**Oxfordshire Highways**

# Cogges Link Road
## Geomorphology Study

B0834600/Doc/CLR/Geo April 2008

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# Non-Technical Summary

- Oxfordshire Highways is submitting a planning application for the construction of a new link road in Witney, Oxfordshire, together with an Environmental Statement. The proposed road would link up Witan Way roundabout with Oxford Hill (B4022), north of the A40. The road would cross the two channels of the River Windrush, one which is thought to be the original course of the river (River Windrush - East Branch) and the other (River Windrush- West Branch), being a historic channel cut to provide water to numerous mills in the lower course of the River Windrush, as it crosses the floodplain of the River Thames. The construction of the road would require the diversion of the West Branch of the River Windrush and minor modifications to the East Branch.

- This report provides a baseline geomorphological assessment of the River Windrush in the immediate vicinity of the proposed construction area. It is intended to inform the engineering design of the road across the floodplain of the River Windrush. This includes an assessment of both the West Branch and the East Branch. In addition, the proposed river diversion and modifications are reviewed and suggested alterations to the original design plans detailed. ***It will be necessary that any realignment designs do not adversely affect the river environment which is likely to be a condition of the Environment Agency as part of the consent to the works. As a result, it is of paramount importance that the geomorphology of the river is taken into account in this design process.***

- The results of the geomorphological survey suggest that at the proposed location of the road the Eastern Branch of the River Windrush is showing signs of both deposition and erosion. Numerous, large depositional berms have developed along the channel margins. The channel has a sinuous planform. Bank erosion, although minor, is occurring at several locations within the project reach. Bank failures have occurred at the location of the proposed bridge crossing and these have been created by tree falls. The roots most likely pulled the bank material out as the tree fell. The tree probably originally fell due to erosion of the bank toe due to impinging flow. The fallen tree has since been removed but the holes created in the bank remain.

- The Western Branch of the River Windrush is largely artificially straight downstream of Farm Mill. It has depositional features on both the channel margins and both banks constitute a well vegetated riparian corridor.

- The original river designs for the diversion and modification have been revised to develop a more natural river, acceptable in terms of its form and functioning. This should enable the new diversion designs to be at least in keeping with the present river's form and functioning, offering improvements where possible.

# Contents

# Glossary

**Adjustment:** Alteration of the channel width, depth, slope or mean flow velocity through time as the stream evolves towards a condition of dynamic equilibrium.

**Aggradation:** Build up of sediment at a particular location often associated with processes of channel incision and widening.

**Berm**: Large depositional feature on the edge of the channel that has now developed to such an extent that it is becoming part of the floodplain.

**Channel Straightening:** Engineered shortening of the length of a stream/ river artificially by removing meander bends. Often undertaken in conjunction with relocation of a channel to the edge of the valley floor to improve utility of the land for farming or development.

**Deposition:** Laying down of part, or all, of the sediment load of a stream on the bed, banks or floodplain. Mostly occurs at the end of a high flow event. Forms various sediment features such as bars, berms and floodplain deposits.

**Erosion:** Removal of sediment or bedrock from the bed or banks of the channel by flowing water. Mostly occurs during high flows and flood events. Forms various river features such as scour holes, cut banks and river cliffs.

**Incision / Degradation:** Lowering of the elevation of the channel bed in a reach through time due to adjustment of the long profile by erosion.

**Left Bank**: the side of the channel that is on the left as you face downstream

**Planform:** This is the plan view of a river when looked at from above (eg on a map or aerial photograph). Planfoms can be described variously as sinuous, meandering, straight etc.

**Pool:** Area of deep water formed by local scour of bed at the outside of a meander bend or where the channel width is constricted (e.g. at a bridge).

**Riffle:** Natural accumulation of course sediment (gravel or cobbles) in the bed of the channel to form an area of steep, shallow, highly turbulent flow. Typically found between meander bends.

**Right Bank:** the side of the channel that is on the right as you face downstream

**Riparian Corridor:** Strip of land surrounding the stream channel that is directly affected by flow and sediment processes in the stream/ river.

**Sedimentation:** Build up of sediment over time at a location due to supply that exceeds local transport capacity.

**Sinuosity:** Measure of the channel planform when viewed from above. Defined by the ratio of channel length to straight line valley length. A straight line has a sinuosity of one. A sinuous channel has a sinuosity between 1 and 1.3. A meandering channel has a sinuosity greater than 1.3.

**Terrace:** Old bed level of the river located on the floodplain and formed before the channel incised.

# 1 Introduction

## 1.1 **Background**

1.1.1 The River Windrush, through Witney, has a long history of modification which is primarily linked to mill construction. Mills were an essential part of the woollen blanket industry for which Witney was famous for, particularly in the seventeenth century. About 1km upstream of the site of interest, a bifurcation point exists on the River Windrush. This is the point at which the Windrush splits into two channels. The Eastern Branch is thought to be the original course, while the Western Branch is the channel cut that feeds the mills in the lower part of the River Windrush catchment. The two channels re-join approximately 10km downstream at Standlake.

1.1.2 Oxfordshire Highways is submitting a planning application and accompanying Environmental Statement for the Cogges Link Road within Witney. The route would join two parts of Witney immediately upstream of the A40. The proposed road crossing would traverse both the Eastern and Western Branches of the River Windrush.

1.1.3 This report has been commissioned by Oxfordshire Highways. The main aim is to inform the engineering design and the ecology chapter of the Environmental Statement. ***It will be necessary that any diversion design does not adversely affect the riverine environment and thus realignment designs should ensure that they take into account the fluvial geomorphology of the river. This is likely to be a requirement by the Environment Agency and would need to be addressed effectively in the Environmental Statement.*** The key objectives of this report are to:-

- undertake a review of historic maps to assess the potential for channel adjustment at the bridge crossing points;
- undertake a baseline study of the geomorphology of the River Windrush, in the reach of interest, by undertaking a stream reconnaissance survey;
- review the functioning of the river in the vicinity of the proposed location of the new road, using the results of the stream reconnaissance survey to identify any management or development concerns, particularly with respect to the proposed river diversion and modifications;
- Suggest amendments to the proposals to produce river designs that are at least in keeping with the geomorphological form and functioning of the present river channels on site while offering improvements where possible (ie a more natural form).

# 2 Methodology

## 2.1 Historical channel analysis

2.1.1 An assessment of historical channel adjustment in the project reach was made by comparing the planform of the river on historic maps of the River Windrush, in the project reach, with the contemporary Ordnance Survey Map. This enabled an assessment of potential for channel adjustment to occur to be undertaken. This technique further informs the decision as to whether any bank protection work is needed.

## 2.2 Stream reconnaissance

2.2.1 An assessment of the contemporary status of the River Windrush was made using the stream reconnaissance technique. This technique is a standard tool for assessing rivers (Thorne, 1998). The basis of the stream reconnaissance method is to:-

- supply a methodological basis for field studies of channel form and process;
- present a format for the collection of qualitative information and quantitative data on the fluvial system;
- provide a vehicle for progressive morphological studies that start with a broadly focused catchment baseline study, continue through a fluvial audit of the channel system, and culminate with a detailed investigation of geomorphological forms and processes in critical reaches;
- supply the data and input information to support techniques of geomorphological classification, analysis and prediction necessary to support sustainable river engineering, conservation and management.

2.2.2 The reconnaissance survey was used to identify key geomorphological processes and resultant forms occurring in the project reach and use this information to make an assessment of the likely impact on the survey reach of the proposed road crossing. A series of photographs have also been taken to illustrate various features observed.

