access

Traffic Congestion

The importation of construction materials for the On-line Defence Works could result in congestion of the local road network, particularly along narrow roads with poor line of sight.

Stanmoor Bank may be accessed via Stanmoor Road which, in-turn, may be accessed via Cuts Road (East Lyng to Athelney) and Stathe Road (past Burrow Bridge).

Using silts from the River Tone as fill material will help reduce the number of construction related vehicle movements on the local road network.

Where heavy vehicles are required (eg. for Techniques 1 - low vibration piling), careful traffic management will be necessary. A traffic management strategy should therefore be prepared with the Highway Authority during detailed design and should be implemented for the duration of the construction works.

Strengthening of Stanmoor Bridge

Stanmoor Bridge has recently been assessed as having a load capacity of 17 tonnes. Therefore as part of the Stanmoor Bank scheme there is a strong possibility that the bridge will need to be strengthened. The strengthening works will not involve bank revetment work. If the bridge is not strengthened the Contractor will either need to find an alternative access route or build a temporary bridge adjacent to Stanmoor Bridge. The latter would cause localised disturbance to the Stanmoor Bank residents.

Exceptional Wear and Tear of Local Roads

Exceptional wear and tear of the local roads may be anticipated during the construction phase due to the increase in heavy vehicle usage. Prior to commencement of the works, the condition of the road should be established in the presence of the Highway Authority (Somerset County Council) and remedial action to maintain the road in its pre-contract condition should be undertaken as required.

Access

If not managed appropriately, machinery and materials used for the On-line Defence Works option could block access to houses. Technique 1 (low vibration piling) may cause disruption when manoeuvring long sheet piles and when gaining access to the bank for the piling rig and associated machinery. When constructing the pile cap and raising the core wall concrete delivery lorries will also cause temporary disruption.

Care is therefore required to ensure materials are stock-piled in designated areas away from houses and that machinery is quickly moved away from access routes.

Disruption to Railway

Disruption to the railway (eg. through blockage or damage to the tracks at the level crossing) would be prevented by liaison with the appropriate railway authorities prior to commencing on site.

Alternative Forms of Transport

There is unlikely to be an opportunity to import materials by rail, as it is the fast main line route from London to Exeter. Transportation of materials by river is also unlikely to be viable due to the shallow and narrow nature of the River Tone, other

than at times of flood. However, during detailed design the Contractor may decide that it is in fact feasible to deliver materials such as the piles to upstream or downstream sections of the bank from the local site compound.

4.1.12 Planning and Development

If mitigation measures to avoid potentially significant impacts are successfully implemented, there should be no impact on planning and development during the construction phase.

4.2 PERMANENT IMPACTS OF THE TECHNIQUES IN THE OPERATIONAL PHASE

4.2.1 Introduction

The following sections discuss the potential impacts of the techniques in the operational phase.

4.2.2 Nature Conservation

Maintenance of the Channel and Existing Hydrological Regime

On-line Defence Works would maintain the existing channel line and associated hydrological regime, thereby preserving the County Wildlife Site.

Change in Bankside Vegetation

Whilst the vegetation of the right bank of the River Tone is generally of little interest, it does provide a habitat for birds, invertebrates and mammals. The successful reinstatement of the vegetation should be monitored after completion of the flood defence works.

Loss of, or Damage to, The Badger Setts

As long as the conditions set out in the MAFF badger disturbance licence are followed throughout the construction works, there should be no long term adverse impact on the badgers occupying Stanmoor Bank, or the two outlier setts located within 30m of the construction works.

Damage to Water Vole Habitat

Upon completion of the scheme, bankside and fringe vegetation along the left bank of the River Tone (between Hook Bridge and Stanmoor Bridge) should be reinstated to provide optimal habitat for water vole. The best riverbank habitat for water voles offers a continuous swathe of tall and luxuriant riparian reeds, sedges, herbs and grasses, providing at least a 60% bankside ground cover. Post construction monitoring is recommended to ensure that the river corridor within the Stanmoor Bank study area is being managed suitably to encourage water vole re-colonisation. The longer-term management of the river corridor should be carefully considered by the Environment Agency and the recommended regime incorporated into the Operations and Maintenance Manual.

4.2.3 Fisheries

With the On-line Defence Works option no permanent impact on fisheries would be anticipated.

4.2.4 Landscape

Visual Amenity

The construction of the concrete pile cap along the piled length of the bank will have a visual impact on the area. The visual impact of the pile cap will be somewhat ameliorated by the placing of a soil wedge in front of the cap which can be grass seeded or planted with trailing plants. The use of similar techniques have proved effective along lengths of the River Parrett.

4.2.5 Water Resources

Maintenance of Water Resources

Protection of Stan Moor through stabilisation of the floodbank would allow continued management of existing water resources within the study area.

Maintenance of the Existing Hydrological Regime

On-line Defence works would not affect the existing hydrological regime of the Rivers Tone and Parrett.

4.2.6 Water Quality

Flooding of septic tanks behind Stanmoor Bank would be reduced, thereby reducing the risk of polluted water entering dykes and gardens.

4.2.7 Archaeology and Heritage

Maintenance of the Ancient Line of Flood Defence

Improvement of the On-line Defences would ensure the maintenance of the ancient line of defence, constructed by monks during the 14th Century. On Stan Moor, there would be no anticipated change to the existing level of waterlogging of artefacts.

Protection of Historic Buildings

Whilst there is only one listed building in the study area (Curload Farm), Stanmoor Bank also protects at least 38 houses constructed prior to 1900. The On-line Defence Works would allow for the long-term protection of these listed and old buildings.

4.2.8 Land Use and Ownership

Continuation of Current Land Management Practices

Stabilisation of the floodbank would allow continuation of current land management practices on Stan Moor (i.e. arable, grazing, withy beds, orchards).

4.2.9 Local Community

Reduction in Worry and Fear of Flooding

The On-line Defence Works will achieve the following technical requirements where necessary:

- Reduce seepage
- Increase bank stability
- Reduce risk of overtopping

Upon completion of the works it is anticipated that the residents of 129 houses would benefit from a reduction in the fear of flooding and the threat of a breach.

4.2.10 Recreation and Amenity

Protection of Amenity Facilities

The On-line Defence Works would enable current recreation and amenity facilities (eg. footpaths, angling sites, riverside areas etc.) to continue to be enjoyed by local people.

4.2.11 Infrastructure and Access

Flood Protection of Infrastructure

The On-line Defence Works would help to protect the infrastructure from flooding. This would prevent flood damage to the mainline Intercity rail link between London and the south west, and would ensure maintenance of the existing local road network.