# 3 Study Area

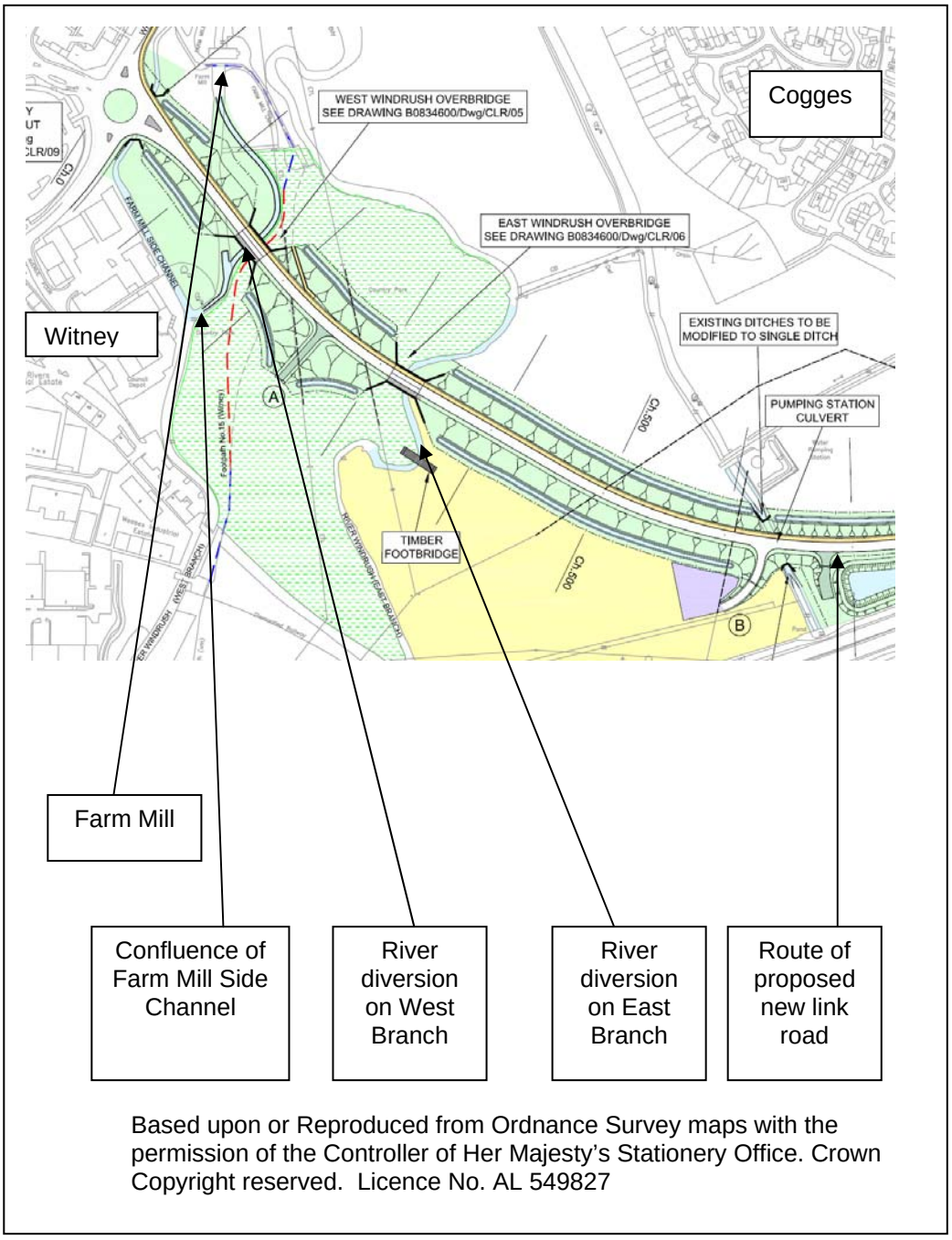
## 3.1 **Historical channel analysis**

3.1.1 The River Windrush has been extensively modified in the project reach. The Western Branch of the Windrush is in fact a cut channel to provide water power to mills in the lower Windrush valley located on the floodplain of the River Thames. The Eastern Branch of the channel is thought to be the original course of the River Windrush.

3.1.2 Farm Mill is located at the upper end of the project reach (see Figure 1). Evidence of the existence of a mill at this location dates back to the 13th and 14th centuries, when corn and fulling mills operated at the site (www.witneyblanketstory.org.uk). Farm Mill has existed at the site since 1695. The mill was closed for the generation of power in the early to mid twentieth century.

3.1.3 The proposals involve diverting the Western Branch of the River Windrush downstream of Farm Mill. In contrast, only minor modifications are proposed at the location where the CLR crosses the Eastern Branch

## Figure 1: Map of project reach



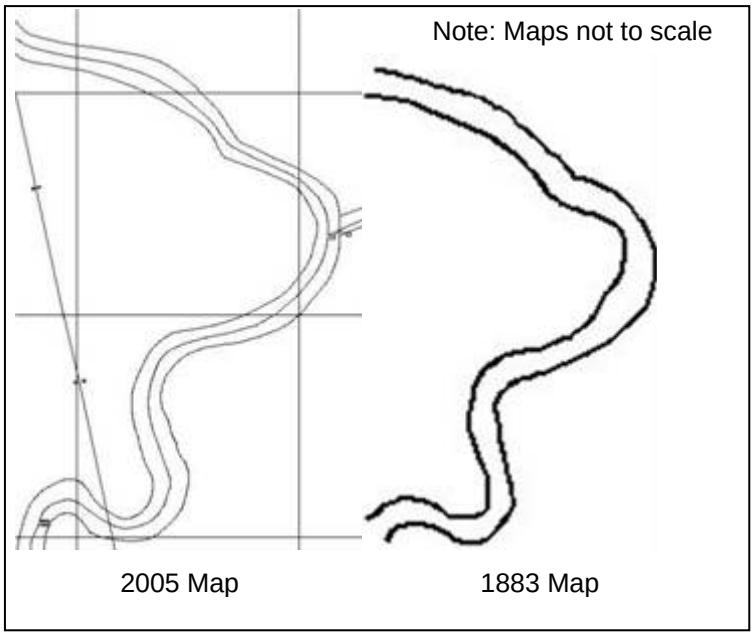
# 4 Results

## 4.1 Historical channel analysis

4.1.1 A historical channel analysis was undertaken on the immediate area of interest to see whether the planform of either of the branches had changed over time. To undertaken this exercise, historic maps from 1833 were compared to the current Ordnance Survey Map of 2005.

4.1.2 On close inspection of the Western Branch of the River Windrush it is evident that no significant adjustment has occurred through time as the current channel course is in the same straightened alignment that existed in both the 1833 and the 2005 maps. The same is the case for the River Windrush on the Eastern Branch (see Figure 2 for comparison maps). Despite the sinuous course illustrated in each of the 1833 and the 2005 maps the planform has not adjusted in any noticeable manner. This indicates that the river has low energy and is incapable of adjusting to any significant degree under the prevailing conditions that exist at the site. As a result, it is safe to assume that the potential for channel adjustment in any of the proposed diversions is low.

Figure 2: Historical channel analysis – Eastern Branch






## 4.2 Contemporary Status of the channel

4.2.1 The fieldwork for the stream reconnaissance was undertaken on 23rd of January 2007. The reconnaissance involved walking the River Windrush from Field Mill for about 250m downstream on the Western Branch and 600m on the Eastern Branch. River reconnaissance was continued downstream of the proposals to ensure that the likely geomorphological effects of the road crossing could be

assessed effectively. A map showing key features on the reconnaissance survey is provided in Figure 3. Photographs of the key features are detailed in Appendix A.

4.2.2 In addition to the stream reconnaissance undertaken, a bank erosion assessment was also performed on the outer bank of the river at the location where the road crosses the Eastern branch. Bank failure was noted at this location and thus the likely cause(s) of the bank erosion needed to be investigated further.

***Eastern link***

*Fluvial Geomorphology baseline survey*

4.2.3 At the start of the project reach (ie upstream) there is long straight section of channel (Photograph 1). This has a significantly steeper bed gradient than in the main project reach. At this location, the River Windrush flows over an old terrace of the River Thames as the river enters the main Thames floodplain. The bed of the channel appears to be a mix of natural gravels and coarser deposits indicating that it could be palaeohydrological sediments (derived from the terrace) or that it could have been used as a ford crossing at some stage (coarser sediments perhaps having been artificially laid). There is a large depositional berm on the right bank within this part of the reach (Photograph 1). Tree lining is scattered along both channel banks.

4.2.4 Between the Western and Eastern branches of the River Windrush a small wetland area exists (Photographs 2, 3 and 26). This has been fenced off. The wetland would be lost with the construction of the road and as such the loss of habitat would need to be mitigated against. A compensation package has already been agreed with the Environment Agency.

4.2.5 At the lower limit of straight section there is a bend which is suffering from minor bank erosion on the right bank (Photographs 4-7). The bank is composed primarily of a cohesive clay (Photographs 5 and 6). A depositional berm is forming on the inner left bank (Photograph 7).

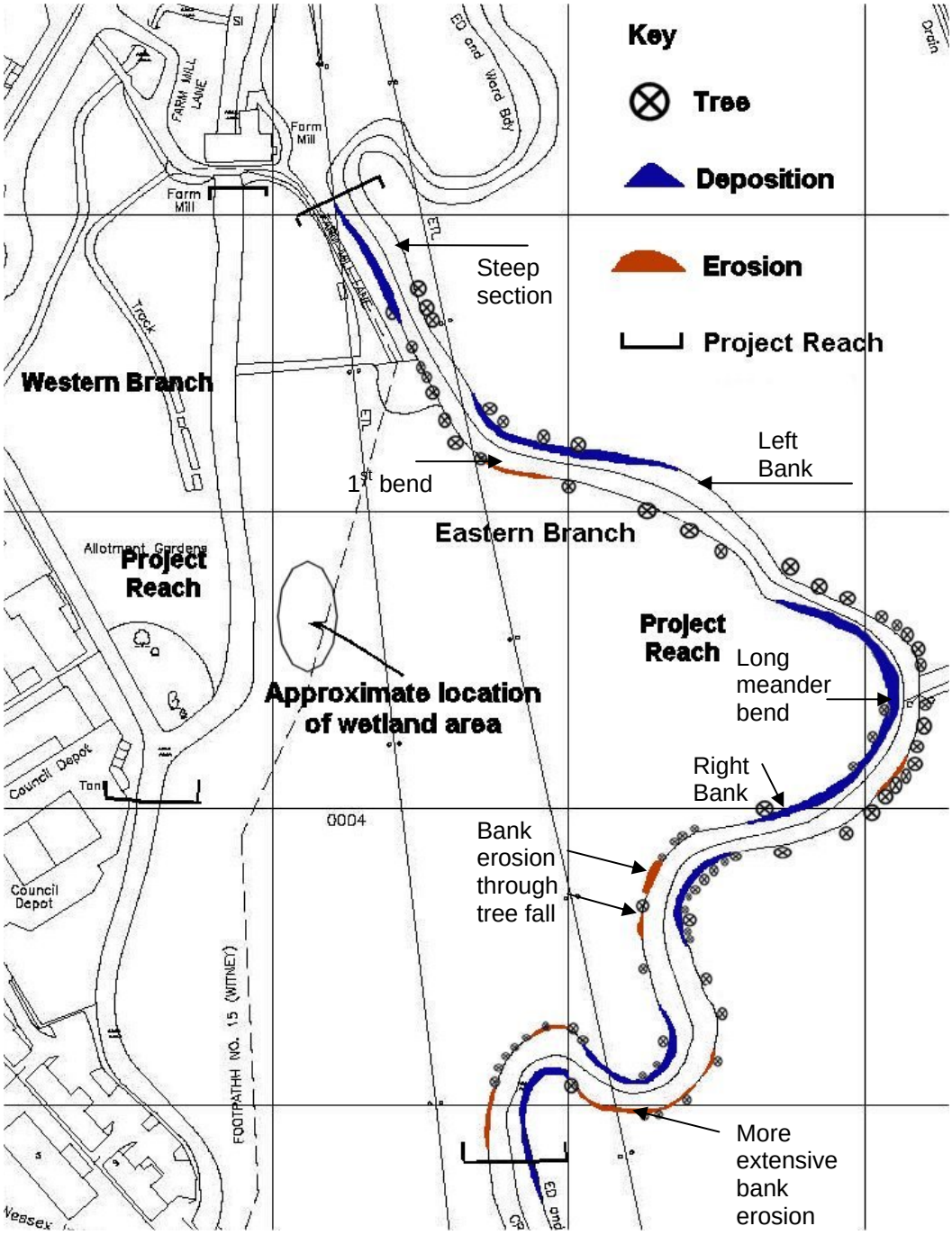
4.2.6 The meander bend is a long continuous loop that has a large berm, which is at a lower elevation than the top of the bank. The berm is vegetated with coppiced willows in places (Photographs 8 -10). This was partially under water on the day of the survey. A small concrete culvert enters the channel along the outer bank. The outer bank line is well vegetated with a small amount of bank erosion along the entire length.

4.2.7 At the location of the proposed road crossing, the channel has a depositional berm on the inner left bank (Photograph 15) and is suffering from erosion on the outer bank (Photographs 11-17). This bank erosion is different form from the rest of the erosion observed within the project reach and has been caused by a tree failing into the channel, potentially due to the bank being eroded at the toe. The tree has since been removed but the hole in the bank remains. This is the same for the second area of bank erosion observed slightly further downstream

on the same bend (Photographs 18-20). A bank erosion assessment was undertaken on the first area of bank erosion, the details of which are presented later in the report.

4.2.8 Downstream of the proposed road crossing another sharper bend exists that is experiencing more bank erosion on the outer bank line firstly on the left bank (Photograph 21), then on the opposite right bank downstream. As is common throughout the reach, depositional berms have developed on the inside of both bends (Photograph 21).

Figure 3: Stream reconnaissance results



*Bank Erosion Assessment*

4.2.9 A bank erosion assessment was carried out on the outer bank line at the location of the proposed bridge crossing (SP36121 08976) (ie the area of bank erosion). This assessment was important to determine the cause(s) of the failure and whether this would then have an effect on the proposed bridge crossing at this location.