4.2.12 Planning and Development

Improvement of the On-line Flood Defences should ensure the continued protection of the local agricultural economy, 129 houses, infrastructure (including the main railway and the local B and C road network) and the integrity of designated nature conservation sites (i.e. River Tone County Wildlife Site, River Parrett County Wildlife Site and part of the Somerset Levels and Moors ESA), as required within the Structure and Local Plans (SCC, 1997 and TDBC, 1992 respectively).

4.3 IMPACT OF RAISING THE CREST LEVEL

4.3.1 Introduction

In the Feasibility Study and Appraisal Report (May, 1998), the preferred Crest Level Option involved an average crest level raising of 0.04m over a 130m length of the bank. However, having taken into account freeboard, sea level rise and bank settlement the average crest level raising along the entire length of Stanmoor Bank would be 0.35m

for both Option B and C. Crest Level Option B however, would be raised in two stages as described in Table 3.0. The maximum raising for Option B and C would be 0.66m.

4.3.2 Temporary Impacts of Raising the Crest Level

Compared with the preferred Crest Level Option described in the Feasibility Study and Appraisal Report raising the defence level to take into account freeboard, sea level rise and bank settlement (average crest level raising 0.35m over the entire length of Stanmoor Bank), will increase the duration of the works and increase construction related traffic movements.

Change in Duration of the Works

The following impacts, previously identified in Section 4.2 are susceptible to changes in the duration of the works:

- Disturbance to wildlife, including breeding birds, water voles, barn owls and otters
- Visual intrusion
- Disruption to land use
- Noise and vibration disturbance to the local community
- Disruption to angling
- Disruption to access

As previously noted the works will be undertaken during the Spring and Summer months and will probably be phased over a period of two years.

Increase in Construction Related Traffic

Crest Level Option B and C will require considerably more raising than that proposed for the preferred option in the Feasibility Study and Appraisal Report (May, 1998). The result will be an increase in the number of deliveries of construction materials. An increase in the number of lorries on the local road network could affect the local community and in particular the residents along Stanmoor Road.

4.3.3 Permanent Impacts of Raising the Crest Level

Introduction

Numerical modelling of the system has shown that under the existing arrangement at Stanmoor Bank overtopping into Stan Moor does occur from time to time. However, the volume of water entering Stanmoor in less than a 1 in 100 year return period event is very small, less than a 1,000m³ (See Table 4.3.3). Raising the crest of Stanmoor Bank to a 1 in 100 year standard (thereby stopping the small volume of water that previously entered Stan Moor from doing so), will have an immeasurable effect on water levels in Curry Moor (See Table 4.3.3). The modelling results suggest that the raising of the Crest Level along Stanmoor Bank (1 in 100 year standard) will not have an adverse impact on the adjacent Curry Moor and Hay Moor SSSI, Special Protection Area (SPA) and Ramsar Wetland of International Importance.

Table 4.3.3

**Maximum Volume of Floodwaters in Curry Moor, Hay Moor and Stan Moor
 Before and After the Raising of Stanmoor Bank**

Return Period Event (Years)	Curry Moor (in 1,000m ³)	Hay Moor (in 1,000m ³)	Stan Moor (in 1,000m ³)
1 in 8	¹⁾ 1,657	¹⁾ 1,918	¹⁾ 0
	²⁾ 1,657	²⁾ 1,919	²⁾ 0
1 in 25	¹⁾ 11,742	¹⁾ 2,684	¹⁾ 0
	²⁾ 11,742	²⁾ 2,684	²⁾ 0
1 in 500	¹⁾ 12,962	¹⁾ 4,100	¹⁾ 0
	²⁾ 12,962	²⁾ 4,100	²⁾ 0
1 in 1,000	¹⁾ 13,377	¹⁾ 5,760	¹⁾ 137
	²⁾ 13,377	²⁾ 5,760	²⁾ 86

¹⁾Floodwaters in the different moors before the raising of Stanmoor Bank.

²⁾Floodwaters in the different moors after the raising of Stanmoor Bank.

Nature conservation, the natural landscape, archaeology and heritage and land use interests on Stan Moor would not be affected by the Crest Level selection for Stanmoor Bank.

Compared with the preferred Crest Level Option described in the Feasibility Study and Appraisal Report (May, 1998), raising the defence level to take into account freeboard, sea level rise and bank settlement, would have a more significant long-term impact on the local community and in particular residents living in property adjacent to the core wall. These impacts are discussed below.

Visual Appearance of the Bank

Upon completion of the flood defence improvement works the bank will clearly be marginally higher than at present. From Stanmoor Bank and the Curry Moor side of the river the increase in the height of the defence will be softened by the placing of a seeded soil wedge in front of the sheet piles. From Stan Moor the concrete wall may seem marginally higher. However, in a lot of cases the wall will be hidden by garden plants and out buildings.

Obstruction of Windows

A combination of Crest Level Option B and C would affect the view and would reduce light through low level windows for a number of properties overlooking Stanmoor Bank. This would represent a long-term impact for the residents concerned. As previously discussed Crest Level Option B will be built in two stages. After the initial raising (some sections of bank raised to Crest Level Option B and some to Option C) it is estimated that approximately nine windows would be affected and a further seven after the second stage of raising (in 25 years time).

Careful design is therefore required to ensure that wherever possible the view from and the light entering windows is not obstructed. Detailed design options include use of stop logs (i.e. wooden planks temporarily placed into slots within the defence to keep out flood water) or use of glass walls in front of windows. Table 4.3.3 compares the advantages and disadvantages of these design options.

Consultation with residents should be undertaken at an early stage in detailed design, in order to fully evaluate the significance of the potential impact on their particular house and to identify a satisfactory solution.

Table 4.3.3

Comparison of Glass Walls Versus Stop Logs

	Advantages	Disadvantages
Glass Walls	<ul style="list-style-type: none">▪ Allow light through all year round▪ Maintain view all year▪ Always in place	<ul style="list-style-type: none">▪ Tend to get scratched and dirty - prone to damage▪ Slightly distorted view▪ Cannot open windows
Stop Logs	<ul style="list-style-type: none">▪ Normal light conditions when removed▪ Normal view when removed▪ Can open windows	<ul style="list-style-type: none">▪ Prone to leakage▪ No light or view when in place▪ Get lost, damaged or forgotten, so may not be in place when required

Access from Properties onto the Bank

Raising the level of the defence would require alteration to some access ways from adjacent properties onto the river bank. Any access alterations would take into consideration resident health and safety issues.

Reduction in Worry and Fear of Flooding

With Crest Level Options B and C in 50 years time the standard of defence against overtopping will be 1 in 100 years. In addition seepage through the bank and the risk of breach will be substantially reduced.

Although large volumes of water do not currently enter Stan Moor by overtopping, overtopping does occur at specific locations. The most recent event was in December 1999. Overtopping is perceived as a major problem by Stan Moor residents and therefore its reduction, together with a reduction in seepage will help alleviate their worry and fear of flooding.

5.0 SUMMARY OF IMPACTS

The On-line Defence Works would secure the bank against breach, thereby preserving present land use and assets.

Three different techniques could be used at appropriate locations along the bank, depending on the technical and environmental constraints at each site.

The preferred Crest Level option will be a combination of Crest Level B and C. Crest Level Option C will be introduced where future access is difficult or other considerations make it desirable. The remainder of the bank will be designed to Crest Level Option B. The crest level at Stanmoor Bank will be raised to a 1 in 100 year standard. Sections of the bank designed to Crest Level Option B will be built in two stages, the first stage allowing for freeboard, 25 years sea level rise and 25 years settlement of the bank. The second stage will allow for a further 25 years sea

level rise and 25 years settlement of the bank. Crest Level Option C is effectively the same as Option B, but all of the crest level raising will be carried out in one go.

As part of the scheme Stanmoor Cut-Off Embankment will be raised and strengthened, to comply with the Reservoirs Act (1975).

5.1 TEMPORARY IMPACTS DURING THE CONSTRUCTION PHASE

Temporary impacts, during construction of the On-line Defence Works, include:

- Disturbance of flora and fauna along the whole riverward face of Stanmoor Bank; the area is a County Wildlife Site and supports legally protected species such as water voles.
- Disturbance to badger territory and two outlier setts which are within 30m of the construction works.
- Disturbance to residents in 100 houses, from the noise of construction plant and from the presence of construction activity close to their homes.
- Possible congestion on the local road network from construction related traffic.

Fill material used to raise the level of the defence or widen the access track will be dredged from the centre of the river channel to avoid affecting bank stability and water vole habitat. On average per 100m length of bank raising and/or widening 70m³ of fill material will be required.

The construction period over which these impacts would arise is anticipated to be six to nine months each year for two consecutive years. The work would be carried out in the spring and summer months to avoid high water levels in the River Tone. Work in front of any one property should last no more than one month, but general construction activity and disturbance would be noticeable throughout the whole construction period.

5.2 PERMANENT IMPACTS IN THE OPERATIONAL PHASE

Permanent impacts from construction of the On-line Defence Works would include:

- Stabilisation of Stanmoor Bank such that it is secure against breach failure, thereby sustaining flood protection to 129 properties, 330 ha of agricultural land, a main line railway and other assets in the Stan Moor area.
- Reduced seepage through Stanmoor Bank, giving relief to those houses along the bank which presently suffer from damp and shallow flooding by seepage through and under the core wall.
- Potential damage to properties from construction activities, e.g. through vibration, although all such damage would be repaired under a compensation scheme.

5.3 ON-LINE DEFENCE TECHNIQUES

The use of low vibration piling (Technique 1) would offer a relatively quiet and almost vibration-free alternative to conventional piling methods. Low vibration

piling would significantly reduce the risk of structural damage to the properties along Stanmoor Bank.

During the delivery of steel piles and concrete (Techniques 1 and 3) there may be short-term traffic congestion problems on Stanmoor Road, which would affect the local community. A traffic management strategy should therefore be prepared with the Highway Authority during detailed design and should be implemented for the duration of the construction works. Technique 2 (installing an impermeable geotextile membrane against the core wall), however, has the advantage of requiring only minor traffic movements and limited disturbance during the construction phase. Technique 2 is however restricted to sections of the bank where only seepage (and not a stability problem) needs to be resolved.

Potential disturbance to protected species such as badgers, otters and water voles is common to all three techniques. However, the implementation of the recommended mitigation measures will ensure that any disturbance or habitat damage/loss is minimised.

Other than impacts relating to noise, vibration, disruption to the community and disturbance to protected species, the remaining temporary and permanent potential impacts can generally be mitigated for all techniques.

5.6 RAISING THE CREST LEVEL

Overtopping into Stan Moor does occur from time to time. However, the volume of water entering Stanmoor in less than a 1 in 100 year return period event is very small. Modelling results suggest that the raising of the Crest Level along Stanmoor Bank (1 in 100 year standard) will not have an adverse impact on the adjacent Curry Moor and Hay Moor Special Protection Area (SPA) and Ramsar Wetland of International Importance.

Raising the defence level to Crest Level Option B or C would affect the visual appearance of the bank from both sides, may require alteration to some access ways from properties onto the Bank, and would alter the aspect from some property windows which face onto the bank. In some cases works would be needed to accommodate windows which otherwise would be partly blocked by the raising of the defence.

5.5 CONCLUSION

As a strategic option therefore, the On-line Defence Works option would allow protection of the local community against the risk of breach and long-term flooding and would enable existing land management practices to continue on Stan Moor. Maintenance of the current hydrological regime would also be assured.