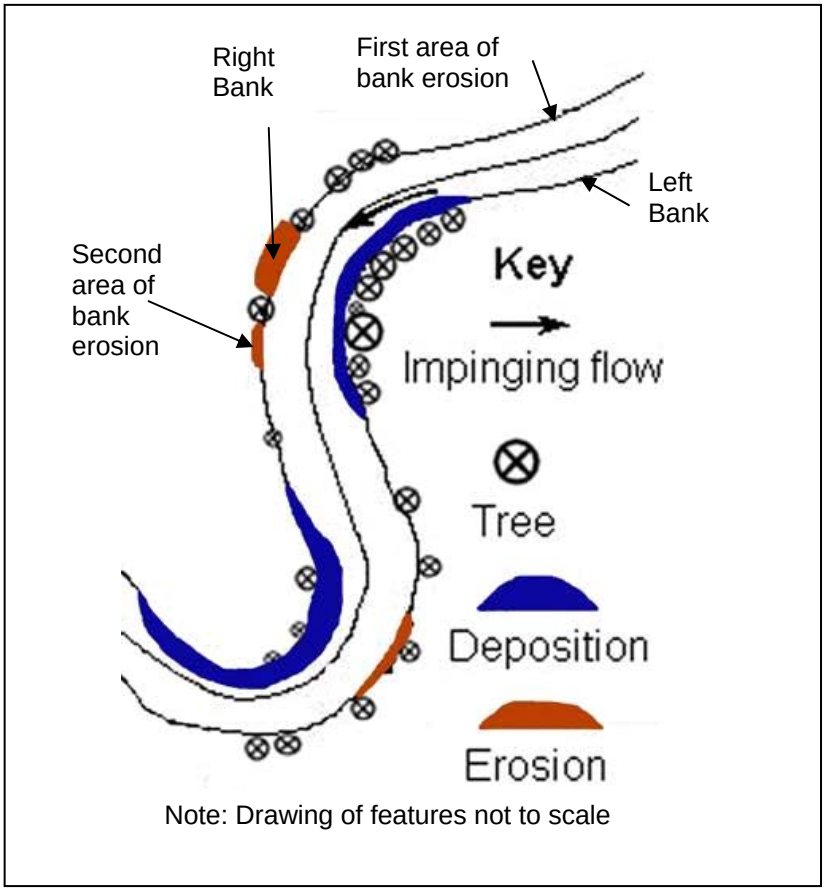
4.2.10 The bank erosion assessment revealed that an area of bank erosion that encompassed 7.5m of the bank length and 3m in depth had occurred just downstream of the bend apex (Photograph 16 and 17; Figure 4). Bank height was approximately 1m with the upper 0.2m being formed of alluvial material (gravels and cobbles present in significant amounts) and the lower 0.8m being a cohesive silty-clay mix. The rectangular form of the erosion area and its disjointed nature compared to the rest of the bank line suggests that this erosion has not resulted solely from bank erosion. It is likely that a tree, or several trees, were present at the site but collapsed after being undermined by erosion of the bank toe. The location of the bank erosion appears to be at a point on the bank that is experiencing impinging flow as the water flows round the bend (Photograph 15, Figure 4). At the downstream end of the eroded area, a tree is currently leaning into the channel on the bank edge (Photograph 15 and 18) providing further evidence for this form of failure mechanism. The width of the bank area affected would have been created as the root plates of the tree were upended taking part of the bank with it as the tree fell. It is likely that the remains of the tree were removed following its collapse leaving a hole in the bank edge. There is evidence to suggest that eddies created by flow separation along the bank line has created further erosion, through slab failure, in the downstream limit of the eroded bank (Photograph 16). However, this process is not causing the erosion of significant amounts of bank material. As such, it is not anticipated that further erosion of this nature would continue to occur to any significant extent.

4.2.11 A further area of bank erosion is present downstream of the remaining tree (Photographs 18 and 19). It is likely that this area of erosion has been caused by a similar process (erosion of bank toe followed by tree collapse) as the form of bank erosion is similar.

*Summary*

4.2.12 The baseline geomorphology survey reveals that the project reach on the Eastern Branch is primarily a depositional environment as there are extensive areas of berm development on the inside of the bends. On the outer bends bank erosion is evident but is of only minor significance. The last bend in the project reach (ie furthest downstream) appears to have the greatest amount of bank erosion. The comparison with historical maps suggest that there has been little change in planform shape over a period of 180 years, thus indicating that overall long term bank erosion has been negligible.

Figure 4: Bank erosion at the location of the proposed bridge crossing on the Eastern Branch of the River Windrush






***Western link***

*Fluvial Geomorphology baseline survey*

4.2.13 The Western branch of the River Windrush is the old artificial mill leat emerging from Farm Mill and, as such, is largely a straight section of channel. A well vegetated riparian corridor, particularly on the right bank, exists along the project reach (Photographs 22-25 and 27-29). A further by-pass channel around the mill comes in on the right bank (Photograph 24, SP35963 09027). This is called the Farm Mill Side Channel. The main channel itself is suffering from deposition at various points along both the channel margins (Photographs 22, 23, 25 and 27). Sediment is also being transferred through the reach. There were no signs of any bank erosion along the reach. This implies that the potential of bank erosion occurring as a result of diverting the channel is low.

*Summary*

4.2.14 The Western branch of the River Windrush suffers mainly from deposition with no erosion evident in the project reach.

# 5 Results

## 5.1 **Proposed re-alignments**

5.1.1 The proposals for the River Windrush re-alignments can be seen in Figures 5 and 6, Appendix 2. The proposed alignments are reviewed below:-

*Western Branch*

5.1.2 The road would require a diversion of around 70m of the western branch of the River Windrush. Currently the proposals show the river diversion having three very sharp bends, two to allow passage under the bridge and one to rejoin the eastern branch downstream of the bridge. It is unlikely that this degree of bend sharpness would develop under any natural circumstances. Whilst it could be possible in this particular location for the diverted channel to remain in this form as the river has very low energy (and therefore the risk of erosion is negligible) it is not recommended that a diversion of this shape should be constructed. It would be preferable that a more natural channel form be developed that enhances the current geomorphological processes that are operating in the reach (ie largely depositional). A form could be constructed that encouraged the natural deposition of sediment on the inside of the bend and a steeper outer bank line is recommended. A steep bank would also be beneficial habitat both for kingfishers and water voles. There is no reason to use any form of bank protection in the reach since it is predominantly undergoing deposition and the diversion would actually encourage this further through the creation of a reduced bed gradient. Preliminary alternative outline designs for the proposed diversion, are detailed in section 6. Where the channel passes under the proposed bridge the recommended sheet piling will be more than sufficient to protect the bridge pier and thus no erosion protection mats would be necessary.

*Eastern Branch*

5.1.3 Under the existing plans only minor modifications are proposed to the Eastern Branch of the River Windrush (see Figure 6). This includes construction of a regular trapezoidal channel under the bridge. It is proposed that this would have erosion protection mats on both re-constructed banks. For the right bank (facing downstream) this would involve re-profiling of the bank from the current steeply graded bank face to a more gently graded slope (approximately 0.58). The left bank would be re-profiled to construct a two stage channel with a slope of 0.56 up to a lower flat area (5.4m in length) before a slope of 0.5 takes the ground level to an equivalent level on the left bank.

5.1.4 It is unclear as to why any re-profiling has been proposed for right bank. A presumption of doing nothing where possible should be followed to minimise impact to the existing river habitat and geomorphological processes operating at the site. On the right bank there is no reason to re-profile except to fill in the currently eroded section. The design drawings show a 5m depth of sheet piling along the bank face to protect the bridge piers. This depth is more than adequate to cope with any scour at the bank toe (thought to be about 2m depth maximum). While there is no geomorphological reason to re-profile the left bank

as it is on the inside of the bend (ie likely to be depositional and thus there is no risk of erosion occurring at this location) this is being undertaken for other purposes.

# 6 Revised river diversion designs

## 6.1 **Revised designs**

6.1.1 The revised river diversions provided as part of this geomorphological study have been constructed through alterations to the existing design proposals (Appendix 3). No ground survey of the channel was analysed at this stage of the designs. It is assumed that the dimensions of the channel in the original design drawings are appropriate with respect to bed and top of bank width. The drawings would need to revised if this was not the case. In addition, no CAD drawings were available for the river diversions and thus the re-designs of the diversion channel are sketches and are not to scale.

*Western Branch*

6.1.2 The revised diversion drawings of the western branch of the River Windrush depict three bends with a lower radius of curvature to channel width (Figure 7). In addition, on the inside of each of the bends a gentle slope from the top of the bank to the bed is proposed to encourage preferential deposition within the channel (on the inside of the bends). Steep outer bank profiles are recommended as they represent good habitat for both kingfishers and water voles and in this location, within a very low energy environment, there is negligible risk of adjustment occurring. This is further inhibited by the underlying geology which is a cohesive clay beneath a thin layer of alluvial material.

*Eastern Branch*

6.1.3 No modification is recommended to the current channel form on the Eastern Branch and thus no revised figure is detailed. If the sheet piling on the right bank is too close to the current bank edge then it might be necessary to backfill behind the sheet piling in the currently eroded section that has been created by a tree fall. Otherwise minimal interference to the current bank form is recommended. The upper section of the left bank is being re-profiled for other purposes. This should be undertaken with as minimal interference to the bank form as possible.