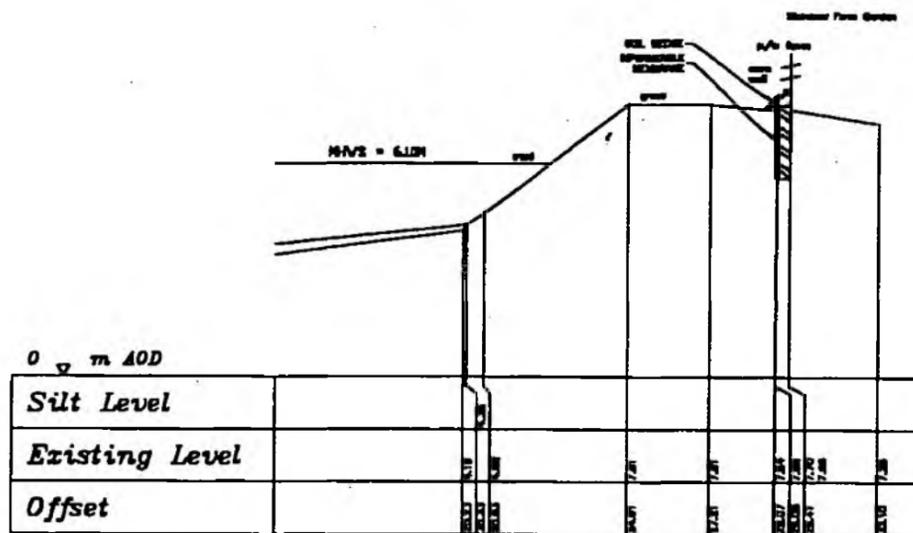
FIGURES

NOTES

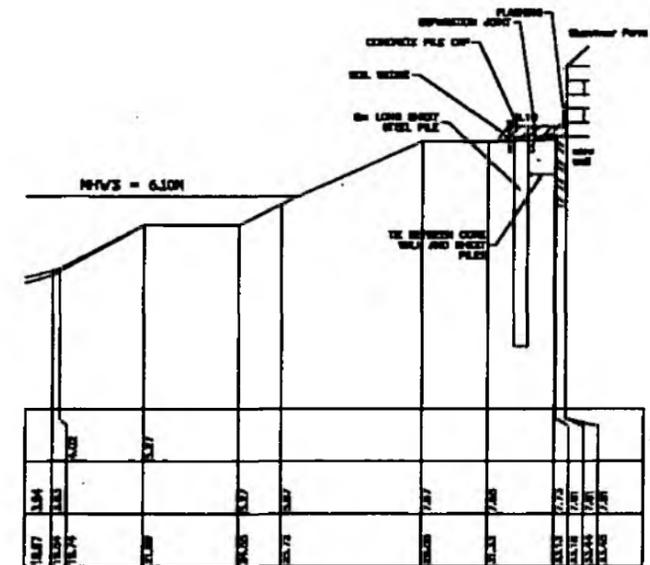
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- 2) ALL LEVELS ARE IN METRES RELATIVE TO ORDNANCE DATUM NEWLYN.

LEGEND

-  EXISTING CORE WALL
-  NEW CONCRETE
-  SOIL FILL



DESIGN TYPE A



DESIGN TYPE B

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TITLE
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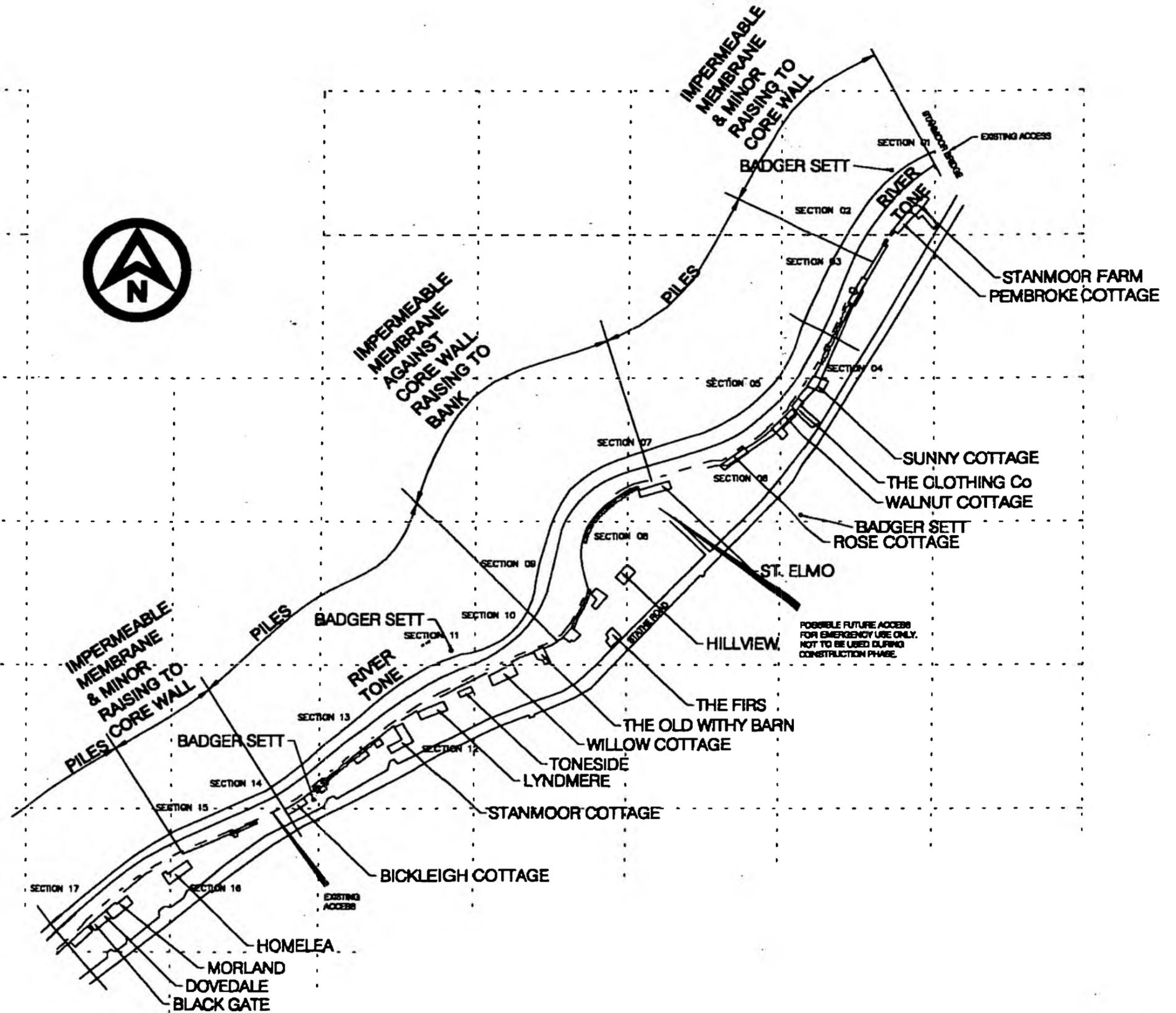
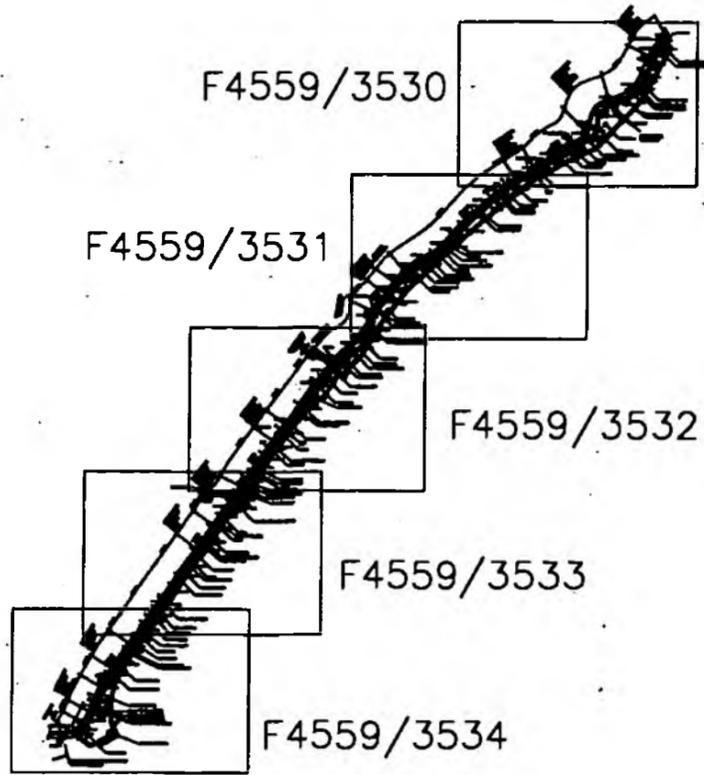
PROJECT
LOWER TONE FLOOD DEFENCE IMPROVEMENTS



CONSULTING ENGINEERS
POSFORD DUVIVIER

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KEY PLAN



DESIGN TYPE G OCCURS AT SECTIONS 08 & 09.
DESIGN TYPE B,C & D OCCURS AT SECTIONS 04-06.
DESIGN TYPE A OCCURS AT SECTION 02 & 14.
FOR DESIGN TYPES SEE DRGS F4559/3520,21 & .22.

OUTBUILDING

TITLE

PROPOSED WORKS
PLAN 1 OF 5

PROJECT

LOWER TONE FLOOD
DEFENCE IMPROVEMENTS



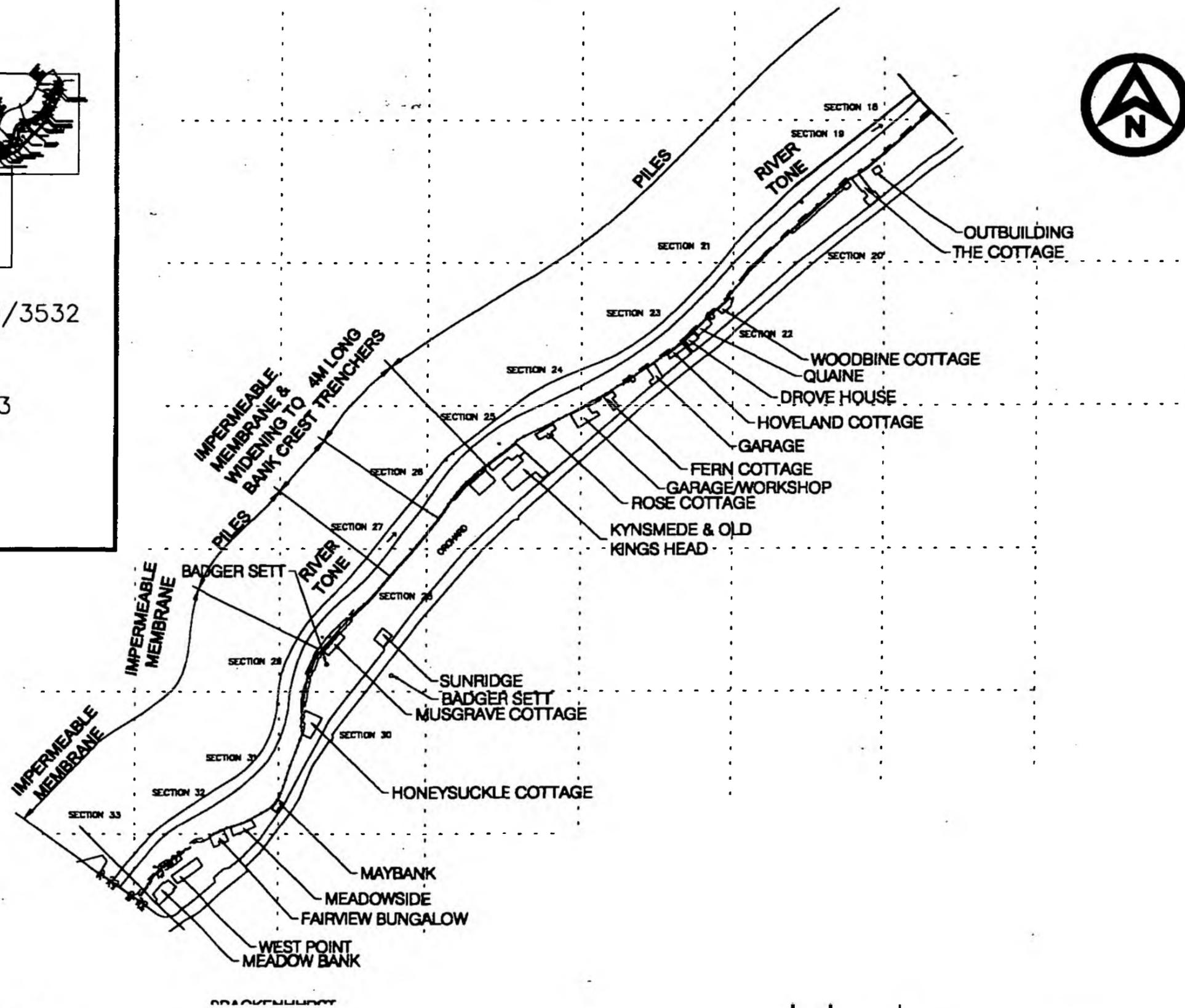
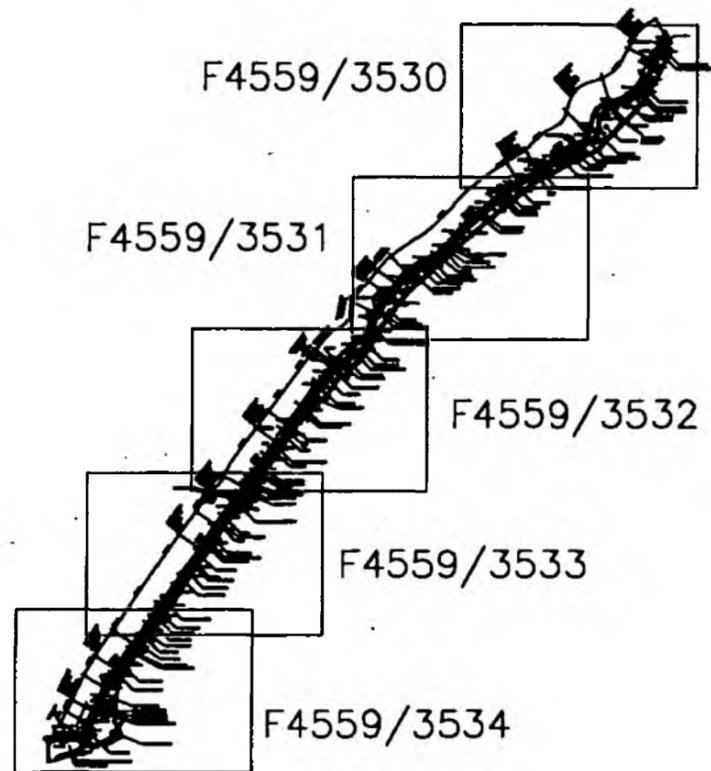
ENVIRONMENT AGENCY
SOUTH WEST REGION