# 7 Enhancement measures

## 7.1 Enhancement measures

Potential enhancement measures for the loss in wetland area caused by the proposed road crossing include realignment of the right bank (facing downstream) of the channel on the Eastern Branch of the River Windrush upstream of the proposed bridge crossing (Figure 8). This would have multiple benefits. Firstly, through removing the right bank to the elevation of the low berm there would be an increase in the frequency with which this area of the floodplain interacts with the river. This would increase habitat diversity. Secondly, lowering this area of land would also allow a more natural flood regime to develop in the immediate vicinity of the river and enable flood flows to pass at a more perpendicular angle to the bridge. The material extracted from this area could be used in the road structure, or alternatively, be used to fill the channelised section of the Western Branch that would become redundant with the new realignment of this reach.

# 8 Discussion

## 8.1 **Overview**

8.1.1 Historical channel analysis has shown that the current course of the River Windrush has remained largely stable over the last 130 years. This is a result of the low energies of both branches of the River Windrush in the existing project reaches. The stream reconnaissance survey revealed that the Eastern Branch of the River Windrush has experienced extensive deposition in the form of berm development throughout the project reach. Bank erosion was present at several locations but its extent and significance is small. The Western Branch of the channel is immediately downstream from Farm Mill and as a result is an artificially straight channel. Deposition on both channel margins is evident in places but sediment is also being transferred through the reach.

## 8.2 **River Diversions**

8.2.1 The existing proposals for the river diversions need revising to take into account the geomorphological processes that are currently dominant through the project reach and thereby maximise habitat diversity. The Eastern Branch of the channel should be modified as little as possible. The proposed sheet piling on the right bank would be more than sufficient to stop bank erosion and thus further modification to the channel form is unnecessary. On the Western Branch, the diversions should incorporate bends that are less sharp and more in keeping with the natural processes operating within the project reach, having gentle slopes on the inside of the bends and steeper slopes on the outside. Deposition is the dominant process in the reach with no erosion evident at all. This indicates that erosion protection matting is unnecessary. As the channel passes under the bridge the sheet piling is more than sufficient to maintain river alignment.

# 9 Summary and Conclusions

- A historical channel survey reveals that adjustment in the channel form in both branches of the River Windrush over the course of 130 years has been negligible.

- Stream reconnaissance survey of the Eastern Branch of the River Windrush demonstrates that deposition is the dominant process with large berms of sediment having developed throughout the project reach. Bank erosion was evident in some locations but was of minor significance.

- Stream reconnaissance survey of the Western Branch of the River Windrush demonstrates that the form of the channel is artificially straight. Deposition is occurring in the channel margins but sediment transfer through the reach is also occurring. Bank erosion was not evident in this project reach.

- The low energy environments of the two channels suggest that the risk of any adjustment following modification is very low to non-existent.

- Review of the designs of the Eastern Branch modifications suggests that any modification to the existing channel form is not necessary with respect to the geomorphology of the channel and is therefore inadvisable (from an Environment Agency consenting perspective).

- Review of the designs of the Western Branch modifications suggests that the realignments should incorporate less sharp bends with gentle slopes on the inside of the bends and steeper ones on the outside. The low energy environment means that risk of channel adjustment following modification is negligible and thus erosion protection matting is unnecessary. Under the bridge, the sheet piling placed along the left bank edge is more than sufficient to maintain channel form at this location.

- This geomorphological assessment of the River Windrush should be used to inform the ecology chapter and engineering design process of the re-alignment of the channels. This should ensure that channels are designed that are in keeping with the current geomorphological processes occurring within the river system and offer an opportunity for enhancement where possible.

# 10 References

Thorne, C.R., 1998, Stream Reconnaissance Guidebook: Geomorphological Investigation and Analysis of River Channels, John Wiley and Sons, Chichester, UK, 127p.

# 11 Appendices

## Appendix A: Photographs

| Photograph Number | Grid Reference | Photograph Number | Grid Reference |
|---|---|---|---|
| 1 | SP 36017 09230 | 16 | SP 36122 08979 |
| 2 | SP 36054 09137 | 17 | SP 36122 08979 |
| 3 | SP 36027 09092 | 18 | SP 36123 08968 |
| 4 | SP 36101 09117 | 19 | SP 36128 08952 |
| 5 | SP 36101 09117 | 20 | SP 36070 08895 |
| 6 | SP 36101 09117 | 21 | SP 36118 08970 |
| 7 | SP 36101 09117 | 22 | SP 36134 08930 |
| 8 | SP 36195 09058 | 23 | SP 35963 09027 |
| 9 | SP 36192 09019 | 24 | SP 35963 09027 |
| 10 | SP 36185 09010 | 25 | SP 35969 09024 |
| 11 | SP 36167 09005 | 26 | SP 35993 09051 |
| 12 | SP 36167 09005 | 27 | SP 35998 09674 |
| 13 | SP 36148 09002 | 28 | SP 35997 09099 |
| 14 | SP 36126 08987 | 29 | SP 35998 09108 |
| 15 | SP 36126 08987 | | |

**Eastern Branch (from upstream limit downstream)**

Plate 1: Steep gradient reach

Plate 2: Wetland area

Plate 3: Wetland area

Plate 4: Eroding bank

Plate 5: Eroding bank

Plate 6: Eroding bank

Plate 7: Meander bend

Plate 8: Depositional berm

Plate 9: Depositional berm

Plate 10: Depositional berm

Plate 11: Meander bend at point where the proposed road crosses

Plate 12: Area of bank erosion (now fenced off)

Plate 13: Area of bank erosion (now fenced off)

Plate 14: Area of bank erosion (now fenced off)

Plate 15: Area of erosion (now fenced off)