CONSULTING ENGINEERS

**POSFORD
DUVIVIER**

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ACAD Ref.		CHECKED	RJB	PASSED	
DRAWN	ACP	DRG No.	F4559/3530	REV	-

KEY PLAN



DESIGN TYPE B,C & D OCCURS AT SECTIONS 17-25.
FOR DESIGN TYPES SEE DRGS F4559/3520,21 & 22.

TITLE
**PROPOSED WORKS
PLAN 2 OF 5**

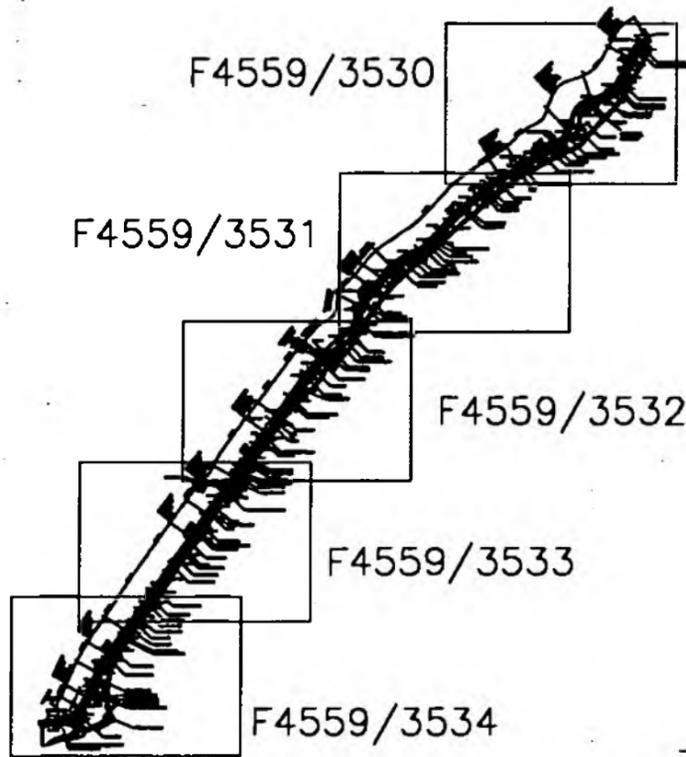
PROJECT
**LOWER TONE FLOOD
DEFENCE IMPROVEMENTS**



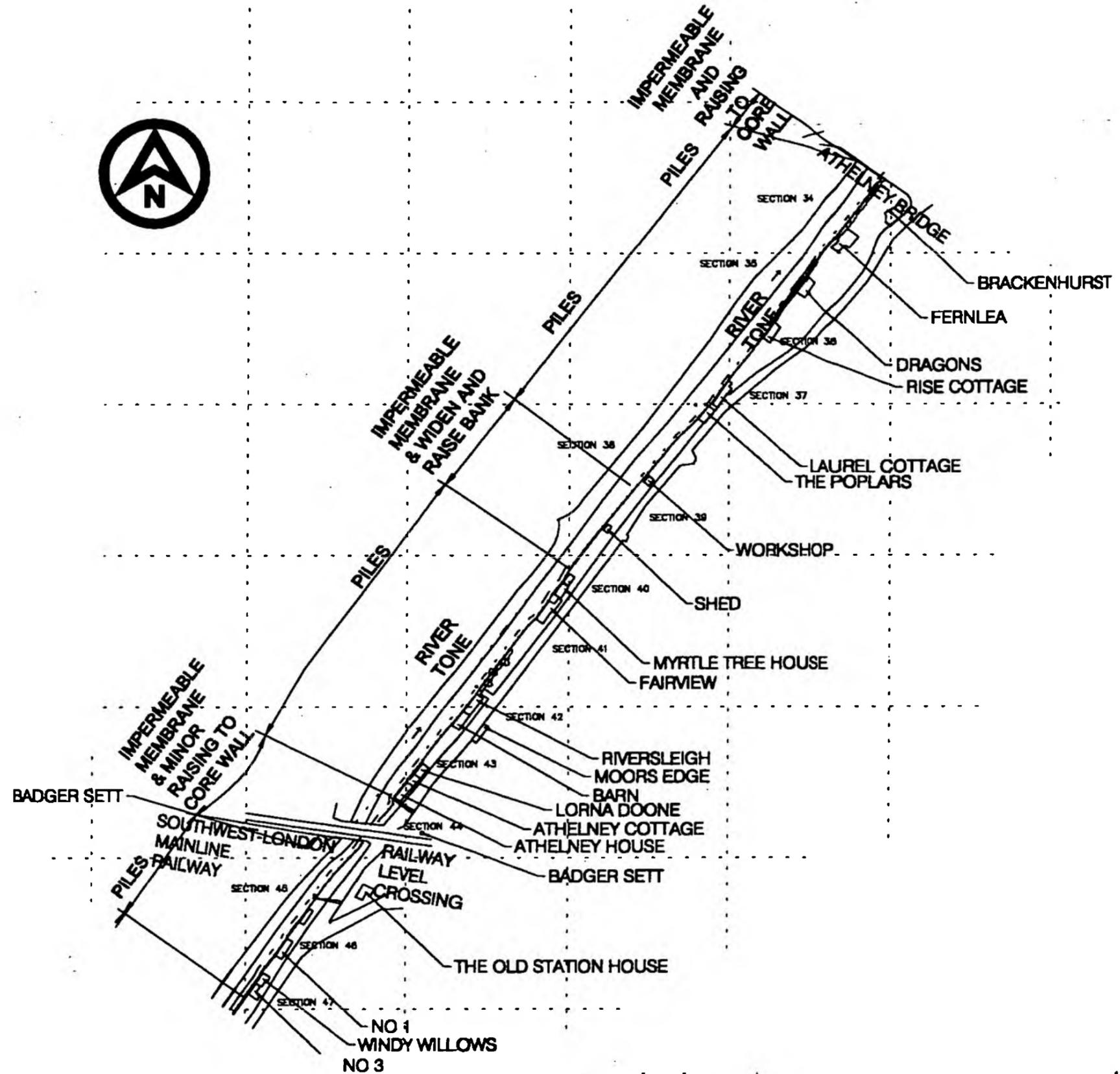
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KEY PLAN



DESIGN TYPES B,C & D OCCUR AT SECTIONS 36-39.
DESIGN TYPE A OCCURS AT SECTION 44.
FOR DESIGN TYPES SEE DRG F4559/3520,21 & 22.



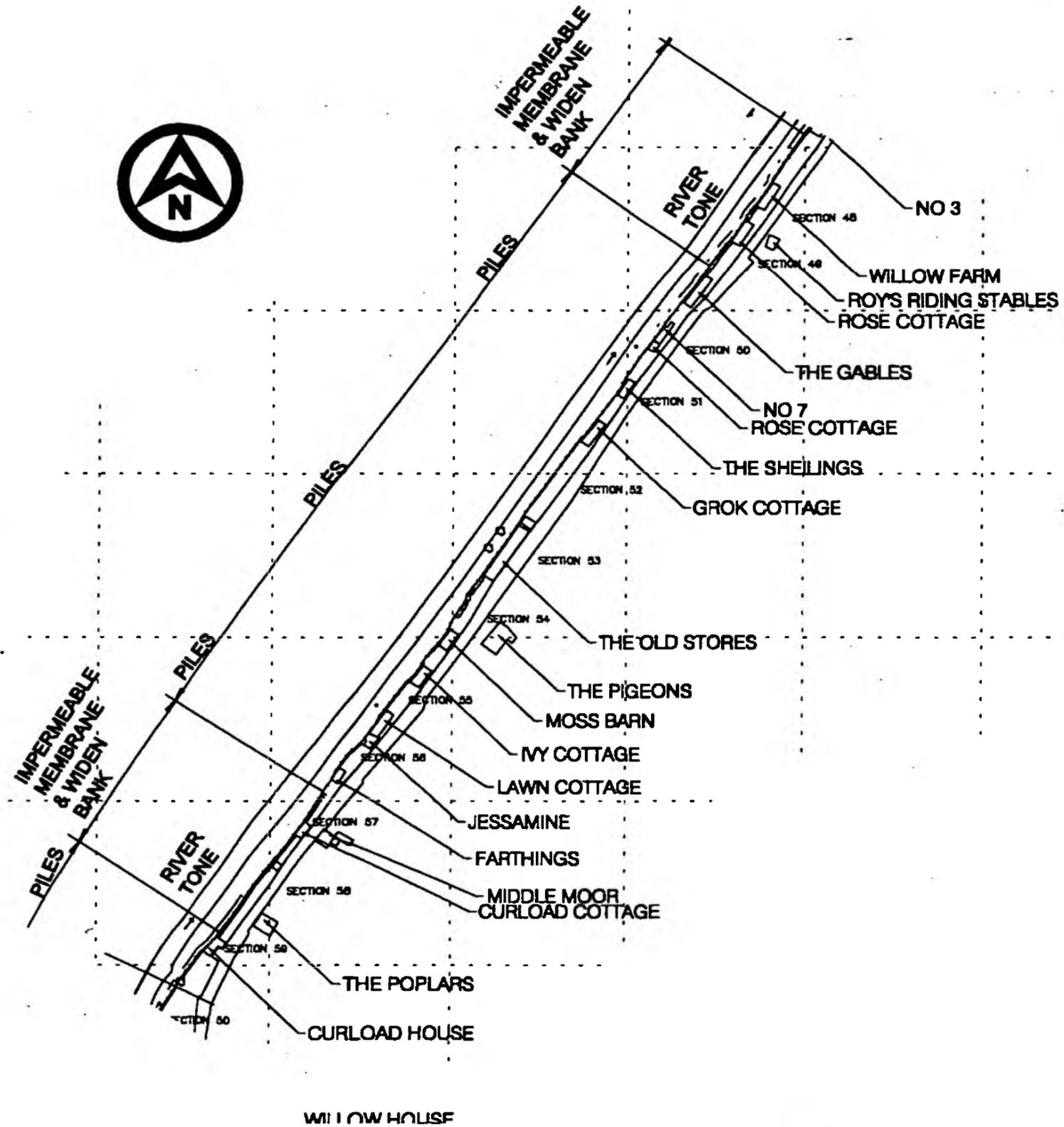
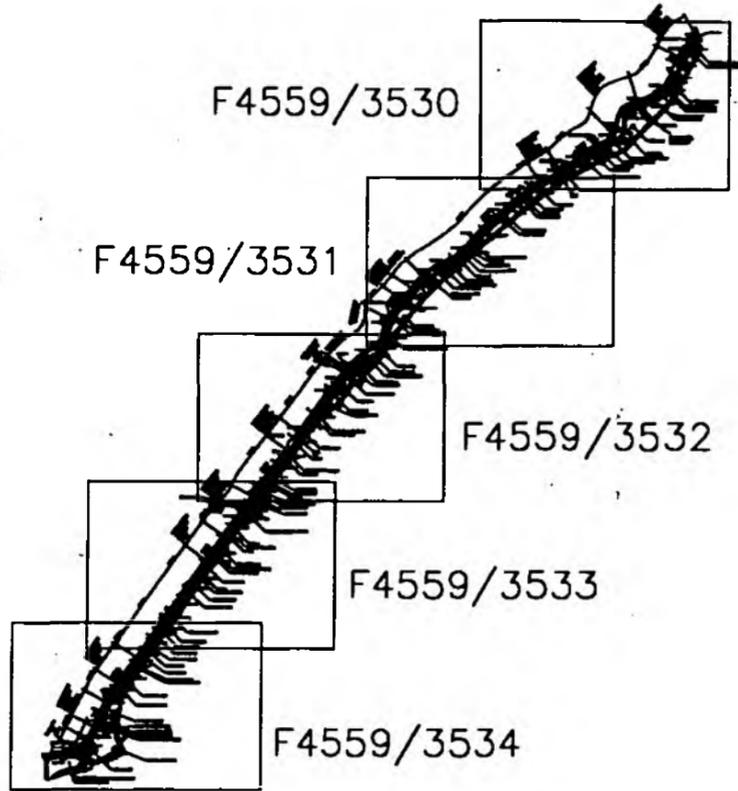
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DRAWN	ACP	DRG No.	F4559/3532	REV	-

TITLE
PROPOSED WORKS
PLAN 3 OF 5

PROJECT
LOWER TONE FLOOD
DEFENCE IMPROVEMENTS



KEY PLAN



DESIGN TYPES B,C & D TYPICALLY OCCUR BETWEEN SECTIONS 50 & 56.
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 FOR DESIGN TYPES SEE DRG F4559/3520,21 & 22.