Plate 16: Eroded bank

Plate 17: Eroded bank

Plate 18: Second eroded bank

Plate 19: Second eroded bank

Plate 20: Looking upstream to the bank erosion at the meander bend

Plate 21: Meander bend

**Western Branch (from downstream limit upstream)**

Plate 22: Typical straightened section

Plate 23: Well vegetated riparian corridor

Plate 24: Confluence of Farm Side channel

Plate 25: Well vegetated riparian corridor

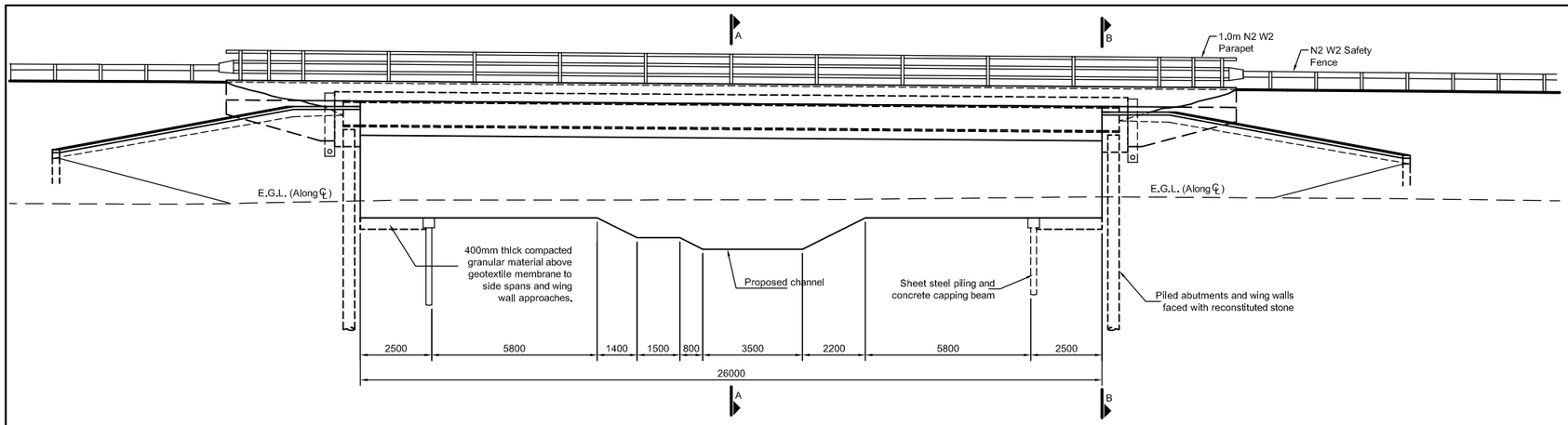
Plate 26: Wetland area

Plate 27: Depositional berm

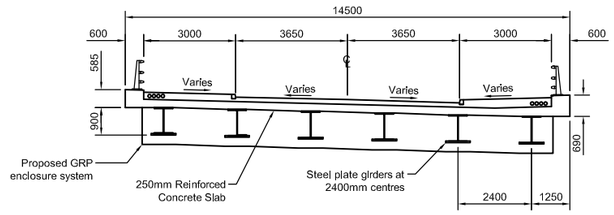
Plate 28: Looking downstream to bend

Plate 29: Looking upstream to Farm Mill

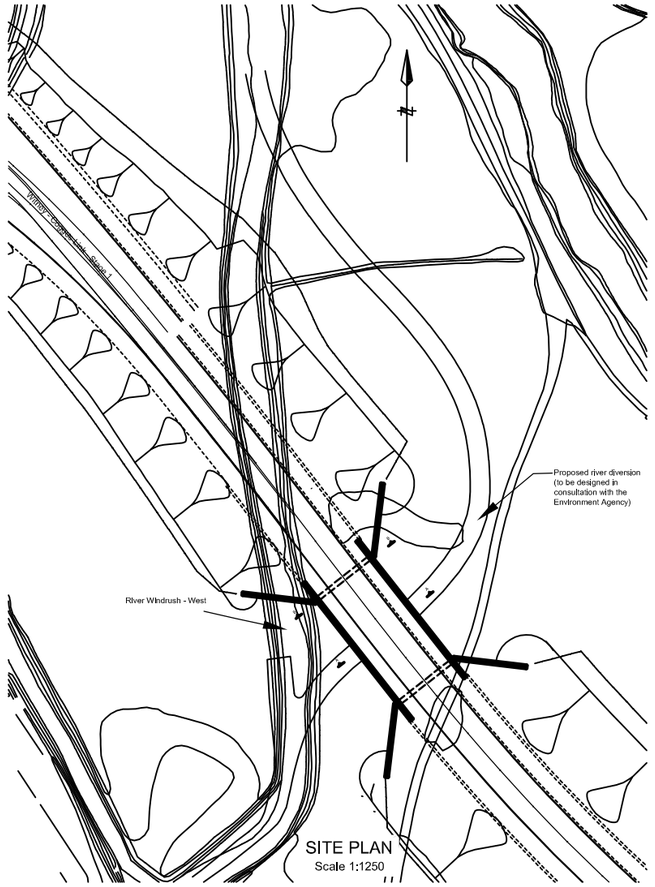
# Appendix B: Original Drawings

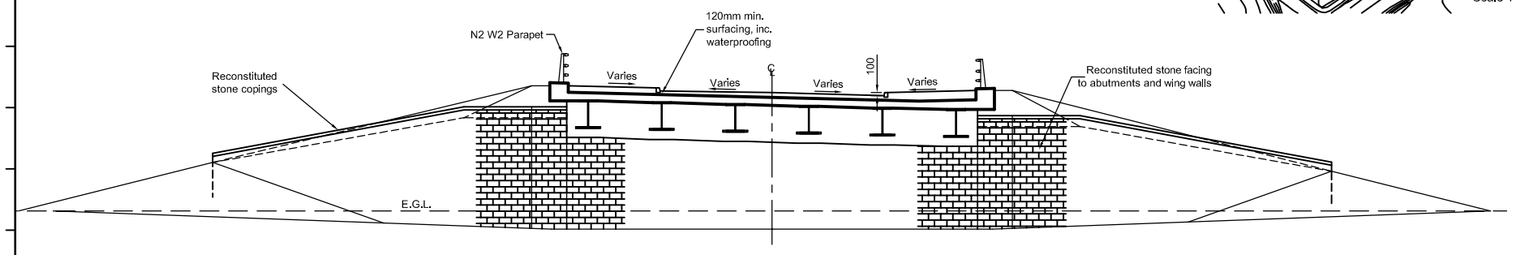



NORTHERN ELEVATION
Scale 1:100




CROSS-SECTION A-A
Chainage 162.984 (Midspan)
Scale 1:100




CROSS-SECTION B-B
Taken at Ch 149.984 (W Abut)
Scale 1:100



Do not scale this drawing

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REDUCED PLAN
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| Scale | Drawn By | Checked By | Approved By |
|---|---|---|---|
| N.T.S. | RDL | JEK | AEF |
| Clients Ref | Date MARCH 08 | Date MARCH 08 | Date MARCH 08 |

Drawing Number
FIGURE 5

Rev
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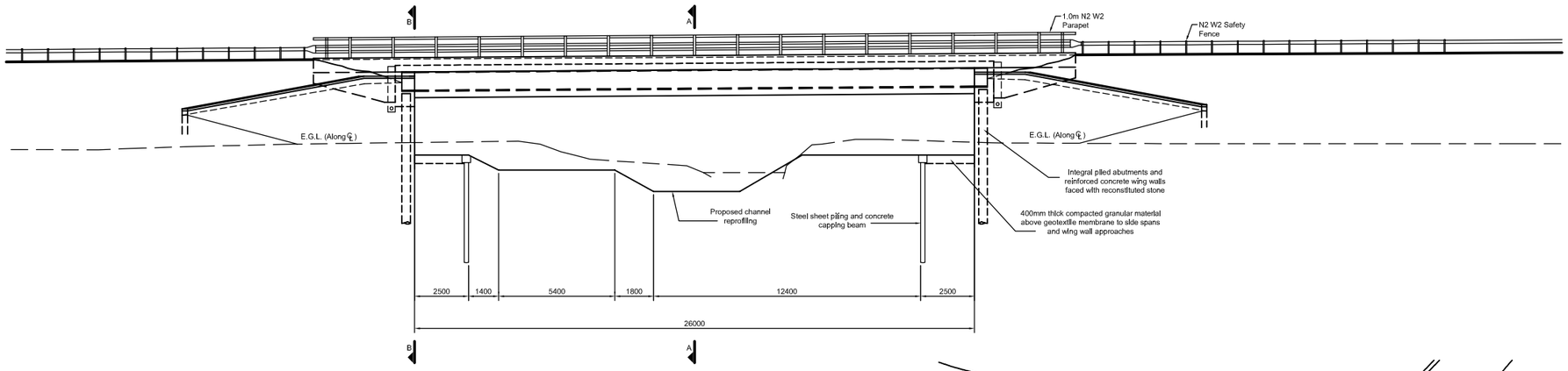
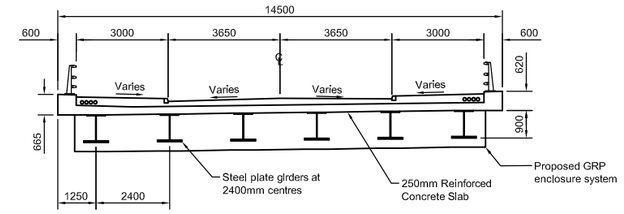
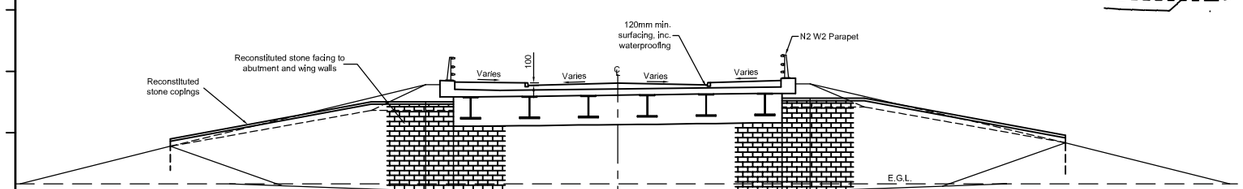


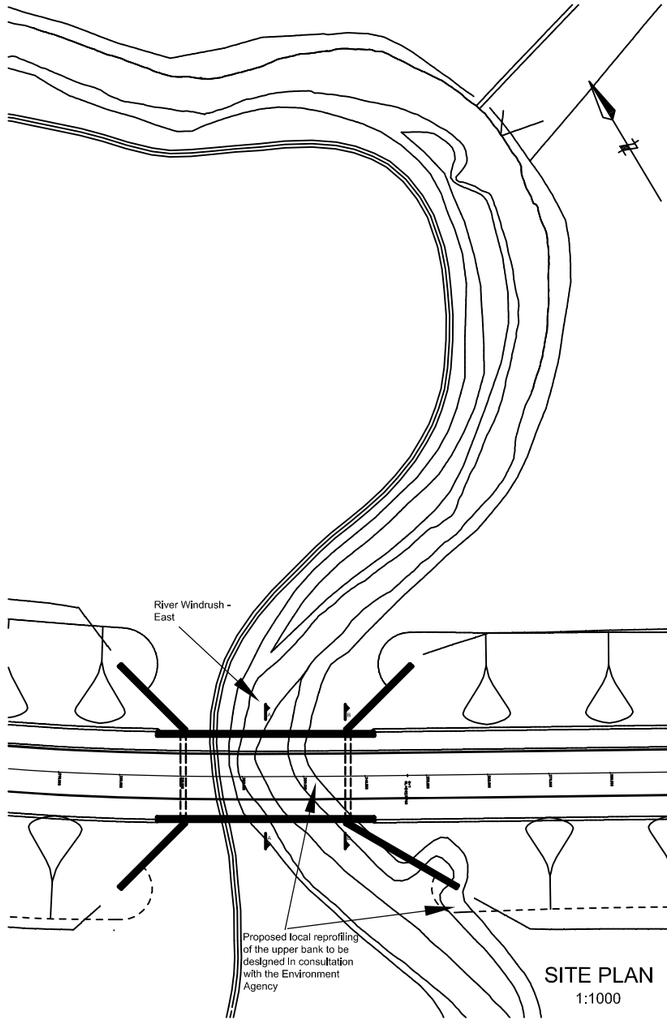

NORTHERN ELEVATION
Scale 1:100




CROSS SECTION A-A
Chainage 323.808 (Midspan)
Scale 1:100




CROSS SECTION B-B
Chainage 336.808 (E Abutment)
Scale 1:100




SITE PLAN
1:1000

10cm



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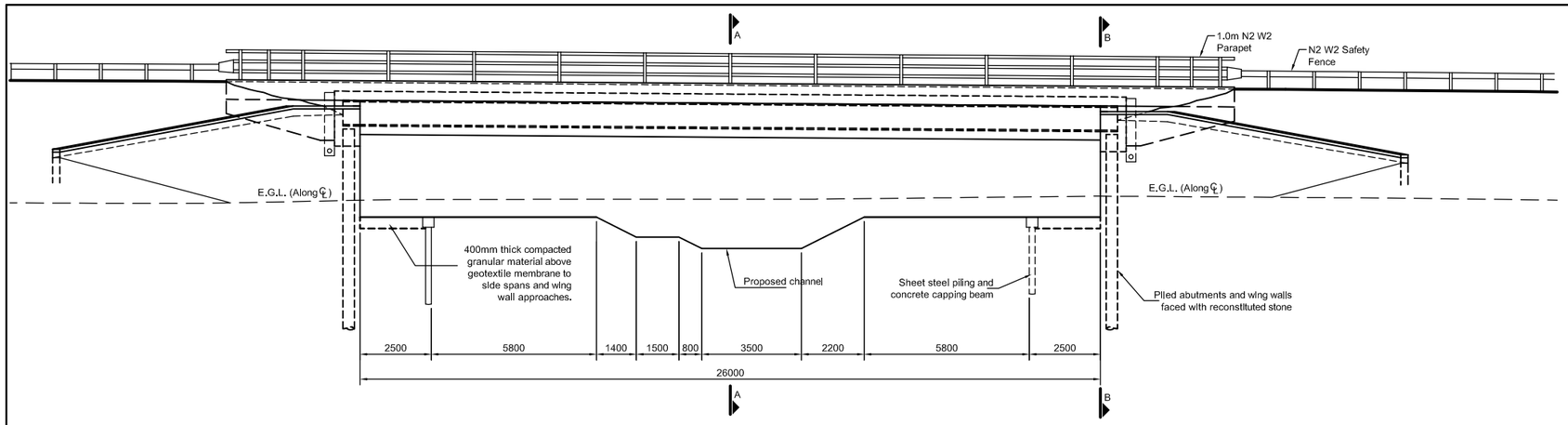
| | Date MARCH 08 | Date MARCH 08 | Date MARCH 08 |