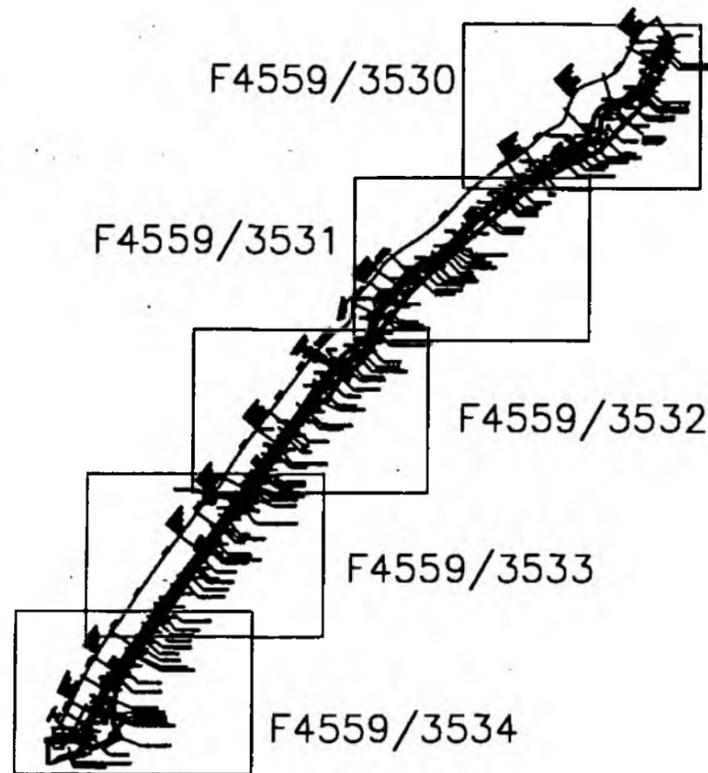
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TITLE
**PROPOSED WORK
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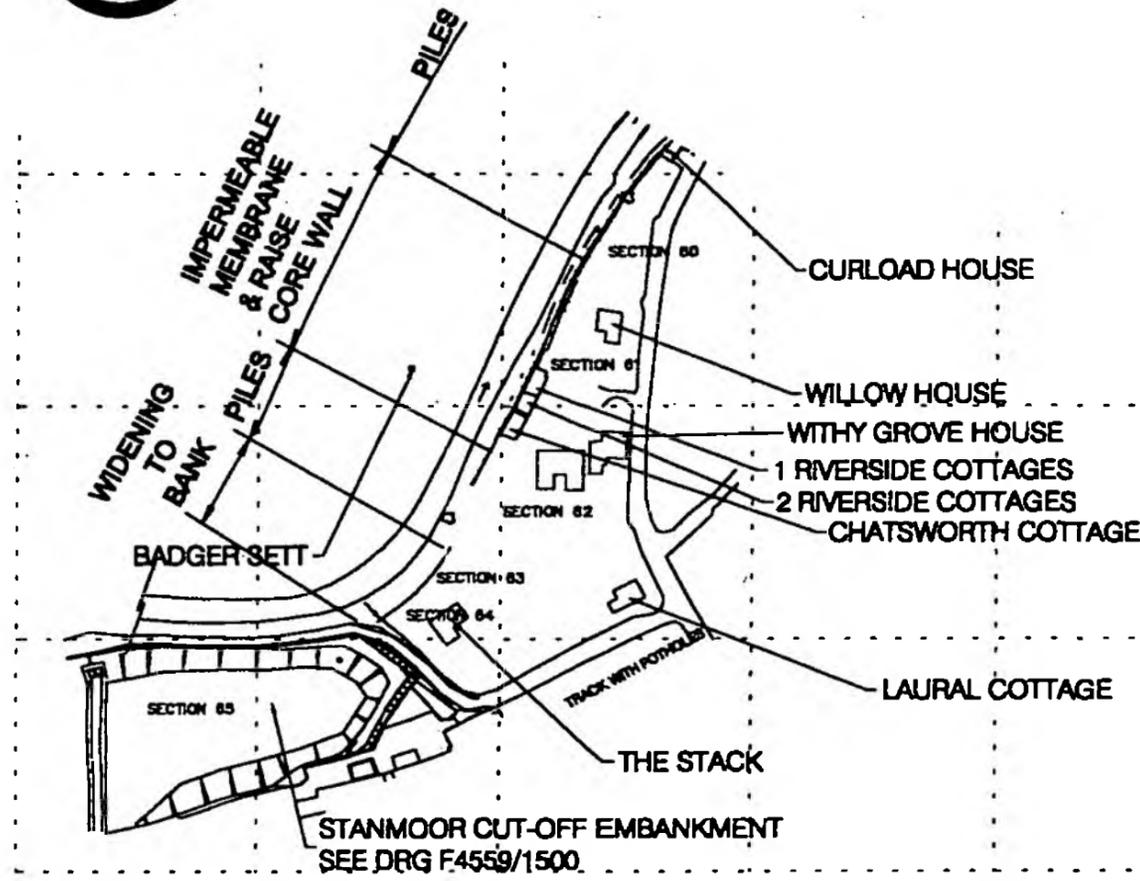
PROJECT
**LOWER TONE FLOOD
 DEFENCE IMPROVEMENTS**



KEY PLAN



DESIGN TYPE A OCCURS AT SECTION 61.
 DESIGN TYPE D OCCURS AT SECTION 60.
 FOR DESIGN TYPES SEE DRG F4559/3520,21 & 22.



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TITLE
**PROPOSED WORK
 PLAN 5 OF 5**

PROJECT
**LOWER TONE FLOOD
 DEFENCE IMPROVEMENTS**



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