Clients Ref
O.C.C. NO. 1128

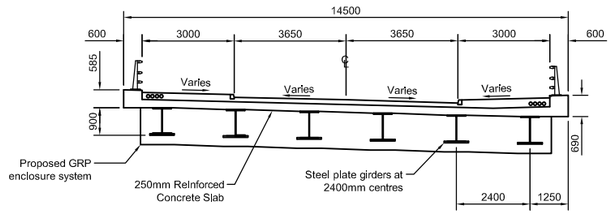
Drawing Number
FIGURE 6

Rev
–

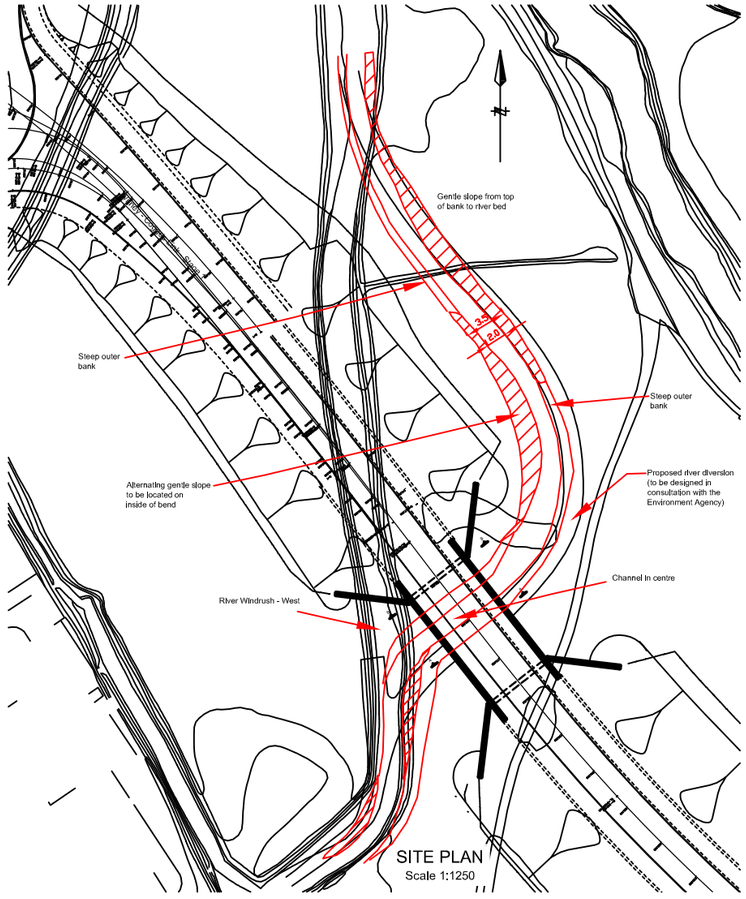
# Appendix C: Amended drawings



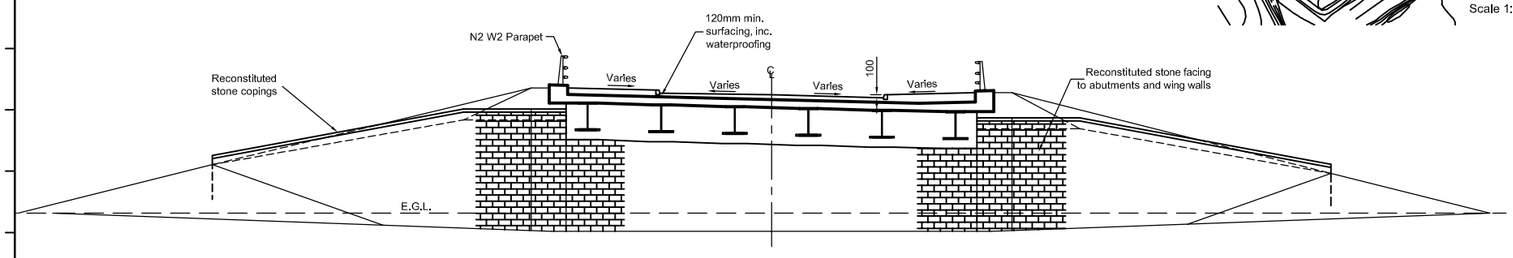

## NORTHERN ELEVATION
Scale 1:100




## CROSS-SECTION A-A
Chainage 162.984 (Midspan)
Scale 1:100




## SITE PLAN
Scale 1:1250




## CROSS-SECTION B-B
Taken at Ch 149.984 (W Abut)
Scale 1:100

10cm



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|---|---|---|---|
| N.T.S. | RDL | JEK | AEF |
| | Date MARCH 08 | Date MARCH 08 | Date MARCH 08 |

Clients Ref

Drawing Number
FIGURE 7

Rev
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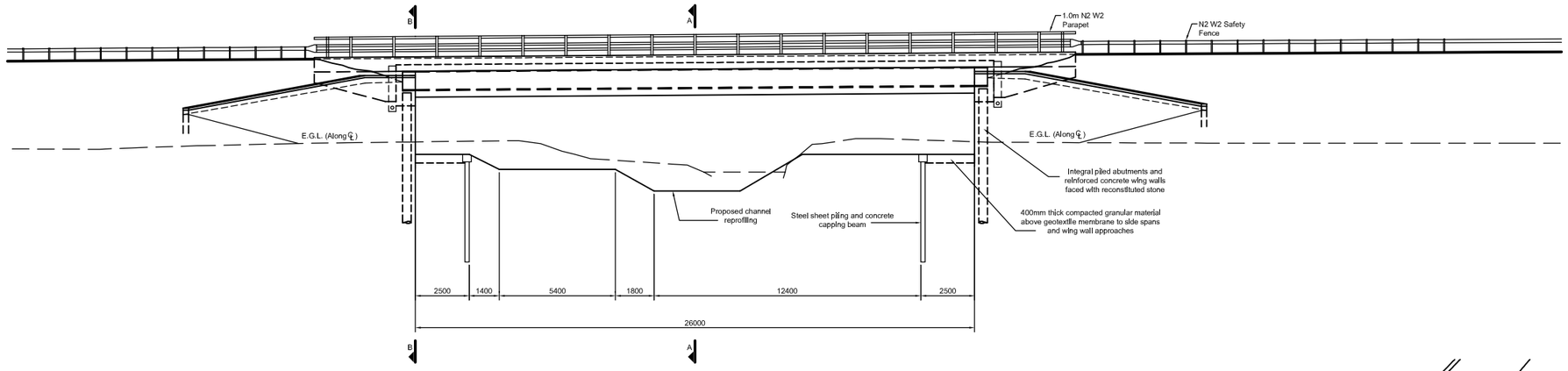
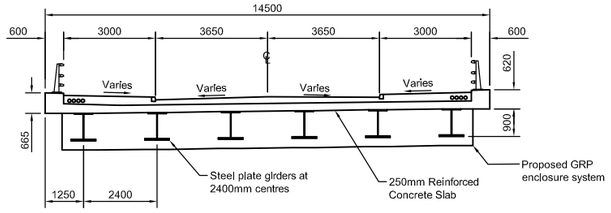
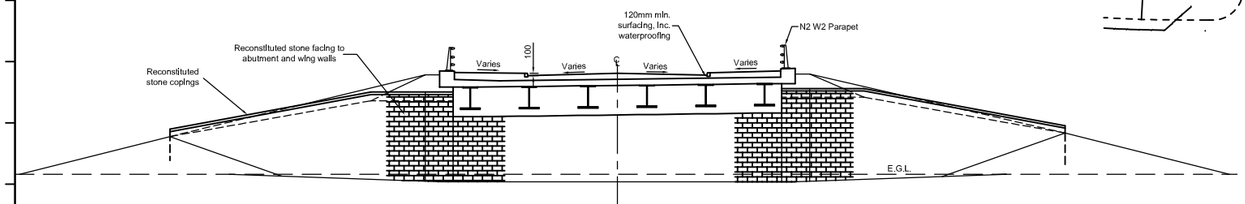


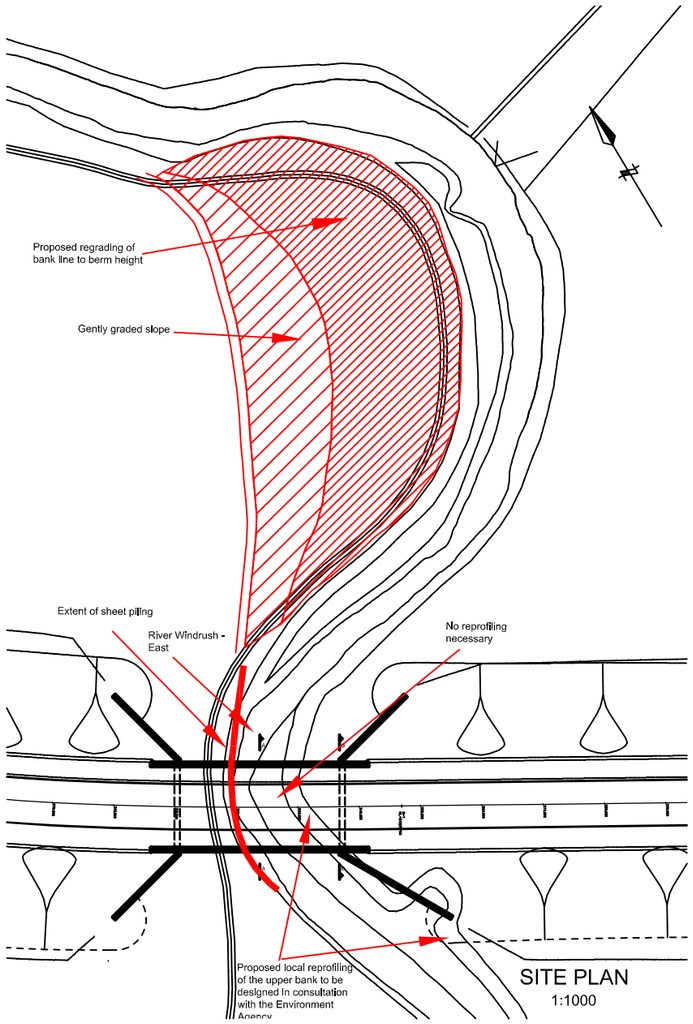

NORTHERN ELEVATION
Scale 1:100




CROSS SECTION A-A
Chainage 323.808 (Midspan)
Scale 1:100




CROSS SECTION B-B
Chainage 336.808 (E Abutment)
Scale 1:100




SITE PLAN
1:1000



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Title
POSSIBLE ENHANCEMENTS TO THE EASTERN BRANCH OF THE WINDRUSH

REDUCED PLAN DO NOT SCALE

| Scale | Drawn By | Checked By | Approved By |
|---|---|---|---|
| N.T.S. | RDL | JEK | AEF |
| | Date MARCH 08 | Date MARCH 08 | Date MARCH 08 |

Clients Ref
O.C.C. NO. 1128

Drawing Number
FIGURE 8

Rev
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